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COST REDUCTION USING PROCESS ANALYSIS IN COMPANY PEGRES OBUV S.R.O.

SNIŽOVÁNÍ NÁKLADŮ S VYUŽITÍM PROCESNÍ ANALÝZY VE FIRMĚ PEGRES OBUV S.R.O.

DIPLOMOVÁ PRÁCE

MASTER'S THESIS

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MASTER'S THESIS ASSIGNMENT

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Pursuant to Act. No. 111/1998 Coll., on Higher Education Institutions, and in accordance with the Rules for Studies and Examinations of the Brno University of Technology an Dean's Directive on Realization of Bachelor and Master Degree Programs, the director of the Institute of is submitting you a master's thesis of the following title:

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Instruction:

Introduction
Executive summary
Theoretical basis of the work
Problem analysis and current situation
Proposals and contribution of suggested solutions
Conclusions

List of literature:

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KERBER, Bill a Brian J DRECKSHAGE. Lean supply chain management essentials: a framework for materials managers. Boca Raton, [Fla.]: CRC Press, 2011, 258 s. ISBN 9781439840825
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Abstrakt

Firma PEGRES obuv s.r.o. se již delší dobu potýká se stagnací v oblasti plánování a řízení výroby. Některé podnikové procesy jsou nyní značně zastaralé a v aktuálních podmínkách již neefektivní. Cíl práce je snížení nákladů s využitím procesní analýzy. Pro dosažení tohoto cíle bude provedena analýza současného stavu zastaralých procesů a budou popsány vybrané metody řízení výroby, které jsou svou povahou relevantní pro výrobu obuvi. Výstupem práce je sada doporučení a návrhů na změny v existujících procesech. Vybrané návrhy budou v prostředí firmy implementovány a práce zahrne zhodnocení výsledků po zavedení těchto změn.

Abstract

Company PEGRES obuv s.r.o. has been long time struggling with stagnation in production planning and control. Some of the internal processes are now obsolete and in current conditions no longer effective. The goal of the paper is to reduce the costs using process analysis. To achieve this goal, analysis of the current state of outdated processes will be performed, followed by description of selected methods of production management, which by their nature are relevant to the production of the shoes. Output of the work is a set of recommendations and proposals for changes to existing processes. Selected proposals will be implemented in the company and paper will include evaluation of results after the implementation of these changes.

Klíčová slova

Řízení výroby, Podnikové procesy, Procesní řízení

Key words

Production management, Business processes, Business Process Management

Bibliographic citation

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Declaration

I declare that this master's thesis is original and has been written independently. I also declare that the list of references is complete and that I did not breach of copyright in the sense of Act No.121/2000 Coll. on Copyright Law and Rights Related to Copyright and on the Amendment of Certain Legislative Acts.

Brno, August 20th 2012

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Jan Gřeš, MSc.

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Firstly, I would like to acknowledge beneficial help and understanding of both my parents, in particular I would like to emphasize professional guidance of my father.

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Table of content

INTRODUCTION

The title of the thesis *"Cost reduction using process analysis in company PEGRES obuv s.r.o."* is expressing both, the content and also the goal of the work.

The company PEGRES obuv s.r.o. was founded in 1993 in small city Petřvald near Ostrava, Czech Republic. At the beginning, the company consisted of 15 employees and one person in charge, with no professional experience in management. All the personnel was working in one small rented building, producing simple footwear from fabric for home-use. As well as many other companies founded after the 1989, also this one was profiting on non-saturated market, enjoying low level of competition (at least in first years).

Over the time, the company has grown and today, there is about 60 employees, 5 people on different managerial / foremen posts, all spread across two production plants, using two large separate warehouses. The range of the products goes from fabric simple footwear, to more complicated models for men, women and children, including also children leather outdoor shoes.

No matter the growth in number of employees, there were no major organisational changes or changes in how does the company work. The management process is close to Functional process, most of the so-called business processes works by intuition including manufacture planning, and work in process is still evaluated manually, despite the ERP system which can cover that.

The company delivers goods to regular small footwear shops and it refuses to deliver to the chain-stores such as Tesco, Kaufland and similar, in order to spread the risks. However that leads to the large amount of customers ordering each relatively small amounts of shoes, requiring short delivery times. All those factors taken into the account, manufacture process became difficult to plan, monitor and control, which at the end generates costs higher than necessary.

The primary goal of this paper is to lower the costs by using the process analysis practices. Since the management of the company was almost typically functional, the author of the paper was adviced to understand and reconsider those management methods at first. Secondly, the company was lacking any standardised process definitions. Therefore in order to fulfil the goal of the paper, to lower the costs by process analysis, the processes needed to be identified and described. After that and with understanding of manufacture planning in selected company, author was able to suggest several improvements, using the background from the theoretical part of the paper. During the work on this paper, a part of those suggestions has been considered useful and implemented in the company. Therefore in cases where the confidentiality requirements of the company were not violated, the results of the changes were measured, evaluated and published in the paper too.

OBJECTIVES OF THE WORK AND METHODOLOGY

The main goal of the work is specified by the title of the paper *"Cost reduction using process analysis in company PEGRES obuv s.r.o."*.

Initially, the characteristics of the Functional management are described to better understand the situation in the company. Various factors of Business Process Management are then described in theoretical part of the paper, including process implementation approaches, process measuring and monitoring concepts and process reengineering.

The role of IT in Business Process Management is also described, since it is relevant for the paper. Also the brief enumeration of selected methods of production management such as MRP II, OPT and JIT is following, preparing ground for better understanding of production planning concepts.

In following part, the company environment is studied and described. At first, the description of more generic factors is held, including the products description, buildings involved during the manufacture process and labour allocation. That is followed by deeper description of those business processes and their relevant factors, which were selected for the implementation part.

In the implementation part of the paper, the two different BPM implementation practices were used to identify, measure, evaluate and improve the selected processes.

The thesis finishes with conclusions, summarizing findings and benefits of the paper.

1 THEORETICAL PART

The functional management will be briefly described at first in chapter 1.1 with it's advantages and disadvantages, to highlight the problems of the company today. For better understanding of the processes going through several units and departments, figure 1 shows the process of new product development, which is not only typical process for the selected company and will be studied closer, but also typical example of process, where the Functional management has many disadvantages compared to Business Process Management, while using several departments and actors and requirements to share the information..

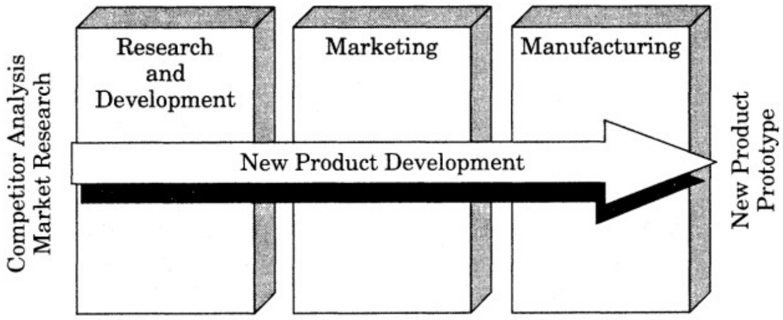

Figure 1: Units and department involvement in Product Development process [5]

Starting from the chapter 1.2, the paper will be focused on Business Process management.

1.1 Functional management

According to [1] the Functional management is the simplest approach to organisation structure, and is typical by units and groups being separated based on similar skills, activities and work performed. Those groups then focus on performing their own tasks without taking a care of whole context and overall process quality.

The Functional Management has several advantages, such as:

- Lower down the duplications in personnel and equipment.
  - Easier coordination.
- More effective usage of resources.
  - Similar tasks solved in the same place.

- Simplifies staff training.
    - Employees specialised in same area are located in same locations.
- Well defined chain of command.

Beside of advantages, Functional management has many disadvantages, such as:

- Rivalry inside of the company.
    - Between the separated groups / departments.
- Goals of groups may not match with goals of the company.
    - Particular functions are not concerned with problems of other functions.
- The management is often not most oriented to the customer.
    - Rather they are oriented to operate the processes.
- Narrowed perspective.
    - Due to the group separation, not seeing the “big picture”.
    - Employee may not be aware of low/none level of contribution of own task to the company.
- Slow communication flows.
    - Due to the long hierarchy chain (high bureaucracy).
    - Unclear responsibilities.
- Every person (managers) gain experience only in own field.
- Hard to measure the cost of particular activities and staff participation.
    - Difficult to reward employees based on the work performed.

[1, 2, 3]

All described advantages, but mainly disadvantages are in higher or lower extent involved in today's company situation, the ones not concerning this particular company have been omitted. More details will be described in sub-chapters of chapter 2.

1.2 Business Process Management

The Business Process Management is a management approach identifying processes within the company, relations between those processes and how those processes contribute to the needs of the clients. From various definitions, the two has been picked. First, simpler, saying that Business Processes are “a collection of activities that takes one or more kinds of input and creates an output that is of value to the customer” [4] and perhaps more accurate for purpose of this paper, “...process is thus a specific ordering of work activities across time and place, with beginning, and end, and clearly identified inputs and outputs: a structure for action”[1] [5] .

1.2.1 Basic characteristics

Beside of the main components, Inputs, Outputs and Activities, business processes concerns also following factors. Process Owner is an actor with defined responsibilities for the process. Demand (for Input and Output) and Resources, needed to run the process. Feedback (to Supplier and from Customer). In this context, the Customer and the Supplier is not necessarily another company, but it can be also another department or actor within the same company. Every process has the beginning (first activity) and the end (last activity), as well as key performance indicators, where Customer satisfaction and length of the process are usually considered to be the main ones. [6]

Process performance can be monitored and the effectivity can be measured. Based on collected data, weak processes may be identified, optimized and improved over the time.

The main steps when implementing Business Process Management are following:

- Business strategy definition.
- Process design.
- Process Implementation, Controlling and Key Performance Indicators setup.

Those steps are to be described in following chapters.

1 DAVENPORT, Thomas H. Process Innovation: Reengineering Work Through Information Technology. 1993. p. 5

1.2.2 Process classification

The part of literature resources talks about the generic processes without any categorization or classification, however for purpose of this paper, the classification scheme will be used. There are several main classification schemes used to identify and categorize the processes [7] .

The resource [5] specifies Operational and Management processes. This distinction is not detailed enough, moreover all processes in general have to be managed, and also needs to achieve (operate) something.

The author [8] defined the Core, Support, Business network and Management processes. However according to [7] , some Business network processes may also be categorised as Core processes which causes confusion.

The resource [7] thus offers so called Process Triangle as a classification scheme, defining Competitive processes, Transformation processes, Qualifying processes and Underpinning processes.

Taking into the account the fact, that this paper is focused on the cost reduction mainly in the manufacture process, too detailed classification scheme will not be needed. More general scheme, which is used in many companies [9] , will be used in this paper too. This scheme defines following process categories [6] :

- Control processes (major processes control and management: resource planning).
- Major processes (generates value for customer, profit to company: manufacture).
- Support processes (support operation of major processes: HR).

This scheme does not concern whether the processes are outsourced or not.

1.2.3 Business Process Management implementation

The main goal of implementation is to recognise the processes, create process map and specify which processes are suitable to be innovated, improved, or reengineered. While implementing the Business Process Management, we focus on key processes contributing to the customer satisfaction. After the decision to implement Business Process Management practices has been made, the implementation team should be assembled. According to [6] , the team should consist of top management representatives, people who have all needed competencies and up to high extend understands to the industry area and problems of employees even in lowest positions in the process.

After the implementation team is set up, the implementation approach needs to be specified. Literature describes several main approaches to the process implementation.

1.2.3.1 Deming's PDCA

PDCA (Plan, Do, Check, Act) approach is more general, suitable for most areas. In the Plan phase, the present status of the company needs to be recognised, including all the main activities, resulting in the list of processes to be implemented and time-frame schedule for implementation.

During the Do phase, lead workers and managers should identify the business processes using brainstorming or multivoting techniques and deploy the Business Process Management practices.

Monitoring and process measuring is the main goal of the Check phase, together with bottleneck identification and overall revaluation of the process scheme.

If the Check phase shows, that the goals of Process Management were reached, the processes are standardised during the Act phase. Moreover, based on results from monitoring, standardised processes are to be improved over the time [6] .

1.2.3.2 DMAIC

DMAIC (Define, Measure, Analyse, Improve, Control) approach is based on PDCA, having however several differences. This approach is presented on figure 2.

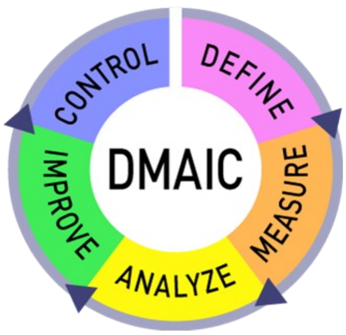

Figure 2: DMAIC scheme (source: [32])

During the phase Define, the problem, or the goal of the project is identified and requirements of the project are specified.

The results from Measure phase are used to gather the data (levels of selected indicators) in order to evaluate the success of changes.

During the Analyse phase, the measured data are analysed, to find a potential for improvements, causes of problems and whether the actual problem is being really solved by offered solution.

After the real causes of problems are identified, Improve phase comes to remove those causes and to optimize the processes. That includes creating a plan for implementation, and its realization.

Similarly as in Check phase in PDCA, also the Control phase in DMAIC, after making sure that the changes in processes led to better results, standardises those changes into the processes, making them new part of the whole system [10] .

1.2.3.3 Approach 7 Step

(Problem, Data, Cause, Solution, Results, Deployment, Debrief) is also based on PDCA. When some problem is discovered, it is described during the Problem phase, together with expected result after solving it.

The Data phase serves to gather available information related to the problem and decide, whether the problem is defined well.

Cause is the phase, in which 7 Step differs the most. In this phase, all possible causes of the problem needs to be identified and considered.

In the Solution phase, the appropriate solution to the problem and its causes should be selected and performed.

The results of the solution are then measured in Results phase, in order to find out whether the problem has been solved.

If the solution was accepted in Results phase, similarly to the PDCA and DMAIC, is then standardised in Deployment part and well documented.

Debrief is another major addition compared to PDCA or DMAIC. In this phase, if the problem was really solved, other workers from possibly other departments are debriefed about the problem and its solution in order to identify similar problems elsewhere.

7 Step is approach designed to identify and create new, complex processes [11] .

For purpose of this paper, DMAIC approach will be used for most problems and 7 Step approach will be used for the complex ones.

After processes are standardized, less radical improvements can continue (more in chapter 1.2.7).

Processes without contribution to the customer satisfaction are adviced to be removed in order to lower the costs.

1.2.4 Defining the processes

The important part of every implementation scheme from chapter 1.2.3 is defining the process and relationship between them. Following sub-chapters describe the main steps and approaches involved in those activities, as recommended by [6] .

1.2.4.1 Process Identification

The author mentions three main methods for Process Identifications: brainstorming, multivoting (group decision-making) and synectics (phylosophical exchange of views). Multivoting should be used "whenever a Brainstorming session has generated a list of items that is too extensive for all items to be addressed at once"[2] [12]. The resource says that large list of issues should be made by brainstorming and then each member should vote for one third of the most important items in the list.

1.2.4.2 Inputs, outputs and objectives identification

To help to identify inputs, outputs and objectives of the processes, [6] recommends using the Turtle Diagrams for more complicated processes and direct inputs, outputs and objectives enumeration for the simple ones. Regarding Turtle Diagrams, [13] then adds that such diagrams are in no meaning designed to be used by employees, they serve only to simplify the identification of the inputs, outputs and objectives of the processes. The

2 DECISION-MAKING TOOLS. Basic Tools for Process Improvement: DECISION-MAKING TOOLS. p. 6

author also questions the contribution of Turtle Diagrams in simple business processes.

The turtle diagram, as shown on figure 3 and described in [13, 14], contains following main parts:

- Inputs and Outputs: materials, documents, information, … .
- What: equipment or facilities being used during the process, machinery, computer systems, software, … .
- Who: participate on the process, process owner, workers, … .
- How: instructions and procedures involved, supporting processes, … .
- Criteria: objectives and performance indicators, used to measure the efficiency.

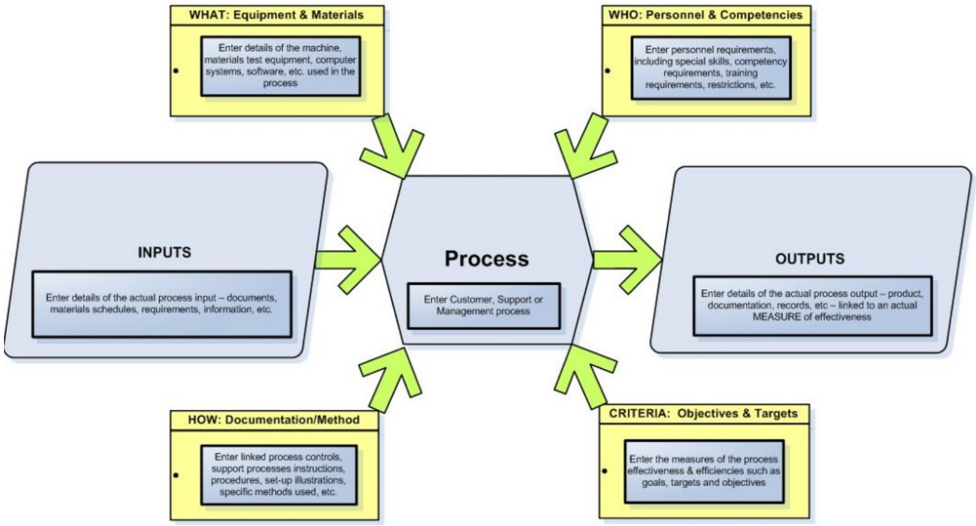

Figure 3: Turtle Diagram schema (source: [14])

Based on previous findings, the simple enumeration will be used for simple processes, while the Turtle Diagrams will be used for more complicated ones, if such found in the company.

1.2.4.3 Relationships between processes

Once the single processes, its inputs and outputs are identified, the relations between them needs to be defined. Table 1 enumerates main methods of Process Definition and Modeling languages. Those focused on the other fields than Business Process Modeling (for example Software engineering) were crossed (Control Flow Graph, Event driven Process Chains, FDL, State and Activity Charts), as well as the solutions used only as a data exchange format (WPDL, XPDL, EPML, Transaction Datalog).

Table 1: Process Definition and Modeling Languages (based on [6, 15])

	Textual Representation	Graphical Representation
Graph-based Languages	• Business Process Modeling Language (BPML) • ~~Workflow Process Definition Language (WPDL, XPDL)~~ • ~~EPC Markup Language (EPML)~~	• Business Process Modeling Notation (BPMN) • Unified Modeling Language (UML) • ~~Control Flow Graph~~ • ~~Event-driven Process Chains~~
Net-based Languages	• Petri Net Markup Language (PNML) • ~~Yet Another Workflow Language (YAWL)~~	• Workflow Nets
Workflow Programming Languages	• ~~FlowMark Definition Language (FDL)~~ • ~~Transaction Datalog~~	• ~~State and Activity Charts~~

Petri Nets are more generic solution, not specifically designed for Business Process Modeling. Since the intention is to find solution which would be easy to interpret and understand, Petri nets (and Workflow nets, as a special case of Petri Nets [16]) will not be further discussed in this paper. BPML was deprecated in and it's support discontinued [17].

BPMN and UML are two candidates left for Business Process Definition and Modeling. UML is a set of various diagram tools, of which the Activity diagram is very similar to the Process Diagram from BPMN [18]. In the conclusion, the author does not favour any solution on expense of the another one, and says that both solutions describe the most of the scenarios sufficiently and both are well readable.

For purpose of this paper, the BPMN was chosen to represent the Business Processes, as it is preferred technology in software tools used later in the paper (chapter 1.4.2). The main capabilities and building blocks of BPMN are described in chapter 1.2.5 .

1.2.5 Process map presentation

As the Business Process Modelling Notation (BPMN) is chosen to present the Business Processes in this paper, main building blocks of BPMN will be enumerated in this chapter, together with basic description.

- Flow objects, figure 4:
  - Event (circle) representing happenings during the processes,
    - Start event (trigger): represents the beginning of the whole process.
    - Intermediate event: The process stops, until the event is catched. To be catched, the event has to be thrown from some other place in process.
    - End event: the termination of the process.
  - Activity (rounded square),
    - Task: an atomic task within the process.
    - Sub-process: set of tasks or processes, presented as one .
  - Gateway (diamond).
    - Decision and connection: separates (based on possible internal condition) or combines the flow in the process. [19]

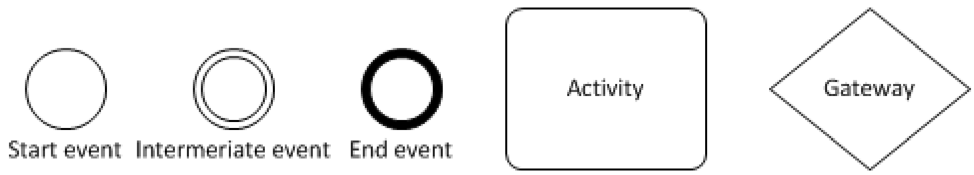

Figure 4: BPMN, Flow objects (source: own work)

- Connecting objects on figure 5:
  - Sequence flow: connects elements and defines the order of the activities being processed.
  - Message flow: represents messages being sent and received between entities in process.

- Association: connects data, text and similar artefacts to the flow objects in order to show inputs and outputs of the activities. [19]

Figure 5: BPMN, Connecting objects (source: own work)

- Swimlanes and pools on figure 6:
  - Swimlane: every actor or person in the process gets own swimlane, while tasks belonging to this actor are placed within that lane,
  - Pool: usually all swimlanes belonging to the one organisation are grouped into one pool. Pool therefore consists from one or more swimlanes. [19]

Figure 6: BPMN, Swimlanes and pools (source: own work)

- Artifacts, representing other information relevant to the process on figure 7:
  - Data object: used often to represent input and output data (documents) of activities,
  - Group: separating large graphs or gathering elements to improve readability,
  - Annotation: such as notes and commentaries,to improve diagram readability

[19]

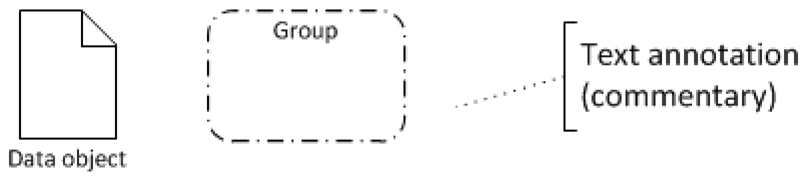

Figure 7: BPMN, Artifacts (source: own work)

1.2.6 Process measuring and monitoring

After the processes are implemented and put into the production, it is desirable to monitor it's performance. The following motivations to monitor or measure the processes are described in [6] :

- The Performance indicators express the actual status of the process.
  - Used by process owner for operational control of the process itself.
- The indicators may serve as employee motivation.
- The results of the monitoring may be used for Benchmarking (chapter 1.2.6.3).
- Results of the monitoring leads to the opportunity identification.

Various frameworks to measure the process performance are described in chapter 1.2.6.1 and more details about the Key Performance indicators can be found in chapter 1.2.6.2.

1.2.6.1 Frameworks to measure the process performance

There are many frameworks to measure and evaluate the performance of the processes. Those the most relevant to this project are mentioned below, while the selected framework will be described closer:

- Activity based costing (ABC).
  - The ABC system is focused to define the unit cost of the activities and its connection to the final product.
- Balanced Scorecard (BSC).
  - Designed to express organisation's performance by using four main perspectives. Financial, Customer, Internal business and Learning and Growth perspective. Therefore compared to ABC, it uses both, financial and non-financial indicators.
- Statistical Process Control (SPC).
  - Following the SPC framework, one has to eliminate as much variations in the process as possible, since SPC is focused to gaining the stable processes

in order to make the predictions.

- Workflow-based Monitoring.
  - Workflow-based Monitoring focuses to measure the performance of business processes (process instances, events in processes, etc.) and does not reach another factors of the business. The framework is designed to consume and automatically produce the real-time data and inform owner about actual costs. That means the faster response in results to changes in process instances on output, however may also mean the more expensive data capturing for valuable inputs.
- Process Performance Measurement System (PPMS).
  - Contains five main aspects, which are being evaluated: Financial, Customer, Employee, Societal and Innovation aspect. The values are measured, compared to the target and historical values in order to create trends.

[15, 20]

Table 2: Characteristics of selected measurement approaches [20]

	Objects measured	Frequency	Type of measures	Recipients of results
ABC	activities and processes	recurring	financial	finance department
BSC	enterprise or organizational units	recurring	financial and nonfinancial, quantitative and qualitative	mainly top management
SPC	processes	continuously	mainly nonfinancial and quantitative	middle management and process actors
Workflow based monitoring	processes	continuously	mainly nonfinancial and quantitative	middle management and process actors
PPMS	processes	recurring or continuously	financial and nonfinancial, quantitative and qualitative	middle management and process actors

The table 8 shows the comparison of selected characteristics of described approaches. Based on the previous analysis, the conclusion about the measurement approaches has been made.

The ABS method is focused only on financial factors, not on other operational ones, therefore it will be excluded, because the concern of this paper is beside of others to monitor the manufacture processes.

BSC as well as PPMS concerns with factors hard to match with the manufacture processes and results would be distorted for example by seasonality in footwear sales. The variations in manufacture depending on seasonality in selected company are well presented in results later in table 4.

SPC tries to eliminate the variations in processes, however variations are common in footwear manufacture.

Therefore Workflow-based monitoring framework is selected as a approach used lately in this paper.

1.2.6.2 Key Performance Indicators (KPI)

To be able to perform the performance monitoring while using Workflow-based monitoring (resulting from previous chapter 1.2.6.1), we need to define the key performance indicators (KPI). Such indicators, being easily understandable and measurable, then express success in particular operational goal. Out of many classification schemes of KPIs, one is selected, as the best fit to the context of this paper:

- Universal indicators of process performance.
    - Often connected with time, costs, time to react to changes.
    - The total running time of the process, Effective use of process duration, Total cost of the process, Spoilage.
- Specialised indicators of process performance.
    - Performance indicators of production processes.
        - Most often used for Production Management.

        - Productivity per worker, average profitability per worker, value of work in progress, spoilage, flexibility to react to changes in production, meeting the norms of workers and machines, overall equipment efficiency, downtime share of the total available capacity of the machines, material turnover.
    - Performance indicators of non-production processes.
        - Prior to production: Development, Marketing research.
        - During production: Repairs, Testing, Maintenance.
        - After production: Delivery, Service, Feedback.
            - Average time of one maintenance procedure, share of downtime during repairs to the available capacity of the workplace.

[6]

1.2.6.3 Benchmarking

Benchmarking is defined as “comparison and learning for improvement”[3] [21]. The goal is to obtain the information about benchmarked process from other partners (units within the same company, other competitors...) and compare it to our practice. The same author mentions that there are various sources to identify potential partners, such as trade offices, fairs and exhibitions, annual reports, trade area experts media, award winners etc. He believes, that initial sceptics of people towards other competitor's unwillingness to share information may be exaggerated, and he claims that “These people are very often surprised by the partners' curiosity and willingness to share information”[4] [21] .

In the case of footwear industry in Czech Republic, there have been no other manufacturers identified, who would produce the product comparable in means of manufacture process and be willing to share any valuable production information.

In connection with this paper, there is only one case of benchmarking performed during the work. That was a discussion during an International Fashion trade with a supplier of

3 ROLSTADÅS, Asbjørn. Performance Management: A Business Process Benchmarking Approach. 1995. p 211

4 In the same place, p 227

plotter machines, who was willing to share information about performance of the other plotter-sellers. Even thus this discussion, together with other factors led to radical change in process of selected company (chapter 2.8), benchmarking was not used elsewhere, it is not exact focus of this work and therefore will be omitted in this paper.

1.2.7 Changes in processes, improvements and reengineering

As described in chapter 1.2.3 , changes, improvements and reengineering of processes is performed in order to improve the performance measured by Key Performance Indicators. Resource [5] defines the difference between innovation and improvement as "If process innovation means performing a work activity in a radically new way, process improvement involves performing the same business process with slightly increased efficiency or effectiveness". The process reengineering is then mentioned as bottom-to-top redesign of the activity including new process map and often connecting more activities into one.

It is difficult to distinguish exactly the border between improvement and reengineering, however this paper will in implementation part include both, less and more radical suggestions.

1.3 Characteristics of Process Management compared to Functional management

Advantages:

- Clearly defined competences.
- Workflows easier to understand, easier problem solving.
    - Faster response to changes in demand.
- Narrow down organisation structure.
    - Easier decision-making.
    - Less bureaucracy.
- Orientation to key processes.
    - To bring value to the customer.

- Enables to define bottlenecks in logistics, stocks, material distribution etc..
- Better support of integrated information systems.
- Team-work orientation, which lowers down the conflicts.
  - Supports communication and information exchange.
  - Less need for controllors.

Disadvantages:

- Fear of employees from degradation of their work positions.
- Initial fear of loosing the job.
- Decision making may be neglected.
  - Too much focus on processes may lead to less attention the decision making.
  - Despite the equality between workers, some has to make (and be responsible for) the decision.

Conditions:

- Motivation to change has to be high on all levels of management.
- Regular employees needs to be involved in process improvement.
- Factor of human persistence and reluctance to change should not be underestimated.
- Individuals defining the processes should understand the problems of workers on lowest positions.
  - To avoid creating processes which are impossible to follow.

[6, 22]

1.4 Information technology

Information technology is widely used in process management and basically led to introduction of modern methods of production management (chapter 1.5). The figure 8 shows how information technology changes several well-known business rules.

RULE	DISRUPTIVE TECHNOLOGY
Information can appear in only one place at one time	Shared Database
Only experts can perform complex work	Expert / knowledge-based systems
Businesses must choose between centralisation and decentralisation	Advanced telecommunications networks
Managers make all decisions	Decisions-support tools (database access, modelling software)
Field personnel need offices where they can receive, store, retrieve and transmit information	Wireless data communication and portable computers
The best contact with a potential buyer is personal contact	Interactive communication
You have to find out where things are	Automatic identification and tracking technology
Plans get revised periodically	High-performance computing

Figure 8: Breaking business rules using IT technology (source: [23])

The selected company is using it's own, custom made information system for manufacture planning, control and evaluation. Since the usage of this system, as well as other systems for business process modelling and simulation are relevant to the thesis, this chapter deals with such issues and prepares ground for practical part of the thesis.

"...the power of databases and expert systems can allow non-specialised workers to make decisions for their specific departments, and hence there is no need to sacrifice the time of specialised workers."[5] [23] .

1.4.1 IT in process monitoring and deployment

Software tools used to monitor the business activities are called Business Activity Monitoring (BAM). Such tools often provide (close to) real-time data about instances of business processes and activities, in order to provide valuable information about the actual state to upper management in order to make faster and better informed decisions. The BAM systems are often built in a way that the data and events are collected from various sources, summarized, and presented as a KPIs in a dashboard form to the user [24, 25] .

The next level of systems are Enterprise Resource Planning (ERP) systems, which not only monitor the business, but also provide interface to control it. The simple systems for example allows to insert new orders, whereas the more complicated ones can do the

5 CASEWISE. The Theory of Business Process Re-Engineering. 1999. p 15

detailed manufacture planning (more in chapter 1.5.2).

The last level of information systems, regarding the cover of business functions are Business Intelligence (BI) systems. Those are not only concerned with detailed business monitoring and control, but such systems can also use historical and statistic data about the business to compute predictions regarding orders, sales, or material and labour requirements for upcoming seasons.

Another categorisation of information systems is based on the level of customization to particular needs. Systems, which are highly customized to the needs of single customer are called Best of Breed (BOB). Those often contain functions specialised not only to the destination business sector, but custom made to the single company. Opposite of BOB systems are Best Practice systems. Those often follow (written and non written) standards within the sector and forces the company to adapt to the needs of the system.

The information system being used nowadays in the company, based on this chapter, can be identified as Best of Breed ERP system. Chapter 2.6 describes how is that relevant to this paper and how can the data be used.

1.4.2 IT in process modelling and simulation

The large amount of the software was developed by various vendors to model, simulate, execute or monitor Business Processes. The tools focused only to process modelling without any advanced features will be omitted in this paper.

Advanced tools not only enables managers to define the Business Processes, but also allows users to enter the data about process instances, fires events and tracks the progress of single processes. The company is interested in software tools connected with Business Processes and would be willing to consider such software tool, provided it will bring reasonable advantages.

1.4.2.1 Microsoft Visio

Microsoft Visio was earlier a tool for creating static charts and visualisations including Business Processes beside of others. However the newest Premium edition, together with other tools like MS SQL Server and MS SharePoint allows not only logical validation of the BPMN charts, but also does dynamic visualisations of the real-time data, enabling detailed monitoring of single Business Process instances [26] .

1.4.2.2 ARIS Express and Process Intelligence

ARIS Express is a free tool limited for creating BPMN charts, created by Software AG company (also creator of SAP system).

However the full software pack called Process Intelligence allows much more. Besides of main features provided by Microsoft Visio, such as chart validation and real-time monitoring, it can also analyse historical data in order to find bottlenecks in processes. Process discovery and identification, and also the benchmarking is available. The Event processing engine can observe predefined patterns in events arising even across various units and execute processes based on those patterns emerging [27, 28] .

1.4.2.3 Drools

Drools, as a complete Business Logic integration platform, is a set of various tools, containing Business Rules Manager, Rules Engine, web-based BPMN graphical editor, Event processing engine and Automated Planner. Developed and maintained by JBoss, it is a free tool connected with community of Java programming [29] .

Drools can be compared to Process Intelligence from Software AG in matter of functions. SAP's Process Intelligence tries to be simple-to-use solution, which brings largest benefit while integrated within the existing SAP environment. Drools on the other hand behaves as standalone product, or it can be integrated into basically any other IS, no matter the platform or the programming language used. For those reasons, Drools have been chosen as a tool for process verification in this project.

Since the graphical representation of swimlanes in Drools was not considered propriate, for this paper, Microsoft Visio was chosen to draw process maps with.

1.5 Selected methods of production management

This chapter briefly describes the main features of the selected methods of production management. The selected company never used any particular method, but rather own production management system, which evolved over the years. Therefore analysis of the main features of some best-practice methods may help to bring new ideas and improvements in the implementation part of this work.

1.5.1 MRP

Material Requirement Planning (MRP) is approach developed in USA at the beginning of 60s. Rather than to production management, it is focused to manage materials. Instead of original approach, where materials were managed by production standards and norms, MRP uses addressed material ordering according to the real production needs.

Rough production schedule is composed first, based on known orders and demand forecast. Taking the present status of materials on stocks into the account, the production schedule is created for certain period (also called “time bucket”, often one week long). Planning horizon is the set of several time buckets and production plans in those buckets.

Literature says, that compared to the systems with no material planning, MRP almost always lowers the quantity of current supplies (also the costs of acquisition and maintenance of storage). However the disadvantage of MRP lies in the fact, that planning is based on the information coming from rough schedule and does not take the real state of the production into the account. MRP does not count with capacities of workplaces, which means that it can produce plans impossible to follow. These disadvantages are particularly fixed in MRP II [3, 30, 31] .

1.5.2 MRP II

As a reaction to disadvantages in MRP, the Manufacture resource planning (MRP II) was created in 70s, closely coupling the material orders, detailed manufacture schedules, capacity constraints, sales and financials. Therefore to operate MRP II system, it is necessary to combine the data from various sources (production, stocks, orders, sales, forecasts) into one database.

Combining such large amount of different data, MRP II systems are sensitive to errors, especially regarding the durations of tasks done by labour, and overall production data collection. Literature suggests this can be particularly fixed with using bar-code readers and RFID technology in production.

MRP II, as a integrated solution, provides information not only for production, but also for overall decision making [3, 30, 31] .

1.5.3 OPT

Optimized production technology (OPT) is production management concept, developed in 70s as alternative to MRP. OPT is based on idea, that the performance of the whole system is as high as the throughput of the most narrow bottlenecks.

Where MRP is focused to increase throughput in each workplace, OPT tries to optimize production flows by identifying bottleneck workplaces and maximize it's workload. An increase of throughput in workplaces, which are not bottleneck, is not valuable, since material will be accumulated in front of the next bottleneck.

Advantages of OPT are increase of overall throughput even in dynamic conditions, making it valuable system for companies using the strategy of differentiation [3, 30, 31] .

1.5.4 JIT

Just-in-time (JIT) is concept also developed in 70s. The basic idea is to manufacture only the necessary parts in necessary amounts, with required quality, the latest the possible. JIT uses very small work batches, pulled-by-demand system (requirements of following workplace are crucial when planning the work batches), recommends make-or-buy strategy (do not create anything you can buy cheaper). Compared to MRP-based or OPT techniques, stabilisation is not reached by work-in-process inventories, but by backup manufacture capacities (part-time workers, working overtime).

That results to the reduction of the work-in-process inventories, however requires the great level of coordination among the workplaces. JIT is also concerned with company culture, when applying the rule that workers should be involved and participate on process improvements, and should get better in some dimension every day.

Implementing the JIT therefore means not only changes in work planning and material distribution practices, but also changes in the overall company culture [3, 30, 31] .

1.6 Summary of theoretical part

During the theoretical part of the paper, the Functional management was shortly described, in order to identify the differences compared to the Process management.

Various factors of Process management were then discussed. Process implementation approaches at first including PDCA, DMAIC and 7-Step approaches, of which the DMAIC and 7-Step were chosen to be used in practical part.

To present a business processes in graphical form, the BPMN notation was chosen based on analysis of similar solutions.

Various frameworks to process measuring and monitoring were also discussed, leading to selection Workflow based monitoring framework to be used during the practical part.

After that, the evaluation of the role of IT in business process management has been performed, which led to understanding that several well known business rules can be broken by correct use of IT.

Selected methods of production management were briefly discussed at last, including MRP II, OPT and JIT, preparing ground and possible direction of improvements offered in practical part of the paper.

2 ANALYSIS OF THE COMPANY

This chapter describes the company environment and it's nature. Product description is performed, since the difference between two main groups of the product is relevant for certain processes. Company buildings and labour allocation is also mentioned, after which follows the description of such business processes, which were selected for implementation part.

Company PEGRES obuv s.r.o. was founded in 1993, as a small manufacture producing slippers for indoor use. It has grown from company operating with 15 employees in rented building into a company employing 60 people, working in two own production plants.

The company offers it's product to small retail-store sellers, having about 600 of them spread over the whole country. The company representatives are also participating on various fashion fairs in Czech Republic, while being several times presented also in TV.

Even thus there has been growth in number of employees, there were no major changes in management practices or manufacture planning in company history.

The company has been long time struggling with stagnation in production planning and control. Internal processes for labour allocation, material distribution, order registration and fulfilment, as well as evaluation and appreciation of the work were introduced more than ten years ago, when the company had only one manufacture plant and just fraction of the workforce. Some of these processes are now obsolete and in current conditions no longer effective.

2.1 Indicators of financial situation of the company

The following table 3 contains indicators of financial situation of the company for the years 2009 and 2010. Since the financial analysis is not the goal of this paper, only basic indicators of rentability (ROE, ROA, ROS) and liquidity (Cash, Quick and Current ratio) have been chosen to be presented.

Table 3: Indicators of financial situation of the company (source: company's internal data)

Indicator	2009	2010
Rentability		
ROE	95 %	42 %
ROA	19 %	35 %
ROS	13 %	16 %
Liquidity		
Cash ratio	1,16	0,47
Quick ratio	8,04	4,07
Current ratio	11,11	8,81

2.2 Product description

Before the year 2004, the company was manufacturing only simple slippers for home use. Such models of shoes are relatively simple to create due to the low amount of operations (left side on figure 9). There is also not many different materials used on one model, and many materials are common among many models. The cost of the materials, as well as the cost of the final product is relatively low.

Figure 9: Example of the company's product (source: company's web: pegres.cz)

In 2004, the company started to produce also the leather outside-shoes for children (right side on figure 9). Those are typical by the large amount of operations in the manufacture process, as well as many different materials used in that process. The cost of materials and final product is in some cases even several times higher than in the case of slippers.

The company produces about 800 pairs of slippers and about 300 pairs of leather shoes per day.

Today, the company offers about 70 different models of shoes and slippers for inside and outside use. Every model is created in approximately 10 different sizes and 4 variants in average (colours or gender groups), resulting to around 2800 variants of the product, which may be ordered. It worth to mention that from perspective of the manufacturing process, there is only several components of the product, which are shared among more variants (for example some rubber soles are used for both, boy and girl shoes). Most of the components are specific and unique for every size and variant, which has strong influence on manufacture planning and in-process inventories.

Several years ago, a substantial amount of seasonal orders have been made more than 4 months before the season, so the company had enough time for production. For last 5 years, customers (retail shops) do not want to have large stocks and the same orders are being made not more than month before the season. That calls for great demand prediction, manufacture planning and control.

2.3 Buildings and logistics

Today, the company has two production plants, the original building A (500 m^2) and the new building B (1200 m^2, bought in 2004), about 1 km far from each other. The large stock is in separate building, 1 km distant from the building B, as presented on figure 10.

The idea of moving into the one large building was considered in the past. It was however refused, and concept of smaller and partly independent building with one foreman (closely described in chapter 2.4) was preferred.

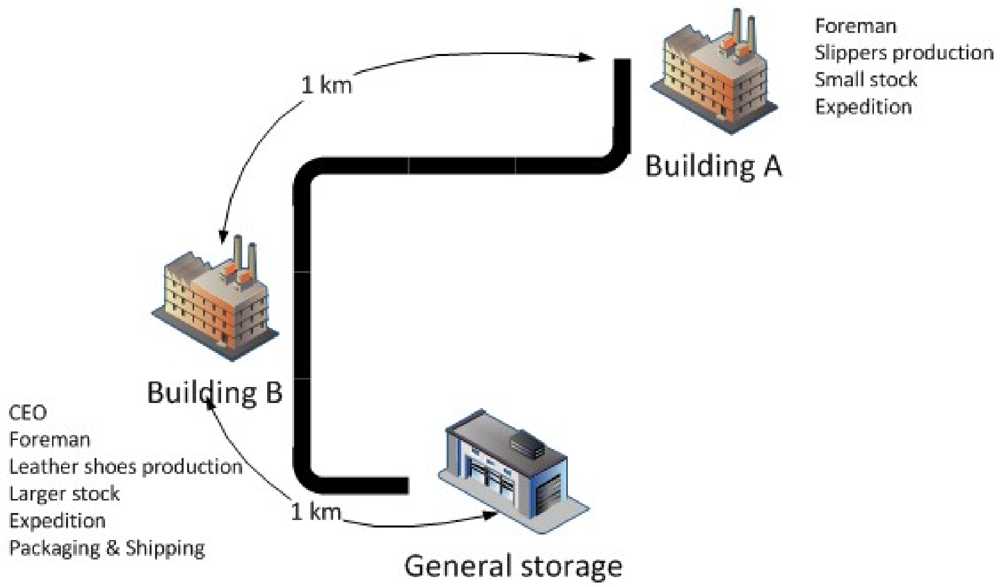

Figure 10: Company buildings (source: own work)

Several materials consumed on both buildings, are being produced only on one of them (case of molding described in chapter 2.9 and packaging described in chapter 2.5). Therefore the company uses a driver, who travels about 4 – 6 times during the day between the three buildings.

2.4 Labour structure and allocation

As described in chapter 2.3, the labour is distributed among two production plants. There is about 20 employees in the building A, working under one foreman. Another 30 employees works in the building B, also under one foreman. Every foreman is therefore responsible for manufacture processes in own building, and each building becomes partly independent in means of manufacture.

The building B has also the employees of product packaging and shipping department, CEO, accounting, IT and research and development.

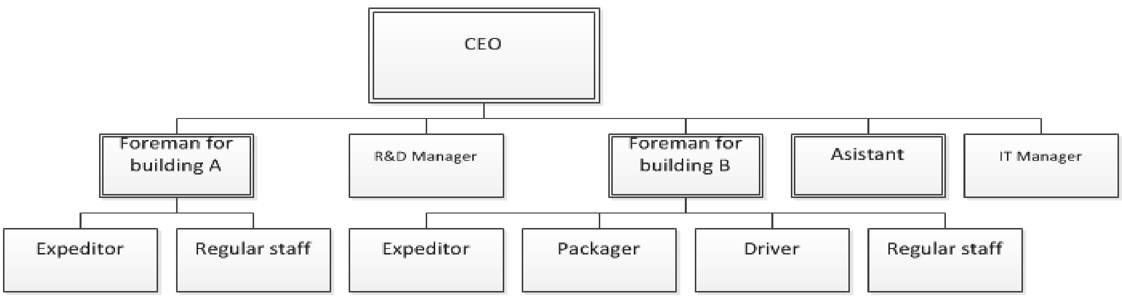

Figure 11: Organizational chart of the selected company (source: own work)

Stabilisation of the manufacture process is for small variations ensured by work-in-process inventories (similar to MRP, chapter 1.5.1), and for larger changes by sharing the labour among the departments (similar to practices in JIT, chapter 1.5.4). Since only part of the operations is being done on both types of the shoes, and therefore in both buildings, the possibility of labour sharing is limited by tasks and operations the employees are trained in.

2.5 Order registration, fulfilment and delivery

In footwear business, it is usual that the retail shops can make the order only in form of so-called assortment package. That is the package of one shoe model, containing predefined amounts of shoes in different sizes and variants. This approach simplifies the manufacture planning for manufacturer, however it is then impossible for small retailer to order only specific amount of selected shoe in selected variant.

Despite over the 1600 variants of the products, selected company uses ordinary model for product ordering. The only constraint says that the retailer needs to order at least 10 pairs of the footwear. The company also promises 5 – 10 days delivery time, which may get slightly longer during the season.

Such large amount of products and variants does not allow to fully deploy the Assemble-to-order (components are not universal), nor the Make-to-stock strategy (stock would be enormous) [3]. The company is therefore partly using the Make-to-stock strategy, when the most often ordered models are created in the most expected variants for the selected season, and when the new order is being filled, the missing models are Made-to-order.

Orders are registered by different employees through different channels. The most often used way to register the order is self-service on the company website, to which the customers are given their login information. A significant amount of orders is however made on phone, by mail or fax.

Every single order is rewritten onto a paper form, which goes to the packaging department. Employees in packaging department starts to package the products into the boxes, most often ending up with a list of missing products. Those lists are once a day gathered, summarized and production plan for next day is adjusted accordingly to fill the gaps.

The adjustments are in form of “priority production orders” (PPOs), which means that exact amount of missing product, grouped by model, size and variant, is ordered for production. Those products then go through the whole manufacture process with priority over other production orders.

Therefore, until the box for every customer is filled by all goods requested in the order, it stays in the packaging department. When there is many orders processed at the same time, the packaging department gets filled. When missing products are delivered to the packaging department, the time needed to find the proper order missing those products, and therefore finish the order, grows dramatically with amount of not-finished orders in the department.

2.6 Current IS system

Based on information in chapter 1.4.1, the information system used in the company is clearly Best of Breed system fitting into the ERP category. It has been custom made not only to the needs of the shoe manufacturing industry, but customized to the needs of this particular company. It is a server-client-mobile client system, in which the work of the most employees is monitored in real time.

The work orders are issued as a tickets containing amount of the batch and shoe model, including size and variant. Then the ticket travels through the manufacture process with the batch, while employees use personal mobile terminal, to enter the data about task they have performed on particular work order.

The system at the end provides for example statistical data about employee performances. Since it is also connected with an attendance system, it provides data which are used to calculate the wages more about processing wages is in chapter 2.7.

Important advantage of the system is the fact that all the data are easily accessible through SQL and EJB-QL queries. Since this paper is not focused on economic and not on IT side of the problem, the details from IT perspective will not be further discussed. Important fact is, that using proper queries, the system can provide statistical data about manufacture process. Those data are further used in the paper, even thus in most cases, the values were multiplied by random coefficient. That way, the proportion between values still has information value, without compromising sensitive company information.

2.7 Evaluation and appreciation of the work and wages

The current IS exports the monthly task summary and attendance data into the excel sheet. Since the system was originally not designed to be a payroll system (it is concerned with manufacture monitoring and control, not with wages legislation), further manual processing of such sheet is necessary to prepare all the data required by another payroll system.

The processing of those sheets starts with printing out one such sheet per employee. Then the additional information is filled by foreman from each building, such as the data about the time, when the employee was assigned to another than own task (therefore financial compensation is needed due to the worse results in such day) and premium appraisals.

After that, the sheet goes to the CEO, who counts (by hand) more information, such as meal vouchers gained for that month, various performance indicators and the final salary. At the end, the data are entered into a payroll information system.

This process takes about 2,5 hours per month to each foreman to complete, however consumes more than 5 hours each month of the CEO's time.

2.8 Research and development

The company is also developing own models of the new shoes. In last years, the company has made about 2 new models of slippers and approximately 4 new models of leather shoes every year. There is an external designer co-operating on the process of development.

In the first step, the company asks for a new model with brief description of the shape. After a several days, the external designer sends a graphics of various designs, of which the company selects the desired one. The external designer than spends about 10 days by creating cardboard templates for every component of the selected model in one size of that model. After the templates are delivered into the company by post, desired shapes are hand-cut from raw materials and the final shoe is produced. During that, many construction errors in design are discovered, which are reported to the designer, who then fixes the shapes accordingly (making one component longer means shortening several other ones etc.). The designer than again sends the new cardboard templates, and this process continues in many iterations, until the shapes of the model are accepted in one default size of the model for the production.

After the one size of the new model was accepted, the designer does size distribution (on-linear resizing of the components in the shoe for all shoe sizes) and again sends the cardboard shapes. The sizes close to the original one are usually accepted for the production in the first trial, but most of the other sizes of that single model again needs to be fixed, as if it would be new model.

After all sizes of the new model are accepted for the production, the final cardboard templates are used to create metal knifes used to cut the shapes from raw materials in mass production. Usually, the process of developing the single model (and all it's sizes) takes from one to two months, requires hours of imprecise hand-cutting from elastic materials and includes many iterations in which the faulty shoes are produced.

2.9 Molding

The company has two departments doing the operations of molding and cutting from materials other than leather. Since the departments are being used on its maximal capacity, employees are often doing overtime and there are still shortages on the semi-product coming out of this department, those are considered to be a bottleneck.

For the operations of molding, the ordinary shoe-molding machines are used. Such machine takes the place approximately 4 m^2 and the departments are both already filled with total of 4 machines (3 + 1). It has low preparation and cleaning times when changing the material being cut from, however even with experienced worker, it has only average speed of cutting and average waste (particular numbers are measured in chapter 3.2.2).

Several years ago, the company acquired the large molding-bridge machine (16 m^2). Such machine is expected to be able to cut from more layers of the material at the same time and therefore to produce much more pairs per minute. However it is also expected to have higher preparation and cleaning times. It has never been put into production, because there are too high preparation and cleaning times expected and that would require better manufacture planning. Unlike the molding-bridge, the ordinary shoe-molding machines are considered to be flexible and operative in means of manufacture planning.

2.10 SWOT analysis

The goal of this paper is to lower the costs with help of process analysis, therefore the brief SWOT analysis was performed with focus to process management, based on information gathered during the work. SLEPTE analysis was not performed, since the paper is not focused on global aspects.

2.10.1 Strengths

The company has two main groups of the product, the slippers for inside use and leather shoes for outside. That, being certain diversification, spreads the seasonality variations in manufacture process, due to the fact that seasonality during the year of both products is almost opposite to each other.

The company does not need to ship products in packages of whole assortment. Instead, it is able to ship the goods in packages with at least 10 pairs, allowing even smallest retail sellers to order the product from the company.

The company has large amount of small customers (retail sellers), therefore it does not depend on demand of one large customer.

2.10.2 Weaknesses

There are no major Business process management standards, nor any modern practices of production management in the company.

It requires large amount of time to train new employee for most of the positions. Also preparing the present employees to manage new tasks is very time consuming.

The company has many customers (small retail sellers) who orders relatively small amounts of the product, requiring short delivery time. Combined with large amount of models, sizes and variants of the product, the production planning is very difficult in such conditions.

2.10.3 Opportunities

Since there are no modern production management practices in the company, it is opportunity to perform at least deep study including simulations, whether such practices could bring any improvements.

It is very time consuming to train employees to perform new tasks. The training programme could be set up, according to which, the employees would be trained out of the season.

2.10.4 Threats

Given the current conditions, even when not being concerned with costs, it is difficult to outsource most of the processes, while not decreasing the quality of the final product. In order to preserve the same quality, even the processes outsourced earlier has to be nowadays done inside of the company.

Only short fluctuations in manufacture process can be covered by in-process stocks. Medium fluctuations can be covered by repositioning certain employees to different tasks, however the possibilities are still very limited. There are no major approaches how to manage large fluctuations in manufacture / demand.

3 IMPLEMENTATION

The whole chapter 2 contains description of several particular company processes. This chapter describes the deployment of Business Process Management implementation practices. Namely usage of DMAIC and 7 Step approaches (described chapters 1.2.3), process identification (chapter 1.2.4), representation (chapter 1.2.5) and measuring (chapter 1.2.6). In some cases, the changes in processes were not only suggested, but also implemented. In those cases, results of the changes are also provided, together with conclusion about success of the proposed solution.

According to findings in chapter 1.2.3, the implementation team has been set, consisting besides of the author of the top management representative, a foreman, a skilled worker and author of the thesis. Those were however assigned only for consultancy purposes.

3.1 Order registration, fulfilment and delivery

The process of Order registration, fulfilment and delivery was described in chapter 2.5. The process is known to be hard to manage and slow in case when there is too many orders in process of packaging, for those orders, for which there is not all ordered product on stock and thus such needs to be manufactured additionally. From now on, the paper will be focused only on those orders, which are not packed and shipped at once, but which stays opened in packaging dept. and wait for relevant PPOs (Priority production orders) to be finished.

3.1.1 Define

When there is more than approximately 10 orders being packaged at the same time, the employees loose their orientation in what products are missing in which package. That is a problem when the relevant PPO is finished and missing goods are delivered to the packaging department. In order to keep the promised 5 – 10 days delivery time, additional workforce is needed during the season to manage the situation, which raises the costs.

The brainstorming led to conclusion that the goal of the change in the process is to increase the rate, with which the orders are being packaged during the season. To be more precise, to lower the Total time to find correct order per day per order, according to formula 1. Also the order-to-delivery time period should not increase noticeably. Those are the KPIs for the process of Order registration, fulfilment and delivery.

$$TFCOpDpO = \frac{TFCO \times PPOpD \times PpPPO}{OPD}$$

Formula 1: Total TFCO per day per order (source: own work)

TFCOpDpO	- Total TFCO per day per order
TFCO	- Time to find correct order for PPO
PPOpD	- Total amount of PPOs delivered to packaging dept. per day
PpPPO	- Average amount of products per (contained in) one PPO
OPD	- Total amount of orders packaged per day

3.1.2 Measure

The time before and during the peak in the season was chosen to measure the performance of this process. That was the way how to identify the performance with minimum personnel of 1 and maximum personnel of 3 employees working at the same time.

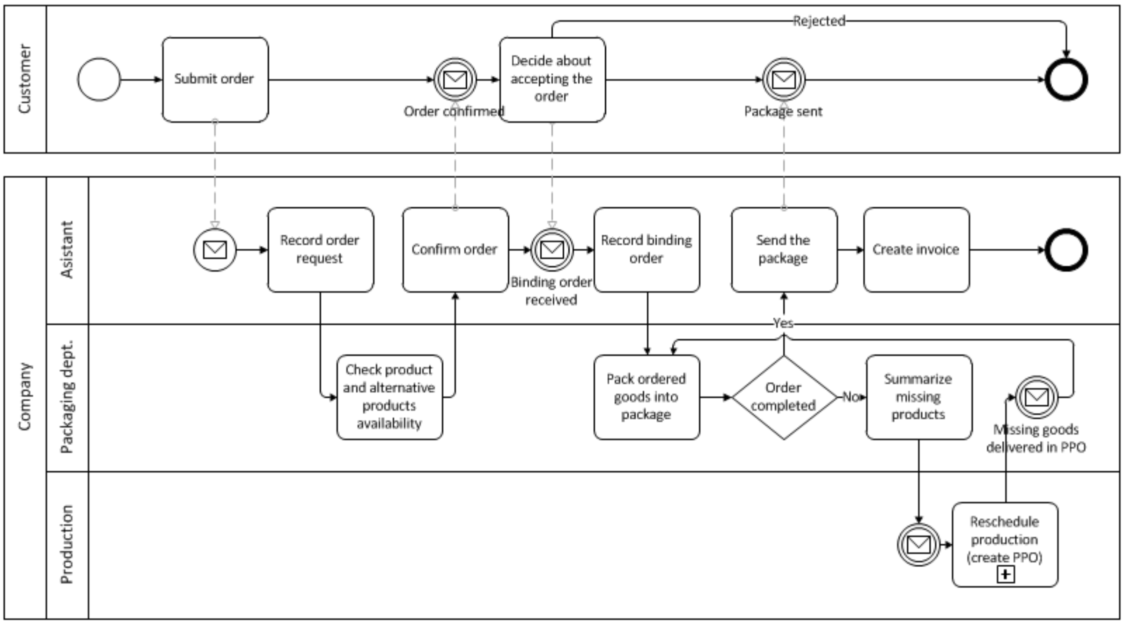

Figure 12: BPMN diagram of the Order registration, fulfilment and delivery process (source: own work)

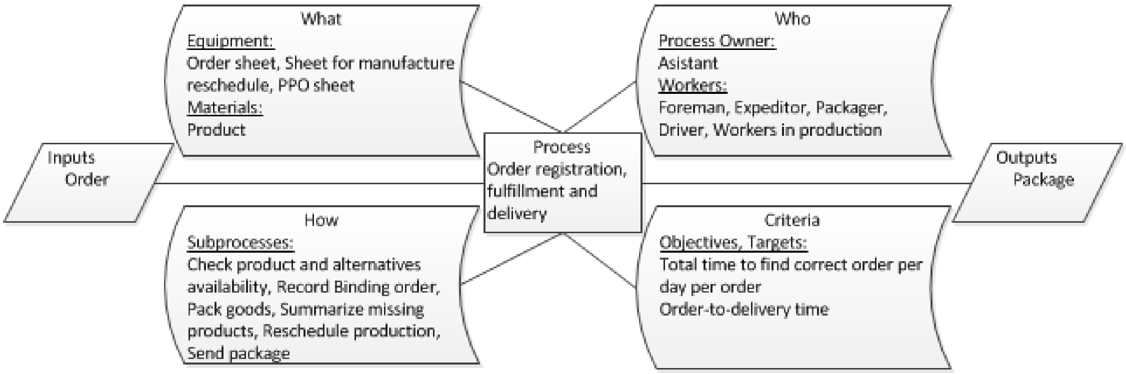

Figure 13: Turtle diagram of the Order registration, fulfilment and delivery process (source: own work)

The table 4 and figure 14 shows the performance of the process. Since the company did not wish to share absolute data, the original values were adjusted by coefficient.

Table 4: Performance of tasks in Packaging process (source: own work)

	Out of season	Season
employees working on packaging	1 employees	3 employees
Total amount of orders packaged per day (OPD)	25 orders	55 orders
Opened orders at the same time (OO)	10 orders	20 orders
Total amount of PPOs delivered to packaging dept. per day (PPOpD)	15	35
Average amount of products per PPO (PpPPO)	5	10
orders / employee / day	25	18,3
KPI: Total TFCO per day per order (TFCOpDpO)	**5,6 * 15 * 5 / 25 = 16,8 sec**	**12 * 35 * 10 / 55 = 76,3 sec**

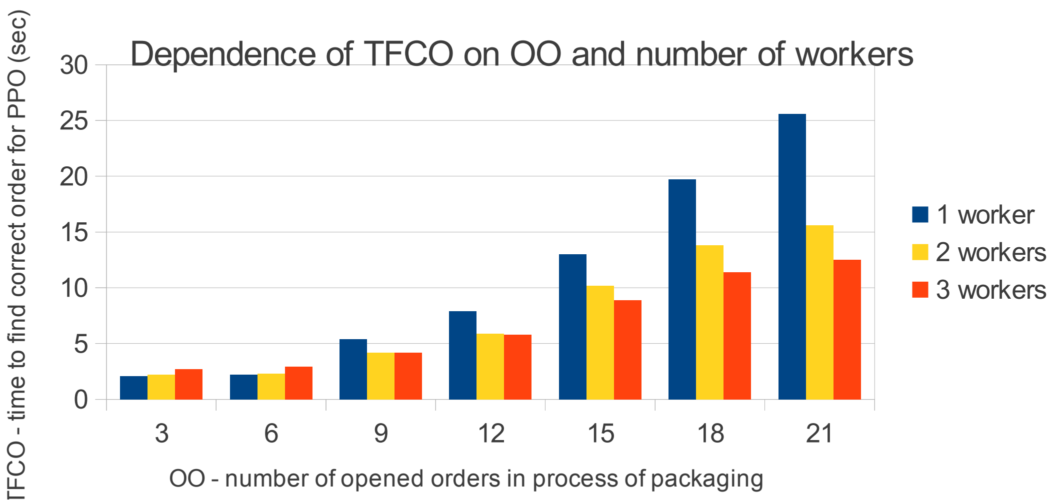

Figure 14: Dependence of TFCO on OO and number of workers (source: own work)

3.1.3 Analyse

During the season, there is increase in PPOpD (because the goods are not on stocks and needs to be manufactured directly) and PpPPO (the PPOs contains more products), so the total time spent on finding the correct order per day increases accordingly to formula 1.

The TFCO times are shown in figure 14, from which it is clear, that the TFCO increases with increasing amount opened orders (the workplace gets messy), with acceptable values up to approximately 10 opened orders at the same time.

Therefore to improve (lower down) the value of KPI, it is needed to decrease the value of TFCO, PPOpD or PpPPO, or to increase the OPD. Since we have no influence on OPD, that leaves TFCO, PPOpD and PpPPO values to work with.

3.1.4 Improve

Result of the analysis is that the process of Order registration, fulfilment and delivery can be improved by decreasing TFCO (Time to find correct order for PPO), PPOpD (Total amount of PPOs delivered to packaging dept. per day) or PpPPO (Average amount of products per (contained in) one PPO). Work on all three factors was done separately in following chapters.

3.1.4.1 TFCO (Time to find correct order for PPO)

When trying to decrease the time spent on finding a correct package for PPO among all other unfinished packages, the organisation scheme on the workplace was studied. Several possibilities of sorting or queuing the packages by different keys have been considered. However the only idea in this field was a suggestion, that when there is only several products missing in the package, the list of the codes of the missing products could be written by large letters on the side of the box. It was expected to improve overall overview about missing products, however that expectation was faulty and the situation did not improve.

3.1.4.2 PpPPO (Average amount of products per (contained in) one PPO)

As mentioned in chapter 2.5, PPOs are put into the production due to the products missing in orders, which are being already packaged. Information about missing products are summarized once a day and based on those data, PPOs are put into next day's production. However the batch of one PPO does not consist of the particular missing products from one particular order (that is why the packaging worker has to search order for every product in one PPO, and not only one order for one PPO).

Therefore a suggestion has been made, to base batches for every PPO on products missing in one particular order. Then, the amount of time to find a correct package for every product in PPO would not be equal to $TFCO \times PpPPO$, but just to $TFCO$. Or in other words, finding a correct package for PPO is enough, because all products in PPO goes into the same package.

That idea was however refused before the trial, because the work batches contain the same products (several pieces of the same model in the same size, variant and colour) to decrease various overhead in production. Mixing different products with different workflow in one PPO would mean delays during the production, which would certainly be higher than delay during packaging.

3.1.4.3 Grouping PPOs by model

While suggesting improvement in the previous chapter 3.1.4.2, the problem was with mixing the different models of shoe (with different a workflow) in one batch and overhead it generates.

Therefore a grouping the products by model in PPO was suggested. That way one PPO would consist of products of the same model (with same workflow), but in different sizes and variants. Therefore some overhead would be saved compared to managing more PPOs with less products in the batch.

After a short meeting, this solution was shortly tested. There were no major savings during the production process and in some cases, this solution still generated higher overhead, due to the fact that several models have slightly different workflow in selected sizes or variants. This solution was declared as a failure, however inspired a last suggestion in following chapter 3.1.4.4.

3.1.4.4 PPOpD (Total amount of PPOs delivered to packaging dept. per day)

The total amount of PPOs, which is every day delivered to the packaging department, is given by the speed of the manufacturing process and by the amount of PPOs put into the production in previous days.

It is assumed that it is not easily possible to speed-up the manufacturing process (PPOs are prioritized in the manufacturing process, so no unnecessary delays are involved), therefore amount of PPOs put into the production is the only parameter left.

Since the PPOs are put into the production because of the missing products, the possibility to lower the PPOpP is to lower down the amount of missing products. The PPOs are relatively small batches (containing purely the products which were missing previous days on packaging), so suggestion has been made, to increase the size of the batch in PPO at least to the usual batch size, or to its closest multiplication.

Having PPOs containing more products than what are actually missing, combined with an observation, that PPOs issued within the same month often contains similar products in similar sizes and variants, may lower down the chance of missing products in following days.

The only change proposed for the process and later also implemented is therefore this. While entering the new PPOs into the production, foremen will round the amount of pieces in PPO on closest higher multiplication of regular batch size for that model (does not apply in cases of rarely sold shoes). That involved only minimal overhead during the production process, because the size of such PPOs has increased by 10 – 25 %. That led to slightly higher stocks, which is not considered to be a problem.

The change has also slightly lowered the chance that several pieces of the same product will be missing for some order.

Table 5: Performance of tasks in Packaging process after improvement (source: own work)

	Season before the change	Season after the change
employees working on packaging	3 employees	3 employees
Total amount of orders packaged per day (OPD)	55 orders	64 orders
Opened orders at the same time (OO)	20 orders	16 orders
Total amount of PPOs delivered to packaging dept. per day (PPOpD)	35	29
Average amount of products per PPO (PpPPO)	10	14
orders / employee / day	18,3	21,3
KPI: Total TFCO per day per order (TFCOpDpO)	**12 * 35 * 10 / 55 = 76,3 sec**	**11 * 29 * 14 / 64 = 69,8 sec**

The initial measures after the change are shown in table 5. Due to the time constraints, the measures were performed only during the season (season finishes after the deadline for this paper). The data shows that *average amount of products per PPO* has increased, while the *total amount of PPOs delivered to the packaging dept. per day* decreased. That led to the lower amount of *opened packages at the same time*, which meant there was better overview on workplace about opened packages and KPI lowered from initial **76,3 sec** to **69,8 sec**.

3.1.5 Control

The proposed solution was tested for the time period of two weeks. After that period, with results according to table 5, the proposal was considered not to have a significant contribution, therefore the changes have been reversed.

3.2 Molding

The process of molding was described in chapter 2.9. Until the work on this paper began, the both molding departments were using regular shoe-molding machines, which has low preparation and cleaning times, however also produce average amount of pairs per minute (a unit expressing the performance in footwear). The same chapter also describes, why are those two departments considered to be a bottlenecks. At the end, a large molding-bridge machine is mentioned in the chapter, which has however never been put into the production.

3.2.1 Define

The brainstorming with the CEO and foreman led to a conclusion, that there are several problems with molding departments. The workforce needs are relatively high, considering the amount of product coming out of the department, compared with other places in the production. The departments already operate on its maximum level, being bottleneck for the whole production process. Based on practices from Optimized production technology (OPT) in chapter 1.5.3, author suggested to remove the bottleneck. Due to the large amount of space the shoe-molding machine takes, considering the fact that both department are filled already, there is no obvious way how to increase the production at this point.

The two different key performance indicators came out of the define part. First is the amount of Pairs produced per person per day (PpPpD). Second key performance indicator is the percentage of waste produced during the operation (Waste). For the purpose of this paper, waste is measured by weight of the material before and after the operation.

3.2.2 Measure

The large molding-bridge machine was temporarily put into the production in the storage room in order to perform the measuring of the exact times of several operations. It was working in configuration with one layer of material however it was discovered that the machine can operate reliably with up to 6 layers of the material. For purpose of this paper, configuration with 5 layers was tested. In that way, overall performance of both types of molding machines can be compared and evaluated. The table 8 shows the result data including the average waste produced on both machines. Since the company does not wish to publish absolute values, the numbers were multiplied by coefficient, which however has no influence on comparison purposes.

Table 6: Performance of Molding process (source: own work)

	Shoe-molding	Molding-bridge	Molding-bridge x5
Preparation time (PP)	13 min	17 min	20 min
Cleaning time (CT)	10 min	8 min	
Speed	9,5 sec / pair	10 sec / pair	10 sec / 5 pairs
Relative speed (pairs / min) (RS)	6,3 pair / min	6 pairs / min	30 pairs / min
Waste (%)	13 %	6 %	
Changes of material per day (CH)	10 x	15 x - 10x - 8 x	
KPI: Pairs produced per person per day (PpPpD)	**1386**	**450 - 1200 - 1500**	**900 – 5100 - 6780**

The need to change the material being cut from depends on manufacture planning, but in time of doing this paper, there were about 10 materials changed per day on all of the 4 shoe-molding machines, while up to 15 different materials were exchanged in total.

$$PpPpD = (WD - CH \times (PP + CT)) \times RS$$

Formula 2: Pairs produced per person per day (source: own work)

PpPpD - Pairs produced per person per day (pair / person / day)
WD - length of one Work Day, equal to 450 minutes (min)
CH - Changes of the material per day
PP - Preparation time (min)
CT - Cleaning time (min)
RS - Relative speed (pairs / min)

According to the formula 2, the measured values gives the total of 1449 pairs per day on one shoe-molding machine, therefore 4 x 1386 = 5544 pairs per day in total.

When measuring the large molding-bridge, amount c*hanges of material per day* was considered in worst case 15 (which is equal to amount of all materials exchanged before) and in best case 8 (expected value with better manufacture planning). In the worse scenario (CH = 15), the machine managed to produce 450 pairs in configuration with one layer of the material and up to 900 pairs per day in configuration with 5 layers of material. However in the most optimistic scenario (CH = 8), the machine would be able to produce up to 6780 pairs per day.

3.2.3 Analyse

The present distribution of the shoe-molding machines in company is 3 machines in one building and 1 machine in second one. All four machines can not be replaced, because the production would be insufficient and because one building would loose certain level of independence.

A radical suggestion has been made, to replace the three shoe-molding machines from one building (cutting 4158 pairs per day in total) by the molding-bridge (expected to produce up to 6780 pairs per day with good planning), while the one shoe-molding machine in the second building would be still left as backup. That machine would be used to cover the missing material and to process small batches, which would not worth to be processes on the molding-bridge due to the higher preparation time, but not for full-time production.

However compared to the present situation, the amount of c*hanges of material per day* would need to be lowered down. The figure 15 shows influence of CH to performance of the machine. To produce more pairs than 3 shoe-molding machine, there would need to be not more than 11 *changes of material per day*, while to replace 4 machines, the CH would have to be not more than 9.

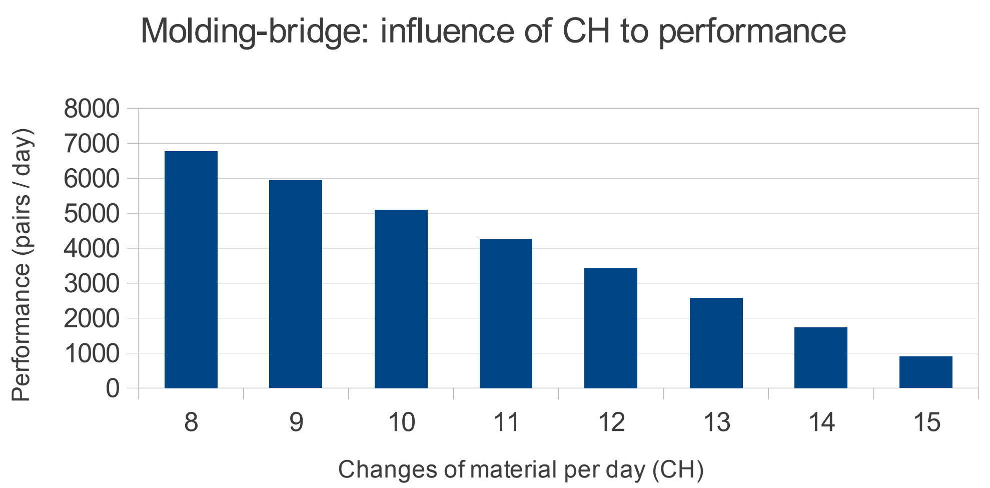

Figure 15: Molding bridge: Influence of CH to performance (source: own work)

The change can be successfully realized only after improving the planning of the work on the molding-bridge, while batches would need to be grouped by material being cut from. By grouping, there will be more pairs cut between every *change of material* (therefore slightly higher in-process stocks will be needed).

To suggest a solution how to improve the production planning, inspiration have been taken from Just-in-time (JIT) practices in chapter 1.5.4, which says to produce only the necessary amount of material the latest the possible. Before the change, the production plan for molding was done twice a day, based on those shoes in the manufacture process, for which the molding-product was needed at the same day or the following day. The observation has however shown, that products of molding process are basically needed in manufacture process for particular pair 4 - 5 days after the work order for that pair has been issued. It is also possible to gather the data from ERP system about new work orders and therefore about a products, which will be needed from molding department in several days.

3.2.4 Improve

Initially, the new concept of assembling the production plan for molding department needed to be tested. A simple interface has been made to the ERP system, which allows foremen to check the newly added work orders and review the materials needed during their production. The interface has proven to be working and reliable in means of summarizing the requirements for molding department.

After that, the molding-bridge was put into the production in permanent configuration of 5 layers of material, replacing the three shoe-molding machines. After several days, the number of *changes of material per day* decreased to 9 – 8 changes, leading to theoretical production around 6300, however the real potential production over 5800 pieces per day (number measured in real production, however the machine is not operate the whole day). Since there is only one person working on molding permanently, that is also result of KPI (Pairs produced per person per day) equal to **5800**, compared to the original value of **1386**. Also the waste was lowered from original **13%** of the material weight to the value of **6%** on molding-bridge.

As a result, since one worker now covers the production of previous three workers, the costs savings are equal to 2 wages (the company does not wish to publish absolute values). As a second benefit, the amount of waste has been lowered by 7%. The differences in operating costs of the machines are negligible.

3.2.5 Control

The task of production planning for the molding-bridge was practised several times with the foreman, in order to gain confidence in it. Also a backup plan was made, for case that ERP system would not provide reliable data for some reason temporarily. In that case, if necessary, foreman would summarize the new production manually at the end of the day and from own knowledge of the product composition would create an improvised production plan for molding.

In usual cases, foreman checks the records about new work orders once per day or once per two days, and based on those numbers and on actual status of the in-process stocks makes a production plan for the molding-bridge for next days.

The one shoe-molding machine left in the second building is being used only in two cases. Firstly, when there are too small batches needed in the same building, which would not worth to be done on large machine. Secondly, for batches which are in hurry (that happens occasionally after large production re-scheduling).

3.3 Research and development

The main process in Research and Development, designing the new model of the shoe, was described in chapter 2.8.

3.3.1 Problem

The process is considered to be too long and exhausting for both, company's and external employees, finishing with compromise in means of the shoe construction and the time spent on the process. That means there are often comments specially on the details of the shoe construction, however those does not worth the time to be solved. That applies already to designing of the initial size of the new model, however the same problems continue in the size distribution (non-linear resizing of the components in the shoe for all other sizes of the one shoe model), which is process done by external designer by hand. As described earlier, the problem is also in the fact that before the new model is approved for production, it is kept in form of cardboard shapes, one for every component of the shoe in every size. Those shapes are used in production to hand-cut the material (which is often flexible) making it almost impossible to follow the shapes.

The company management is for long time not satisfied with the results of this process and is opened even to the radical solutions.

The key performance indicator to be improved for this process is the Total average time spent on the new model development (measured in days).

3.3.2 Data

Introduction to the process of Research and Development in chapter 2.8, performed observation and brainstorming with CEO were enough to specify the process map, as shown on figure 16.

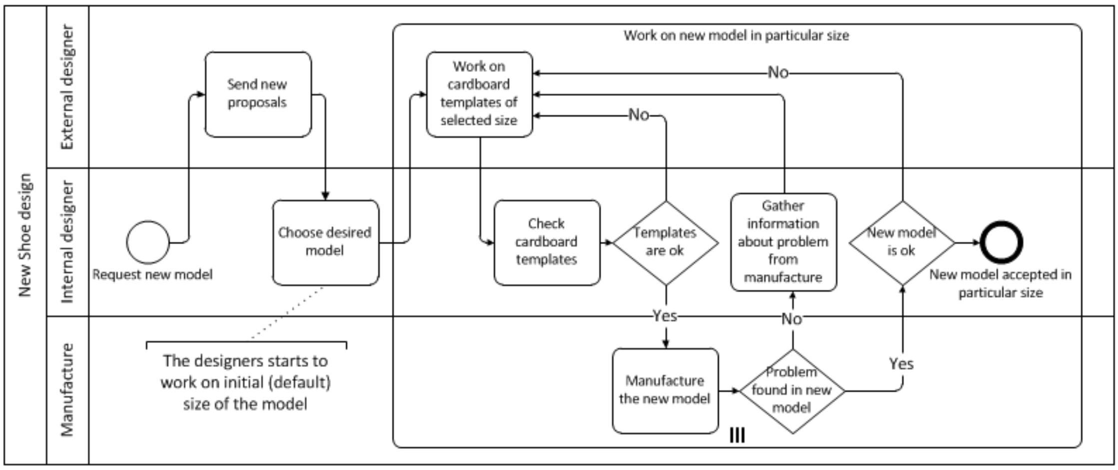

Figure 16: Process map of Research and development process (source: own work)

As presented in process map on figure 16, the sub-process *Work on new model in particular size* is repeated in multi-instance loop. That is a representation of the fact, that once the initial model has been approved in default size, the work on all other sizes of that model progress in parallel execution and therefore work on all the other sizes at the same time consumes almost as much time as work only on one size. The KPI will then be counted according to the formula 3.

$$TTND = TTFI + TTOI \times IdS + TTOI \times IoS$$

Formula 3: Total time spent on new model development (source: own work)

TTND - Total time spent on new model development
TTFI - Total time for first iteration
TTOI - Total time for other iterations
IdS - Iterations per default size of the model
IoS - Iterations for all other sizes

The table 8 shows the durations of significant tasks (those taking more than 2 hours) of the Research and Development process, together with summaries of TTFI, TTOI and overall TTND results.

Table 7: Performance of Research and development process (source: own work)

Task	Duration / Count
Send new proposal	2 days
Choose desired model	2 days
Work on cardboard templates of selected size (first iteration)	9 days
Work on cardboard templates of selected size (other iterations)	4 days
Manufacture the new model	2 days
TTFI: Total time for first iteration (of one size)	**15 days**
TTOI: Total time for other iterations (of one size)	**6 days**
IdS: Iterations per default size of the model	*3 x*
IoS: Iterations for all other sizes	*3 x*
TTND: Total time spent on new model development (KPI)	**15+6x3+6x3= 51 days**

The data collected from one typical execution of the process shows that the KPI for this process is 51 days. This is also close to the value reported by CEO, who claims that usually it takes from one to two months to develop and approve the whole new model.

3.3.3 Cause

According to formula 3, table 8 and figure 16, the high result of KPI is caused by four components. All those components are described separately in following chapters.

3.3.3.1 TTFI - Total time for first iteration

The TTFI includes several tasks. Initially, it takes 2 days to choose desired model, which is includes series of brainstorming and discussions, and it is a task not to be changed in this paper. Then it takes 9 days to the designer to create initial cardboard templates. The company is not willing to use another designer, nor to give up on external designer and those 9 days are considered to be a valid time for the work done. There seems to be no way how to lower TTFI down.

3.3.3.2 IdS – Iterations per default size of the model

IdS expresses the amount of iterations it takes from the proposal of the new model to the cardboard templates which are accepted for the production. Otherwise it could be expressed as amount of faulty models, before the final one is created. This number is already considered to be relatively low, even remembering that accepted result is already compromise. It is reached by experiences and best practices of both, external and internal designer. Therefore it seems there is no obvious way how to decrease the IdS.

3.3.3.3 IoS – Iterations per all other sizes

Once the default size of the model was approved, the shapes of every component needs to be non-linearly resized to all other production sizes as well. This process, done by external designer, uses the combination of best practices combined with certain mathematical methods to do such resizing. Using the benchmarking method of process performance evaluation (chapter 1.2.6.3), there have been identified cases where the resizing is being done successfully at once, with help of software and advanced measuring techniques *(source: personal visit of the fairs)*. That would mean lowering down the IoS from current 3 iterations to 1 iteration and the possibility will be therefore investigated further.

3.3.3.4 TTOI - Total time for other iterations

The TTOI factor express the time spent on fixing those construction errors, which appeared before the initial model was approved, or due to the resizing. Errors are being fixed by external designer by hand, after which the new cardboard templates are again delivered and shoe is always manufactured in the production.

The changes on the model have primitive nature, however editing one component means to edit all others connected to the first one. To maintain all the changes correctly, which the external designer does by hand, is the reason this task takes relatively long time. Since the designer is external, bad communication just makes everything harder. The proposed direction to decrease TTOI is similar as in IoS, to explore the possibilities of the software tools in this field.

3.3.4 Solution

Since there was several solutions proposed in this area, one chapter will be given to each from them.

3.3.4.1 Solution 1 – Invite external designer

First approach to speed up the process was to invite the external designer into the company every time the new models are being designed. Expectations were that having the designer working several days exclusively for this company should lead into minimal delays between the tasks, as well as make the communication with internal designer easier. This idea was actually realized, and after 10 days of intensive work of both, internal and external designers, the new model seemed to be approved for production. However many construction errors have been discovered later in production and the whole design process have been later described as unnecessarily stressful and too fast by internal designer and employees in production.

3.3.4.2 Solution 2 – Universal software tools

Secondly, the proposed solution was searched for in the fields of universal software tools, which could be used to exchange and edit the shapes of the particular components of the shoe. Therefore, the company would avoid using the cardboard templates and information exchange would be faster and easier, as well as managing the changes in models. Those efforts however finished with universal software having problems with several functions specific to footwear industry (for example non-linear resizing).

3.3.4.3 Solution 3 – Industry-specific professional tools

While solving this issue, the author was also sent to several Textile and Footwear fairs and exhibitions in Czech Republic and also abroad. A research has been carried out on various industry-specific software tools, plotters, digitizers, 3D scanners and cutting machines. The content of that research is confidential and is not supposed to be a part of the thesis, however the result can be published.

One contractor has offered a solution, which connects a professional industry-specific software design and construction tool for (from now on called the footwear-software), communicating with a digitizer allowing to record any shapes precisely into that software, and cooperating with a two-axis cutting-plotter machine, able to cut out those shapes from nearly any textile or leather material used in the company.

After a several brainstormings with CEO, based on the research and information gathered from fairs and exhibitions, the decision has been made to buy the solution described above. The whole package included all three components: footwear-software, digitizer and almost a ton weighting cutting plotter. After that, author of the thesis was together with other company employees and external designer sent to a one week lasting training.

3.3.5 Results

Several weeks after deploying the new solution, the process of design is changed in a following way. When the new proposals are sent and the company has picked one, the designer uses the footwear-software to create the initial shapes of each component of the shoe. Those are sent by mail to the company, who can than use the plotter machine to cut out all the shapes, directly from the production materials.

After the construction errors are discovered during the production, the internal designer is able to fix those errors with the help of the footwear-software, without any need of consultancy with an external designer.

Also the resizing of the newly designed model is now done automatically with a help of the footwear-software, and without any consultancy with external designer. Due to the footwear-software, the resizing is in significant amount of cases well done on first trial. However when a inaccuracies appear, those are again fixed by internal company personnel, mostly in the same hour when they were identified.

The table 8 contains new metrics of the tasks in the process measured after deploying the solution. In cases when the original values were different, those are in brackets next to the new ones for comparison purposes.

Table 8: Performance of Research and development process after improvements (source: own work)

Task	Duration / Count
Send new proposal	2 days
Choose desired model	2 days
Work on cardboard templates of selected size (first iteration)	6 days *(9)*
Work on cardboard templates of selected size (other iterations)	0 days *(4)*
Manufacture the new model	1 days
TTFI: Total time for first iteration (of one size)	**11 days** *(15)*
TTOI: Total time for other iterations (of one size)	**1 days** *(6)*
IdS: Iterations per default size of the model	*3 x*
IoS: Iterations for all other sizes	*1 x*
TTND: Total time spent on new model development (KPI)	**11+2x3+1x1 = 18 days** *(51)*

Beside of the new model design, the solution proved well as complement in standard production process. The digitizer was used to record the shapes of the models, which were already in the production, into the footwear-software. The focus has been put to the parts which are difficult to cut in ordinary way (complicated shapes, small shapes, etc.). When not used for designing purposes, the machine is working in production and in cases of complicated shapes is also considered as a contribution.

3.3.6 Deployment

The plotter, after it was deployed, was considered to be the most complicated machine in the production and the employee assigned to operate it needed to be trained. The author of the paper made several step-by-step manuals and put those on the wall next to the machine. In this case, the employee selected to operate the plotter proved well in managing new technology and after several consultations was able to fully operate it without any help.

Another issue appeared while using footwear-software to fix the construction errors in new models. As it was said, resizing one part of the shoe means resizing at least all the neighbour parts too, which is usually well managed by the software. However in some cases, the software or the personnel did not manage to do the task well. With too much trust to the machine and software, many faulty components have been cut out before the fault was discovered later in production process. To avoid similar mistakes, everytime the change is done anywhere in the model using the software, the old and the new shapes are cut out of the regular paper and every new shape is compared to the old one, whether all the differences are desired.

The company does not wish to publish the absolute costs of the processes, therefore the savings are expressed in relative amounts.

As a result of the changes, the cost savings in the process are following. The external designer originally spent costs equal to $TTFI + TTOI + TTOI \times IoS = 2 + 15 + 6 \times 3 = 35$ days, while after the change, the cost is equal to $TTFI + TTOI = 2 + 11 = 13$ days. The overall process cost decreased according to table 8 from 51 to 18 days, to which other costs (electric consumption of the machine, post-mail delivery, ...) are negligible.

3.3.7 Debrief

Purpose of the Debrief step is to identify similar issues elsewhere in the company and consider, whether similar solution could be applied in those situations too.

The process of designing the new model is unique in the company and there have been no similar processes found, which the solution could be applied to. There is no other place in the production process, to which it would worth to buy a brand new type of the machine, nor is there a need for another industry-specific professional software package.

3.4 Evaluation and appreciation of the work and wages

The chapter 2.7 briefly describes the process how the wages are assembled. It describes the process of exporting the monthly data about the tasks the employees performed from internal ERP system into a excel sheet (one sheet per employee), to which each foreman fills additional data and sends to CEO, who then spends almost a working day by manually counting the wages data and filling them into the payroll information system.

3.4.1 Define

The problem with the process lies mostly in a manual work of monotonic nature, which is performed by CEO every month and in large amount of time the work consumes, since the work performed by foremen is considered appropriate. Therefore KPI to improve in this process is the amount of time the CEO needs to spend on assembling the wages.

3.4.2 Measure

Due to the fact the process is performed once a month, it was measured only three times from reasons of time pressure of the work on this paper. The fourth month was allocated to measure the process after the changes.

The process map is presented on figure 17, including the data each actor needs to enter, enumerated in comments. The only task *Export excel sheet* is done once for all employees from given building together, otherwise each task is in loop, which expresses it needs to be performed once for each employee.

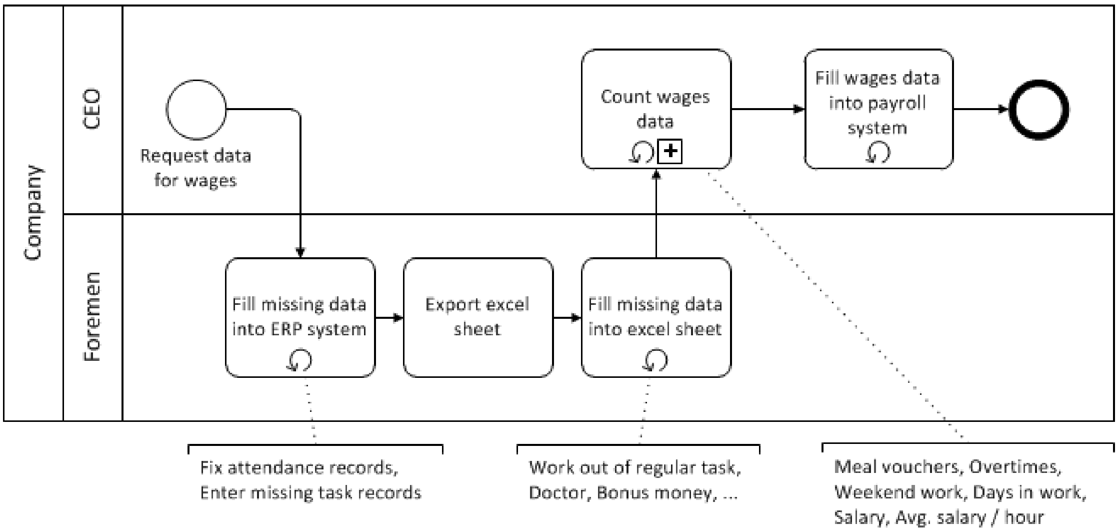

Figure 17: Process map of Evaluation and appreciation of the work (source: own work)

The table 9 shows average times the actors have spent in particular tasks during the process in last three months, when the measuring was performed.

Table 9: Task duration in process Evaluation and appreciation of the work (source: own work)

Task	Actor		
	Foreman A	Foreman B	CEO
Fill missing data into ERP system	0,5h	0,5h	-
Export excel sheet	0 h	0 h	-
Fill missing data into excel sheet	1,5 h	1,5 h	-
Count wages data	-	-	5,3 h
Fill wages data into payroll system	-	-	1,1 h
KPI: Total time in the process	2 h	2 h	**6,4 h**

All the values provided are summaries for all iterations performed in particular task and not as a time per one iteration. Usually, the KPI and all other times should be evaluated as time per employee, however since the amount of employees were not changed during the work on this paper, for better presentation purposes, the values were held in absolute numbers.

3.4.3 Analyse

Foremen use the knowledge about the progress of the manufacturing process and exceptions in it during the whole month, and also about a performance and behaviour of each employee. CEO however uses similar information only exceptionally and instead performs simple monotonic computations on supplied data.

During the process improvement, the focus is therefore put only on the tasks of CEO.

While considering improvement of the task *Count wages data*, is is important to remind, that all needed data are delivered to CEO in form of excel document, with records about one employee per sheet. When having all needed raw data, adding the correct equations equivalent to the CEO's computations directly into each sheet could replace the manual work of CEO during this task. After studying the equations and excel possibilities, this has proven to be a valid assumption.

Secondly, the improvement of the task *Fill wages data into payroll system* was also considered, with expectation of importing the data in some form into the payroll system, since it is possible to export the data from excel into several universal formats. However the payroll system used in the company is significantly old and does not provide any similar possibility of automatic nor manual import of the payroll data.

3.4.4 Improve

For better understanding, the example of the excel sheet produced by ERP system is shown in attachment 1 (values of performed tasks, as well as attendance records have been changed) and the same sheet accompanied by data from foremen is in attachment 2. In this form, the sheet comes to CEO. The blue cells contain the data about tasks done during the month and light yellow column is financial summary just for the tasks in a particular day.

Instead of performing manual calculations, the new template-sheet was prepared, containing all the equations. CEO opens that template-sheet and using the method Ctrl+C, Ctrl+V inserts the equations block, which is prepared in separated document. After the equations block is inserted to every sheet (for every employee), the document looks like attachment 3, having the dark yellow colour containing the summary for the whole day including various compensations. Also the summaries at the bottom of the sheet are added at once, containing all data needed for the payroll system.

This solution was chosen and approved by CEO as a sufficient compromise to advanced methods like excel-macros etc.

The length of the tasks after implementing this change are in table 10.

Table 10: Task duration in process Evaluation and appreciation of the work after improvement (source: own work)

Task	Actor		
	Foreman A	Foreman B	CEO
Count wages data	-	-	1 h (5,3)
Fill wages data into payroll system	-	-	1,1 h
KPI: Total time in the process	2 h	2 h	**2,1 h (6,4)**

The rows not influenced by the change were omitted and where the values have been changed, the original numbers are for comparison purposes in brackets next to the new values. After the change, the whole hour in task *Count wages data* is being spent on overall checks of the numbers and printing the records for cataloquisation purposes.

At the end, cost of the process was reduced by the cost of 4,3 hours of CEO's time (the company does not wish to share absolute values), which were saved by the proposed change.

3.4.5 Control

Since the implementation is considered successful, it needs to be standardized. The equation block in the separate template-sheet differs depending on amount of days in a month it will be used for. Therefore the separate template-sheet contains a different blocks of equations, customized for a months with 28, 29, 30 and 31 days. CEO just needs to pick the right one while copy-pasting it.

4 CONCLUSION

During the work on the theoretical part of the paper, the author gained information and knowledge about Business Process Management, with focus to process identification, implementation, measuring and monitoring. Information technologies were also mentioned in connection with the BPM, as well as brief description of selected well known production management methods.

During the work on first section of the practical part of the paper, author described the company environment. That is followed by deeper introduction of main business processes of the company, which helped to deeper understanding to those processes and prepared ground for the implementation.

During the implementation part, the selected business processes were studied deeply and some of them improved with following results. The company does not wish to publish any information about absolute values regarding the costs of the processes, therefore the cost reduction is expressed in relative amounts, with respect to the original values.

Molding was a process using a four smaller shoe-mold machines with average preparation and cleaning times, and also average performance. As a result of the work on this paper, three of those machines were replaced with one large molding-bridge machine with high performance and low amount of waste. Due to the high preparation and cleaning times of the new machine, the production planning for molding had to be changed, to lower down the amount of batches and to increase the batch size. That was done by using the internal ERP system, leading to total cost savings on wages equal to 2 wages per month and 7 % of the material due to the low waste of new machine.

Order registration, fulfilment and delivery was a process identified with performance decrease during the season periods. The process was deeply studied and four different approaches to improve it were offered, while two of them were actually deployed. None of them however led to satisfying results, therefore all changes have been reversed, leading to no cost reductions in this process.

The process of assembling the Evaluation and appreciation of the work and wages was identified to require a large amount of monotonic calculations performed by CEO. As a result of several proposals in data processing, beside of increases in resistance to errors of the process, the savings equal to 4,3 hours of CEO's time per month were achieved.

Last process to be improved was Research and Development. This was a process requiring large amounts of time for each new model development, including external and internal designers using handwork in most tasks and needing many iterations before the acceptable version of the model was made. Since the company was opened even to a radical improvements, several solutions were suggested. At the end, based on the findings of the author, the company has decided to buy industry-specific professional solution containing a software design-tool, digitizer and two-axis cutting plotter. That solution has decreased the length of the process from initial value of 51 days, to 18 days in total, while decreasing the involvement of external designer from 35 days to 13 days on one new model development. The proportions in process length improvements corresponds to proportions in process cost savings.

The thesis and it's results are overally considered to be a valuable contribution by the company management and experiences gained during the work are benefits for the author.

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LIST OF ABBREVIATIONS

BAM - Business Activity Monitoring

BI - Business Intelligence

BPM - Business process modeling

ERP - Enterprise Resource Planning

IS - Information system

KPI - Key Performance Indicator

MRP - Material Requirements planning

MRP II– Manufacturing resource planning

OPT - Optimized production technology

ROA - Return on Assets

ROE - Return on Equity

ROS - Return on Sales

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APPENDICES

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	Nováková																				
2			10 ra	42 le	45 le	47 le	48 le	50 le	8 vší	Mimo úkol	Součet	Poznámka	Minuty	dorovnání peníze	dorovnání čas						
3		1.7.12	10	210	30	40		120	160		283,2		410								
4		2.7.12	185	250		25	40	70	110		348,32	D	529								
5		3.7.12		619		60	40				319,9	D	536								
6		4.7.12		470	30		30		30		319,9	D	531								
7		5.7.12	265		50	130	70	60	110		331,2	S	539								
8		6.7.12	30	280	20	40		50	20		333,5	S	540								
9		7.7.12																			
10		8.7.12	70	360	10			40	160		283,2		540								
11		9.7.12	100	180					490		206,5	D	540								
12		10.7.12	10	210	30	40		120	160		283,2	D	540								
13		11.7.12	185	250		25	40	70	110		348,32	D	543								
14		12.7.12		619		60	40				319,9	D	538								
15		13.7.12		470	30		30		30		319,9	D	538								
16		14.7.12	265		50	130	70	60	110		331,2		417								
17		15.7.12	30	280	20	40		50	20		333,5		529								
18		16.7.12																			
19		17.7.12	70	360	10			40	160		422,7		536								
20		18.7.12	100	180					490		206,5		531								
21		19.7.12	10	210	30	40		120	160		283,2		539								
22		20.7.12	185	250		25	40	70	110		348,32		540								
23		21.7.12		619		60	40				319,9		410								
24		22.7.12		470	30		30		30		319,9		543								
25		23.7.12	265		50	130	70	60	110		331,2		540								
26		24.7.12	30	280	20	40		50	20		333,5		540								
27		25.7.12									409,11										
28		26.7.12	70	360	10			40	160		422,7		538								
29		27.7.12	100	180					490		206,5		538								
30		28.7.12	30	280	20	40		50	20		333,5		417								
31		29.7.12																			
32		30.7.12	70	360	10			40	160		422,7		529								
33		31.7.12	100	180					490		206,5		536								
34			2180	7927	450	925	540	1110	3910	0	8928	0	14007	0	0						
35																					
36																					

Attachment 1: Excel sheet with data for wages, not processed

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Nováková														
2			10 ra	42 le	45 le	47 le	48 le	50 le	8 vší	Mimo úkol	Součet	Poznámka	Minuty	dorovnání peníze	dorovnání čas
3		1.7.12	10	210	30	40		120	160		283,2		410		100
4		2.7.12	185	250		25	40	70	110		348,32	D	529		
5		3.7.12		619		60	40				319,9	D	536	50	
6		4.7.12		470	30		30		30		319,9	D	531	50	
7		5.7.12	265		50	130	70	60	110		331,2	S	539		
8		6.7.12	30	280	20	40		50	20		333,5	S	540		
9		7.7.12													
10		8.7.12	70	360	10			40	160		283,2		540		
11		9.7.12	100	180					490		206,5	D	540	50	
12		10.7.12	10	210	30	40		120	160		283,2	D	540		
13		11.7.12	185	250		25	40	70	110		348,32	D	543		
14		12.7.12		619		60	40				319,9	D	538		
15		13.7.12		470	30		30		30		319,9	D	538		
16		14.7.12	265		50	130	70	60	110		331,2		417		100
17		15.7.12	30	280	20	40		50	20		333,5		529		
18		16.7.12													
19		17.7.12	70	360	10			40	160		422,7		536		
20		18.7.12	100	180					490		206,5		531	50	
21		19.7.12	10	210	30	40		120	160		283,2		539		
22		20.7.12	185	250		25	40	70	110		348,32		540		
23		21.7.12		619		60	40				319,9		410		100
24		22.7.12		470	30		30		30		319,9		543		
25		23.7.12	265		50	130	70	60	110		331,2		540		
26		24.7.12	30	280	20	40		50	20		333,5		540		
27		25.7.12									409,11				
28		26.7.12	70	360	10			40	160		422,7		538		
29		27.7.12	100	180					490		206,5		538	100	
30		28.7.12	30	280	20	40		50	20		333,5		417	20	100
31		29.7.12													
32		30.7.12	70	360	10			40	160		422,7		529		
33		31.7.12	100	180					490		206,5		536		
34			2180	7927	450	925	540	1110	3910	0	8928	0	14007	320	400
35															
36															

Attachment 2: Excel sheet with data for wages, processed by foreman

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Nováková												
2			10 ra	42 le	45 le	47 le	48 le	50 le	8 vší	Mimo úkol	Součet	Poznámka	Minuty
3		1.7.12	10	210	30	40		120	160		283,2		410
4		2.7.12	185	250		25	40	70	110		348,32	D	529
5		3.7.12		619		60	40				319,9	D	536
6		4.7.12		470	30		30		30		319,9	D	531
7		5.7.12	265		50	130	70	60	110		331,2	S	539
8		6.7.12	30	280	20	40		50	20		333,5	S	540
9		7.7.12											
10		8.7.12	70	360	10			40	160		283,2		540
11		9.7.12	100	180					490		206,5	D	540
12		10.7.12	10	210	30	40		120	160		283,2	D	540
13		11.7.12	185	250		25	40	70	110		348,32	D	543
14		12.7.12		619		60	40				319,9	D	538
15		13.7.12		470	30		30		30		319,9	D	538
16		14.7.12	265		50	130	70	60	110		331,2		417
17		15.7.12	30	280	20	40		50	20		333,5		529
18		16.7.12											
19		17.7.12	70	360	10			40	160		422,7		536
20		18.7.12	100	180					490		206,5		531
21		19.7.12	10	210	30	40		120	160		283,2		539
22		20.7.12	185	250		25	40	70	110		348,32		540
23		21.7.12		619		60	40				319,9		410
24		22.7.12		470	30		30		30		319,9		543
25		23.7.12	265		50	130	70	60	110		331,2		540
26		24.7.12	30	280	20	40		50	20		333,5		540
27		25.7.12									409,11		
28		26.7.12	70	360	10			40	160		422,7		538
29		27.7.12	100	180					490		206,5		538
30		28.7.12	30	280	20	40		50	20		333,5		417
31		29.7.12											
32		30.7.12	70	360	10			40	160		422,7		529
33		31.7.12	100	180					490		206,5		536
34			2180	7927	450	925	540	1110	3910	0	8928	0	14007

	N	O	P	Q	R	S	T	U	V	W
2	dorovnání peníze	dorovnání čas	CELKEM	víken	přesč	stravenk	Práce	Přícho	Odcho	Pauzy
3		100	344,2167	410			6,8			
4			348,32			1	8,8	05:12	14:30	00:20:00
5	50		369,9			1	8,9	05:12	14:30	00:20:00
6	50		369,9			1	8,9	05:12	14:35	00:20:00
7			331,2			1	9,0	05:12	14:30	00:20:00
8			333,5			1	9,0	05:12	14:31	00:21:00
9			0	410			6,8	04:56	12:04	00:11:00
10			283,2	540			9,0			
11	50		256,5			1	9,0	05:12	14:30	00:20:00
12			283,2			1	9,0	05:12	14:30	00:20:00
13			348,32			1	9,1	05:12	14:35	00:20:00
14			319,9			1	9,0	05:12	14:30	00:20:00
15			319,9			1	9,0	05:12	14:31	00:21:00
16		100	392,2167	417			7,0	04:56	12:04	00:11:00
17			333,5	529			8,8			
18			0			1	8,8	05:12	14:30	00:20:00
19			422,7			1	8,9	05:12	14:30	00:20:00
20	50		256,5			1	8,9	05:12	14:35	00:20:00
21			283,2			1	9,0	05:12	14:30	00:20:00
22			348,32			1	9,0	05:12	14:31	00:21:00
23		100	380,9167	410			6,8	04:56	12:04	00:11:00
24			319,9	543			9,1			
25			331,2			1	9,0	05:12	14:30	00:20:00
26			333,5			1	9,0	05:12	14:30	00:20:00
27			409,11			1	9,1	05:12	14:35	00:20:00
28			422,7			1	9,0	05:12	14:30	00:20:00
29	100		306,5			1	9,0	05:12	14:31	00:21:00
30	20	100	414,5167	417			7,0	04:56	12:04	00:11:00
31			0	0			,0			
32			422,7			1	8,8	05:12	14:30	00:20:00
33			206,5			1	8,9	05:12	14:30	00:20:00
34	320	400	9492,037	3676	0	22	258,15			

	P	Q	R	S	T	U	V	W	X	Y	Z	AA
36	Definice Pracovní den			480								
37	Definice Přesčasu			120								
38	Definice aktuálního pr			36,61								
39	Definice čtvrtletního p			61,65								
41	14007	235										
42	14407	240										
44	Denní průměr informativní (z minulého měsíce =								292,88			
45	Přesčas týten min =			0,00	úpr.	0	konečný přes		0	příplatek	20,00%	0
46	Přesčas víkend min =			3676,00	úpr.	0	konečný přes		3676	příplatek	25,00%	944,3
47									Přesčas Celkem			944,3
49	Pracovní dny =								12			
50	Přepočtené pracovní dny (Celková suma hodin / 8)								30,009			
51	Suma Hodin								240,07			
52	Celkový součet (výkon + lekař + doplatky)								9492			
53	Prémie =								250			
54	Stravenky (25kč/den) =				22	dní			250			
55	Výpočet aktuálního průměru pro příští měsíc hodinový								39,539			
56	Výpočet aktuálního průměru pro příští měsíc denní								316,31			

Attachment 3: Excel sheet with data for wages, processed by foreman and CEO