



**SAVONIA**

# **FUNCTIONAL LOCATION STRUCTURE**

**DEVELOPMENT OF SAP ERP MACHINERY HIERARCHY**

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Field of Study Technology, Communication and Transport			
Degree Programme Degree Programme in Industrial Engineering and Management			
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Title of Thesis FUNCTIONAL LOCATION STRUCTURE - DEVELOPMENT OF SAP ERP MACHINERY HIERARCHY			
Date	21.04.2016	Pages/Appendices	23/1
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Client Organisation /Partners UPM Kymmene Wood Oy, Jukka Rantasalo			
<p>Abstract</p> <p>The purpose of this thesis was to implement and increase the usability of already existing resources by creating a new operating model for continuous development of the Functional Location Structure in mechanical wood processing environment. The Functional Location Structure includes an available hierarchy and spare part listing for the existing machinery at the mill.</p> <p>The development of the Functional Location Structure creates the preconditions to generate up to date information for maintenance workers of the mill's machinery spare parts as well as their usage amounts, also including the repaired and updated machines. By using a Functional Location Structure can be ensured that the costs and spare parts levels of use are segmented in the correct cost centers. At the same time the risk of using incorrect materials is minimized.</p> <p>The new operating model was designed to create the possibilities for maintenance workers to operate at the central warehouse's spare part environment in such a way that the needed spare parts would be faster to find and stock control would be better, especially outside of warehouse's normal opening hours.</p> <p>For personnel detailed instructions on how to use a Functional Location Structure were created. Instructions were done in such a way that each party that uses the software will be recognized according to their job description. In the thesis it was aimed at facilitating the planning of revisions of the maintenance supervising. The main goal of the thesis to add value for maintenance and central warehouses operations as well to improve their cost-effectiveness with the new operating model.</p>			
Keywords SAP, ERP, FUNCTIONAL LOCATION STRUCTURE, NEW OPERATING MODEL			
Public			

## PREFACE

After finishing this thesis, I want to present my thanks for all of the people who were taking part in promoting this project. Especially I want to thank UPM-Kymmene Wood Oy and Savonlinnas plywood mill for giving me the possibility to work there for the passed four summers as well as this opportunity to do my final thesis on an interesting topic.

I also want to thank Savonia University of Applied Sciences Varkaus department and its personnel for an interesting study program and for the possibility to work in an international environment.

In Savonlinna 21.04.2016

Savonia University of Applied Sciences

Niko Linnamurto

## ABBREVIATIONS AND DEFINITIONS

SAP	German software producing company
ERP	Enterprise resource planning software
Functional location structure	Structure for existing production lines, machines and spare parts used in the mill
Functional location	Production line which is connected to Functional Location Structure
Equipment	Machine which is connected to Functional Location in the Structure
Material	Spare part which is connected to equipment in the Structure
Revision	Period of time which is reserved for maintenance work when the production is shut down
Machinery hierarchy	Functional Location Structure is called also as machinery hierarchy, especially in Finnish
Transaction	In the SAP ERP software different functions are called as transactions
Operator	Worker in the production line
Malfunction report	Report of the error from the production to maintenance which is done to ERP
Maintenance request	Request for maintenance work from production which is done to ERP
Moving equipment	Forklifts and pallet lifters connected to Functional Location Structure is found with the name of moving equipment from Structure
MRO	Maintenance, repair and overhaul
JIT-filosofy	Justi in time filosofy

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## 1 INTRODUCTION

The idea of topic for the thesis started during my work for UPM last summer. Based on the discussions with colleagues and supervisors it was noticed that there is a need for development work of SAP ERP Functional Location Structure.

The development work was started by making a necessary critical evaluation of the starting usage level and by finding out the situation with the amount of "Functional Location", "Equipment" and "Material" connections to Structure. Next thing a plan was made on how the development work will be implemented and how the system will be developed and managed continuously in the future. It was decided to make a totally new working model for usage and development of Functional Location Structure. Maintenance supervising made the decision that the new working model will be part of daily tasks of maintenance.

In the thesis it was aimed at implementing and increasing the usability of already existing resources. The new operating model was created in order to develop Functional Location Structure through usage cycle of the materials. The purpose of this method is that the central warehouse workers add the connections for the materials to Structure, when the maintenance workers replace materials for machines. From now on new materials connections are added when the material is ordered for the first time. In this way it is ensured that the particular material is connected to correct equipment in Structure and it keeps Structure upgrading all the time.

The goal for the new operating model was to make the use of Functional Location Structure as clear and simple as possible with helpful and comprehensive instructions. It was aimed at improving the usage level as high as possible to reach the benefits of the system.

1.1 Mindmap

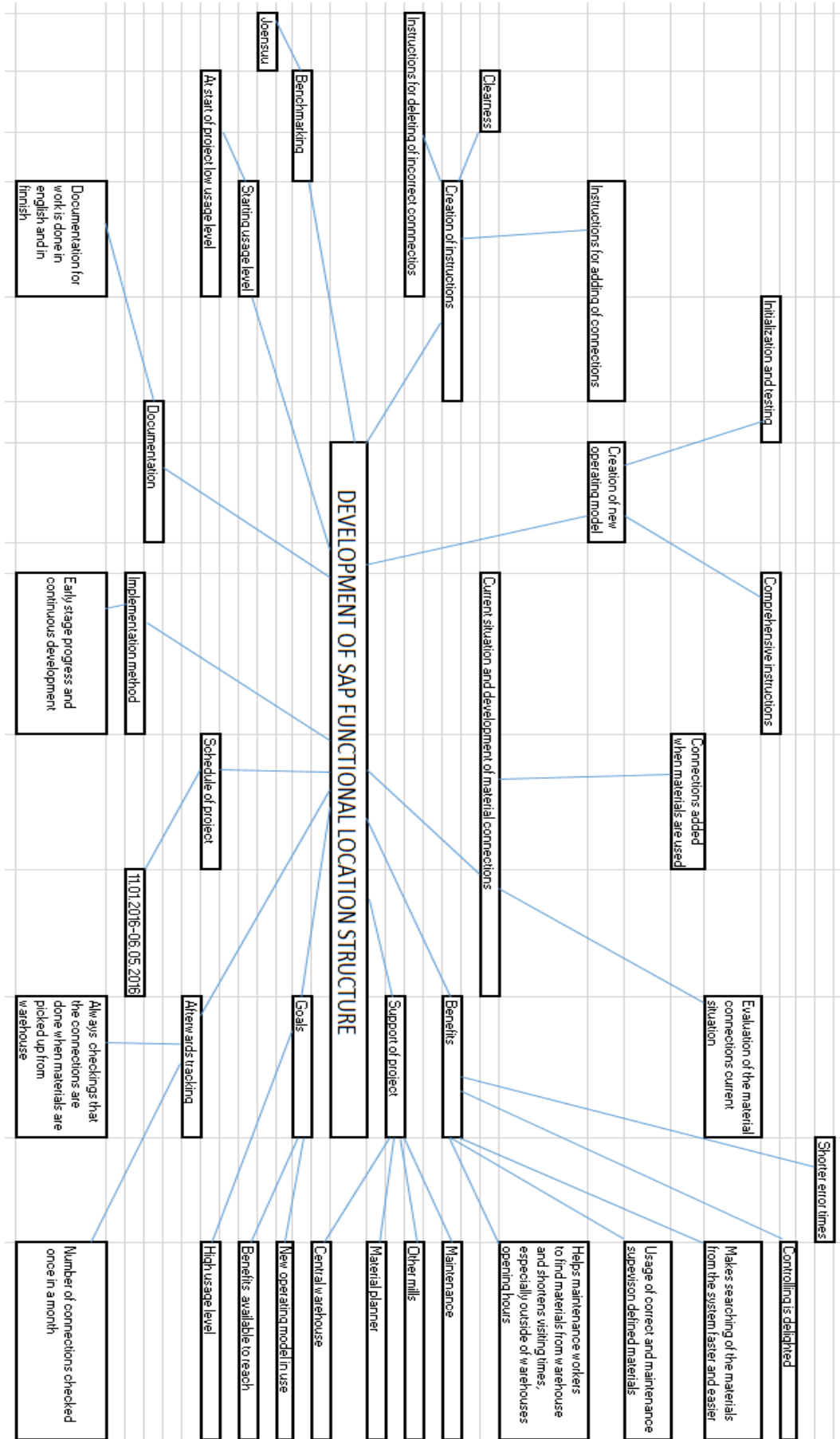


FIGURE 1. Mindmap of the project (Linnamurto 2016-01-17)

## 2 COMPANY INTRODUCTION

### 2.1 UPM-Kymmene Oyj

UPM-Kymmene Oyj is a Finnish concern, which operates in wood industry. The UPM concern was founded when Kymmene Oy and Repola Oys subsidiary United Paper Mills (UPM) were united in the autumn 1995. UPM concerns first paper and groundwood mills started operating at the 1870's. After that in the 1880's concern expanded to manufacturing of pulp and then to plywood at the 1910's. Paper processing business took a place in the 1920's. (UPM Homepages)

UPM-Kymmene Oyj is involved in 10 different business areas, which are listed below.

- Biochemicals
- Biocomposites
- Biofuels
- Energy
- Forest
- Labels
- Paper
- Plywood
- Pulp
- Timber

UPM has production plants in 13 different countries and a global sales network on 6 continents covering the whole world. At the end of year 2015 UPM's turnover was 10 138 million euros and the total personnel was 19,578 employees all over the world, whereof around 38% was working in Finland, so UPM employed approximately 7400 people in Finland. (UPM Homepages)



Picture 2. UPM's global operations (UPM Homepages 2016-04-11)



## 2.2 UPM-Kymmene Wood Oy (Plywood)

UPM has nine plywood mills and seven of them are operating in Finland, other two mills are located in Estonia and Russia. UPM is the largest manufacturer of plywood products in Europe. Plywood business area produced a turnover of 439 million euros in 2015 which is 4% of the total turnover. In the year 2015 personnel amount of UPM plywood was 2469 and the maximum production capacity is 975,000 m<sup>3</sup> per year. Plywood businesses products are coated smooth plywood, veneer, coated patterned plywood and uncoated plywood. For the products different coatings and dimensions depending of the end usage can be chosen.

UPM manufactures plywood products for six main end uses:

- Concrete forming
- Construction
- Vehicle flooring
- LNG carriers
- Buses
- Parquet

### 2.2.1 UPM-Kymmene Oy, Savonlinna's plywood mill

UPM Savonlinna mill produces mainly birch plywood for transport and construction industry. The speciality of the plywood mill is ability to make maxi sized panels with max dimensions up to 13,5 m x 2,8 m. Of Savonlinna's production approximately 80% of the products are further processed. In Savonlinnas mill there are approximately 270 employees and the maximum production capacity of the mill is 100,000 m<sup>3</sup> per year. (WELCOME TO SAVONLINNA PLYWOOD MILL, General overview)

Environmental performance of Savonlinna mill

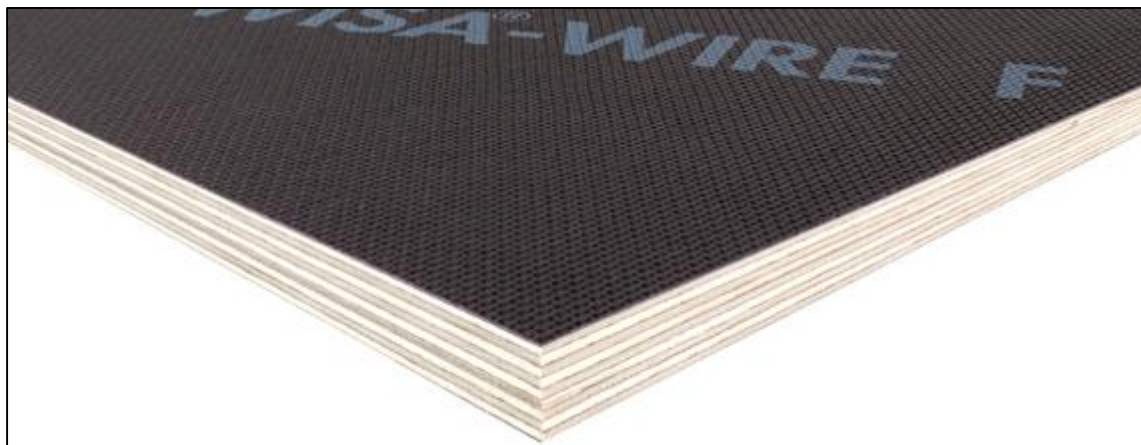
- Waste water treatment: 100% goes through treatment plant
- Bio-energy: 91% of production
- Wood: 100% of used wood comes from sustainably managed forests



Picture 3. UPM Savonlinna plywood mill (UPM Homepages 2016-04-11)

### Savonlinna mill's products

- WISA-Wire
- WISA-Form
- WISA-Form Stone
- WISA-Hexa
- WISA-Birch



Picture 4. Product Wisa-Wire F (UPM Homepages 2016-04-12)

### 2.2.2 History

Savonlinna's plywood mills facilities were reopened for use in 1921 when Oy Wilhelm Schauman AB started manufacturing of plywood in former Eastern Finland weaving mill facilities. The mill was unfortunately totally destroyed in fire at 1930, but afterwards it was rebuilt immediately. The production of the maxi sized plywood plates was started 1973 and in 1980 fibreboard and blockbord mill were shut down as well as the saw mill. The companies Kymmene Oy and Schauman Oy merged in 1988 and then 1995 UPM-Kymmene Oyj concern was founded. UPM-Kymmene Wood Oy was established in 2004.

### 3 SAP ERP

SAP SE is a German company and a provider of systems and products for data management. SAP is Europe's biggest software producer and fourth biggest in the whole world, SAP is also largest ERP (enterprise resource planning) software producer in the world. ERP is one of the categories that SAP is offering for customers and companies worldwide. UPM started to use SAP software at the end of 2004. ERP is a software which is designed for business management of companies. With ERP it is possible to collect, manage and store information of companies processes and business activities to databases. (SAP Homepages)

ERP can be included and used for different kind of sections, for example:

- Material planning
- Warehousing management
- Production planning
- Accounting and payrolling
- Shipping and payment management
- Marketing and sales
- Manufacturing and delivery processes
- Project management
- Maintenance management

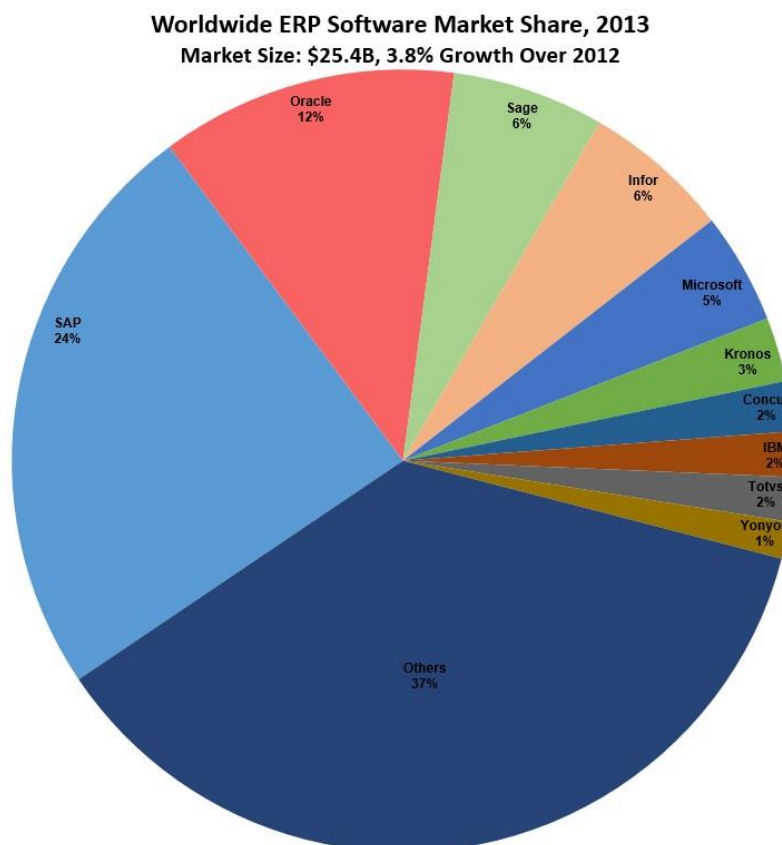


Figure 5. Worldwide ERP Software Market Share, 2013 (Forbes web pages 2016-04-16)

### 3.1 SAP ERP - FUNCTIONAL LOCATION STRUCTURE

Function Location Structure is a transaction in ERP where all the machinery and spare parts used in the mill can be included and connected. All connections to Functional Location Structure together form a structure list of a mill. Every Functional Location and equipment does have its own number in the plant's Functional Location Structure. The spare parts are called materials and they have their own material number in mill's usage, but they can also be used globally.

Functional location can be for example, "Grinding and sorting" and every Functional Location can include sub Functional Locations, "Grinding line1, Grinding line2 etc." or equipments "Grinding machine1 etc.". Then the equipment includes the materials (spare parts for machine). Also to materials sub materials can be connected, for example for pneumatic cylinder can be connected suitable seal kit as a sub material.

### 3.2 PREVIOUS USAGE AND USABILITY OF THE SYSTEM

Earlier in some of the cases when the production faced error in the machine, the operator who was working on the machine, made a call to maintenance workers and sometimes did not inform shift foreman about the problem. It is always necessary to inform both of them, because if the shift foreman doesn't know that there is an error in the production, he is not able to do malfunction report. When the report is done, the ERP system creates a number for that specific report and the maintenance workers need to have that number to open up a work order for that particular work. As a result of that, earlier maintenance workers did not always have the work order number with them when they came to pick up materials from the warehouse. That kind of action caused a problem, because the materials which are picked up from the warehouse need to be deleted from the ERP by using the work order number.

Earlier usage level of the Functional Location Structure was not high, because of the small amount of material connections to structure and a lot of connections were missing. Even though already a good groundwork was done with the amount of Functional Locations and equipments. Previously there was a lack of resources to add material connections to Functional Location Structure and mainly the connections were made only for new or high importance materials. Lack of material connections had a high impact on usability, because when the needed materials are not connected to Functional Location Structure, finding them in warehouse gets a lot harder especially for maintenance shift workers if they are going to pick up materials from warehouse, out of its normal opening hours and the searching of materials can take a long time.

## 4 NEW OPERATING MODEL

### 4.1 Production

In production Functional location structure is used for sending malfunction report or maintenance request. As mentioned earlier this is also very important, because the system creates a number for that particular work. When the operator who is working on the machine notices the error in the machine, which affects production a malfunction report is always done. In cases if machine has some not urgent problem that is not affecting work of machine maintenance request can be used. In both of the cases shift foreman needs to target the correct Functional Location or equipment to malfunction report or to maintenance request. To make targeting of the correct Functional Locations easier, the operators were told to inform the Functional Location number which is found in the frames of the machines. The operators were also told to always inform the shift foreman as well about the errors.

### 4.2 Maintenance

Now when the maintenance workers are informed of the error and they have analysed the problem, and when the malfunction report is done, maintenance workers can open up a work order. Then it is possible to open a list attached to the order, which is showing content of the Functional Location or equipment where the notification has been targeted. Otherwise the whole Functional Location Structure can be opened, searched from there the correct equipment and by opening that needed materials, their stock availability and their warehouse locations. If missing material connections are noticed at this point, the fact needs to be informed to the maintenance supervising or central warehouse personnel. After choosing the correct materials and amounts, a document can be printed out and at that point the ERP system will make a reservation for the chosen materials. The print of a document will come to the warehouse printer and from the document it is possible to see once again the locations of the materials at the warehouse. When the materials are found, the printed document will be left in the mail box of the warehouse. To make informing of the missing connections easier for maintenance shift workers, information of missing material connection can be marked also to the document before leaving it to the warehouse, including information of equipment number which the connections are to be added. For new Functional Locations, equipments or materials connections are made by maintenance supervising. From now on the connections are made for new materials at the same time, when the material number is sought or ordered first time.

### 4.3 Central warehouse

In central warehouse the personnel makes the connections for materials when the maintenance workers are informed of the missing connections. Warehouse personnel can also help maintenance workers on how to use ERP if needed and give guidance for usage of the software as well. Warehouse operators check the documents that are left to warehouse in the mail box and delete the materials from ERP. In this way the ERP system will automatically make orders for those materials that have been set the material planning parameters and which are going under ordering point. If the materials which are going to use and will be deleted from a system don't have material planning parameters, the warehouse personnel will ensure the maintenance supervising that the materials need to be reordered immediately or possibly later on.



Figure 6. The dependence of three main sectors on each other (Linnamurto 2016-04-15)

4.4 Process chart

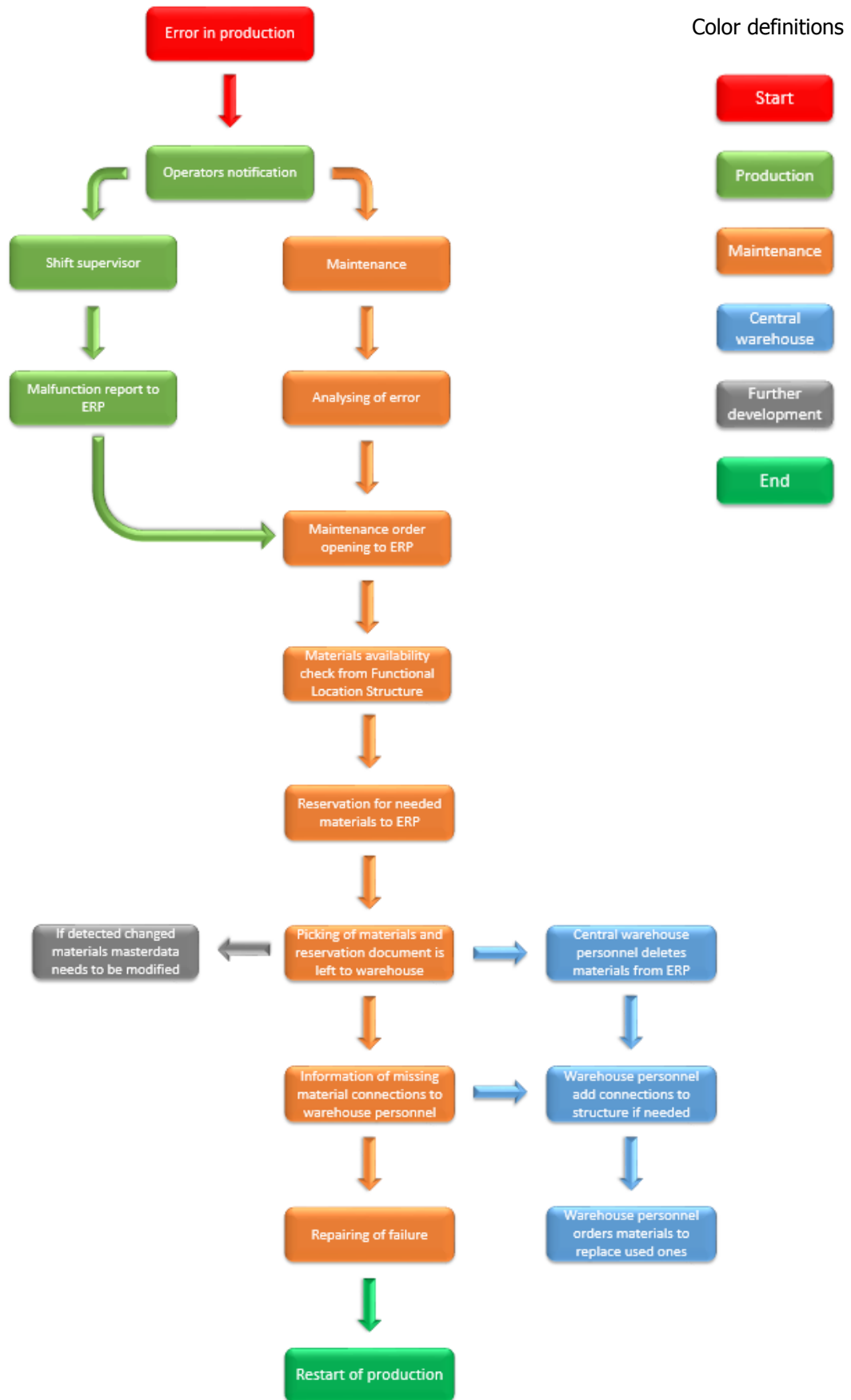


Figure 7. Process chart (Linnamurto 2016-04-18)

## 5 RESOURCES

### 5.1 Schedule of project

- Start of the project on the 11.01.2016
- Testing of new working model and initialization on 29.02.2016
- Project finished for the client organization on 06.05.2016

### 5.2 Tools, permissions and working environment

UPM Savonlinna's mill offered a possibility work in mill's facilities. There an office in central warehouse for implementation of this project work was reserved. The office was meant to be used mainly during the normal working week from 7 am to 15:30 pm which are opening hours of central warehouse. Also a computer was reserved for personal usage and the permissions to use the SAP ERP software with the transactions needed in the project work.

### 5.3 Support for project and organized meetings

#### Project support

- Mill management
- Maintenance supervising and other maintenance personnel
- Material Planner and other central warehouse personnel
- Other mills

#### Meetings

- Project starting meeting 14.01.2016 J. Rantasalo, J. Kuikka, K. Heikkinen and V. Löppönen
- Presentation of a topic for production 03.02.2016 J. Rantasalo, A. Kotro, P. Karjalainen, M. Hintikka and V. Löppönen
- Reviewing project progress 09.02.2016 J. Rantasalo, J. Kuikka, K. Heikkinen and V. Löppönen
- Presentation of a topic in maintenance team meeting 25.03.2016 Maintenance personnel and Central warehouse personnel
- Meeting concerning logics 14.03.2016 J. Rantasalo, K. Heikkinen and M. Kuosmanen

### 5.4 Benchmarking

On 29.01.2016 there a meeting was organized in Joensuu with the following participants: Joensuu's and Savonlinna's Material Planners, Joensuu's warehouse operator, Joensuu's maintenance worker and the author. Meeting was concerning the usage level, usage experiences and development of the Functional Location Structure in Joensuu's mill. As a result, at the meeting some improvement ideas for Savonlinna's system were found for example display of warehouse location and stock availability information of materials were added to system.



## 6 MAIN GOALS AND BENEFITS

The main goals of this project were to create a new efficient way to develop Functional Location Structure continuously with a high usage level of the system between workers afterwards. The aim was to create new operating model in such a way that the whole chain of operations will be considered and thought through to make the new model working as smoothly as possible. Also there was a target to create clear and simple instructions for usage of the needed transactions in SAP ERP system. By these earlier mentioned actions, the goal was to expand the number of material connections to Structure.

With the project client organization multiple benefits can be reached. With the usage of the new working model, searching of materials from the system will become easier and faster. In some cases, that can reduce a lot of maintenance workers visiting time in the warehouse, especially out of warehouse's normal opening hours. This will have straight effect on error times in the production, because if the needed material is found faster the maintenance worker will be able to be in the correct place more quickly and this will reduce the whole maintenance process.

From now on when the reservations for the materials are done, the costs are directed to the correct cost centers and the maintenance is easier to check. From the point of view of warehouse material flow controlling it is very useful when the reservations are done for the materials, because it will minimize the risk that the wrong materials would be deleted or for some reason materials would not be deleted at all from the system. In that way it gives more value to tracking of materials and controlling of warehouse. This may also help to find some particular error case in some machine by comparing the maintenance history. All the time when the Functional Location Structure will have more material connections the planning of the revisions will be easier for the maintenance supervising. According to upper mentioned, maintenance supervisors can find out easier the materials list for the machines and pick up from there the materials with amounts which are going to be reserved for revisions. This will also have a positive effect on relationship between maintenance and purchasing departments, because when maintenance supervising can plan and reserve needed materials for revisions earlier it gives more time for purchasing to prepare and tender out the materials.

With all of these actions together the cost efficiency of the whole maintenance chain can be improved. When the chain of operations has more relationships of employees with different kind of job descriptions involved, controllers are delighted as well. One of the most important things is that when the error time is shorter in production that will reduce the costs that stopping of production causes and on the other hand this can increase the running time of production and effectiveness of production process.

## 7 IMPLEMENTATION OF WORK

### 7.1 Phases of project

The project was started by planning firstly the projects stages and the schedule. Then starting meeting was organized according to project and its main goals. After that was made critical evaluation of the systems usage level and the situation with the number of connections to Functional Location Structure (*Appendice 11, Analyses of material connections starting situation*). In central warehouse there are shelves for some of the mill's machines and that was usefull for making analyses of the situation with the material connections. At the same time while making the analyses if missing material connections were noticed they were added to Structure, in cases when usage equipment was clear.

For the training of using the system, there were added for example material connections for moving equipment which consists of forklifts and pallet lifters (*Appendice 10, Spare parts list for forklifts*). Also lathe shelves were checked, with one maintenance worker who close to retirement. With his help and knowledge, it was possible to make numerous of material connections for lathes to the system.

Next were started planning of the new operating model and creating the instructions for usage of the system. While the implementation process the topic of the project was presented also for production management. After the meeting a map of the mill's existing computers for common use with development engineer was done (*Appendice 9, Map of mills common usage computers*). Next milestone was to present the new operating model at the maintenance team meeting and start the testing of the model. When the new model was at the testing stage and taken to use, the instructions were handed over for workers and at that point adding of the material connections became more active.

### 7.2 Creation of a new operating model

As mentioned earlier to reach a smooth chain of operations it was needed to investigate precisely how the system worked earlier. After that the methods how the whole chain will become useful and fluent had to be thought and planned. In central warehouse there is now reserved a computer for use of the maintenance workers, to bring the tools easily available. With this action it was attempted to get the personnel start to use the new working model on daily basis and will be committed for usage. That is very important for reaching the benefits which were sought with the project. When the decisions of the methods were done, the instructions for all of the workers who are working as a part of the operations chain had to be created.

### 7.2.1 Instructions

Instructions for the workers needed to be categorized according to their job descriptions. The idea was to create clear and understandable instructions with specific examples. The instructions were done in Finnish and English to enable the usage of them in other mills also abroad. English instructions were done only for maintenance, warehouse and production, because they do still include all the same instruction slides as the Finnish version. In the Finnish version, instructions are categorized further and they are shared according to employee's job descriptions. Central warehouse personnel can give guidance for the use of the software if needed.

Finnish instructions were done separately for:

- Maintenance supervising (*Appendice 1, Instructions Maintenance supervising*)
- Maintenance dayshift workers (*Appendice 2, Instructions Maintenance dayshift workers*)
- Maintenance 3-shift workers (*Appendice 3, Instructions Maintenance 3-shift workers*)
- Central warehouse (*Appendice 4, Instructions Central Warehouse*)
- Production (*Appendice 5, Instructions Production*)

English instructions were done separately for:

- Maintenance (*Appendice 6, Instructions Maintenance*)
- Warehouse (*Appendice 7, Instructions Central Warehouse*)
- Production (*Appendice 8, Instructions Production*)

The most important thing in the warehouses instructions was that it needed to be found how to add and delete material connections. There is also help for example how to find quickly all the material connections to the whole Functional Location Structure for one particular material. The maintenance supervising instructions have quite a lot of similarities with warehouse instructions.

For the maintenance worker's instructions, it was included how to open up and use Functional Location Structure from the start. There are also instructions for opening and searching the equipment and the material lists. On the other hand, if it is wanted to add materials for work orders instructions on how to do that in the easiest way can be found. For the maintenance shift workers, the instructions are a little bit wider than for dayshift.

For production, instructions are shorter and they include how to make malfunction report or maintenance request by getting a benefit of Functional Location Structure. From the instructions is also possible to find the example of Functional location number attached to machine.

## 8 FURTHER DEVELOPMENT

Obviously the Functional Location Structure needs to be developed and updated all the time to keep it up to date. Especially during the summer revisions when maintenance and repairing work is done for most of the mills machinery there will be an opportunity to add a lot of material connections to Structure. For further development of a system there is a wide range of different aspects that could be improved.

In the system the mechanical and electrical materials could be differentiated in their own categories, this would make the list of materials clearer in the Structure.

Even though the system is mainly for MRO materials also added production critical materials could be as well.

For the connected materials there can be added more detailed and relevant information or instructions for the installation. For example, from usage amount of the conveyor chain it is possible to add information on how many links of the chain is used when it is replaced for some particular machine.

For the materials there would also be a possibility to add pictures from sketches or photos to help, for example installation process.

If the maintenance workers would have tablets which would be durable and have enough performance to run the SAP ERP system, it could improve this working model's functionality, effectiveness and save maintenance workers time in some cases.

## 9 CONCLUSIONS

As an outcome of this thesis a new working model to develop Savonlinna mill's SAP ERP Functional Location Structure was successfully created. During this year it will be noticed how this new working models usage level has developed. Number of connections to Functional Location Structure will be tracked afterwards by checking once at the end of a month the progress compared to previous month is connections. The results have already been tracked from the beginning of 2016 till the end of March 2016 and they can be seen below (*look below figure 8*). Especially the summer revision will have large impact to adding of connections, because of the wider amount of maintenance work.

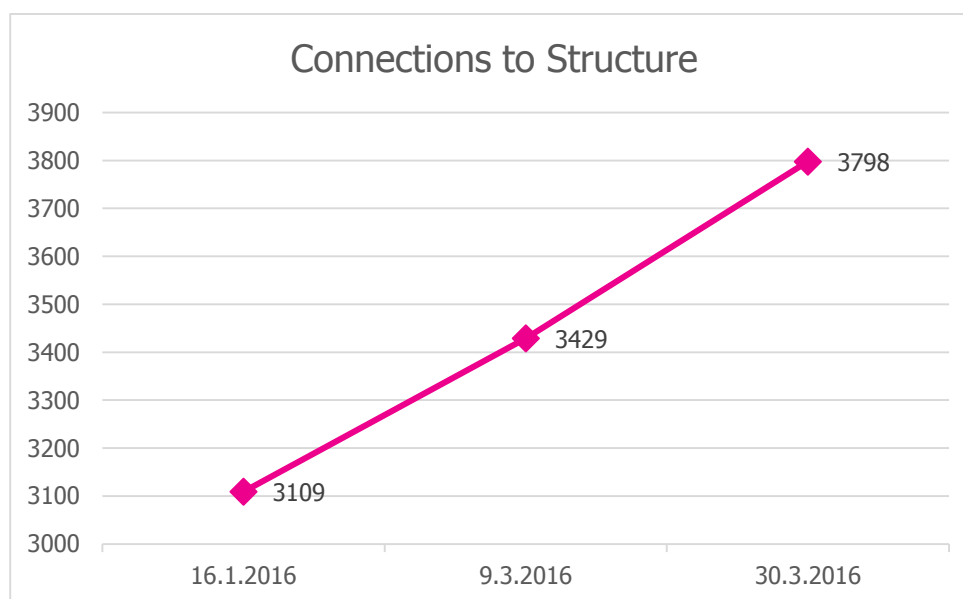


Figure 8. Development of the connections to Structure (Linnamurto 2016-04-19)

It is possible to expect that when the system is in use the error times can become shorter and the production restarted faster in some cases. At some point new system can also release capital which is invested in the warehouse. Because the maintenance supervising can be planning not only the revisions but also maintenance days for machines earlier then the system works in accordance with the JIT-filosofy (*Mindtools web pages*). That is based on a correct timing of ordering and receiving. This will generate a possibility to store materials in the warehouse for a shorter period of time.

If this new system will work as it is meant to, then it can be supposed that some of the other mills might be interested in trying system as well. It is important that the personnel who is working as a part of the operations chain is committed to using the system actively and it seems that the start has been promising. In that way it is possible to get best results from the system.

## FIGURES

1. Linnamurto, Niko 17.01.2016. Mindmap of the project [figure]. Location: Savonlinna: authors electrical collections
2. UPM Homepages 11.04.2016. UPM's global operations [picture]. Available: <http://www.upm.com/Businesses/Global-operations/Pages/default.aspx>
3. UPM Homepages 11.04.2016. UPM Savonlinna plywood mill [picture]. Available: <http://www.wisaplywood.com/fi/yhteystiedot/tuotantolaitokset/savonlinna/Pages/default.aspx>
4. UPM Homepages 12.04.2016. Product Wisa-Wire F [picture]. Available: <http://www.wisaplywood.com/Products/product-catalogue/wisa-wire-f/Pages/Default.aspx>
5. Columbus, Louis 14.04.2016. Worldwide ERP Software Market Share, 2013 [figure]. Available: <http://www.forbes.com/sites/louiscolombus/2014/05/12/gartners-erp-market-share-update-shows-the-future-of-cloud-erp-is-now/#7e9f357474a1>
6. Linnamurto, Niko 15.04.2016. The dependence of three main sectors on each other [figure]. Location: Savonlinna: authors electrical collections
7. Linnamurto, Niko 18.04.2016. Process chart [figure]. Location: Savonlinna: authors electrical collections
8. Linnamurto, Niko 18.04.2016. Development of the connections to Structure [figure]. Location: Savonlinna: authors electrical collections

## REFERENCES

## PUBLISHED MATERIALS

WELCOME TO SAVONLINNNA PLYWOOD MILL, may 2013. General overview

## ONLINE PUBLICATIONS

UPM Homepages [11.04.2016]. Available: <http://www.upm.fi/Liiketoiminnot/tuotantolaitokset/Pages/default.aspx>

UPM Homepages [11.04.2016]. Available: <http://www.upm.com/About-us/Pages/default.aspx>

UPM Homepages [11.04.2016]. Available: <http://www.upm.com/Businesses/Pages/default.aspx>

UPM Homepages [13.04.2016]. Available: <http://user-fudicvo.cld.bz/UPM-annual-report-2015#2-3>

SAP Homepages [15.04.2016]. Available: <http://go.sap.com/index.html>

Mindtools Web pages [20.04.2016]. Available: [https://www.mindtools.com/pages/article/newSTR\\_78.htm](https://www.mindtools.com/pages/article/newSTR_78.htm)

## OTHER REFERENCES

Project starting meeting [14.01.2016] J. Rantasalo, J. Kuikka, K. Heikkinen, V. Löppönen and author

Presentation of a topic for production [03.02.2016] J. Rantasalo, A. Kotro, P. Karjalainen, M. Hintikka, V. Löppönen and author

Review project progress [09.02.2016] J. Rantasalo, J. Kuikka, K. Heikkinen, V. Löppönen and author

Presentation of a topic in maintenance team meeting [25.03.2016] Maintenance personnel, Central warehouse personnel and author

Meeting concerning logics [14.03.2016] J. Rantasalo, K. Heikkinen, M. Kuosmanen and author

## APPENDICES

1. Linnamurto, Niko 18.02.2016. Ohjeet Kunnossapito Työnjohto (Instructions Maintenance supervising) [21 Powerpoint slides] Confidential
2. Linnamurto, Niko 22.02.2016. Ohjeet Kunnossapito päivävuoro (Instructions Maintenance dayshift workers) [16 Powerpoint slides] Confidential
3. Linnamurto, Niko 19.02.2016. Ohjeet Kunnossapito 3-vuoro (Instructions Maintenance 3-shift workers) [21 Powerpoint slides] Confidential
4. Linnamurto, Niko 09.02.2016. Ohjeet Keskusvarasto (Instructions Central Warehouse) [27 Powerpoint slides] Confidential
5. Linnamurto, Niko 24.02.2016. Ohjeet Tuotanto (Instructions Production) [6 Powerpoint slides] Confidential
6. Linnamurto, Niko 18.03.2016. Instructions Maintenance [20 Powerpoint slides] Confidential
7. Linnamurto, Niko 11.03.2016. Instructions Central Warehouse [27 Powerpoint slides] Confidential
8. Linnamurto, Niko 21.02.2016. Instructions Production [6 Powerpoint slides] Confidential
9. Linnamurto, Niko 28.03.2016. Map of mills common usage computers [Powerpoint slide] Confidential
10. Linnamurto, Niko 29.03.2016. Spare parts list for forklifts [Excel file] Confidential
11. Linnamurto, Niko 02.02.2016. Analyses of material connections starting situation [27 Excel files] Confidential