Requirements for Manufacturing Operations Management and Control Systems in a Dynamic Environment

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ABSTRACT

In today's highly dynamic manufacturing environment smooth information flow between planning and shop floor level is essential to ensure rapid reaction to changes. Unfortunately, the currently utilized dispersed MS Excel applications for production scheduling and control don't provide such an information flow. The transparency between different operational levels, and therefore the big picture, is lacking. To illustrate these challenges, this paper presents the first results of interviews, conducted among Finnish machine building companies, relating to the current practices and challenges as well as future requirements for manufacturing operations management and control systems.

1. INTRODUCTION

Today's manufacturing environment is characterized by rapidly changing requirements in terms of customized products, fluctuating and unpredictable demand, small batch sizes, and increasing regulations. The manufacturing systems have to flexibly and competitively adapt to these frequent changes, disturbances and other events that can not be foreseen, at least not in detail. In such a dynamic environment, the information systems are becoming more and more important. The manufacturing operations information needs to be effectively managed and served in a way which supports the production planners, managers and operators in their daily tasks, and facilitates rapid decision making and fast reaction to changes. This is especially crucial in Lean manufacturing [1], which targets to smooth, continuous material and information flow, wide involvement of the operators in problem solving as well as continuous learning and improvement.

Most of the manufacturing companies have implemented Enterprise Resource Planning (ERP) systems, which facilitate the business planning as well as high level production scheduling and materials management. The Manufacturing Operations Management (MOM) and Manufacturing Execution System (MES) landscape, on the other hand, is currently highly unconsolidated [2][3]. Especially in smaller companies, the detailed production scheduling, dispatching and operations control are commonly performed by various MS Excel spreadsheets, which are not integrated with other IT systems of the company. The information flow, which should pass through the planning and shop floor levels and systems, does not exist.

To illustrate how big the above mentioned challenges are in practice, this paper presents the first results of interviews conducted during national LeanMES-project among Finnish manufacturing companies. The interviews regard the current status of the manufacturing operations management and control, as well as requirements for future manufacturing IT-systems. The interviews cover the following topics: 1) Current production planning and scheduling practices, associated tools and encountered challenges; 2) Practices and challenges on shop floor operations level; 3) Key Performance Indicators (KPIs) currently followed and desired in the future; 4) Currently utilized Lean practices and status of Lean implementation. The goal of the interviews is to define practical requirements for future manufacturing operations management systems. The ultimate goal of the LeanMES project (2013-2017) is to provide a lean, scalable and extendable concept for new type of MES that supports the human operator in a dynamically changing environment.

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2. BACKGROUND

2.1. MES/MOMS LANDSCAPE

According to the ISA-95 standard part 3, *"the activities of manufacturing operations management (MOM) are those activities of a manufacturing facility that coordinate the personnel, equipment, material and energy in the conversion of raw materials and/or parts into products. They include activities of managing information about the schedules, use, capability, definition, history and status of all the resources within and associated with the manufacturing facility."* [4] The standard defines a large number of tasks belonging to the Manufacturing Operations Management (MOM) level. These tasks are grouped in sets of activities in a generic activity model illustrated in the right side of Fig. 1. The same model can be applied to four categories of operations management, including: Production operations management; Maintenance operations management; Quality operations management; Inventory operations management. [4]

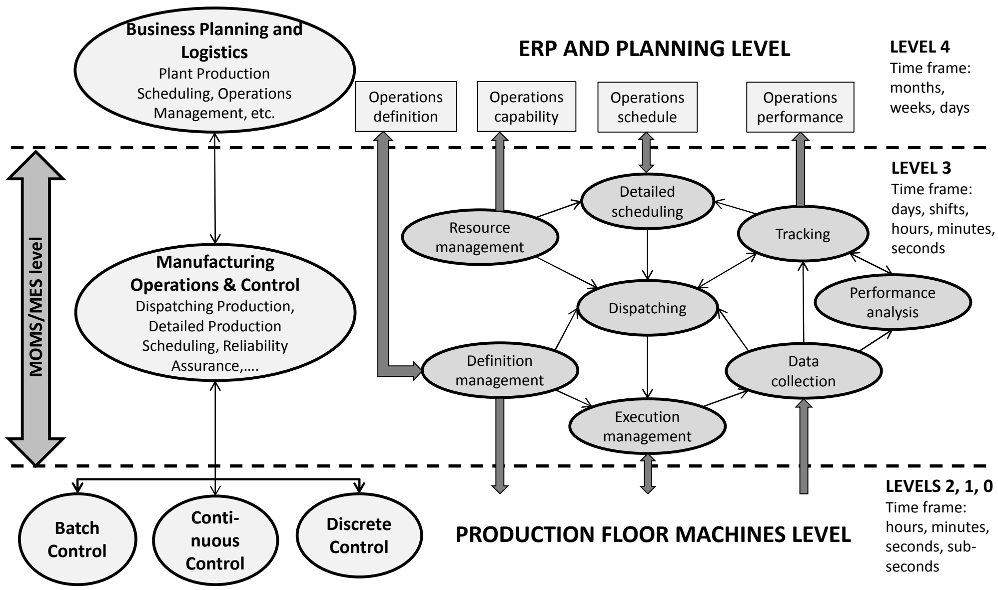

Figure 1. Functional hierarchy of Enterprise control system levels and generic activity model of manufacturing operations management based on ISA-95 standard, modified from [4].

The yearly survey among the MES providers [3] shows wide variety of functionalities provided by the IT-systems referred as MES. There is no clear distinction of the functionalities of MES and other manufacturing IT systems. Therefore, the term MES is often used (e.g. in [3]) to refer to systems providing any MOM functionalities. In the 1997, MESA International defined the 11 functions of MES. Still today, these functions are generally used to provide a common understanding of the main MES content. These 11 functions include: 1) Resource allocation and status; 2) Operations detailed scheduling; 3) Dispatching production units; 4) Document control; 5) Data collection and acquisition; 6) Labour management; 7) Quality management; 8) Process control; 9) Maintenance management; 10) Product tracking and genealogy; 11) Performance analysis. [5]

2.2. LEAN MANUFACTURING, KPIS AND MES

More and more companies in Finland aim to improve their operations and eliminate waste from their activities by following Lean principles. Lean is about continuous improvement, learning and involvement of employees to the daily problem solving and improvement actions [1][6]. In order to improve and learn, one needs to know the current state and the desired state. For this, metrics are needed to tell the current state and allow monitoring the progress when improvement actions or countermeasures have been implemented. Therefore, measuring the Key Performance Indicators (KPIs) allows also learning, when the measurements are connected to the improvement or other change actions.

MES can support Lean in multiple ways. According to Meyer [7], MES allows constant monitoring of the production status and quality, and therefore facilitates rapid reaction in case of failure, deviation from target requirements or other problems. It enables preventive maintenance and reduction of defaults by condition monitoring or based on usage factors (e.g. operating hours). MES also provides transparency of information to all who need it and reduces the waste of time used for searching information or doing the same things multiple times. [7] Kletti [8] also highlighted the information transparency. MES provides information to the workers on all levels of organization allowing them to measure their own success and to improve their work performance and make continuous improvements to the production processes. MES eliminates the waste of reporting and recycling/transporting those reports from one organization level to others (needing a lot of manual work prone to errors). [8] According to Cottyn et al. [9] MES can trigger, feed or validate Lean decision-making process by providing useful information, e.g. by web-based Kanban system for job dispatching and supplier communication, tracing and performance monitoring, visual management screens, and KPI generators. Cottyn et al. [9] state that the (near) real-time information flows of the MES looks like a better fit for Lean than the batch-oriented ERP system.

3. Description of the Research

3.1. Research Methodology

The presented research is qualitative and is based on interviews conducted among Finnish machine building companies. Before the interviews, an introductory letter is sent to the interviewees, in order to familiarize them with the topics of the interview. The introductory letter reveals the topics of the questions (Table 1), but not the actual questions. The goal in such an approach has been, first of all, to hinder rehearsed "correct answers" and reduce the burden and wasted time of the interviewees, and secondly, to limit the length of the answers. The selected approach has its shortages and advantages. On the one hand the answers may not be as thorough as they would be if the questions would have been revealed beforehand. On the other hand this approach ensures that the answers are spontaneous and should therefore better reflect the actual opinions of the different types of personnel in the companies.

The interview has around 80 standardized open-ended questions, which have been divided into four categories and related topics indicated in Table 1. The pre-questions in the introductory letter include questions relating to: Turnover and profit; personnel; product and variety; previous changes in the operation volumes. The interview session consists of plant tour and interview of three types of personnel: plant or production manager, production worker and IT manager. The same fixed questions are asked from different types of personnel, and they are expected to answer from their own perspective. Only the relevant questions are asked, which means that the production or plant manager is asked almost all the 80 questions, while the production worker answers to about 40 questions and the IT-manager about 15 questions. The interview takes about five hours per company and the answers are recorded. The purpose of asking the same questions from different types of personnel is to find out if there are any differences between their perceptions of the situation. Compared to, e.g. internet survey, the interviews allow more flexible reaction to the answers. This means that the questions can be adapted ad-hoc based on the characteristics of the specific company and interviewee and follow up questions can be asked.

Table 1. Question categories and related topics.

Production planning and control practices and requirements for future MES	Shop floor level production control	Key performance indicators (KPIs)	Lean practices and their implementation status
• Overall process and IT-tools from production planning to factory floor level production control • Control and traceability of material and product flows • Management of resources and capacity • Integration level of IT-systems used for production management and control • Communication in the production network • Quality control and maintenance • Challenges in current production planning and control practices and tools • Future MES	• Demand forecasting and reacting to fluctuation • Control of the WIP and inventories • Management of the change and problem situations • Flexibility of the production • Challenges and development targets in the current shop floor level production control practices	• Currently followed KPIs in different work steps • Collection of the metrics data • Analysis and utilization of the metrics data • Future KPIs	• Familiarity of Lean philosophy in the company • Utilization of Lean practices and tools • Material control and flow • Standardized processes and work instructions • Respect, involvement and motivation of the personnel • Current IT-system support for Lean

3.2. INTERVIEWED COMPANIES

The interviews have been divided into two parts. First the Original Equipment Manufacturers (OEM) were interviewed. These companies operate on the manufacturing of machinery and equipment sector and focus primarily on assembly of their self-designed products, while the fabricated parts, components and some sub-assemblies are bought from subcontractors and suppliers. In the second phase, the suppliers and subcontractors, representing smaller companies and focusing mainly on metal cutting and welding, will be interviewed. The work is still ongoing and therefore the results presented in this paper view the topic from the six OEMs' perspective, described in Table 2.

Table 2. Interviewed companies.

No.	Personnel	Branches	Variability of products
1	250-500	Flexible manufacturing and automation systems	Highly customized solutions, almost all products are unique
2	< 100	Material management and storage systems	System built mainly from standard modules, but about 10% of the product is customized
3	250-500	Metal working machines	A lot of variants built from standard modules, some options are customized based on individual customer requirements
4	500-1000	Forestry machines	A lot of variants built from standard modules and options
5	> 1000	Crushing and screening systems for mining, construction and minerals processing	Few different products, which each have different standard models, about 5% of products require customer specific design.
6	< 100	Heating systems and equipment, Machining and metal work (subcontracting)	Standard product models and models variating from standard modules, sometimes customer specific solutions

4. RESULTS OF THE FIRST COMPANY INTERVIEWS

Based on the results from the first interviews, this chapter outlines the current practices and challenges recognized in the six interviewed companies. The results are categorized according to the topics of the questions.

4.1. CURRENT PRACTICES, TOOLS AND CHALLENGES IN PRODUCTION PLANNING AND CONTROL

None of the interviewed companies have implemented MES. Instead, they use various self-made excel applications to plan, schedule and control their production and resources. ERP systems are used to make rough planning and scheduling. The various excel files are not integrated with ERP (or with each other or any other systems), but manual re-typing of the data is needed between the applications. This increases the probability for human errors. These excel applications are often highly personified to a single person. In many cases the detailed schedule and load balancing (or the knowledge on how to make it) is only in the head of the production planner or production supervisor. If that person is absent, nobody else can make the planning. The detailed scheduling and dispatching is commonly done by the supervisor ad-hoc on the production floor with the paper work orders.

In highly project-oriented companies, especially in company 1, which focus on design and assembly, and where the order-delivery time can be from several months to even few years, the production doesn't play such a big role in the whole. More important than minimizing the production throughput time, is to minimize the whole order-delivery lead time and streamline the whole process all the way from the sales and design, to the testing and delivery, in order to ensure that the agreed delivery schedule is attained. It is extremely important that the right items are available in the assembly station at the right time. From the planning this requires identifying the critical components (with long delivery time) and analysing the critical path throughout the whole project chain: When the design needs to be ready in order to have enough time to order the components with long delivery times? Because the focus in such project-oriented companies has not been on optimizing the production processes, they have not considered it essential to implement MES. They see ERP is enough, when used correctly throughout the different operations. Unfortunately ERP doesn't provide a real time feedback loop from production floor to the planning level as MES would do [8]. Neither does it allow fast reaction to the changes, e.g. in the form of re-scheduling.

The common lack of integration of IT-systems and various applications means, that it is impossible to get an overall view of the situation. For example, estimating the lead times for large customized systems is very challenging. One needs to consider the lead times for multiple operational functions, and e.g. the design is further divided into sub-functions, including mechanical, electrical and software design, which each takes their time to complete. Each department has their own plans and schedules in different places. The wholeness is difficult to conceive and manage, because these plans are not integrated or synchronized. There is no transparency between the operations, or no clear vision on how the decisions taken in one operation affects to the others and to the whole (e.g. how schedule change in the design affects to the production and vice versa?). Currently it is very cumbersome to make any changes in the schedules and requires a lot of communication between the different functions. The desire in the companies is to get rid of the dispersed excel files and applications and use the same planning and scheduling system throughout all operations, to ensure better transparency across the company and easier access to the needed information.

The communication with the suppliers and sub-contractions is done mainly by emails and telephone. In company 2, automatic sales orders are sent (in some cases) to the suppliers by the automatic material handling system, when the inventory level reach the defined minimum. In company 3 RFID-kanban system is used for fixing parts to send orders automatically to the supplier. Company 4 has put a lot of effort to the supplier communication and their suppliers can see their production schedule directly from their ERP in real time and supply the components to the assembly line in correct time. The companies don't have visibility of the order status in their suppliers and therefore supplier portals are planned in few companies, to improve the communication and allow better visibility throughout the supply chain.

4.2. Current Practices and Challenges in Shop floor level production control

The interviewed companies don't have much complexity in their resource management and allocation, because the production resources are mainly multi-skilled assembly workers and simple tools. This means that the capacity needs to be evaluated only based on the number of workers, not based on the skills and capabilities of the resources. Also, there is not so much maintenance, which should be fitted into the production schedule or breakdowns which would disturb the schedule. In large machine shops with multiple machine tools and other equipment resources, managing these resources cause more complexity to the overall process and therefore there is also a bigger need for MES. This is noticed in companies 4, 5 and 6, which make also part manufacturing in addition to the assembly.

Especially in companies 1, 3, and 4, there are high variations in the processing times, due to the high project orientation and customization. For basic systems the assembly times can be known with the accuracy of one hour or even one minute, but the customized parts and options are difficult to estimate. Sometimes the actual assembly time of customized machine can be 100% longer than estimated, sometimes even half-times shorter. Due to the lack of proper time recording tools, the process times are commonly known on the assembly station level, not on smaller process phase level. This would be desired in order to be able to more accurately estimate the assembly times of customized solutions and to balance the workload between the stations. Company 1 assembles the products in single assembly cell and the assembly takes two to three weeks, depending on the product. In such layout variation, delays and problems on the station do not mess up the whole production or other orders. In assembly lines (companies 3, 4, and 5) the standardization and balancing of the assembly times at each station becomes important. E.g. company 3 has assembly line with three stations. The operations in each station take about one day in two shifts to complete. Due to relatively long cycle time, small variations in the assembly step times don't affect so much to the overall system. In company 4 the cycle time on the assembly line is less than 4 hours, which requires careful balancing of the assembly phases. Earlier the company 3 used to have several assembly cells. The line type assembly layout was selected, because the cells were "stealing" components from each other and transferring the problems to other cells. Also the control of the production was difficult, because the products were completed in indefinable cycles. Now the control is easier, because every day starts one new machine. Also the inventory levels have dropped down. In company 3 one assembly phase is performed by two consecutive shifts. This is sometimes problematic, because the completed assembly tasks are not recorded to anywhere (only bigger wholes are). The evening shift usually writes down to a paper a message to the morning shift, to tell what the next task is. Sometimes they forget, and especially in the testing the same phases may be repeated again.

In each of the interviewed companies the biggest disturbances on the shop floor are caused by the unavailability of the needed components. It causes waiting or confusion if the assembly is performed in "wrong" order. In order to avoid problems relating to this, two of the companies are collecting the critical components to boxes several days before the assembly work is supposed to start, to be able to react to the component shortages in time. These boxes are stored either in front of the assembly line or in the storage system. Such approach causes work in progress (WIP) and waiting, which is against the Lean principles. In case of highly variating and customized products, most of the components are ordered from the sub-contractors to a specific order. Therefore the delivery reliability of the sub-contractors is crucial. Product modularization and sharing the same components in different product variants has been used to reduce the component shortages. The demand for components having long delivery time needs to be forecasted to buy them in advance, or at least to be able to reserve the capacity of the suppliers. Especially company 5 has big challenges with such components getting unused and obsolete in the storages.

4.3. Key performance indicators (KPIs)

The most important indicators mentioned during the interviews were delivery reliability (on-time delivery), total manufacturing lead time, throughput time, and production costs. In each company, the delivery reliability was considered as the most important metric and the lead time is raising its importance. WIP is actively measured in only few companies. The supplier quality incoming is followed in every company. The companies' own quality is measured based on the reclamations, post-deliveries and warranty costs. All the delivered machines are separately tested in the plants from where the first pass yield can be defined. Company 3 is following the manufacturing efficiency of the whole factory and individual workstations, and using it as a basis for bonus payments for the operators. The efficiency is defined as the ratio between the planned (standard) hours and the hours actually used. In companies 3 and 4 the delivery reliability is used as a basis for bonus payments.

The KPIs are followed monthly, fortnightly or weekly, not in real time. The statuses of the orders are checked in the weekly meetings of production planners, supervisors and team leaders. The data is collected from different manually filled forms or hour recordings from ERP. None of the companies use the metrics to control the everyday work of the operators. Basically, the only thing that the operators are watching in each company somehow is the throughput time of the assembly stations/phases. The targeted delivery date is the most important individual aspect that controls the everyday production work on the shop floor level. Hours that don't belong to the actual assembly work, such as waiting for something, are reported in some way in each company. However, the level of detail of the recording is not enough to be able to accurately identify the proportion of the value adding time of the total manufacturing lead time. The desire of the companies is to be able to more accurately follow to which kinds of activities the manufacturing lead time is used in each order/product (actual assembly/processing time, material handling time, waiting time, correcting defects, etc.), how the costs are generated during the production and for which kinds of activities the resources use their time.

4.4. Followed Lean practices

In each of the interviewed companies some Lean practices are applied, but none of them can call themselves as true Lean manufacturer. None has successfully implemented pure continuous single piece flow controlled by pull from the next production step throughout the production. Highly customized production without standardization makes the implementation of Lean pretty hard, because the prerequisite for efficient flow are standardized processes [1]. The companies try to help this by modularized products, but in many cases they still include a lot of project specific work. However, a lot of work has been done to eliminate unnecessary waiting, and reduce WIP. For example, company 3 has put much effort on balancing the assembly times of each station, in order to support continuous flow. Of course, due to special customized options, there remains variation in the times. The multi-skilled operators can flexibly move between the stations and are guided to help the busy ones. This has been supported by bonus payments, which are based on the efficiency of the total assembly line. In most of the interviewed companies maximizing the resource utilization was still considered more important than minimizing the lead time, which contradicts with Lean principles [1]. However, in most of these companies it didn't lead to overproduction. In each company the goal is to become Leaner. A lot of improvement projects are going on relating to lead time reduction, and improving efficiency and quality.

To implement pull, most of the companies utilize some sort of Kanban elements in their production, e.g. 2-box Kanban system for fixing parts, or empty storage place of modules working as a visual sign to assemble a new module. None of the companies use systematic methods to ensure the quality during the assembly. For example no recordings of each assembled parts is used, but it is assumed the operator is careful and makes sure all the parts are assembled. Module tests and final product tests in the end are used to make sure the customer receives a good quality product. If the testing finds a problem, often the one who has done it, goes to fix it. This facilitates learning. In those companies, which assemble products on a fixed pace assembly line (companies 3, 4 and 5), problem, e.g. a missing part or quality error, doesn't stop the whole line, but the imperfect product flows through the line and is fixed later. This is against the Lean "ready at once" and "making the problems visible" principles. Some poka yoke activities are utilized occasionally, e.g. collecting all the components to the boxes in order to ensure nothing is forgot from the assembly, or using features which ensure the parts can not be assembled wrong. Most of the companies practice frequent job rotation to facilitate learning and keep the workers motivated.

Regarding the work instructions the interviewed companies have varying practices. In highly project-oriented or customized production, there are no work instructions at all, or only for the critical parts and assemblies. The work is performed relying on the expertize of the assembly operators. This turns out to be problematic especially when rented workforce is used to balance the workload. For more standard products, there are paper work instructions in material folders. In some companies the product models and drawings are available to the operators through the PDM-system. Finding the work instructions and drawings from the system is sometimes difficult, because one needs to know the project number, and each optional part or module has their own numbers. The operator should understand the mind-set of the designer in order to be able to guess where the part drawings can be found, in which structure the drawings have been linked. A lot of time is wasted for trying to find the drawings.

5. REQUIREMENTS FOR FUTURE LEAN MES

Together with the current practices described in the previous chapter, another aim of the interviews was to find out the needs for the future MES/MOM systems. In this chapter, these results are discussed.

Visualization and customization:

The detailed work scheduling and load balancing view needs to be visual and intuitive. One should be able to see by just one glance what is the status of the works and where the possible problems are. There should not be too much information on the screen, but one must be able to read it without a struggle (and print it on one sheet if needed). The level of detail, shown in the user interface, needs to be able to be customized according to the needs of the company and the individual user. It should include only the information that is needed by the user to perform his/her task. However, more details and information should be easily found behind links, if needed. It should also be able to customize the way the information is displayed to each individual user. Some users may prefer text-based method, while for most users more graphical and visual method would suit better.

Functionality and ease of use:

In factory floor the operator should have an easy access and visibility of his/her calendar, work orders and their status and priority, as well as the needed work instructions and drawings by just few clicks. Complicated searches, where one needs to know the project number and try to guess where the designer has linked certain drawings, should be eliminated. The tasks should be easily set off in the system by just one click and recording of the work hours should be as easy as possible. The system should enable easy reporting of the hours to different kinds of process phases and tasks, not only to the tasks which are included into the standard process, but also times used for waiting for material or tools, waiting caused by machine breakdowns or quality defects and so on. This would enable easier measurement of the actual value adding time compared to the total manufacturing lead time, and facilitate the capacity planning of future orders. It should also include functionality for reporting of noticed defects. The work instructions should not be static, but something (e.g. wiki-based) in which the operators can affect and modify. The most important requirement turned out to be the ease of use. Especially for those, who are not using the system daily, too much time may be wasted for trying to find the needed information. If the reporting or giving feedback requires good retention and multiple clicks, it won't get done, or it gets done only occasionally. This can cause more problems than no reporting system at all.

During the interviews it was highlighted, that companies which design and assemble customised, large scale systems, have relatively different requirements towards manufacturing operations management compared to companies focusing on component manufacturing. In such project houses, the focus is on managing the whole project including sales, design, production planning, procurements and supplier interaction, production, testing and shipping. Therefore the future MES needs to provide support for this whole chain. The schedule of the whole chain should be viewed on a one screen. It was also highlighted that machines (MES) can not replace human, but the orders still need to come from human. The operators need to maintain the feel of control of their own work. The system should adapt the schedule, based on what has been selected to be done.

Integration, information transparency and traceability:

Currently the companies have multiple dispersed IT systems and files that are used for the manufacturing operations planning activities. It is desired that all the needed information for planning and running the production would be integrated in the same system (or at least linked) and more information relating to certain order or project could be found through links. For example, from rough planning one could jump into detailed planning and load balancing, and from there one could click to see detailed information of resources on the factory floor (and component shortages, faults, problems,…). This would improve the information transparency throughout the operations.

The system should also provide transparency to the suppliers and subcontractors of the current status of the orders, inventory levels, and problems encountered. On the other hand, the transparency should be two-directional. For example, the principal company should be able to see and know in advance if there will likely be some problems with the delivery of the ordered components. These anticipated problems should be shown in the scheduling and load balancing view, in order to rapidly react and possibly re-schedule the work before the component shortages disrupt the assembly line. The system should also provide traceability to already delivered products. This is especially important for companies, which provide services, e.g. maintenance and repair. The company needs to be able to track what has been produced, the components and parts each delivery included, and what was their version. This would drastically ease the maintenance planning of the delivered products and improve the customer service.

Structure, implementation and cost:

The system should be scalable, extendable and allow upgrading when needed. The customer should be paying only from those functionalities that are needed. It should be possible to start the implementation with the most important modules and then extend it while the benefits have been proved. The system should support usage with different platforms, including e.g. PC, tablets, mobile phones and other mobile devices. One relevant point relating to the cost of MES was also mentioned: The users and need for MES comes from the production department, not from those who decide about the money in the company. Therefore, in order to get the MES project realized, the starting costs need to be as low as possible. It could also help the decision if the cost could be reported to the variable costs. For the MES provider this could mean providing the system as a service and charging e.g. on monthly basis, or based on the usage.

6. Conclusions

This paper studied the current status and future requirements for the manufacturing operations management and control systems. The paper was based on the interviews conducted among the Finnish machine building companies. The presented results focused on OEM perspective, while the following interviews will be conducted from supplier and component manufacturers' perspective. Most of the interviewed companies believe that by more systematic utilization of ERP in all operations, they could attack most of their current production management challenges. However, according to Kletti [8] ERP is only suitable for rough production planning, not detailed planning or production control. This is due to the open loop, which means that the feedback from production floor is not recorded in real time [8]. ERP can't fix e.g. the problems relating to re-scheduling, because it doesn't take into account the reality on the factory floor, including e.g. machine breakdowns, lost parts, or absenteeism. Therefore MES is needed to take these things into account and provide real-time information of the status of the production and to allow more realistic plans and real time reaction to the actual situations. None of the interviewed companies had MES, and they didn't clearly see the benefits of implementing one. It is assumed that this is because of the lack of knowledge and confusion caused by highly unconsolidated MES markets. The potential benefits of future MES implementation related not so much on new functionalities they could provide, but to easing and fastening the existing MOM activities currently performed by dispersed excel spreadsheets or pen and paper. The future MES should reduce the amount of manual work (re-typing), and therefore improve the reliability of the data and increase the efficiency of operations, and provide better transparency between the operations.

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