UNIVERSITY OF TAMPERE
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IMPLEMENTATION OF AN INDUSTRIAL VARIANCE ANALYSIS PROCESS

- A CONSTRUCTIVE STUDY AT ALSTOM

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ABSTRACT

The spark for this research came from case-company's need to strengthen its' manufacturing control function. Key focus there is to understand the behavior of direct manufacturing costs. When differences between planned and actual results are seen it is possible to detect the root-causes for the problems, which makes also performing of corrective actions possible. The need, to see the most critical problems on operations and performing corrective actions to fix them, is universal for all the companies. One possible method to detect those problems is variance analysis. However, only detecting problems and reporting of information is not enough and real actions are also needed. Therefore, this research examines the whole control process from creating figures to the follow-up of corrective actions.

The theoretical framework concentrates on presenting good characteristics of the manufacturing control function. Manufacturing control is split to five important areas: target setting, performance measurement, distribution of information, corrective actions and to reconciliation to financial books. The criticism towards variance analysis and management accounting is deeply emphasized in the theoretical part. Major part of this criticism arises from utilization of modern manufacturing practices and the case-unit provides a good environment to study this discrepancy.

The empirical part observed case-units' most critical deficiencies in the current manufacturing control process. The construction was then built based on recommendations of the theoretical framework, and by taking the specific characteristics of the case-unit into account. Major part of the construction was implemented into use during this research and the process implemented is assessed in the end of the empirical part.

Several problems of case-unit were solved during this research. Especially the understanding of the bridge between the operations and the financial statements was improved. However, mainly due to limitations of the unit's IT-systems and due to limited time of involved people, not all of the recommendations provided in the theoretical framework, were actually implementable. Although some corrective actions were implemented, some remained at low level due to limited time usable for this research. The scientific contribution of this research can be controversial because the construction was built only to one unique company. However, some observations can be applied in a different environment and be beneficial for other manufacturing companies.

CONTENTS

1. INTRODUCTION

1.1 Motivation and the relevance of the research

Company X publishes its' annual results; change to previous year is dramatic and all the stakeholders are asking what has happened. Ideally corrective actions have taken place a long time ago and the root-cause is well-known by the operational management. However, things don't usually go ideally and corrective action plans need a lot of relevant information. In fact very few organizations are actually mastering this (Hon 2005, 5). The ability of a corporation to understand actual performance compared to estimations has always been a critical factor to meet its objectives, but importance of this is nowadays maybe even higher than ever before.

Managing of companies in the modern business environment demands more and more accurate and timely information (Banker & Hwang 2008). For example, needs of customers change quickly and competition creates challenges. Companies that are not able to perform continuous improvement are probably losing their competitive advantage as competitors are improving all the time (Porter 1985). Management itself could be described as a process using organization's resources to achieve organizational objectives through the functions of planning, organizing and staffing, leading and controlling (DuBrin 2000, 3).

Control, as one of the management functions, has huge number of meanings and not all of them should be used in the field of management (Carenys 2010). However, supporting organization to achieve its' targets seems to be unifying factor for most of the definitions (Anthony 1965, Merchant 1985, Siriyama 2007). Controlling has been defined as the final function in the management process that is keeping things on track (Merchant 1985, 1-2). Controlling has been also described to be process that compares planned and actual performance and identifies possible corrective actions (Stoner & Wankei 1986, 17). Controlling of activities is important because people generally improve what is measured (Mauboussin, 2012). To sum up, controlling is the function that should be able to explain changes in business environment and to provide proposals how to improve processes.

Control and decision making are the two fundamental parts of industrial management that are aided by accounting information (Fleischman & Tyson, 1998, 1). Thereby, management accounting is in key role on providing this information but the information needs also to be utilized. Indeed, it is interesting to see how management accounting information is adapted by firm's functions in practical terms. Is it really creating value? It seems that not a lot research is done about the contribution of management accounting (Emsley 2001, 1).

Accounting people have been criticized a lot about excessively narrow focus on bottom line financial numbers (Pierce & O`Dea 2003, 18). The basic message seems to be that use of financial measures alone is not sufficient anymore (Hon 2005, 2.). In addition, management accounting systems are often too closely connected to financial accounting systems, which can distort information. For all practical purposes, it is very important that management accounting system is consistent with organization's planning and control systems needed to run the business (Fry & Steele & Saladin 1995, 2).

Modern manufacturing practices such as Lean-manufacturing, Six Sigma and Value stream mapping have been gaining ground on the field of performance measurement. For example the objective of Lean-manufacturing is to prevent deviations from occurring in the first place and not to waste time to historical events (Manjunath & Bargerstock, 2011). However, actual impact to results of those modern theoretical techniques is not clearly known.

Development of information technology has also very important role in this topic. Current IT-systems enable often a comprehensive real-time follow-up, but also there the utilization of capabilities is a question. For example business intelligence solutions and big data-phenomenon are taking ground also on manufacturing industry and management accounting. However, technological development does not help anything if the advantages are not really utilized. For example it is said that ABC – management is way more important than just ABC – reporting (Kaplan 1990). The same principle is probably applicable for all the accounting methods, for traditional and for the modern methods.

Johnson (1987) argued that accounting people are controlling operations: "like drivers using the rear view mirror to drive a car or a tennis player watching the scoreboard to play tennis'. There clearly is a pressure to move from retrospective to proactive information. Nevertheless, it is anyway necessary to know the actual score before predictions can be done (IMA 1998). Traditional methods like variance analysis to historical data seem still to have their place, but there is room for improvement. Traditional results review often only results, instead of causes for those results, which reduce the probability that a poor outcome would be really changed (IMA 1998).

Despite all the criticism, it seems that traditional management accounting practices are still important and used widely. In fact a survey done about Australian companies in 1998, found that traditional management accounting techniques were ranked as providing the best benefits (Chenhall & Langfield-Smith, 1998a, 380). This was still supported in 2009 on research done for companies in United-Kingdom (Horngren 2012, 228).

Variance analysis is one of the most fundamental financial management tools. Despite the fact that the method has been used from the beginning of the 20th century, it is still used by almost all companies in the world. According to research done fourteen years ago, 95% of organizations are using variances for business controlling purposes (Chenhall et al. 1999). The need for variance information is high especially on manufacturing companies with high volumes. Variance analysis is also seen to be especially critical when recession is impacting business (Horngren & Datar & Rajan 2012, 226). There is also a lot of criticism towards traditional variance analysis and it's even considered to be obsolete for purposes of this day. However results of researches, mentioned above, have supported this criticism weakly.

There are various different types of variances, for example: labor, material, quality and overhead variances. Moreover, variances can be financial or non-financial (Horngren et al. 2012). In performance measurement variances can be also split to effectiveness and efficiency variances (Simons 2000). All of the variances can't usually be followed up due to limited time of financial and other people. Prioritizing is very important under the limited time schedule. What needs also to be taken into account is that if there is no variance, it does not necessarily mean that problem doesn't exist. Moreover, variances

are unique to each company. For example Simons (2000) reminded that although different systems of variance analysis may appear to be similar, they differ significantly in detail.

Plenty of research has been done about variance analysis but major part of it is very old. Changes in modern business environment that were presented earlier in this chapter have very probably impact also to traditional variance analysis. Therefore, it sounds astonishing that recently so little amount of research has been done about the most popular management accounting tool. Moreover, overall in management accounting, amount of constructive research is still very low (Lukka 1999). It is really important and interesting to understand holistically how firms implement new management accounting processes and how this information is utilized through the organizations.

The empirical part of this research will be done as a constructive research to an engineering and manufacturing unit producing power compensation products at Tampere, Finland. Unit is part of global French company Alstom. Basis for this research comes from Case-company's need to have better understanding of industrial variances. Environment for research is particularly interesting because Case-company is performing modern manufacturing practices. In addition, a consistent variance analysis process did not exist in the beginning of this research, which gives more potential for new thoughts. Moreover, this study has a very high emphasis on the recent criticism towards variance analysis, which may increase the theoretical contribution of the study.

1.2 Objectives and limitations of the research

Target of this research is to implement a feasible solution to the case company to understand differences between estimated and actual direct costs under manufacturing. The method to compare estimated and actual is Variance analysis. The case company would like to have better understanding on the monthly deviations of gross margin and to be more rapid on reacting to problems. Here it needs to be remembered that not only performance-variances have an impact to margin. Margin can have fluctuations for example due to incorrect inventory movements and booked accruals et cetera. Therefore, also those factors are included to the research area.

Variance analysis itself is only a mathematical tool that can be used for several purposes. Targets of this research originate from the need of Case-company's management that wants to strengthen unit's manufacturing control process and have more information about industrial performance. Thus, variance analysis in this study needs to be built based on needs of manufacturing control. Moreover, manufacturing control needs to be built based on needs of management. Therefore, the first two research questions are following:

1. What characteristics does a good manufacturing control process using Variance analysis as a tool have in the modern business environment?
2. How manufacturing control process using Variance analysis as a tool, should be implemented to this particular Case-unit?

Construction will be built based on information acquired from the theoretical framework and by taking unique characteristics of the case-unit into account. In addition, the requirements of mother-company have to be met. Answers of the second research question are compared to first question, and possible differences are discussed and justified.

Another need arising from management is having a better understanding of monthly results on financial books. Industrial variances play a significant role here, but there are also other factors such as inventory movements and accruals. It is not enough just to see such movements on financial books – the real root cause for major part of them needs to be known. If everything would go in accounting like in theory, this problem should not even exist, but due to practical reasons it is lined to be absolutely necessary part of this research. The third research question can be explained in following way:

3. How to build reconciliation between planned direct costs of orders sold and the actual P&L statement?

As implementation is also included to this thesis, it is very valuable to assess how well those targets defined in the construction were actually met. Due to limited time usable for this research, not all the suggestions of the construction will be actually implemented but major part should be done until August 2013.

4. How the implemented construction answered to questions arisen from management's needs? (Research questions 1-3)

As seen, the area of this study expanded to be quite large, especially as connection to financial books is required. The study could be easily concentrating only to one of these research questions, or to go on even more detailed level. However, this thesis pictures the whole process that is performed by one particular function in the case-unit. The need of the management is to get this whole process working so also this research is built to answer to this need.

This kind of broad approach has clearly disadvantages. When research tries to answer to too many questions it easily leads to a situation where nothing is covered well and analysis is not deep enough. However, as instructor of this research, Dr. Vehmanen, guided the purpose of a constructive research performed to a corporation purpose is not to find a *perfect* solution to cover the problems. Instead the purpose of the constructive research performed to the corporation purpose should be to find an *implementable* and *good enough* solution to cover problems. This was lined to be the target also for this research.

Nevertheless, due to broad area of the research, even more limitations were needed. At first, the focus is only on direct material and direct labor costs of manufacturing. These two cost groups are enough to answer the research questions. Production overheads are also included to the area above gross margin, but the case-company is handling them in a way that allows excluding them from this analysis. It is important to remember that direct costs of manufacturing comprise only a part of product costs. This is presented on the figure 1.
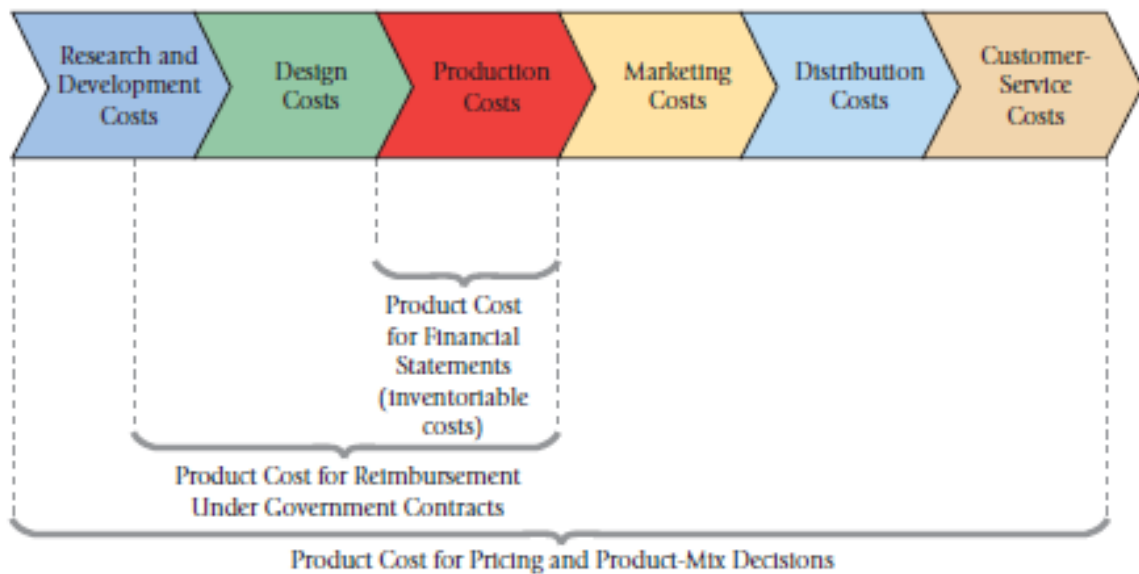
Figure 1. Product costs (Horngren 2012)

Variances investigated are mainly going to be used on operational level, but also strategic use is possible. However, it can be said roughly that research questions one and two concentrate on operational level issues. Research question three is important mainly for strategic use.

Even though the research is longitudinal and implementation is performed, it was decided that human behavioral issues are excluded. A lot of interesting ideas are missed due to this decision but it was necessary to keep the area on a controllable level.

1.3 Research methodology and method

This is a longitudinal constructive research that is done based on a need of a case company. Constructive research was invented in Finland in the early 1990s and the main idea of it is to build a new construction on a solid theoretical basis. Constructive research is pretty close to an action oriented research but there are some clear differences. At first the intervention to the organization where the construction is done is way stronger than in the action oriented research. Secondly, constructive research is mainly concentrating on the new construction, meanwhile action oriented research concentrates on the change process itself (Lukka 1999, 139-145). As seen on the

previous chapter, the constructive research method is clearly the right choice for this study. Phases of the constructive research can be seen from the figure 2. This research follows the same order.
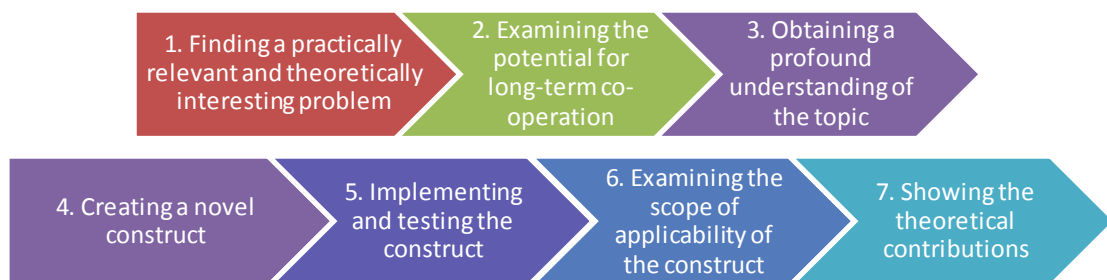
Figure 2 Phases of constructive research (Labro & Tuomela 2001, 416)

Theory is very important in this study and the whole empirical part will be connected to the theory. Theoretical framework is based mainly on management accounting research but also some sources from industrial management are utilized. In addition, this thesis includes plenty of very basic level concepts of management accounting. It was seen that the most previous educational accounting literature is the most suitable source for those concepts, even though the use of educational books is not usually recommendable on the researches.

The construction was built around a time period between November 2012 and August 2013, when researcher was working in the case company as a temporary Manufacturing Controller. In addition researcher has worked earlier with industrial variances in another company, which gives a good basis also for this research. This type of interventionist research has of course its advantages and disadvantages. As an advantage the researcher has an excellent access to all the information in the case company. On the other hand objectivity of the research is in danger. However, the temporary type of contract should allow way better objectivity than a permanent would do. The empirical material of research is collected by researcher from IT-systems, meetings and all the other relevant sources available. No figures about case-company will be shown in this research due to confidentiality reasons.

Construction will be tested with a weak market test. "The weak market test is passed when a manager is willing to apply the construct to his or her actual decision-making problem" (Labro & Tuomela 2003, 429). Results of this research cannot be generalized because the empirical part is done to only one company with its' unique specific characteristics.

1.4 Structure of the research

This chapter was an introductory chapter. Chapter two presents the theoretical framework. A highly aggregated summary of chapter two is presented on page 32. The third chapter is for the empirical part including: presentation of the case-company, beginning state of the control process, targeted state of the control process and the implementation process. Summary of the suggested construction for the case company can be found from page 56. The fourth chapter is reserved for the discussion and for conclusions.

Appendices have very essential role in the empirical part and they can be found from the end of this paper. The appendices are referred in the text when they are being handled. In addition, the acronyms used in the empirical part are explained on the appendix 7.

2. THEORETICAL FRAMEWORK

2.1 Manufacturing control

There are plenty of ways how managers use the management accounting information. Information provided by accounting systems can be found from profit and loss statement, balance sheet, the statements of cash flow, and from performance reports. This information is used by managers for example for coordinating manufacturing process and for product design. Also, developing, communicating and implementing the strategy needs management accounting information (Horngren et al. 2012).

The commonly used term for the system coordinating and controlling decisions throughout an organization is management control system (Horngren et al. 2012). Control is defined as "keeping things on track" (Merchant, 1985, 1), and it has been identified as "the final function of the management process" (Merchant, 1985, 2). The scope of this research is focusing on those activities which are directly connected to manufacturing processes within an organization. Therefore, other areas such as marketing, research and development, share price and human resources are excluded from this research. Based on these definitions manufacturing control was selected to be the name of the process that is investigated in this research. The distinction between manufacturing- and management control is not unambiguous. In fact manufacturing control system provides information for management control purposes. Therefore, where applicable, literature about management control is also used as a basis for the theoretical framework of this research.

Control as a word can have many meanings. It will be defined in this research based on applicable management accounting literature (Horngren et al. 2012, Siriyama 2007). In this research, control is comprised of target setting, performance evaluation, distribution of information, and following up implementation of corrective actions. The first purpose of the control system is to define the desired results. The results defined can be based for example on the strategy of the company, or to targets set by operational people. After that standards, or estimates about incoming results, can be established. The comparison of actual performance to planned performance is the control role of

information. This information needs to be distributed to those stakeholders inside the organization that need this particular information. Control comprises also following up the corrective actions that were implemented. This includes deciding how to evaluate performance, and how to provide feedback to operational people. Good control system promotes organizational learning and helps future decision making (Horngren et al. 2012, Siriyama 2007).

Performance measurement is another term that is closely connected to manufacturing control. Performance measurement is a very essential part of manufacturing control system. On the other hand, control is often said to be part of performance measurement system (Hon 2005). In this research performance measurement is seen as one part of manufacturing control system. Drawing distinction between manufacturing control and manufacturing performance measurement is not clear. In fact they can have totally same meaning. Taking these similarities into account it was seen beneficial to use also performance measurement literature as a basis for the theoretical framework.

Anyway, performance measurement is seen to be indispensable for manufacturing enterprise (Hon 2005). If performance of an activity cannot be measured, it cannot be controlled properly (Hon 2005). It is also said that: "Measurement is at the heart of the organizational process. What is measured becomes visible, what is rewarded gets done" (IMA 1998, 1). Performance evaluation targets can be for example time reductions, quality improvements, cost reductions and trend measurements (Hansen & Mowen & Guan 2009, 277). In this research main focus is on cost efficiency, but also other performance measures have an important role. For example poor quality increases costs as well as excessive time consumed for an activity.

This research is done from a perspective of management accountant. On performance measurement the key role of management accountant is described to be comparing planned and actual performance, which is also referred as scorekeeping (Horngren et al. 2012). Comparing planned and actual outcomes is the most important performance measure also in this research.

Manufacturing control system should be in line with organization's strategy and goals. In addition it should be designed to support operational management (Horngren et al.

2012). The next chapter presents the way how manufacturing control process should be implemented on a modern business environment.

2.2 Characteristics of a good manufacturing control process

Plenty of research about the optimal way to perform management control and performance measurement has been done. Those recommendations are applicable also for manufacturing control systems. In addition more specific recommendations for manufacturing environments are presented in this chapter. On the previous chapter, control was divided to four parts: target setting, performance evaluation, distribution of information and to follow up that corrective actions are really implemented. Good characteristics to perform those phases well will be handled next.

2.2.1 Target setting

As in many processes, also in manufacturing control, setting of targets can have very significant impact to actual results that will be achieved (Horngren et al. 2012, 817). The target here can mean targeted performance on operations, or targeted increase in understanding of one particular process. After all, the most important targets are those that really impact overall performance without biasing problem solving between other important targets (Emsley 2001). Target setting for increasing of understanding of something is not covered by this research, but 80/20 percent rule is worth mentioning. Creditable performance measurement system should be able to explain 80 % of the performance gap (IMA 1998, 19).

Improving on one particular performance area almost always involves trade-offs to other dimensions of performance (Davila & Wouters 2007, 849). For example higher efficiency on manufacturing can lead to higher amount of defective products. Therefore, it would be recommendable to have more broad-based targets for targeted performance. For example in addition to cost efficiency, also quality and delivery targets should be defined (Emsley 2001). Very often these dependencies between different targets are forgotten in target setting phase, which can clearly lead to undesired consequences.

However, understanding of these dependencies in the target setting phase is indeed really difficult (Davila et al. 2007, 849).

Another very important part of target setting is that also responsible people for those operations that are controlled are participating to the target setting. It is shown in many researches that for example participative budgeting increases commitment of people to those targets (Horngren et al. 2012). In fact it would be beneficial if responsible managers would participate to develop the overall manufacturing control system (Waal 2002). Target setting performed in correct way increases motivation of workforce and promotes continuous improvement (Hansen & Mouritsen 2007, 734).

For targets themselves, there is not one correct answer, how challenging those targets should be. Very commonly recommended description for optimal targets is that they are realistic and attainable (CIMA 2013, Horngren et al. 2012). They should not be too easy to attain, because it could lead to situation where processes are not improved anymore when a target is met. On the other hand too difficult targets could be demotivating (Waal 2002).

On manufacturing environment target setting is particularly interesting, because the accuracy of costs targets, and non-financial targets may depend a lot of the manufacturing environment (Davila et al. 2007, 849). Quite surprisingly, it has been found that when the product standardization is low, high participation and use of budgets as static targets were significantly more effective in promoting departmental performance than when product standardization was high (Davila et al. 2007, 849).

2.2.2 Performance measurement

As mentioned earlier, performance measurement is necessary for manufacturing companies. Key contribution for performance measurement done by management accountant is comparing planned an actual results. However, playground of management accountant is changing and more comprehensive analysis is often required (Horngren et al. 2012, Pierce et al. 2003).

Based on IMA (1998), measurements must satisfy: follow up important objectives, measure performance against key customer requirements, make strategic objectives

clear, focus on core processes, critical variables, signal where performance is headed, where attention is required and provide basis for assess and reward performance.

On manufacturing environment requirements for performance measurement are pretty similar and can be summarized to following four parts (Hon 2005):

1. *"To reflect current state of manufacturing"*

How key customer requirements and strategic objectives are met? Is the manufacturing process going well enough so that management is able to keep a holiday? Almost all performance measurements start from understanding the current state of process.

2. *"To monitor and control operational efficiency"*

Where attention is required and corrective actions should be done? Controlling of everything is not possible so monitoring system should point attention to the most critical variables. Very often what is measured gets done, so keeping eye on operational efficiency can likely have a positive impact on performance.

3. *"To drive improvement programs"*

Only recognizing where the problem comes from does not itself change anything. Corrective actions to the most critical problems need to be done. A good performance measurement system also promotes continuous improvement. For example trend measurements could be used for this purpose.

4. *"To gauge the effectiveness of manufacturing decisions"*

When corrective actions or decisions related to them are done it is often beneficial to assess what was the impact of those actions and decisions. This kind of feedback increases organizational learning.

Broad-basis of information is one very essential part of performance measurement systems. At first different kind of aspects of performance should be assessed. Those aspects can be, like mentioned earlier, quality, costs and time reductions. In addition, to avoid partial optimizing, the entire cycle from design, production planning, manufacturing and delivery to customers should be considered as a complete system. It

is very important to see also the *global* picture when more detailed *local* measurements are done (Horngren et al. 2012, IMA 1998).

There is also a need for nonfinancial performance measurements. Nonfinancial reports are often easier to quantify and understand which makes immediate short-run feedback possible. They point also attention to physical processes. Sometimes nonfinancial figures are also better measures for long-term performance (Horngren et al. 2012, 243).

The selected performance-measurements have to be such that it is possible measure them reliably. It is very essential that managers believe the reports they receive. Otherwise the reporting could be worthless (IMA, 1998). Useful performance measurements are also persistent, consistent and comparable (Hon 2005, Davila et al. 2007). In addition they demonstrate the causal relationship between action and outcome, which makes them more predictive (Hon 2005, Mauboussin 2012).

2.2.3 Distribution of information

"You don't maximize profits by producing reports. You maximize profit by giving people the information they need, and a lot of the time the two don't necessarily go hand in hand" (Pierce et al. 2003, 276).

It is important also for management accountants to see their work as a service function where managers are customers who need information (IMA 1998). On the other hand also benefits of producing the information needs to be considered with common sense. How will the provided information help managers to do their job better, and do the benefits of producing this information exceed costs (Horngren et al. 2012)?

One essential thing to consider is the purpose for which the information is used. Is the information meant for the top-management, or for operational people? For example non-financial information is often easier to understand and distribute, especially on manufacturing environment. However, it is not clear how sophisticatedly those nonfinancial figures should be included in reporting presented to the top-management (Hansen et al. 2007). In addition, it is common that managers from different functions have different requirements for the information and the reporting. Even people working in same function may require different kind of information (Horngren et al. 2012).

Management accounting information should not however be static forever (Hon 2005). Based on CIMA (2013), the hierarchy of control reports could be the following:

- "Top level report reconciling budgeted and actual profit should be prepared for senior management"
- "Variance reports might be prepared for individual managers with responsibility for a particular aspect of operations."

There is a tendency for companies to overload themselves with huge amount of indicators. After all the amount of performance measurements should not be too high. In fact it is often recommendable to upkeep just a low number of simple performance measurements (IMA 1998, Hon 2005). Managers have to understand management accounting information to do their job well. That's why as simple as possible measurements are often the most recommendable. If more sophisticated measurements need to be used, it is management accountant's responsibility to train people who receive this information. Often we are also said to live an era of excessive amount of information, so low number of performance measurements could be easily justified (Barnett 2006). One way to limit the amount of information, meanwhile keeping it comprehensive, is to provide management accounting information only to those people who have control over those particular areas measured. People tend also to react in better way to information if they feel that they have control over the reported area (Waal 2002, IMA 1998).

Timeliness of information is a very important factor (Hon 2005). It is very commonly said that management accounting information should be provided in timelier manner (Pierce et al. 2003). Nowadays there could be even need for real-time information (CIMA 2013). From the perspective of control all unexpected deviations should be recognized at the earliest possible time, so that corrective action can be done promptly (CIMA 2013, 241). If the information is provided several weeks after the control period there is a risk that it will be considered as "out of date" information (CIMA 2013). Another important time-related issue on management accounting information is the frequency of feedback. Ideally this frequency should equal to the cycle time of the reported operation. Correspondingly, on manufacturing environment frequency should match to cycle time of manufacturing (Lind 2001, 48, Horngren et al. 2012).

2.2.4 Corrective actions

Organizational performance partly depends on the ability to solve problems and managers should enhance this ability at operational levels by implementing various problem solving improvement programs (Hon 2005, Emsley 2001). The purpose of the management control system is to gather and use information to aid and coordinate planning and control decisions throughout the organization. One clear signal of a good performance management system is that managers are using it regularly (Waal 2002). Same purpose and signal applies probably also for manufacturing control systems.

It is really important that measures can be acted on (IMA 1998). For example timeliness and understandability of information are essential factors here like mentioned earlier. Also behavior of managers and other employees should be guided. Indeed one characteristic for an effective control system is that it increases motivation of employees. Control function that systematically explores alternative ways to improve processes in future is also called as learning function (Hansen et al. 2009, Horngren et al. 2012). After all very few organizations manage to understand well, how corrective actions done based on control, are succeeding. Anyway, usually what is measured gets done, and even more often, what gets rewarded gets done (IMA 1998, Lind 2001).

2.3 Variance analysis as a manufacturing control tool

"*Variances lie at the point where planning and control functions come together*" (Horngren et al. 2012, 227).

Variance analysis compares actual results to expected performance (Function 1). The term used for expected performance is most often *standard*. There are several ways to define standards. The expected performance is often also called budgeted performance, which is used as a reference to make comparisons. There are always variances at some level and there can be enormous number of causes for them. To help to understand those causes better, variances can be split to more detailed parts. Variances can be also utilized in many different ways by different people (Horngren et al. 2012).

Characteristics of variance analysis for manufacturing control purposes will be discovered in this chapter.

Function 1*: "Price variance = (Actual price of input – Budgeted price of input) * Actual quantity of input"* (Horngren et al. 2012, 236).

This research is concentrating only on direct costs and is based on a commonly used classification where manufacturing costs are split to direct materials, direct labor, and to indirect costs. Direct costs are those costs that are directly traceable to the good or service being produced. Cost tracing can be done to number of different cost objects, for example on product, project and on customer level. Cost object level has very essential impact on cost-tracing. The more detailed level, the more difficult it is to trace costs directly to objects. For example some raw materials may be easy to trace directly to production line level, but when order level information is needed it is maybe not feasible anymore. Untraceable costs are often allocated to cost objects by using overheads (Horngren et al. 2012).

Standards can be defined in several ways. Often it is stated that standards should be demanding but achievable. Too easy or too difficult standards lead probably to behavioral problems (Waal 2002). Standard setting should be also done in a way where all people subject to standards are participating. In fact same rules as in *participative budgeting* can be used here (Hansen et al. 2009, 298). Possible sources for standard setting can be for example historical data, data from other companies with similar processes and engineering studies. Using of historical data is usually easily available and it is clearly real data – not hypothetical. Problem with historical data is that it can include inefficiencies, and changes expected for the budgeted period are not taken into account. On the other hand, actual data from previous periods makes it possible to see trends, which promotes continuous improvement. If hypothetical standards, set by engineering studies are used, it is possible that standards are not comparable to previous years. For example if standards are updated to be more challenging, unfavorable variances can rise although actual efficiency is better than on previous period. Standards set by engineering studies are defined usually in a way where skilled worker does a job in an efficient manner. Also, chances expected for the budgeted period are taken into account. In addition it is sometimes possible to use data from other companies as a

benchmark. This kind of benchmarking can be very beneficial. Problem here however is that it is often very difficult to get fully comparable information. Even factories belonging to same company can use different ways to gather data, so this kind of analysis needs to be treated with caution (Hansen et al. 2009, Horngren et al. 2012, CIMA 2013).

The purpose of the variance analysis is to support managers to implement strategy and focus attention to areas where the most critical exceptions are occurring. Noticing of exceptions should lead to looking for the root-cause of the problem and finally to the corrective actions. Variances are also very important for organizational learning and for performing continuous improvement. For example those corrective actions could be measured after implementation with variance analysis. Variances can also even make company to change its strategy (Horngren et al. 2012, 228).

There are always variances at some level. However, if operations are under control, negative and positive variances should cancel themselves in long-term (CIMA 2013). If variances start to be all-the-time negative or positive, it is a signal of an unstable process. This means that variance analysis could work as an early warning system. Nonetheless, not all the variances are controllable. Thus, it is very important to understand the normal level of variation in the system. The focus of variance analysis should indeed be on controllable variances, which could be caused for example by incorrect standards, incorrect recording of costs, operational reasons or by several random factors. Those causes may also occur at the same time and they can be interrelated (Horngren et al. 2012).

Another important thing to remember about variance analysis is the cost-benefit ratio. Investigation of variances shall not cost more than expected benefits. Sometimes variances could be controllable but they are so minor, that it makes no sense to use time for them. There is no unambiguous rule when variances should be investigated, but depending of circumstances, some kind of thumb rules can be stated. For example rule to investigate variances exceeding standards by certain percentage, or by some absolute value in euros, could be defined. Also, following up variances in cumulative basis, or by using control charts could be often beneficial. In addition it is good to remember that not only unfavorable variances should be investigated. Favorable variances can also be

problematic because it could be signal for example of too easily attainable standards. These too easily attainable standards could have been used for example in pricing, which could have led to mistakenly lost orders (CIMA 2013, Horngren et al. 2012, 229).

Although variances themselves provide useful information for control, almost all companies are splitting variances to more detailed parts. Developing standards for input prices and input quantities is the first step which allows the split to price- and efficiency variance. The unit standard cost is standard price counted by standard quantity. Price variance shows a difference between actual input price and budgeted input price (Function 3). Efficiency variance shows a difference between actual input quantity and budgeted input quantity (Function 2). Hierarchy of variances can be seen on the figure 3.

Function 2*: Efficiency variance = (Actual quantity of input used – Budgeted quantity of input allowed for actual output) * Budgeted price of input*

Function 3*: Price variance + efficiency variance = flexible budget variance"* (Horngren et al. 2012, 236)
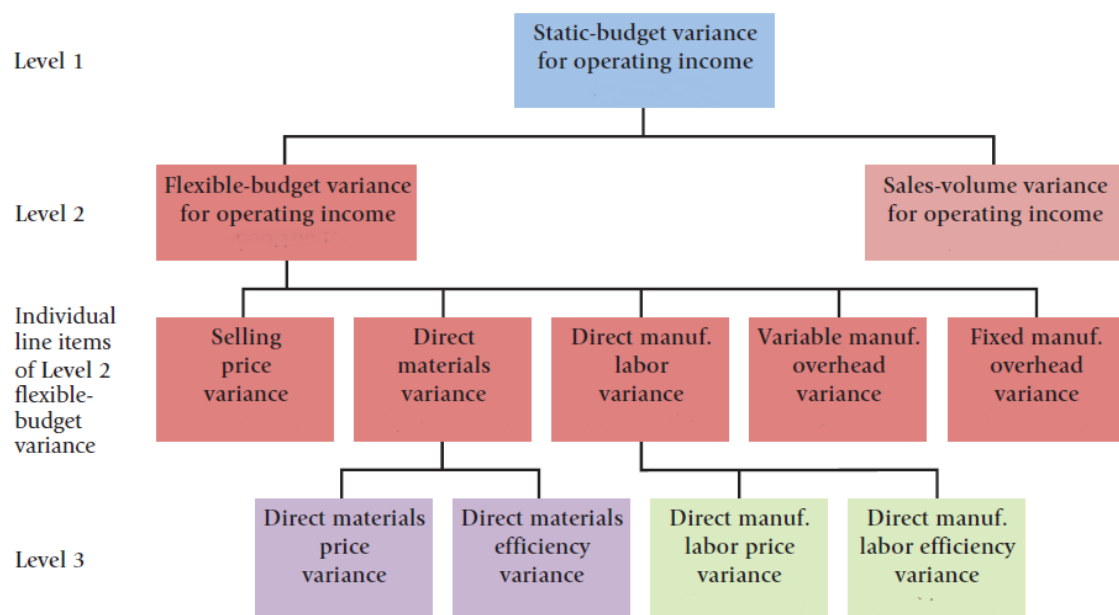

Figure 3 Flexible budget variances (Horngren 2012, 236)

Variances can be also split to planning and operational variances. The planning variances are caused by invalid setting of the original standard. Planning variances are not controllable for the operational management so it is better to separate them and give feedback to those individuals who are responsible for these variances. Correspondingly, operational variances are caused by operational processes, and give more realistic measurement of the operational efficiency. Split to planning and operational variances improves variance analysis from many aspects but it can also create problems. It is often not possible to make the split in an absolutely objective way and it can be time consuming. Also behavioral problems can arise, as subjective information can be manipulated easily, which may lead to conflicts. However, if this split can be done well enough it could increase motivation of operational people and support planning function (CIMA 2013, Horngren et al. 2012).

Sometimes management has possibility to use substitute inputs to produce the final product or service. When this happens, it is beneficial to split variances to mix- and yield variances. Mix variance comes from using cheaper or more expensive mix of inputs. Yield variance compares input quantity to standard (Horngren et al. 2012, 528).

2.3.1 Direct material variances in detail

Direct material costs are those materials that are directly traceable to the good or service being produced. A standard usage is usually determined by an engineering department (Hansen et al. 2009, 256). The total direct material variance can furthermore be split to efficiency- and price variances. Please see appendix 1 about the possible factors.

The direct material price variance is mainly impacted by supply and demand on the market but also other factors can be important. For example: quantities purchased, skills of procurement people and contract specifications play often significant role there (Horngren et al. 2012).

Direct material usage variance can be caused by many reasons, from which major part are quality related factors. For example scrap or wastage level can vary due to different quality of material or due to better quality control. Efficiency in the use of material is

nowadays very important measurement as companies want to be environmental friendly and of course also to cut the costs to minimum at the same time (Horngren et al. 2012).

Total direct material cost is after all the most important value to optimize. Although it is impacted by both, material price and quantity used, it is good to follow-up total costs. Direct material price and quantity used are often interrelated, which means that optimizing another of them may lead to increased total costs. For example if lower quality material with lower price is purchased, the consumption will be possibly higher (Horngren et al. 2012).

2.3.2 Direct labor variances in detail

Direct labor costs are those labor costs that are directly traceable to the good or service being produced. The standard usage is usually determined by the engineering department (Hansen et al. 2009, 256). Total direct labor variance can be split to efficiency- and price variances. Important thing to mention here is that overtime premiums and idle time of direct labor are not usually allocated directly to particular products. Instead they are considered as overhead costs. It is also important to remember that direct labor variances have often very significant impact on periodic results, because overheads are commonly allocated based on direct labor hours (Horngren et al. 2012).

Direct labor rate variance can be caused for example due to: unexpected increase in basic rate of pay, payment of bonuses and using of more or less experienced labor than normally. Also more larger-scale questions like geographical location and trade union contracts have essential impact to rates, but these factors are usually more predictable (Horngren et al. 2012).

There are several possible causes for labor efficiency variances. The most common causes are: simply efficient- or inefficient working, using less or more experienced labor, change in working methods, quality of supervision, learning effect amongst the work force and unexpectedly occurred production bottlenecks or shortage of resources (Hansen et al. 2009).

Similarly, like on direct materials, also on direct labor, the total cost should be optimized. Appendix 1 presents possible variances related to direct labor in a comprehensive way.

2.4 Criticism towards traditional variance analysis

Traditional accounting methods have been criticized a lot about their suitability to modern business environment (Pierce et al. 2003, 18). Standard costing and variance analysis was originated already in the early twenties meanwhile, number of new management techniques have been introduced for the use of 21st century. Standard costing was also originally developed for needs of mass manufacturing, which may not be suitable approach in the modern business environment (Manjunath et al. 2011).

However, the traditional methods like variance analysis to historical data seem still to have their place, but criticism towards it has to be answered. The criticism is not a new thing from the 21st century. Already in 1980s standard costing and variance analysis were even stated to be obsolete for modern manufacturing environments (Kaplan 1984). Despite that, now, 30 years after that, variance analysis is still the most widely used management accounting tool. The major criticisms will be discovered in this chapter.

The first criticism concerns about excessive use of solely financial numbers. In addition even those financial figures are seen to be too narrow, focusing only to bottom line figures (Pierce et al. 2003, 18). The use of only financial measures alone is said not to be sufficient anymore (Hon 2005, 2). For example, at plant level financial measures can be meaningless, meanwhile non-financial information would be more beneficial (Emsley 2001, 25). Management accounting systems have also been said to be too closely connected to financial systems, which can distort information, or reduce the amount of it. For example if average price is used also in management accounting system as a valuation method for stock, due to statutory accounting requirements, the difference between expected and actual price can be more difficult to catch. The answer for this criticism is quite simple as it is criticizing the way how standard costing and variance analysis is done. Non-financial information should be included to variance

analysis process and utilization of financial accounts should be done carefully. In fact variance analysis is fundamentally split to quantity and price variances, so problem is not in theory – it regards utilization of variance analysis.

The second criticism is related to standard costing that is very often used as a comparison in variance analysis. Standards are very essential in management accounting as they are inputs for planning and controlling (Hansen et al. 2009). Standards should be correctly estimated and it is difficult to define who has the best knowledge to set the standard. For example, standards calculated by the plant itself could be more valuable for continuous improvement (Emsley 2001). Standards are often criticized to create weak support for continuous improvement (Kaplan 1990, Hansen et al. 2009). If standards are not updated regularly, it encourages people to be happy just for achieving this particular level. Another opportunity is to use historical data as a standard and to compare variances from year to year, which would encourage continuous improvement. However, this would be not meaningful if significant changes on operations occur (Kaplan 1990). For example if totally different products are sold every year, historical data is not comparable. Standard costing is said to be appropriate when a stable production process is used to manufacture high volumes of similar products, but when variety of products increases it comes problematic (Fry et al. 1995, 22). If product variety is high, maintaining of detailed standard costing systems can be wasteful and cumbersome. In such a business standard costs can be difficult to understand without talking about how to exercise the control. Also, if overhead costs comprise a high percentage of total costs, the importance of standard costing can decrease (Fry et al. 1995, 22). In overall it can be said that standard costing isn't suitable for all kind of businesses, but if standards are defined well they can be also very useful (Horngren et al. 2012)

The third criticism is very common among all the accounting methods and it criticizes the retrospectiveness of the information. There clearly is a pressure to move from retrospective to proactive information (IMA 1998, Kaplan 1990). Undoubtedly it is anyway necessary to know the actual score before predictions can be done (IMA 1998). Also, variances are often necessary to be taken into account when forecasts are done.

For example if material requirement planning doesn't take variances regarding to use into account, it will lead easily to too low level of stock.

In addition the accounting information is often said to be presented too slowly. One important characteristic of good information is that it is timely, but instead cost-based variances are often presented a considerable time after the problem has occurred (Emsley 2001, Manjunath et al. 2011). Variance analysis is said to "regularly compare actual to expected performance", but regular as a word can have many meanings (Emsley 2001). Sometimes information is needed in daily-basis and on the other hand sometimes even yearly data is enough. The regularity of management accounting information used for problem solving should be designed for that purpose (Emsley 2001). Regularity should be equal to operational cycle time and this information should be as timely as possible. Modern IT-technology makes providing of timely information possible at feasible time, which promotes the increased use of standard costing systems for product coting and control (Horngren et al. 2012, 241).

Typical variance analysis is also not usually utilizing statistical methods, which means that for example normal variance of the system is not understood. This may lead to investigating variances that are caused by the system itself and are not assignable. It would be good to utilize statistical process control with variance analysis and set upper and lower limits, between which the variation is on acceptable level. Statistical process control has been used extensively in the area of quality control and it could be very useful tool also on traditional variance analysis (Martin 1998).

The fourth criticism concerns identification of problems and solving of them. Traditional methods review often only results instead of causes for those results, which reduce the probability that a poor outcome would be really changed (IMA 1998). The way how variances are reported is also an important factor, because reports should be distributed especially to those people who are able to solve the problems. Instead variances are often reported to superiors at the head office, and there is a risk that the information will be discarded or explained with vague reasons, which is wasteful for problem solving (Emsley 2001).

Even if problems are really being solved based on management accounting information it is important to remember that also corrective actions are influenced from the same information. Traditional accounting methods have been criticized to encourage competition between internal functions and to lead to partial optimizing. Optimizing the whole operation should of course always be the target, and there are newer methods to improve this area on management accounting, for example value stream costing (Martin 1998). Traditional accounting methods are also said to encourage maximizing the short-term results, which harms long run profitability. For example, when absorption costing is used, company could produce excessive amount of goods to inventory, which improves financial results for the period, but long-term profitability goes down. It is noted that achieving of specific standard direct cost efficiency targets, is often leading to worse efficiency in the whole process. All the factors that impact competitiveness should be taken into account. For example lead times, batch sizes and quality issues (Johnson 1991, Hansen 2007 et al).

The fifth criticism comes from traditional way to split manufacturing costs to the three narrow cost categories. Those categories are direct material, direct labor and factory overhead that may mean focusing only on utilization of resources, efficiency of labor and to allocation of overhead. Also, this perspective is not optimal to see interrelationships between operations or to perform continuous improvement. For example decision to use cheaper material may lead to increase on labor costs. Thus it would be good to connect costs that are related, even if they come from totally different cost categories (Martin 1998).

Especially focus on direct labor costs is said to be very often on excessive level. One reason for this is commonly used method to allocate overhead costs to products based on direct labor hours. However, even if allocation of overheads is not done in this way the emphasis on direct labor costs seems to be great. The criticism of great emphasis on direct labor costs has arisen due to popular assertion made by accounting thinkers, which claims that importance of direct labor is declining and overhead costs are rising. In a research done on year 1987 it was not shown that there has been an essential change in significance of direct labor, but this is a long time ago. Also, increase in overhead costs was not clear as costs were rising on some industries and decreased on

some other industries (Boer & Jeter 1993). Traditional methods are also seen to be on too overall level when direct material costs are analyzed. Overall material costs include for example purchasing and delivery costs (Martin 1998).

2.5 Variance analysis and modern manufacturing practices

Based on criticism presented on previous chapter it was found to be highly beneficial to take a bit closer look on how traditional variance analysis could be developed so that it supports modern manufacturing practices well. Those selected practices for this thesis are Lean-manufacturing and Value stream mapping. It needs to be remembered that, there is no clear guidance when new techniques should be adopted. Also, it is unclear how development of a management should be done when new techniques have been adopted (Kaplan & Johnson 1987).
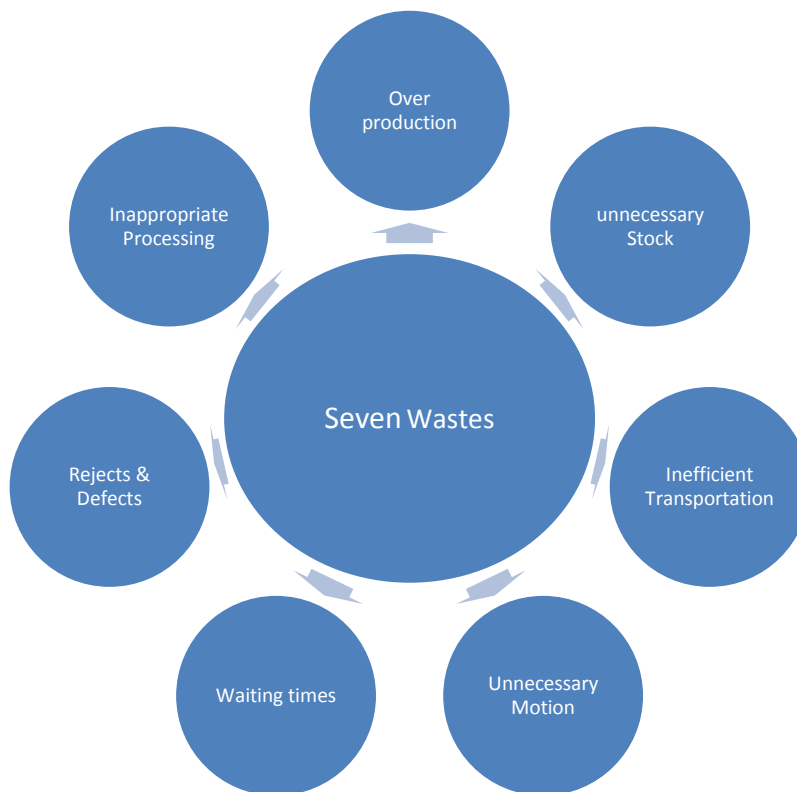
Figure 4 Seven wastes according to Lean-practices

Just in time manufacturing that is often referred also as Lean-manufacturing, is adapted by vast number of companies. Traditional management accounting methods may encourage to increasing the inventory levels, meanwhile in Lean-manufacturing every kind of inventory is seen as one type of waste. From lean enterprise perspective standard costing is seen often as a problematic tool. At first, standard costing calls for very detailed data collection systems, that collects also information that is not useful. For example amount of different kind of costs where standards are done can rise to too high level to be controllable. On the other hand, the information collected through standard costing is seen to be too narrow. In Lean-manufacturing the focus on waste-related costs is very high, meanwhile in traditional variance analysis those costs can be easily hidden into those variances. However, the need for supportive management accounting function is anyway recognized by those firms who have been implementing lean manufacturing strategies (Fullerton & Widener & Kennedy 2012, 1). Typical seven wastes of lean can be seen from figure four. All of those wastes could be included also to management accounting reporting.

Variance analysis has been still seen to be a powerful tool especially for middle and upper level managers as it shows the big picture on a periodic basis. It is suggested that a good analysis includes a follow-up of total costs and number of non-financial measurements for waste related costs. Also, these measures should optimize the performance of the whole operation instead of doing partial optimization to one particular function. In overall variances should focus more on quality related costs instead of excessive focus on direct labor costs (CIMA 2013, Hansen et al. 2007).

According to Lean accounting, profitability reporting should be organized around value streams. "A Value stream is the sequence of processes through which a product is transformed and delivered to the customer" (Haskin, 2010, p.91). Value stream costing is one commonly accepted method that answers to problem of partial optimization inside the organization. In value stream costing material, labor and overhead costs are traced to individual value streams (Fullerton et al. 2012). Value stream costing in addition works well with *capacity constraints* theory because bottlenecks are taken into account. Also, variance analysis could be performed on value stream level and it of course does not mean that deeper investigation would not be possible when needed.

The need for deeper investigation could be shown by control charts. If variances start to go out of upper and lower control limits it is a signal that the process is not under control and an investigation is needed. Control charts are among techniques that can be used also on variance investigation (CIMA 2013). An example of control chart is presented on figure 5.

Figure 5 Control Chart (http://www.tangram.co.uk/images/Tool08.gif)
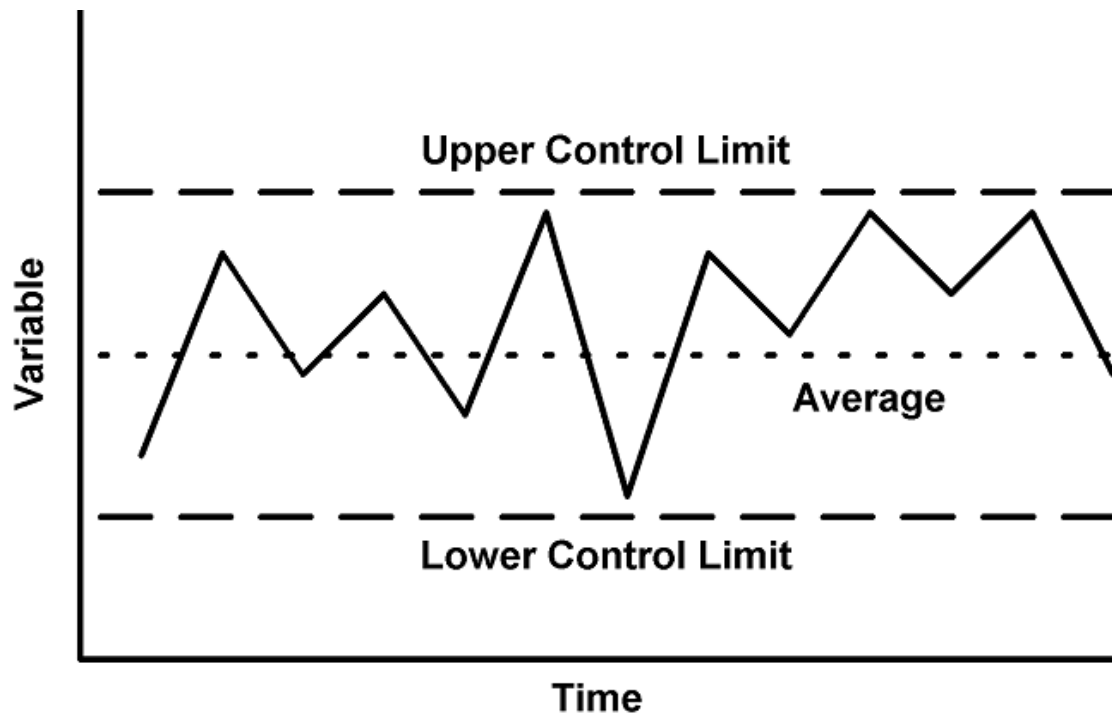
2.6 Variances and financial books

Management accounting systems have been criticized to be too closely connected to the financial accounting systems. Also, focusing on short period - like monthly - results has been criticized (Fry et al. 1995). However, it is a fact that especially stock listed companies have to explain their periodic results and that's why it is necessary to understand how costs of period have been established. Also, one main research question of this thesis is to explain monthly variances on margin on direct costs in financial

books. Variances between actual and budgeted figures should explain all the differences but there are many essential things to take into account on manufacturing environment.

All manufacturing costs are inventoriable, which usually means that all costs are going through inventories at some phase. Thus understanding of inventory movements is very essential part of manufacturing control. Shortly, the target of inventory accounting is to ensure that the cost of product sold is booked at the same as corresponding income. It is good to mention that for manufacturing-sector companies, period costs such as research & development and tendering costs are classified as nonmanufacturing costs and they are out of this analysis (Horngren et al. 2012).

In conventional absorption costing P&L statements themselves include only cost of goods sold, because manufactured items are still in inventory values. In addition to cost of goods sold, it is very recommendable to keep an eye also on cost of goods manufactured during a period. Typically these costs for a specific period can be calculated in the following way in four steps (Function 4). (Horngren et al. 2012, 41):

Function 4:

1. "Cost of direct material used = Beginning inventory + Purchasing of direct material – closing inventory
2. Total manufacturing costs incurred in period = Direct material used + Direct labor costs + Production overheads
3. Cost of goods manufactured = Work in progress, opening – Work in progress, closing + Total manufacturing costs
4. Cost of goods sold = Finished goods, opening – Finished goods, closing + Cost of goods manufactured"

Especially if levels of inventories are high, the reliability of the database is very important factor. At first cost of sales should be recognized at the same time in the P&L statement. Practically this does not always happen, which means that accrual has to be used in accounting in order to overcome this issue. Also, some fixed costs are often allocated wrongly as variable costs, which may confuse periodic statements. Finally it is always possible that some data is mistakenly added, or not added at all to the system when it should be there. For example incorrect inventory values have direct impact to

periodic results (Horngren et al. 2012). To summarize, variances on direct costs are practically not the only factors that impact on periodic results.

Variances on direct costs should be theoretically isolated at the time when variance has occurred. In addition they should be prorated to cost of goods sold and to various inventory accounts depending of the production-phase. Direct materials price variance should be isolated at the time of purchase, and journal entry to direct material control account should be done. Direct material efficiency- and direct labor variances should be booked to work in progress control accounts (Horngren et al. 2012, 240). Variances should not be always prorated to inventory accounts. If the variance has been avoidable it is often more recommendable to write off the variance, instead of booking it to inventory values. Unavoidable variances belong to inventory values (Horngren et al. 2012, 241).

When everything is under control it should be possible to reconcile actual manufacturing costs of period to financial books, and in addition to explain variances to budgeted figures. Based on William Vaughan – consulting company, this reconciliation is one of the most important steps of a successful costing system. Despite that, it is the most overlooked step. Also, IMA (1998, 22) recommended the reconciliation between different IT-systems to ensure the quality of information.

2.7 Summary of the theoretical framework

As seen the most of the criticism is related to the management by variance analysis information – not to the theoretical models. Also, the question that there would be no need for management accounting information in "Lean-enterprises" seems not to be valid based on literature. However, it seems to be recommendable to renew management accounting information to meet the needs of current environment. The theoretical framework is presented on a highly aggregated version on the figure 6. The figure 6 also answers to the research question one: "What characteristics does a good manufacturing control process using Variance analysis as a tool have in the modern

business environment?" This summary, which in fact can be printed on one A4-paper, works as a main basis for the construction.

Need of management:
- Manufacturing control system in line with organization's strategy
- Manufacturing control system supports operational management

Target setting:
- broad based targets
- Participative target setting
- optimal target : challenging but attainable

Performance measurement (Variance analysis)
- Broad-basis of information, avoid partial optimizing
- Also nonfinancial measurements
- Managers trust to measures, and measures are comparable
- More emphasis on quality / waste related figures (LEAN)

Distribution of information
- Keep it simple, no excessive amount of information
- Take different needs of different managers into account
- Timely and appropriately frequent reporting
- Reporting around value streams (VSC)

Corrective actions
- Measures are acted on
- Drive organizational learning
- Measure corrective actions
- Understanding of normal variation of system.
=> Perform corrective actions if process is out of control (SPC)

Reconciliation to Financial books
- Ensure data is correct in system
- Isolate variances promptly
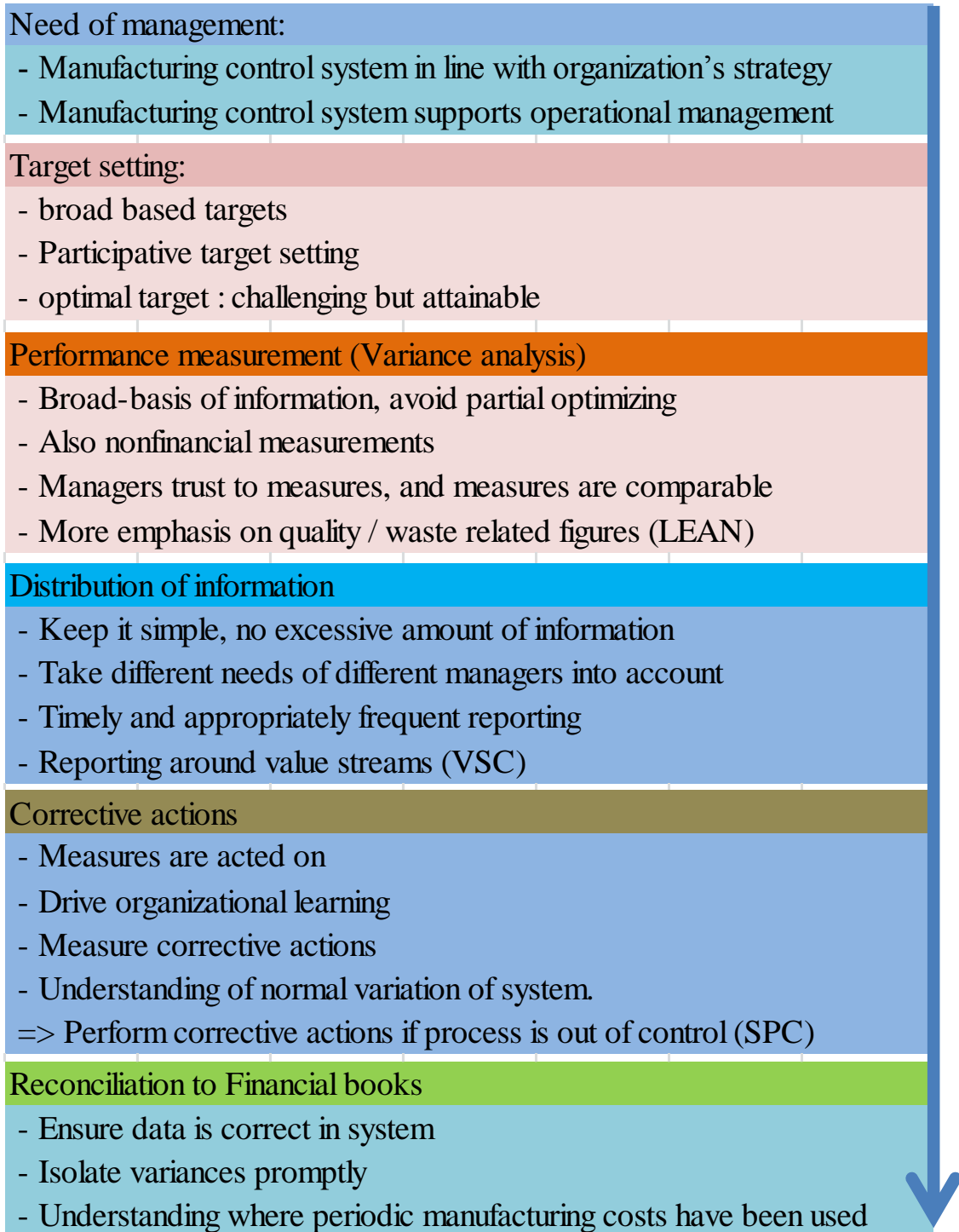- Understanding where periodic manufacturing costs have been used

Figure 6 Characteristics of a good manufacturing control process using Variance Analysis as a tool

3. THE EMPIRICAL PART OF THE RESEARCH

3.1 Presentation of Case-unit

Alstom is a large French company that employs around 93000 employees over the world. Alstom's turnover has been around 20 billion euros on the previous four years and it operates on power generation, electric grid and transport markets. In public Alstom is mainly known from its' urban transport trains. For example Allegro trains between Helsinki and St. Petersburg were provided and manufactured by Alstom.

The unit RMT, where the thesis was done, has relatively long history at Tampere region in Finland where it moved during 1960's. Company's independent name was Nokian Capacitors, which is still used as an auxiliary business name. Before Alstom, Nokian capacitors, has been part of Nokia, Schneider, Areva, and also independent for some years. RMT unit manufactures power compensation products, which are used to improve the quality of electricity and to reduce energy consumption. More than 90% of sales are exported, from which more than 2/3 is going outside of Europe.

Manufacturing is performed on three production lines that are physically separated: High Voltage, Low Voltage and Air Core Reactor lines. Manufacturing processes are not same on the production lines, but the same reporting procedures can be performed to all of them. Company wants to follow-up profitability by production line, so also the construction is built in that way.

3.1.1 Case-unit organization and key stakeholders

This thesis is built from eyes of Manufacturing Controller and almost all the processes presented belong to his scope. Manufacturing Controller reports directly to Site Financial Controller (SFC), who is responsible on overall level of the financial issues of the unit. SFC is reporting to product line level to France. Other main partners are Production management, Warehouse manager, Sales managers, Tendering manager, Quality manager, Sourcing manager, ERP manager, Project controllers, and Accountants. After all, could be said that Manufacturing Controller is working with

almost all functions in the unit. Key stakeholders related to this research will be considered more sophisticatedly on *management's needs* and *distribution of information* chapters.

3.1.2 Information systems and reporting structure

Information systems are very essential factor for this thesis. RMT uses Finnish LEAN-software as an ERP-system, which is not the same that the mother company is using. This of course creates some difficulties when information is integrated to a global reporting software, Teranga (SAP business objects), and it will be discussed later. Inventory management and production master data is managed through LEAN. The unit is also using a simple accounting software Wintime and business reporting software Cognos. The use of four different programs makes the reconciliation very important and sometimes also very challenging. In addition designing department is using separate excel-tools to build tenders. These tools are called as tendering database.

At first it is good to mention the complexity of the master database. At first there are thousands of orders sold during a year. Almost all products are *made to order* so they are unique. In addition these orders include usually several different items, which often are listed as "*mother items*" that have several "*child items*" below them. For example 100 High Voltage- units are produced for one High Voltage- capacitor bank. All of those items have their own Bill-of-Material (BOM) and Routings. One BOM can easily include one hundred different materials. Also routings include several work-phases. Amount of data is so huge that it is not possible to handle it manually.

Standard costs and quantities for DM and DL are found from LEAN. Standard costs are set on item level by the designing department. Standard DM quantities are listed on BOM's and price for raw materials is the weighted average price (WAP) in the system. Standard DL quantities are found from *routings*. Standard hourly rate is set to the LEAN by ERP administrator. Actual salary costs can be found only from Wintime.

The LEAN version RMT uses, is not able to group data from several different schedules and Cognos is used for this purpose. All the data Cognos uses comes from LEAN's database. With Cognos it is possible to run a report that for example shows planned and actual direct costs related to orders sold during given period. This can be done also on

item-level. Unfortunately, there are also problems related to these reports. At first Cognos takes only those materials into account that are listed on BOM. If item is not included to BOM it is not shown on costs. Order specific items are not always added to BOM, for example racks and current transformers. Another problem comes from "actual" cost on Cognos reports, which - in fact - is not actual, but the latest average price in the system. Usually this gives accurate enough estimate of actual costs but sometimes the difference to real actual costs can be high. For example if a big batch of particular items were produced and delivered one year ago and then recently smaller batch of the same items is produced, average cost would be calculated only based on this smaller batch. If Cognos report is now taken for these items also cost of this big batch is valued based on the most recent small batch.

BOM's and Routings are engineered by the designing department before the production is started. Tenders are built based on tendering database. All the bigger orders have their own estimated analysis sheet (EAS), where costs are estimated for the tendering purpose. EAS sheets should include all the costs that are related to the order. Tendering database is not directly connected to LEAN, so price information for materials and other costs needs to be updated manually there. Some orders consist of *make to stock* type of items and price lists are used for them. EAS sheets and price lists provide information about what were the assumptions used when the order was sold.

Non-quality costs are managed in LEAN by quality engineer who is booking for example waste products to waste material stock. There is a special project to follow-up non-quality costs and classification is done similarly as commonly presented in theoretical books. That is, classification to prevention, appraisal and internal- or external failure costs. Quality costs include sometimes also DL and overhead costs so they need to be separated.

3.1.3 Inventory accounting

All the inventory data is stored in LEAN. Items and their stock locations can be found from there in real-time basis. During every monthly closing the accounting department is taking stock reports to value the closing stock in Wintime. The opening stock of the

month is always the closing stock of the previous month and the change goes to profit and loss statement (P&L).

All the stock transactions can be also found from LEAN. Key check points on stock transactions are: arrival of raw materials to stock, picking up of materials to production or backflush to finished products, inventory adjustments, non-quality costs and delivery of finished goods to customers.

Raw-material costs are booked in P&L based on purchase invoices. Purchase invoices are booked directly to Wintime. Cost of raw-materials should be booked at the same time to P&L as value of them is booked into the balance sheet. Often items arrive to stock earlier than purchase invoice is received. Therefore, accrual is booked by accountants for raw-materials that have arrived but have not been invoiced. There is also another stock for inbound goods for materials that are delivered for example from China. Process to book them to accounting is similar.

Items are transferred to production line stocks or picked directly from RM stocks. Items are picked to the production or backflushed when the production is completed. Items under production are in work in progress (WIP) and when they are completed they go to finished goods stock (FG). Valuation of items should stay the same during production so there should not be any impact on P&L during this process. However, should there be difference on actual use versus planned for those items backflushed, is the valuation of WIP not correctly done. Also, on routings some hours are booked to item values based on planned values, because they cannot be traced to orders and the same problem occurs.

Inventory adjustments are booked by warehouse people if actual physical amount in the stock is not the same as in LEAN. There are several transaction types to do this, such as balance corrections, inventory adjustments and transfer between stocks. Items are only valuated based on WAP so all the adjustments are done for quantities. Mismatch between the theoretical amount in LEAN and the physical amount can be caused by several reasons. At first it signals whether there is a difference between an actual consumption of material compared to the planned consumption. That is BOM versus actual use for backflushed items and picking of items versus actual picking, for picked

items. It can be as well caused by human errors on the previous inventory checks. Of course it could also signal about possible inventory fraud.

Value of DM and DL stays in stock balances as long as item is not delivered. Items should be booked out of inventory values at the same time when order is traded. Orders' trading time depends on delivery term. For example ex-works orders can be traded right away after delivery, but some delivery terms require that item has arrived to the customer. Nonetheless, items go out of FG stocks directly when item is delivered. Therefore, a virtual stock is kept for goods in transit. Contract manager is taking care that these bookings are done properly and correspond to reality.

3.1.4 Manufacturing control process in the beginning

It can be said, that when the work for this thesis began, the manufacturing control process did not exist, due to several reasons. However, as distinction between management and manufacturing control is not so unambiguous, many processes were in place already in the beginning. Also, many manufacturing control processes are directly connected to other functions in business, so they have been handled by other functions in the company.

Foundation for this thesis comes already from, June 2012, when Industrial Controller from France did a visit to Tampere to review current processes and to point out the most critical deficiencies in the current processes. It was clearly seen that there were several issues to comply with Alstom's financial standards. The need for improvements, were also seen by the unit itself.

One of those deficiencies was an Alstom standard "COA" that sets rules on how all industrial variances should be collected and reported. Another deficiency connected directly to this thesis, was inability to understand root-causes for monthly fluctuations on margin on direct costs. Industrial variances explain part of those fluctuations but there are also other factors that may have essential impact as stated in the theoretical part. Also, as reporting of variances did not exist, there was no feedback process that would lead to corrective actions. This research was done to build construction to solve these problems and to partially implement those new processes.

3.1.5 The most critical deficiencies observed in the beginning

1. Inability to understand monthly fluctuations on MDC

The monthly MDC was reliable only on cumulative basis on longer periods. Often high margin of one particular month resulted as a low margin on the following month. This is not acceptable situation because it makes it not possible to see possible changes in profitability in timely basis. For example it could be possible that the profitability of one particular month was low due to real reasons, but it would be overlooked by seeing it as a normal monthly fluctuation.

It can be clearly said that theoretical framework's recommendation to report on timely basis is not accomplished here. On the other hand the recommendation to report at the same frequency as a manufacturing cycle time, would not even support the monthly reporting at RMT, as cycle times are often way longer (Lind 2001).

Also, reconciliation between projects sold during the month and financial books was not possible to be performed. Normally total margin on projects sold should be the same as MDC on P&L +/- direct cost variances, not traceable to projects. Reconciliation was recommended earlier for example by IMA (1998).

This deficiency creates also problems for backlog reporting. All the adjustments on backlog need to be justified – otherwise they are not validated and a theoretical margin needs to be reported in Teranga. The theoretical margin on backlog is calculated simply with the following function.

 Function 5: *Opening Backlog + Orders received – Sales +/- Adjustments.*

2. Material inventory is valuated at weighted average price

Standard price is not stored in the database as unit's standard price in the system is updated automatically based on WAP. As a result it is almost impossible to catch the direct material price variance. Use of WAP as a valuation method is justified because IFRS-reporting needs to be done anyway by using it. It was recommended that RMT would start to valuate items at standard price in ERP-system and separately at WAP in IFRS accounting. At least it is necessary that the most important price variations in

WAP are followed-up on monthly basis. The sourcing department was however following up this at some level, because they have to report changes in material prices anyway. This deficiency is related directly to the theoretical part, where management accounting systems were criticized to be too strictly connected to financial accounting systems (Fry et al. 1995).

3. Standard costing data is missing from the system

Some BOM values are missing from the system mainly due to mistakenly used item references. In addition it was found that many BOM's and routings were in incomplete state, which meant that costs were missing from them. It was difficult to detect whether the BOM or routing is completed without engineering knowledge. Also, Cognos was using incomplete BOM's to allocate costs to orders and items, although they should not be used before completion.

4. There is no return on experience between planned and actual direct costs

This was seen as a key priority to strengthen manufacturing control function in order to guarantee master data accuracy and to optimize industrial efficiency. However, production engineers have been following up actual and planned hours on work-phase level for a long time. Based on production engineers, standards have been updated when needed and reporting has been done on frequent basis. Financial department has not been controlling variances on DL hours. What has also been missing is a more accurate variance analysis performed on order or on item level.

5. Leakage (Indirect time of indirect people) was impacting direct labor costs instead of being booked into production overheads.

Like mentioned in the theoretical part of direct labor costs, indirect time of indirect people should be normally booked as production overhead cost (Horngren et al. 2012). In addition there were no clear instructions on how leakage hours should be reported and classified.

6. Concerns on inventory accuracy

Possible incorrect values on inventory have direct impact on P&L statements as inventory change is an essential factor there. Inventory is under control by Warehouse Manager and Contract Manager is keeping eye on goods in transit. However, finance department was not controlling this process in a thorough way and possibilities for unexplained monthly movements were high. There are also no clear instructions on how inventory adjustments should be booked in LEAN.

RMT is also partially using *Backflushing*-method, which requires very accurate master data to work reliably (Bragg 2005). Inventory accuracy was checked on monthly basis by Warehouse Manager and Manufacturing Controller for 10 random items. This was not seen to be sufficient and RMT was recommended to implement *cycle counting*-process according to ABC-methodology.

7. Reconciliation between IT-systems not performed thoroughly

LEAN and Wintime are not integrated solutions, which creates difficulties to see relation between inventory variation and general accounting. Also, the relation between Cognos and LEAN is not fully known, even though Cognos is gathering all the data it uses from LEAN. Reporting in Teranga is done manually based on data in Wintime, Cognos and LEAN.

3.2 Targeted state of an industrial variance analysis process

The targeted construction for an industrial variance analysis process was built based on the theoretical framework and unique features of the case-company.

3.2.1 Management's needs

Management's needs have been presented already on the overall level. That was to have a control between actual and planned costs and to understand the monthly MDC fluctuations. However, like discussed in the theory, different people want their information in different ways. So it is good to take it into account already when the construction is built.

At first Alstom has requirements for industrial variance reporting and there are clear instructions about it (COA). Purpose of this instruction is to describe how all industrial variances - that are not dedicated to specific customer order - should be reported. These industrial variances include differences between actual and standard costs, as well as some non-quality costs. Those variances that are related to customer orders should be considered as margin slippages. For RMT this approach is not always feasible even though unit is mainly operating on MTO business. RMT's volume of orders is pretty high and some orders are quite small, which would make the reporting cumbersome, if all the variances would be reported as margin slippages on an order basis. Therefore RMT is reporting *COA* based on MTS rules.

Industrial variances reported under COA, MTS-business:

- Purchase price variance, DM (Standard price vs. Actual price)
- Quantity variance, DM (Standard quantity in BOM vs. Actual quantity used)
- Labor: hourly rate variance, DL
- Labor, quantity of hours variance, DL (Standard qty. of hours in routings vs. actual)
- Inventory adjustment, DM & DL
- Inventory revaluations
- Scraps originating from manufacturing process, repairs on stock, DM & DL

COA requirement includes a fundamental variance analysis split to quantity and price variances. In addition there are some other measures related to quality, which was recommended also in the theoretical framework (Hansen et al. 2007).

RMT is valuating materials based on WAP and standard price is not available. It was also decided that the current process is not changed in LEAN. Decision was done because changing of the valuation method would have been too expensive and risky compared to the remaining lifespan of the current ERP-system. As a result PPV variance is not reported under COA. However, changes in WAP should be followed up in monthly basis. All other COA-requirements should be available in IT-systems.

Based on Alstom standards, inventory adjustment should correspond inventory take variance valuated at standard price. Due to ERP-limitations, RMT has to use WAP. Warehouse manager should be able to explain major adjustments on a monthly basis

and inventory adjustments should be validated by finance before monthly closings. RMT is not revaluating stocks so inventory revaluations should not exist.

COA itself is a simple key indicator of the industrial performance that groups all industrial variances under two accounts (COA DL, COA DM). By following up the above-mentioned variances it is possible to review accuracy of BOM's and routings, production efficiency and productivity, and the quality of manufacturing process. COA is reported on P&L statements very visibly so it is a figure that is very probably going to be noticed also by the top management. It is good to note that COA is not only a reporting requirement. Units should have detailed enough data themselves to be able to perform corrective actions.

Supporting of the operational management is one of the most important tasks of the manufacturing control function (Horngren 2012). From operational management's view the need for more punctual control process did not seem to be so immoderate. It was not surprising because people seldom enjoy if their work is being controlled by other people (Waal 2002).

Production management was already following DL efficiency and productivity on the production line level. Manufacturing scrap and defective products are followed up by quality engineers. So it was seen that costs of manufacturing processes are already under control. The common mindset about BOM and Routing's accuracy seemed to be that they are pretty accurate and close to the actual use. Nonetheless, the need for comparing tender cost calculations to actual costs, and to BOM-phase was seen also by the operational management.

It is commonly known that stock listed companies want to report as flat results as possible. It does not, however, mean that the flat result should be achieved by just booking right sized accruals. The results reported should represent the reality. RMT is reporting results on a monthly basis to the product line management that basically wants to know how the unit is performing. Currently RMT has experienced problems on understanding the monthly MDC and there is clearly a need to improve the quality of the monthly data. Fluctuating MDC figures are not acceptable from management's view.

3.2.2 Target setting

RMT has three types of targets for DM and DL related costs. The most accurate targets are standards that are defined for every manufactured item by designers. Then there are targets that were defined by the tendering department when orders were sold to customers. The third type consists of more subjective targets that are defined by the management. For example the budgeted total DM cost for a period or the targeted efficiency level of DL.

Standard quantities for materials are listed on BOM's and standard quantities for labor hours on Routings. Basis for these estimates comes from engineering studies. Especially BOM accuracy should be very high because RMT is using backflushing. Based on inventory accounting books, the accuracy of BOM's should be so high, that variances to actual material consumption would be less than two percentages, when backflushing is used (Bragg 2005, 22). Participation of all involved people is not possible because amount of BOM's and routings is so high during a year. However, should there be consistently differences between actual quantities and standard, it must lead to discovering whether designing tools should be updated.

It is important to ensure that the interface between production and designing department works and variances are investigated. Based on discussion with Unit Managing Director, a good target level at manufacturing environment of RMT could be between x and y percentages for DM and DL quantities. In addition similar difference could be accepted between tender calculations and BOM's. It would be beneficial to set an official target level that is communicated to tendering-, designing-, and production departments. Targets have often a significant impact to actual results so also a clear target on EAS, BOM and Routing's accuracy could improve the process (Horngren et al. p.817). For price variance BOM's are using WAP and Routings the same budgeted DL hourly rate. Manufacturing scrap of raw materials is estimated on raw-material master data.

The quantity differences between tendering EAS and BOM & Routings can be explained by the fact that there is less time to prepare EAS for customer tenders. EAS represents the as sold version of the order and of course accuracy of it should be also on

good level. Incorrect tender assumptions can lead to lost sales, or to too low sales prices. Important factor here is that material prices and DL hourly rate is updated to tendering tools manually. It is vital for RMT to ensure that price-data in tendering tools is up-to-date.

The third type of targets, set by unit's management, includes several overall level targets related to DM and DL. Targets that are important for this thesis are: productivity and efficiency of DL, budgeted total direct costs for DM and DL, estimated direct costs that are traceable directly to orders (cf. Simons 2000). These targets are set on production line level.

DL efficiency targets are defined by the production management. DL efficiency represents the rate: *Allocated hours to direct works divided by booked hours to those works*. DL productivity rate represents: *Allocated hours to direct works divided by presence hours (Presence hours = Booked hours + Leakage hours).* So leakage hours play a significant role on productivity rate. It is not clear, whether these rates are defined by using a principle, where targets are slightly challenging but attainable. Properly speaking target-setting seems to be based strongly on historical data that does not take changes in operations into account. Here it is also good to remind that targets should be broad-based enough so that they don't lead to partial optimizing or other problems. For example if manufacturing people book more hours to BH instead of leakage, leakage rate goes down but productivity stays same. Therefore, it could be more recommendable to follow-up productivity rate instead of leakage. Moreover, for example paid absences and quality of labor performed have to be kept under eye. According to SFC this area was considered in a comprehensive way by the management at RMT.

Target setting for leakage hours was done by taking, the expected major changes into account and by making the target little bit more challenging after that. Target setting was criticized by the production management to been done with so called "cheese slicer-method", which does not correspond reality. However, this kind of approach can be supported with the continuous improvement approach, and with assumption that targets have a significant impact on actual results. Anyway it is important that the operational management is committed to targets. Possible differences could be later

divided to planning and operational variances if necessary. Also, it was found that there was no uniform instruction for booking and reporting of leakage hours, so new instructions had to be done according to Alstom standards.

Budgeted total direct labor and material costs don't play a significant role in this research, because change in sales volume, is not included to area. However, budgeted proportion of DL and DM costs of total sales works as a good comparison, when monthly MDC is analyzed. If either of those costs is far away from budgeted value, and there is no COA to explain it, it signals about problems in inventory valuation. Based on discussion with SFC it was decided that understanding 80% of performance gap between direct costs on projects sold and P&L statement is good enough level, like proposed in the theoretical part (IMA 1998).

Direct costs, not traceable directly to orders, may arise easily questions because normally such costs should be booked as overheads (Horngren et al. 2012). However, there is a small amount of such costs on RMT's P&L and they have to be taken into account. DM costs that are not traceable consist mainly of visually controlled items and of packing material. These costs are taken into account on GM calculation on orders with specific coefficient. Accuracy of this coefficient should be updated, when needed, based on actual data on P&L accounts. Moreover, a trend of those costs should be followed-up. DL not booked on orders comes mainly from common works (NN-works) that are included into routings. Those costs go to cost of orders based on standard times in routings. Accuracy of these particular routings is very important because a mismatch means also mismatch on inventory valuation and on the MDC.

3.2.3 Industrial performance evaluation

Performance measurements related to this thesis can be classified to three groups. Those measures should indicate the accuracy of master data, production efficiency and productivity, and the quality of manufacturing process. Those indicators are defined on Alstom standards so it is assumed that they represent also objectives and strategy of the top management. Those indicators provide also a pretty broad-based representation of industrial performance. Nevertheless, it is always easy to find possible imperfections from simplified measures. For example improving the accuracy of master data may

increase costs of engineering people, which is out of this research. It is important to ensure that those measures are also understandable for the operational management so that it is possible to perform corrective action when needed.

The accuracy of master data (BOM's & routings) is followed up by comparing standard quantities to actual consumption. Moreover, data in tendering database needs to be updated frequently. DL efficiency and productivity are followed up on production line basis. The quality of manufacturing process is performed by keeping eye on inventory adjustments and costs booked on quality project (LAATURMT).

Need for nonfinancial-measures were highly recommended in the theoretical part and on criticism towards Variance analysis (Horngren et al. 2012). Number of non-financial indicators is high in this construction as all performance measurement groups include them. In fact deficiencies on this construction are on price variances, because standard prices for materials are not available.

Good performance-measurements are comparable and persistent from year to year (Hon 2005, Davila et al. 2007). This target is difficult to meet for RMT because most of the products are MTO type and there are often changes, which makes comparisons to previous years often unsuitable. Therefore, RMT is mainly using standards set by engineering studies as a basis for comparisons. Nonetheless, RMT should look for consistent ways to measure trends of performance. Otherwise performing of the continuous improvement would be questionable.

3.2.4 Distribution of information

Distribution of information can be divided to two parts. At first Alstom requirements of reporting need to be met. Second part consists of reporting done for internal purposes to meet requirements arising from RMT's manufacturing environment and operational management. Target is to integrate internal reporting in line with Alstom's requirements as well as possible to eliminate wasteful double-work. The same data that is collected to report COA can be used also for operational purposes. Proposal to distribute this data is explained on next paragraphs. The target is to keep reporting as simple as possible and to distribute data only to people who need this information (Waal 2002, IMA 1998, Barnett 2006).

Direct labor efficiency is followed up by production management on a weekly basis by production line. Production engineers are measuring efficiency on work-phase level and updating target times based on observations. This approach corresponds the theory that recommends using fast and simple reports for operational purposes (CIMA 2013). So there seems to be no need to change this process. Direct labor efficiency is also directly connected to accuracy of routings. Routings accuracy is not currently followed up on order basis so improvement should be implemented there. BOM accuracy involves the same people so reporting of it should be integrated with variance analysis on routings.

Based on discussion with tendering manager it is good to include also tendering assumptions to same analysis. Then it is possible to see variances between tendered version, designed version and actual results. However, a static reporting is considered to be problematic (Hon 2005). SFC's opinion was that not only reporting this information is enough because it does not ensure corrective actions. It would be better if "Return on experience" meetings will be kept on monthly basis with all involved people sitting at the same table. Idea is to keep meeting on major orders traded during the latest month. Problem with these meetings is that they can be seen as time-consuming by operational people. One revised option could be to keep meetings on production line basis so people would need to stay in the meeting only for the time when their production line is being reviewed.

Quality of manufacturing process is related to BOM accuracy, but to keep it simple, it is better to exclude it from quality reporting. Of course if quantity variances are related to quality issues they should be handled as quality costs. Quality itself has been followed up for some time through LAATURMT project in LEAN. Quality engineer is picking costs related to quality and groups them according to the theory. It can be said that quality costs are under control but it was found that feedback from actual manufacturing results has not changed assumptions used on designing tools. Many inventory adjustments are caused due to difference between actual use and planned use on BOM. Therefore, actual scrap for such items should be measured and designing tool and LEAN parameters should be updated accordingly.

Reporting to the top management is performed based on Alstom rules. However, for example COA needs to be explained to the top management, as well as possible

fluctuations on the monthly MDC. This reporting does not need to be extremely accurate but it should allow seeing the big picture easily (cf. CIMA 2013).

Also, the frequency of reporting will be integrated to Alstom's monthly closing schedule due to time limitations. This is surely not an optimal way because it does not most often correspond the manufacturing cycle-time (cf. Lind 2001). Nonetheless, approach to report most of the financial things on monthly basis, is maybe not so bad thing. Production management gets weekly information for operational purposes and also monthly reporting cycle is quite short. Master data accuracy is followed up by order for orders sold during previous month. This is clearly a mirror looking approach as production of those orders could have taken place already months ago (cf. Johnson et al. 1987). Anyway even this process is seen challenging in order to time limitations so it needs to be accepted. In addition there are some bigger orders sold internally where more frequent cost data is required by Project controllers also during the production phase.

3.2.5 Corrective actions

After all the real contribution of management accounting realizes only after the information provided leads to real actions. Target of the previous chapters was to establish a good enough performance measures and distribution of this information, to be able to promote operational management to corrective actions. As discussed in the theoretical part, implementing of corrective actions is very often the most difficult part for the companies (Hon 2005). In addition it is one of the main areas of the criticism towards management accounting information. Also, at Alstom's financial instructions the importance of corrective actions is highlighted as the primary target of the reporting.

When work for this thesis began there was a very interesting discussion with one production line supervisor. His comments were totally in line with criticism about unsuccessful ability to really improve processes based on management accounting information.

"There clearly is a need for more detailed information about industrial performance – especially on production line x. However, this information should not be only so called

nice-to-know information. The information should be something that really leads to improvement of processes"

Performing of corrective actions of course depends on what is the area to be improved. The first area to control, accuracy of BOM's and routings, was not under clear control when this project started. In addition the common belief was that accuracy is at pretty good level, which clearly also meant that there were no important improvement programs going on. Relying on the phrase stated on theory, *"what is measured, gets done"*, could be good enough incentive here. Based on it, it would be good to follow up whether accuracy of BOM's and routings is on acceptable level or not. There are always deviations at some level, so it is necessary to set a targeted accuracy level for master data. If accuracy of the master data starts to be out of accepted level, people involved, should be pushed to look for reasons to deviations.

Deviations can be caused by two main reasons: incorrect assumptions set by designers and problems on operational side. Operational problems can be split to unavoidable and avoidable issues (cf. CIMA 2013). Very often there is a high incentive to classify all deviations to designing errors. This is the easiest way to fix the error in system because only thing that needs to be done is changing the parameters used in database. If this approach is used excessively for unfavorable variances it leads to easier standards, even though there might be underlying operative problem that could be improved. On the other hand it is nevertheless important to correct mistakenly input designing parameters to ensure the correct inventory valuation and to provide good quality standards for production people.

Unavoidable problems on operations should be sometimes included into standards and sometimes not. If those problems are occurring regularly it is advisable to add them to standards but this should be done with caution. However, if problems are really unavoidable, not too much concentration should be directed to them.

Avoidable problems on production are something that has real potential to improve the company's performance. These problems are also directly linked to operational efficiency and productivity. At RMT this area is mainly under responsibility of the production management. However, sometimes there are problems caused by

challenging specifications set by customers. Sales and tendering department have usually the best knowledge about these problems. Theoretically they should have been taken into account already on the tendering phase, but things don't go always perfectly. It is good to distinguish also these problems from avoidable operational problems, because it is something where production management doesn't usually have controllability.

After all taking into account the complexity of RMT's manufacturing processes, financial department cannot do a lot more than bringing forward information about inefficiencies and to push production management to corrective actions. Purpose of those "Return on experience" meetings is to ensure this. Procedure to control manufacturing quality costs is similar. Quality engineers are responsible to plan and implement corrective actions but duty of manufacturing control function is to follow up that actions are being done. For all the corrective actions it is essential to also follow the actual results. Probably this should be done on ad-hoc basis, but there are problems on this approach. There is a danger that problems are forgotten after bringing them forward. This may lead to it that nothing was really changed despite the discussions. Even if corrective actions were implemented successfully it would be good to measure them to create a learning effect.

3.2.6 Variance analysis criticism and modern manufacturing technologies

Criticism towards variance analysis has been taken previously into account as well as possible, but everything cannot be covered due to practical limitations. At least it was observed that variance analysis is not obsolete for RMT even though unit is practicing also modern manufacturing practices.

At first criticism towards excessive use of only financial figures should not concern this construction due to high amount of non-financial information. Moreover, performing of corrective actions was discovered already on previous chapter. Problems related to measurements being not broad based enough, such as partial optimizing, are not discovered sophisticatedly in this thesis because emphasis is only on DM and DL costs.

Criticism about using standards as comparison values is a real problem of this construction. RMT has high variety of products, which results as a very complicated

standard costing system that is difficult to control. In addition amount of overhead costs is relatively high, which suggests based on the theory that standard costing is not the best possible method. Also, setting of those standards, to be challenging and attainable, is not always going perfectly. Moreover, historical data is often not comparable. Nevertheless, it is of course clear that the costing system would not be changed based on this thesis. Same goes also for cost classification to only DM and DL costs – it is not under the area of this thesis. BOM's and routings are used also for other purposes than for cost accounting, for example for material resources planning and to production planning, which makes standards important. So RMT is just trying to minimize the problems caused by this method. Even though standard costing system is pretty cumbersome, it can be controlled through the IT-systems. In addition it is possible to improve the quality of those targets and try to find areas and ways to utilize also historical data.

Value stream costing could be one option for the current standard costing system. However, there is not a necessary requirement to change the current system to get benefits of VSC. If production lines are seen as value streams, it is possible to build industrial variance analysis around them. Data is collected in a complicated way, which is against VSC methodology, but it should not harm the analysis itself. Already many reports are done on production line basis so there are no obstacles to perform also industrial variance analysis on a production line level. Lean-manufacturing perspective is taken into account by including a high number of quality related variances to the construction.

The third criticism towards retrospectiveness of information and frequency of reporting was not answered very well in the construction. Reality is that as RMT doesn't currently have even a decent follow-up for historical costs, it is too early to talk about predictive information. Frequency of reporting is not matching the manufacturing cycle but as discussed timeliness is achieved as well as possible based on capabilities of human resources and IT-systems used.

The criticism towards weak utilization of statistical information could be answered quite well. This was also under discussion with unit's production development manager who is responsible for utilizing the Lean-methodology on factory:

"You should not only follow-up average values for longer periods. Instead you have to understand how figures behind those values are behaving. It is necessary to understand are those variances occurring consistently towards one particular direction before parameters are updated. Also, if there are high variations somewhere, from side to side, it is a signal to investigate this process"

The advice was taken into use and target is to understand behavior of numbers behind all indicators before reporting. The understanding of normal variation is taken into account when targeted accuracy on BOM's and routings are set. Accuracy for BOM's and routings could be followed through control charts by using SPC methods on the production line level. If accuracy of BOM's and routings stay between targeted upper and lower limit process is under control and no investigation is needed. If not, designers involved should discover with production and sales management what is going wrong.

3.2.7 Reconciliation to financial books

Reconciliation to financial books may be seen as detached from the other areas at this thesis that concentrates on the industrial variance analysis. However, based on William Vaughan & company reconciliation is in fact the most commonly overlooked part of costing system. Reconciliation is the final thing that groups all industrial variances next to P&L statement and allows seeing proportions compared to total manufacturing costs. Reconciliation is also a final test for quality of industrial variance analysis. Reconciliation between systems also ensures the quality of reporting (IMA 1998). Also at RMT, reconciliation is necessary to make financial management to trust the figures.

As stated earlier, inventory accounting has a significant impact on RMT's MDC calculation. The more inaccuracies there are on inventory, the more inaccurate is the MDC of the period. RMT has experienced heavy problems on inventory accuracy especially during yearly stocktaking when all the items in stock are gone through. Cycle counting process using ABC methodology was implemented during summer 2013. However, results of it start to show up after this research is already done. Therefore, inaccuracies are just accepted in this construction and they are taken into account on the reconciliation.

RMT's direct costs are classified on P&L statement in a conventional way to direct materials and to direct labor. In addition there are costs classified as *other direct costs*, which includes mainly transportation and testing costs. Theoretically DM and DL on projects sold in Cognos-report should match with accounting books. Practically it never happens as there are several industrial variances and inaccuracies on inventory levels. In fact the gap between Cognos-reports and financial books is so high that it is questionable whether company knows where its' direct manufacturing costs are actually coming from. It seems to be absolutely necessary for RMT to learn where this difference comes from. Of course it is also possible that something could have been done wrong on those reports. Especially it is important to check parameters used on Cognos-reports. However, due to limited amount of time, not all the difference needs to be explained on monthly basis. The target for monthly analysis is to be able to explain 80 % of this reconciliation difference.

Based on theory variances should be isolated as soon as possible. Variances occurred from manufacturing process should be booked into several inventory accounts or under cost of goods sold depending of the manufacturing phase. It is also recommendable to write-off avoidable variances directly to the period when this variance occurred. Due to time-limitations RMT is not isolating variances manually into several different accounts. However, part of this isolation works automatically due to inventory accounting process and COA reporting.

At first DL hourly rate variance will be calculated for all the hours worked during the period. Separation between cost of goods sold and items in inventory will not be done because benefits of it would not probably be more useful than consumed time.

Value of DL for items in WIP and FG stocks are mainly calculated by counting actual hours booked into those items in system with the budgeted hourly rate. This means that quantity variance will realize on P&L when the order is traded. Nevertheless, it needs to be remembered that DL hours not traceable on order basis are going to inventory values based on standard quantities. This means that possible variance occurred there impacts directly costs of goods sold during the period. It would be beneficial to compare direct hours booked into system and direct hours activated to inventory during the month. DM quantity variances have impact on P&L in a similar way but terms are different.

Backflushed items are activated to inventory based on standards and items picked based on actual consumption in system. The possible difference occurred in backflushing should be seen from inventory adjustments which are booked into P&L at the time when these adjustments are done. Time when this backflushing difference occurred is not taken into account and reliability of this figure relies on physical inventory checks. Therefore, it was seen that it would not be beneficial to split inventory adjustments into different accounts in a complicated way. Not booking all variances in theoretical way creates problems for reconciliation but it is accepted because selected accounting way was seen to be accurate enough. Also, it will be possible to make ad hoc analysis about this theme when the need is observed. Shortly RMT's P&L statement includes always some variances not occurred during the reported period.

3.2.8 Summary of construction

Summary of the targeted state is presented in similar form like summary of the theoretical framework. As seen, it was noticed that not all the characteristics defined on the theoretical framework can be utilized – even already before the implementation phase. The proposed construction is summarized on the figure seven on page 56.

Recommendations that were investigated in the theoretical framework were achieved partially in the construction. Based on the theory, manufacturing control system should be in line with organizations strategy and to support operational management. Meeting this requirement was also target of the construction. Nevertheless, how well this requirement is actually met depends heavily from other parts of the process.

Quality of target setting was maybe the most problematic area in the construction. At first the broad basis of targets cannot be guaranteed because the focus is only on direct manufacturing costs. In addition there are also other measurements that enable risk of partial optimizing, for example reporting of leakage hours. Aim of the construction is that target setting is done on a participative way. Practically this is really difficult to implement mainly due to time constraints. Based on theory, targets should usually be attainable but challenging. There should not be any obstacles to practice it also on this construction.

Performance measurement in the construction creates also non-financial and quality related information, which can be reported around the production lines. This was well in line with the theory. However, the use of WAP in the ERP-system disables the possibility to report DM price variance that is one of the most fundamental parts of Variance analysis. Also, making the measurements comparable from year to another year is very difficult, which may harm the continuous improvement.

According to the theoretical framework the distribution of information should be done in as simple way as possible. This is the target also in this construction, but the complicated manufacturing process and four separated IT-systems may make it difficult to achieve. Different needs of different managers are taken into account. Nevertheless, the timeliness and appropriate frequency of information is not going perfectly. Reporting will be mainly aligned with the monthly financial reporting cycle, which is sometimes not so suitable selection. However, quality costs and labor efficiency and productivity are followed-up by operational people more frequently. Corrective actions and reconciliation to financial books should be in the same way like suggested in the theoretical framework.

Need of management:
- manufacturing costs are under control
- understanding root-causes for monthly MDC fluctuations
- ensure accuracy of BOM's and Routings
- Measure production efficiency and productivity
- follow-up quality of manufacturing process

Target setting
- set upper and lower limit for BOM & Routings accuracy
- Efficiency and productivity target setting for continuous improvement
- minimize non-quality costs

Performance measurement
- Variance analysis on DL quantity and hourly rate
- Follow up DL productivity & efficiency (Leakage)
- VA on DM quantity used, follow up WAP change on monthly basis
- Follow-up quality costs through LAATURMT project in Lean

Distribution of information
- Provide feedback of BOM & Routings accuracy to designing department
- Use control charts for global level of BOM & Routing's accuracy
- Large orders (+500k€) are followed up, based on need of project controllers
- DL efficiency and productivity is followed up by production management frequently
- Non-quality costs are frequently followed up by quality engineers
- Create reporting around production lines
- At least 80 % of performance gap has to be explained to higher management

Corrective actions
- Update designing & tendering parameters when needed
- Monthly ROE meetings with all involved people for orders traded
- Drive improvement programs and measure them afterwards
- Corrective action are performed only after analyzing figures behind KPI's

Reconciliation to Financial books
- Ensure accruals are booked correctly
- Ensure accuracy of inventory
- Create reconciliation between financial books and Cognos report for orders sold

Figure 7 Construction

3.3 Implementation and assessment of construction

Due to limited time to use for this project, not all the recommendations proposed in the construction were actually implemented. However, many points brought forward in the construction remain recommendable for RMT to be commissioned later with better time. More technical description about ways to implement this construction can be found from next sections and split is done based on areas included to management's needs. Different processes were established during the work of the thesis and some of them demanded several iteration rounds.

3.3.1 Industrial performance

1. *Follow-up quality of manufacturing process*

DM and DL costs related to quality issues are reported under COA on a monthly basis. Quality costs can be tracked down from the transaction table in LEAN and it is possible to set up saved filters there to make this process simple. Separation of DM and DL costs has to be done carefully. Reporting of quality related material costs under COA started in February 2013. Based on experience of following months it might be better to use stock transactions schedule in LEAN, instead of transaction table. Stock transactions schedule would be better because it shows actual movements on stock values, which also finally defines result on P&L statement. For example keeping eye on movements to waste-material-stock could be clever.

It needs to be mentioned that interface between quality department and finance needs to be working well to report reliable figures. Sometimes it is for example possible that significant quality related costs are booked into LEAN in correct way, but company has managed to invoice customer for those costs. Therefore, the most recommendable way to implement the process is that finance takes a quality report from LEAN during monthly closing and sends it to Quality engineer before reporting. Also, possible missing quality costs could be noticed in this way.

More detailed and frequent control on quality related costs should mainly stay under specialized quality engineers. Quality employees are also reporting in pretty

sophisticated way based on their requirements so it is difficult for financial people to create contribution here. However, there could be a need for indicators showing comparable figures of the production. COA itself does not take into account the level of activity. Therefore, it would be recommendable to identify the most critical quality related processes in production and to start reporting those costs or quantities as proportion compared to level of activity. Based on discussion with quality engineer the number of scrapped HV-units compared to number of HV-units produced during the period could be useful indicator. LEAN allows doing this pretty easily on stock transactions schedule. During the thesis this was done only on ad-hoc basis to selected bigger orders.

2. *Ensure accuracy of BOM's*

Differences between actual and planned consumption of material is also quality related issue so possible variances here need to be communicated to Quality engineers. Another major reason for variances is so called planning variance caused by mistakenly estimated assumptions in the designing phase. Clear distinction between those reasons cannot be done, so it is recommendable to communicate with both departments before conclusions. As discovered, BOM's include items that are either picked from stock to production, or backflushed based on standard quantities.

Especially backflushed items are directly related to quality because raw-materials that are not measured in full units belong there. Consumption differences on backflushed items cannot be done on ERP on an order basis but their global level consumption difference can be estimated based on inventory adjustments. If actual use of particular item is higher than in LEAN parameters, it results as a negative inventory adjustment, and in other way around for items which have lower use than estimated. Inventory adjustments were started to be reported under COA material in April 2013.

If inventory adjustments are consistent from period to period, it signals to inspect the used parameters. As part of this thesis, top five items where inventory adjustments occurred were analyzed during June 2013. For all of them those adjustments were consistently done towards one particular direction. It needs to be remembered that accuracy of inventory adjustments relies on accuracy of physical inventory checks.

These physical inventory checks are done only once per quarter for A-Class items. Therefore the time-period for which this analysis is done has to be relatively long and frequency is not at all at good level. However, it is not a reason to correct possibly incorrect assumptions on tender database or on LEAN parameters.

The incorrect assumption can be caused from used scrap % or from the quantity of material. Especially if assumption mistake is related to scrap percentage this should be analyzed also by Quality engineers. Notwithstanding, the incorrect assumptions on the tender database can lead even to losing of profitable orders if consumption rates are exaggerated. Moreover, problems in the inventory process can occur. For example if actual consumption is lower than estimated, it pushes system to make a reorder before it is necessary.

After all, based on this analysis, designers updated their assumptions that were used to build BOM. This should lead in long term to lower amount of inventory adjustments and to more reliable stock level assumptions. Two significant raw-materials had essentially higher actual scrap compared to estimations. As a result the top-management of the unit was now convinced about the problem and it was decided that corrective actions should be done to improve competitiveness of unit at this area. More information about this analysis is presented on an appendix 2.

Gathering of quantity variances for items that are picked to production is more complicated. Amount of different raw-materials on BOM are listed on BOM browser in LEAN, and actual consumption can be tracked from stock transactions in LEAN. However, as the amount of orders and items is so huge on RMT, just comparing those two schedules is absolutely too time-consuming.

LEAN is able to calculate total DM cost per item but it uses WAP as a price factor. LEAN also calculates actual average cost for manufactured items but as discussed earlier this value is often not reliable. Moreover, the average price could be based on very old WAP if manufacturing occurred a long time ago, meanwhile cost in BOM is based on the current WAP. However, if manufacturing has occurred only a short period ago both of those values should be quite accurate. A new Cognos report was created to compare actual DM and DL costs to BOM and Routing values. This report needs,

however to be used with a caution due to above mentioned reasons, but it could be accurate enough if time period is only the previous month.

3. Ensure accuracy of Routings

As discussed, quantity of DL hours used behaves in a similar way like materials. Part or hours go to inventory values based on actual hours booked into works by employees, and the rest goes simply based on standard quantities. Actual quantity of those hours that go to inventory based on standard quantities are booked into the system in the similar way like normal hours related to work-id's. Number of hours can be found from LEAN, from the schedule *acceptance of hours*. Also, efficiency and productivity follow-up is based on this schedule in LEAN.

It is very important to remember that accuracy of this data relies on accuracy of booking of hours to the system by employees. Based on estimate done by thesis creator, the accuracy allows only an item level follow-up of DL hours. This is justified because sometimes there are work-phases that are necessary in real-life to manufacture the item but hours were never booked there. Instead those hours were probably booked under another work that is probably established for the same item. This means that there are often variations between different works to produce a particular item, even if it is not true in reality. The level of variance analysis should be adjusted to the level of accuracy of the source data (Horngren et al. 2012). Item level should be good enough for this purpose but if absolute accuracy is desired the analysis should be performed on the production line basis. Production lines have their own work-phases and the amount of data is higher, which improves the quality of statistics. This approach is also supported by Lean-manufacturing-practice, which recommends establishing reporting around value-streams.

Actual quantity of hours can be found as average cost from LEAN's item data, including similar problems like average cost for materials. The most accurate cost information can be found from stock transactions. Comparison of DL hours is anyway easier than on DM's because the system uses always the same standard rate when cost is calculated. Therefore, quantity difference can be calculated directly from LEAN values.

The report mentioned under DM section is usable also for DL variances on a monthly basis.

4. *Use of control charts to ensure BOM & Routing accuracy*

As mentioned earlier, control charts could be very beneficial tool to ensure good enough accuracy of the master data in the system. This could be implemented quite simply by utilizing Cognos reports and by accepting small mismatches in the source data. At first there already is a Cognos report that is able to gather BOM and AVG costs and this could be performed on item, or even on production line level. With this report, it is possible to see variances between BOM and actual. Then upper and lower limit should be set for BOM and Routing accuracies. Based on discussion with Unit's Managing Director the limit could be between x and y percentages.

If this report is done on the production level it is pretty simple because it just shows average accuracy of standards. However, this approach is not so good to highlight problem. If it is done on item level it is more complicated. Theoretically the highest and lowest values should be used on control chart to show whether the process is under control (CIMA 2013). Nevertheless, practically there are always some very insane values, for example due to mistakes done when hours were booked into system. Therefore, some statistical methods could be used to eliminate this impact. For example it could be accepted that process is working well enough, if 95% of BOM's and routings are inside of upper and higher limit. Idea is presented in the figure eight.
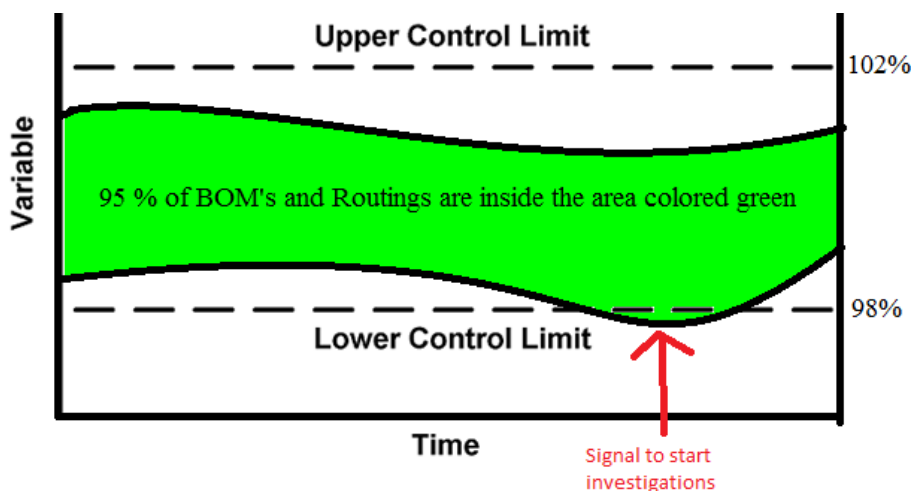

Figure 8

However, there was an interesting discussion with SFC when this method was presented.

"We are struggling with way more simple issues and you are proposing to take something like that into use. Well, it could be in fact utilized but first we have to solve those basic things before moving to more sophisticated methods"

Management accounting has been criticized a lot about not utilizing more modern methods, but maybe the answer lies here? In fact most of the companies cannot even utilize the basic methods, which kills also the development (Hon 2005). However, the idea to utilize control charts on the production line basis could be implemented on a faster schedule if only average value is used.

5. *DL efficiency and productivity*

DL efficiency is related to the accuracy of Routings and this area will be discussed on the next section *"ROE meetings on projects sold"*. However, like mentioned in the theoretical part, it is good to follow-up operational indicators also on a more frequent basis with non-financial values. Therefore, it is highly recommendable that production management continues to follow up efficiency rates on DL on a weekly basis by the production line. Same goes also for the productivity. As a part of this thesis new instructions for leakage hours reporting, according to Alstom standards, were established based on several meetings with the production management (Appendix 3).

6. *ROE meetings on projects sold*

Based on experience of SFC organizing meetings where all the involved people are participating is the best way to promote organizational learning about projects sold. ROE meetings will be organized on an order level for all the orders with value more than x thousand euros, and delivered during the previous month. Tendering phase cost assumptions will work as a primary basis for comparison to actual costs. Also, values defined on a more accurate designing phase between tendering and actual values, which means BOM's and Routings, would be compared (Appendix 4). This process should start taking place after September 2013.

One problem with these meetings is that they are clearly backward looking as orders are assessed only after trading of them. On the other hand the frequency of reporting matches perfectly the operational cycle, like recommended in the theoretical framework (Lind 2001). Moreover, it needs to be reminded that orders with value more than 500 thousand euros have to be anyway followed up in a more forward-looking basis because Project controllers around world demand information also during the manufacturing phase.

7. DM PPV change follow-up

DM PPV changes have been under control of the sourcing department already for a long time but it is necessary also for the financial department to know what is happening to raw-material prices. One significant reason for this is the above mentioned problem that LEAN provides BOM values only for the moment when the analysis is performed.

PPV change follow-up was pretty easy to implement. LEAN has schedule for item price history, which can be used for this purpose. Item prices of the previous and current month can be extracted to excel and then it is possible catch items where WAP has changed radically. Process to follow up this from finance's side started in May 2013.

It was noticed that follow-up of PPV changes of direct materials can be beneficial also for ensuring reliable inventory valuation. For example in June a big batch of one raw material arrived to stock but for some reason a wrong pricing coefficient was used in the system. As a result the value added to stock was thousand times too small meanwhile costs were booked to P&L based on purchase invoicing. This had of course a big negative impact to MDC and corrective booking had to be done to accounting books. Probably the mistake would not have been noticed without PPV-change follow-up process.

8. DL hourly rate variance

The calculation of hourly rate variance is pretty simple but some aspects need to be taken into account. At first actual salary costs can be found only from Wintime – the accounting software. Actual number of hours can be found from LEAN's schedule "acceptance of hours". Then, indirect time of direct people needs to be taken into

account. Those costs and quantity of hours belong to overhead expenditure. So it was decided that transfer of those hours to overheads will be done based on standard hourly rate on a monthly basis. Booking of COA related to hourly rate variance started already on February 2013. Please see appendix 5 for more details.

3.3.2 Reconciliation

9. *Reconciliation between LEAN and financial books for orders sold*

Reconciliation between LEAN and financial books is the most critical thing to increase the understanding of the monthly MDC. The most significant amount of direct costs should be directly traceable to orders. Consolidated report of orders sold can be extracted with Cognos that takes data from LEAN's database. As discussed, the average price Cognos uses, is not always correct – especially on a longer time-period. Therefore, it was found that if more accurate estimation is needed it is recommendable to use LEAN's stock transactions schedule for this purpose. This can be done by extracting delivery data from LEAN and attaching it to Cognos report. Then, those more accurate values can be allocated to projects by using relevant excel-functions. After that, when actual cost of orders sold is known, there is still difference between this cost and P&L report – 80 % of this difference has to be explained based on target.

The first thing that explains difference between orders sold and financial books are those costs that are not traceable directly to orders. As discussed earlier those costs are booked into inventory levels based on standard quantities. Difference on backflushed raw-materials can be found via inventory adjustments. Difference on DL that is not directly traceable to orders has to be estimated manually. Information for this can be found from LEAN schedules: *"work phases" and "acceptance of hours"*. It is important to use work phase id as filter when the comparison is done. These costs should be calculated anyway for COA, so no additional work should be needed. Same goes for non-quality costs that have naturally impact on direct manufacturing costs but are not seen on cost of orders sold report.

The most critical thing to ensure a reliable monthly P&L statement is the accuracy of inventory values. The first thing to check is the booking of accrual for items arrived and not invoiced yet. When raw-materials are purchased they should go to inventory values

at the same time when cost is booked into P&L. Another side of operations needs to be also checked, which means deliveries to customers. Items should be taken out from inventory values at the same period when the order is traded. If an item is delivered, but not traded yet, it should be booked into the virtual stock. Also, such deliveries done that will never be traded have to be recognized. For example deliveries of exhibition goods that would belong to marketing costs. Both of these verifications can be done based on information on LEAN, but several extracts to excel need to be taken.

Keeping eye on all other stock transactions is also critical. Balance corrections and transfers from stock to another are done frequently. Usually those transactions have zero-impact on P&L level but not always. Sometimes items are for example transferred to stocks belonging to another Finnish Alstom unit at Tampere. Like mentioned earlier there is a need for RMT to create clear instruction for employees on how those inventory bookings should be done. Luckily all of these transactions are found from LEAN and usually there is also description for what was done. It is also possible to see who has done this transaction. Clear rules for inventory adjustment bookings will be done after September based on this recommendation.

After detecting unusual transactions it is sometimes necessary to make a more accurate investigation to detect possible mismatches. It was detected that sometimes some values can be even missing from stock values without a reason, or also some human errors on normal inventory booking could happen. A bullet proof way to detect those errors is simply to take an extract of the opening stock on an item level and comparing it to the closing stock and transactions during the period. In this way it is possible to detect for example if something is missing from WIP values.

Also, it is important to exclude visually controlled items out of analysis, because they are handled in a different way in the inventory valuation. In addition currency rate changes, packing and delivery costs booked into DM costs have to be excluded. All of those costs are booked into specific accounts. These costs should be anyway pretty marginal compared to total costs. They are taken into account on Cognos report for cost of orders sold with a coefficient. This coefficient should be checked at least on annual basis and the possible difference could be booked as COA?

With all of the above mentioned inspections the target to explain 80 % of the performance gap can be easily achieved. There is however, a danger that on some months even these explanations are not enough. One reason for that is it that RMT is not isolating variances at absolutely correct time. However, usually impact of this is not big enough to wave figures essentially and in cumulative basis the variations start probably to cancel each other. Especially if volume of sales is low for one particular month, it is possible that 80 % explanations will not be reached without very time-consuming investigation – and probably it is not even necessary? An example of reconciliation is presented on appendix 6.

3.3.3 Summary of implementation

When finalizing of this thesis was done major part of the construction was taken into use in the unit. So, the weak market test was realized partially. ROE meetings on orders sold should start taking place in September 2013. Use of control charts to ensure master data accuracy was not taken into use because there was not enough time for it. However, as discussed it could be possible to make it a bit simpler by staying only on the production line level and following only the average accuracy. In this way also this process could be taken into use. Targeted status defined on figure 7 was achieved pretty well.

Nevertheless, also problems appeared. The use of several different IT-systems leads to very high number of excel-files. In addition in this LEAN-version schedules can be connected to each other only with Cognos or Excel. This kind of system is difficult to handle and also possibilities for mistakes go higher.

RMT's manufacturing control process was reviewed by Industrial Controller from France in July 2013 and feedback was well in line what was expected. The high number of excel files used leads to cumbersome processes that are difficult to understand. However, improvements compared to situation before beginning of this project were noticeable. Requirements of Alstom are still not fully met and will not probably be as far as the current ERP-system is not updated. The successor of the researcher in the company was trained to use the methods created in this research, and those processes

will very probably continue to be used also as long as the current ERP-system is not updated.

4 DISCUSSION AND CONCLUSIONS

4.1 Summarizing the study

This research was done based on a need of the case-unit that was to strengthen manufacturing control function by implementing an industrial variance analysis process. Moreover, there was a need to improve understanding of monthly deviations related to direct costs on financial results. The need was justified because no consistent process existed in the beginning of this research. In addition, the reporting did not meet the requirements of Alstom.

Relevant theoretical knowledge was acquired from the management accounting and industrial management literature. The theoretical framework was built to cover the whole industrial variance analysis process that is one essential part of the manufacturing control system. The whole manufacturing control process using variance analysis as a tool was divided to six areas. At first need for manufacturing control comes from management. Then manufacturing control itself can be split to target setting, performance measurement, distribution of information and corrective actions. Finally, this process should be able to explain variances on financial results on a global level. In addition, high emphasis on the most recent criticism towards variance analysis was included to this research. Part of this criticism is arising from the use of modern manufacturing technologies and main characteristics of them impacting on variance analysis were taken into account. The theoretical framework was built to answer to the first research question:

What characteristics does a manufacturing control process using Variance analysis as a tool have in a modern business environment?

Good characteristics were gone through for all the six areas one by one. The main message from the theoretical part was that variance analysis is still a very important

tool, but it needs, and can be developed to answer more to the modern business environment. Summary of the theoretical framework, figure 6, can be found from page 32.

Empirical research started by presenting the case-unit. The main emphasis was on IT-systems and on inventory accounting process. In addition, the main deficiencies in the current manufacturing control process related to direct costs, observed by management in the beginning of this research, were gone through. The second and third research questions were answered based on above mentioned information:

How manufacturing control process using Variance analysis as a tool, should be implemented to this particular company?

How to build reconciliation between planned direct costs of orders sold and the actual P&L statement?

After taking the specific characteristics of this case-unit into account and remembering recommendations from the theoretical framework, was the construction built. Summary of the construction, figure 7, can be found from page 56. The actual construction did not match totally with the recommended solution in the theoretical part. This was caused mainly due to deficiencies of current IT-systems, and also due to limited time of involved people. NB: The limited time of involved people means here the normal time-limitations of personnel in all the companies – not that there were abnormal time-limitations in this particular case-unit.

Major part of the construction was implemented and taken into use of case-unit, which means that weak market test was partially accomplished. Control charts for master data control were not implemented due to their excessive complexity and time-limitations of involved people. This implementation project was disclosed in the fourth chapter. The fourth research question was:

How the implemented construction answered to questions arisen from management's needs?

Although, major part of the construction was taken into use were not all the needs of management met. At first utilization of many IT-systems leads to cumbersome

processes. In this case it meant very high number of excel files extracted from those different systems. However, on the other way around, it can be said that deficiencies caused by current IT-systems can be passed if some manual work is performed. This was seen for example on direct material purchase price variance, which was difficult to attain because standard price is not available in ERP-system. Thirdly, it is good to remind that the most important purpose of manufacturing control process is to drive operational management to corrective actions. Actual corrective actions realized clearly based on this construction concerned only accuracy of assumption of direct material used regarding to backflushed items. However, this was mainly caused due to limited time available for this final area.

Especially, the reconciliation between accounting books and analytical reports from ERP system was appreciated. These reports were reviewed on a top-management level and many additional questions were done. The questions concerned mainly understanding of root-causes behind variances and the anticipation towards the future. Finally the management was able to see clearly the magnitude of different industrial variances with a link between financial statements and operations.

4.2 Academic contribution of the study

Although, the main emphasis of this research is on the construction, was academic contribution created also on the theoretical part at some level. Variance analysis, with the latest criticism towards it, was linked to the theory of manufacturing control. The latest criticism included also aspects arisen from modern manufacturing methods. In addition this whole process was linked to financial books and the importance of reconciliation between operational calculations and financial books was bolstered by this research.

Theoretical recommendation and the final construction were not finally similar. However, it could be said that all the recommendations brought up in theoretical part would be desirable, if there would not be any practical limitations on implementation. Practical limitations in this research arose from deficiencies in IT-systems and limited

time of employees in case-unit. Nevertheless, both of these causes have been mentioned several times on several researches, so the contribution there is only support of the existing knowledge.

Academic contribution arisen from empirical part is more difficult to define. However, at least in Finland, the number of researches handling *backflush accounting* has been low. The construction included variance analysis on raw-materials that are backflushed, which indeed is very simple as only inventory adjustments need to be followed-up.

Management accounting research has been criticized a lot of not bringing the newest inventions into practice. This research included one possible reason for this problem. This reason was arisen in empirical part as control charts were presented to management of case-unit. The idea was not shot down, but the fact was that it was not possible to move to more sophisticated processes before basic processes are working as desired.

4.3 Critique of the study and implications for future research

The first criticism about this research is very obvious as it is a construction implemented to one particular company. Therefore, results of this research cannot be generalized. However, some parts of this research could be applicable especially for other manufacturing companies.

The second criticism concerns the relatively broad area of this research which covered everything from gathering data to real actions based on this data. This does not allow a very deep analysis of any particular areas and the same problem affects both theoretical and empirical parts. Especially on the theoretical part it needs to be highlighted that the theoretical framework was built with an intention to provide a solid theoretical basis for the construction. However, when the research area is such a broad it is practically unavoidable not to miss any useful theoretical information available for this purpose.

The third criticism concerns the limited amount of analyzing the actual utilization of the construction in operational management. After all, corrective actions finally define how valuable the manufacturing control process is. It would be very beneficial to have more research about how control process using variances, are practically working. Indeed,

when theoretical framework was written it was not so easy to find real experiences of corrective actions performed based on management accounting information.

For future research there could be dozen of areas handled in this research that could be also mentioned. However, the second point that arose as material for theoretical background was being searched, was the utilization of modern manufacturing techniques and management accounting. There was a lot of research, whether management accounting information is still important in such an environments, but number of researches really handling how to develop management accounting for these purposes was pretty low.

4.4 Final Remarks

This was a constructive research done to solve a real problem of the case-company. The target was to provide a holistic view of one process that is part of manufacturing control function. The process presented in this research represents approximately only one fifth of monthly work tasks performed by one person in a company. Therefore, it was necessary to keep this holistic approach – otherwise the process could not be understandable in a feasible time.

The process implemented used very traditional method as a tool and that tool was Variance Analysis. This research did not find any reasons why variance analysis would not still be valid tool even in modern manufacturing environment. However, there are always ways to improve processes, and also Variance Analysis belongs to this group.

Despite the fact that not the all recommendations presented in the theoretical framework were actually implementable, it was delighting to see how close they can be compared to practical needs. Especially criticism towards traditional variance analysis highlighted very beneficial points that can be taken into account pretty easily, also at practical level.

The research managed to increase an understanding between operations and financial statements. The thesis paper was also used as a training material for the next Manufacturing Controller in the unit so the practical contribution was very high.

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APPENDICES

APPENDIX 1: ROOT-CAUSES FOR VARIANCES (http://maaw.info)

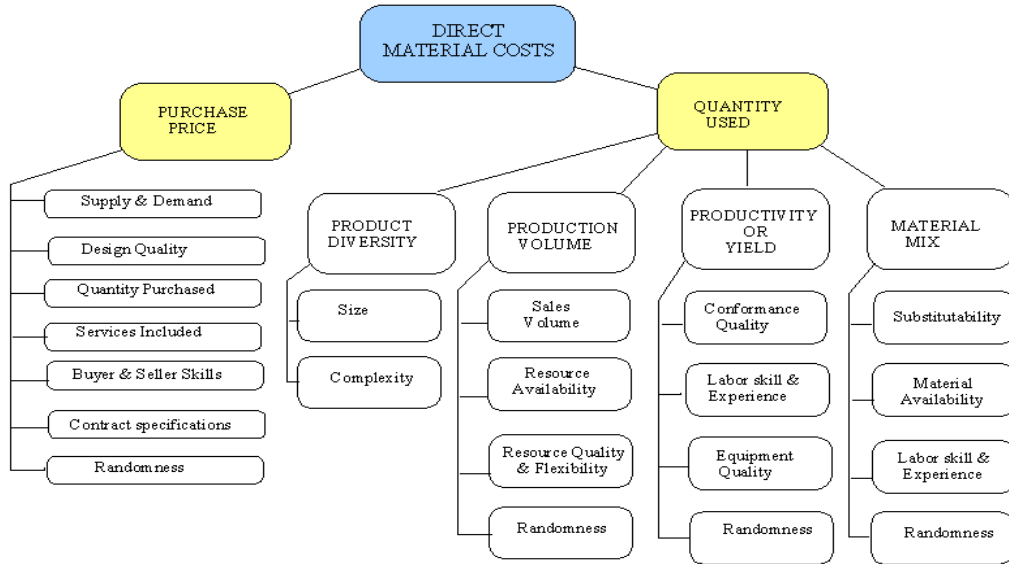EXHIBIT 10-9
CONCEPTUAL VIEW
DIRECT MATERIAL COST DRIVERS

DIRECT MATERIAL COSTS

PURCHASE PRICE
- Supply & Demand
- Design Quality
- Quantity Purchased
- Services Included
- Buyer & Seller Skills
- Contract specifications
- Randomness

QUANTITY USED

PRODUCT DIVERSITY
- Size
- Complexity

PRODUCTION VOLUME
- Sales Volume
- Resource Availability
- Resource Quality & Flexibility
- Randomness

PRODUCTIVITY OR YIELD
- Conformance Quality
- Labor skill & Experience
- Equipment Quality
- Randomness

MATERIAL MIX
- Substitutability
- Material Availability
- Labor skill & Experience
- Randomness

EXHIBIT 10-13
CONCEPTUAL VIEW
DIRECT LABOR COST DRIVERS

DIRECT LABOR COSTS

PURCHASE PRICE OR RATE
- Supply & Demand
- Education & Training
- Experience
- Geographic Location
- Union Contract
- Labor Mix*
- Randomness

* Affects the average rate.

QUANTITY (HOURS) USED

PRODUCT DIVERSITY
- Size
- Complexity

PRODUCTION VOLUME
- Sales Volume
- Resource Availability
- Resource Quality & Flexibility
- Randomness

PRODUCTIVITY OR EFFICIENCY
- Labor skill & Experience
- Material Quality
- Equipment Quality
- Randomness

LABOR MIX
- Substitutability
- Labor Availability
- Union Contract
- Randomness

APPENDIX 2: BACKFLUSHING VARIANCES
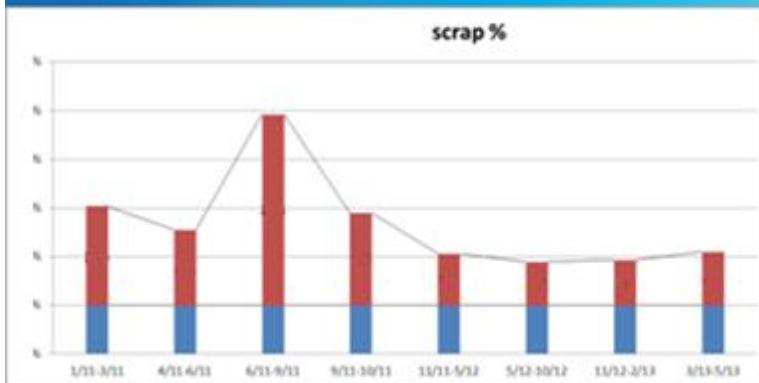
INVENTORY ADJUSTMENTS

- RMT is not measuring all the actual material scrap caused by manufacturing processes but:
    - Actual scrap % can be estimated based on inventory adjustments.
    => Also, accuracy of these estimations relies on accuracy of physical inventory checks.

- Incorrect assumptions could be used on tender base or in ERP-system. This can lead to too high or low tendering cost estimates.
⇒ even to losing of orders, that would be actually profitable

- Also, problems on stock process, can occur, for example:
    - Actual consumption is lower => items are reordered before it's necessary => excessive inventory levels
    - Actual consumption is higher => Material runs out of stock => production stops

    - TOP 5 items where inventory adjustments have been done are gone through on next slides.

ITEM X
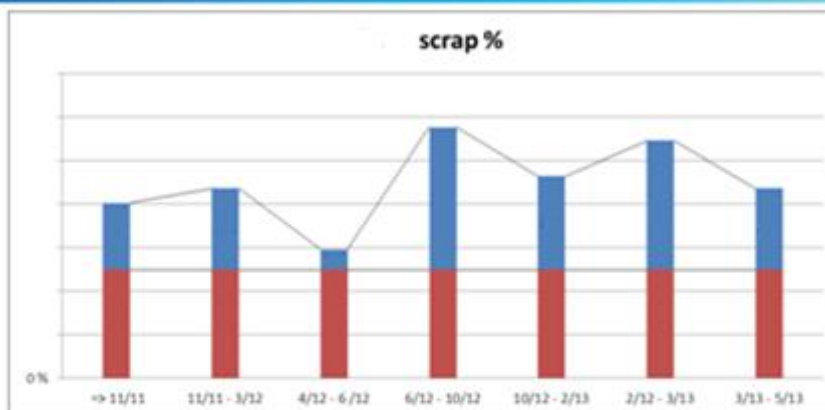
- Standard scrap % in LEAN colored red (%)
- Inventory adjustments colored blue
- Average scrap % for   after beginning of 2012:   %
    - In euros: k€ more than standard amount in FY 12/13
    - Accuracy is based on accuracy of inventory adjustments!
    - Inv. Adjustments quite consistent (negative adjustments)

ITEM Y

- Standard scrap % in LEAN colored BLUE (5%)
- Inventory adjustments colored RED
- Average scrap % For   after beginning of 2012:   %
  - - In euros: k€ more than standard amount in FY 12/13
  - - Accuracy is based on accuracy of inventory adjustments!
    - Inventory adjustments not always consistent, also positive adjustments!

ITEM X1

1.6.2012-31.5.2013	amount	€
Scrap %	0,00 %	
Consumption LEAN:	3779,117	
Inventory adjustments	1645,949	
Inv. Adj. %	44 %	
1.6.2010-31.5.2012		
Consumption LEAN:	9781,88	
Inventory adjustments	3077,83	
Inv. Adj. %	31 %	

- Positive inventory adjustments done regularly
- => Actual consumption of   essentially lower than estimated on BOM's in Lean
- Possibly as one consequense rotation time in stock has been quite slow for this item (days avg in stock, delivery time   days)
- But based on   , "Single source item. Korean supplier. Risk management", it seems to be justified.

ITEM Y1

1.6.2012-31.5.2013	amount	€
Scrap % 0,00 %		
Consumption LEAN:	265,5	
iventory adjustments	245,5	
Inv. Adj. %	92 %	
1.6.2010-31.5.2012		
Consumption LEAN:	1708,35	
iventory adjustments	1548,21	
Inv. Adj. %	91 %	

- Actual consumption is less than 10% of estimated amount!
- No new purchases done after 2011

Actions

- Standard scrap %'s, or material consumption estimations on BOM's to be updated to be in line with actual consumption.
- Seek for possibilities to reduce wasted amount of █████████████

APPENDIX 3: HOURLY REPORTING INSTRUCTIONS

Laatijat:	J.Mononen	

Sivu	1/8
Rek.nro:	

Hyväksyjä: ▮▮▮▮

Pvm:	19.06.2013
Korvaa:	0

|	
Kieliversio	FI
Versio:	1

RMT:n tuntityöntekijöiden läsnäolotuntien raportointi

Tuntien raportointi (linjapäälliköt):

- Viikottaiset ja kuukausittaiset tuntiraportit tehdään tallennettujen rajausten perusteella Leanissä. Tuntien hyväksyntä taululle on lisätty tallennetut rajaukset linjoittain Läsnäolo-, vuoto- ja tehdyille tunneille.

- Toimintatapa edellyttää säännönmukaisten työnumeroiden käyttöä. Käytettävät työnumerot määritetty linjoittain seuraavilla sivuilla. Tärkeintä on, että tuntinsa raportoivat henkilöt tietävät mihin kirjaukset tulee tehdä. Tuntityöntekijöillä oltava siis päivitetyt ohjeet. Kesäkuussa 2013 työntekijöille laaditut työnumerolistat liitteenä dokumentin lopussa.
- Mikäli käytettävissä työnumeroissa tarvitaan muutoksia on siitä tiedotettava myös talousosastolle ja tallennettuja rajauksia tulee muokata.
- Kaikkien läsnäolotuntien tulisi periaatteessa sisältyä tallennetuissa rajauksissa määriteltyihin tunteihin. Tämän toteutumista seurattava kuukausittain.

Example of Leakage reporting:
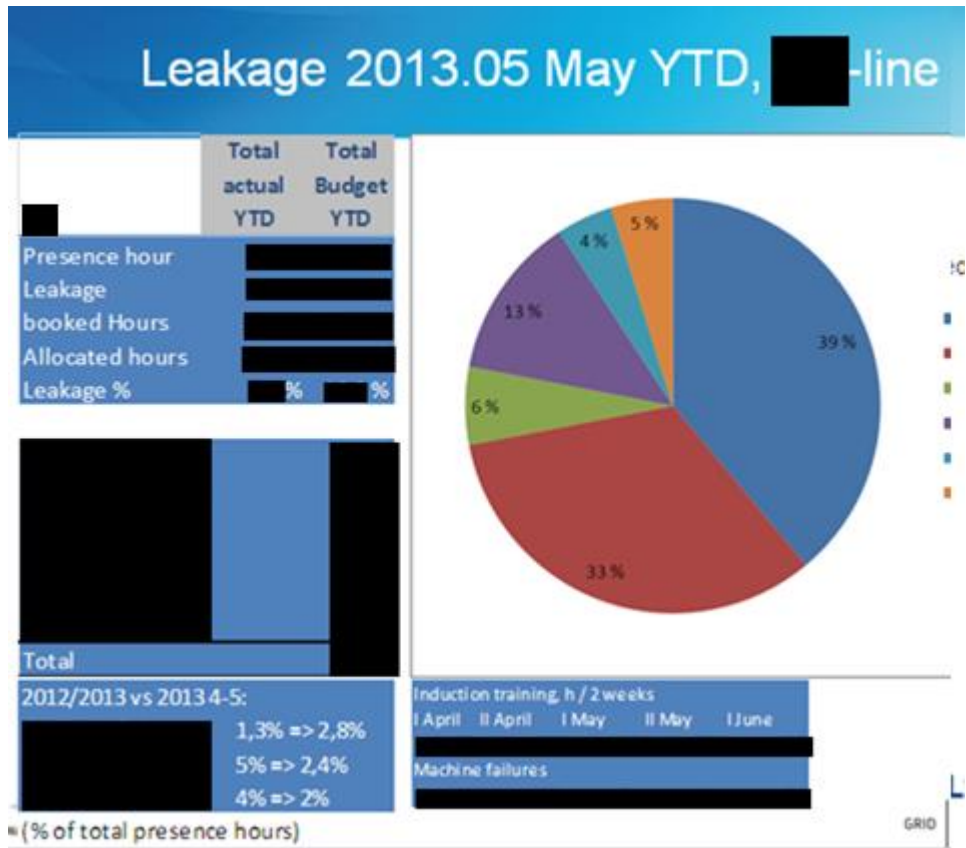
APPENDIX 4: MARGIN VA PROCESS (SFC)

RMT: Margin variance analysis process

Purpose of margin variance analysis is to understand the root-cause for negative margin slippage arising in the various areas (tendering, engineering, manufacturing), build an action plan to eliminate similar type of mistakes in the future

- Main contributors:

    Manufacturing controller

    Tendering manager

    Design engineer

    Quality engineer

RMT: Margin variance analysis process

- Analysis is handled for all the orders above   K €

- Only 100% manufactured and traded orders are analysed

- orders with GM below standard level are included in the analysis

- Analysis is focused on the following variances:
    - Specifications mistakes,
    - Engineering mistakes
    - BOM accuracy
    - Quality issues
    - Manufacturing mistakes
    - Production efficiency

RMT: Margin variance analysis process (example)

- File with the list of orders will be send to tendering, engineering, quality departments.
- Before the meeting they have to prepare the analysis of deviations on direct material cost, hours, cost of non-quality

RMT: Margin variance analysis process

- ROE (return on experience) protocol of the meeting is shared with UMC members and involved departments: tendering, engineering, manufacturing, quality.
- ROE protocol is a formal document consisting of two sections:
  - Main roots causing negative margin variances
  - Corrective actions with the name of responsible person to improve
- Meetings are kept on monthly basis

APPENDIX 5: LABOR HOURLY RATE VARIANCE

Appendix 5 is hidden due to confidentiality reasons

APPENDIX 6: RECONCILIATION FROM LEAN TO TERANGA

MDC in Budget 13/14
Volume impact
Mix impact
LEAN MDC
packing lab & mat . etc.
Labor rate difference (COA)
Inventory adjustments (COA)
Quality related costs (COA)
Inventory valuation mistake
DL qty variance on NN-works
DL hours not included in routings
ODC difference to budget & other
Release of accrual booked to cover inventory mistakes
TERANGA MDC

BUDGETED MDC   Root-causes =>   ACTUAL MDC FINANCIAL BOOKS

Figure:9 Bridge between analytical and financial books

APPENDIX 7: ACRONYMS USED IN THE EMPIRICAL PART

LEAN (With capital letters)	The ERP system in the case-unit
DM	Direct materials
DL	Direct labor
P&L	Profit and Loss Statement
WIP	Work-in-progress
SFC	Site Financial Controller
RMT	Name of the Case-unit
Teranga	Global reporting software of Alstom
BOM	Bill of Material
EAS	"Estimated analysis sheet" (estimated profitability analysis for the order)
WAP	Weighted average price
FG	Finished goods
COA	"Cost of Adjustment" (Alstom standard to report industrial variances)
MDC	Margin on direct costs
MTO	Make-to-order
MTS	Make-to-stock