

DELIVERY RELIABILITY

A Study about Delivery Reliability in Large Machine or Structure Delivery Projects

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ABSTRACT

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ABSTRACT

The aim for this study was to increase delivery reliability in large machine or structure delivery projects. The subject is still almost completely unstudied. Pragmatically the aim was to collect problems that cause loss of time and resources and therefore decrease of quality, to see if there are good practices or solutions to these projects and to test them in actual projects to see if they actually work and to get some data or evaluations about the saved resources.

It took a much longer time than planned to complete this study, but this was rather a good thing for the project. This way it gave time to gather more experience-based knowledge, to see various practices in various projects, and most of all, gave time to try out the small improvements that make the difference.

The method of having experience-based knowledge and other studies side by side brought depth and a good comparison to this study even though the other studies were not exactly about this topic.

It was rather astonishing to notice that though there are hundreds and thousands studies about JIT (just in time) factory improvements and supply chain management for manufacturing industry, very little interest was given to delivery projects. The interviews revealed that every entity in this branch of business worries about some of these issues every now and then, but nobody had never given it a systematical approach.

Quite remarkable is that the problems and solutions are the same in several different kinds of delivery projects. It is also interesting is that these problems are not usually one-of-a-kind and good practices are at least known, but still unused. Even small changes can make significant savings to project.

The solutions introduced in this study have been proven efficient and that by implementing even some of them in use, a fair amount of resources can be saved. Therefore the study can be considered to be a success. Most of the actions are implemented to practice and thus the results can be considered reliable.

Yet, there are still a great deal of possibilities to continue to study this matter and to go deeper in details as this study is at the general level.

Keywords:
Delivery, Reliability, Project, Site, Development

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ABBREVIATIONS

2D	2-dimensional
3D	3-dimensional
AKA	Also Known As
EHSQ	Environment, Health, Safety and Quality
ERP	Enterprice Resource Planning
h	Hour
ICT	Information and Communications Technology
IT	Information Technology
JIT	Just In Time
JOT	Just On Time
M	Million
MW	Megawatt
TQM	Total Quality Management
vs.	Versus

1 INTRODUCTION

In this thesis the area is limited to industrial construction and industrial installations. Both segments are quite old, done at some comparable form since early 20th century. Both segments have been and still are important to Finland's internal economy and even more important to export.

Basically the methods of construction, erection and installation have not changed over the years except of the tools and lifting capacities. However most of the sites are different from each other and different entities timing and hundreds of other variation factors make it challenging to manage. Also the complete amount of time to be spent on project has significantly decreased, as seen in Figure 1. This sets lots of pressure for site supervisors, site managers and project managers. Until now the key for successful installation has been a good responsible person's professional competence. Unfortunately nowadays the planning and design is done partly same time as building and installations and as a whole, the time-period from investment decision to commissioning has shortened. The old-fashioned and competent site managers are seldom "compatible" with modern computers and programs that are, due the tight schedules, essential for managing large projects. Then again, younger engineers who are familiar with modern technology seldom have enough experience. The largest problem is that there is no way to gather experience than learning by doing!

Investment costs of industrial facilities are large. For example only a small 50 MW power plant cost easily 70 M € and guideline is that every MW costs at least a million euro (Sähköä ja lämpöä jätteestä, Pohjoista Voimaa, 3.7.2013). When the investments are large, hundreds of millions, and most of it comes from design and manufacturing the equipment it is easy to forget the installation operations even though that installation can add up to over 20 % of total costs and have most significant effect to staying in time-schedule. There is no place better than building-site to loose a week or two.

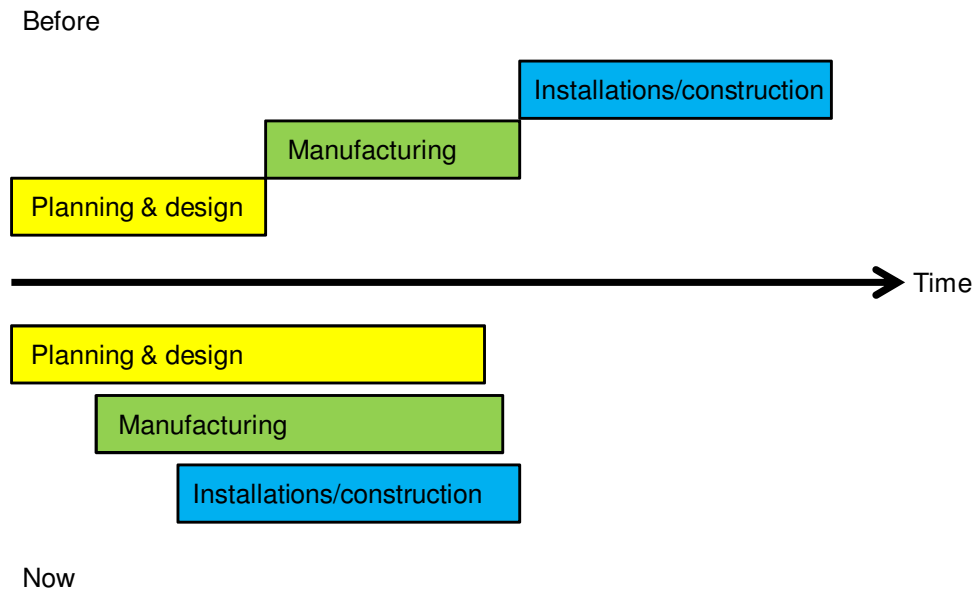


FIGURE 1. Delivery projects before and now

The competition is getting harder and harder on every business, there is no deny of it. “Manufacturing firms aim to achieve the highest levels of performance along areas such as quality, flexibility, delivery and costs.” (Sarmiento & co. 2007. p. 367.) Both construction business and industrial installations businesses are the most competitive, already on good times and even more now, during the depression. As presumption commonly known inside the business is that the two essential things to achieve competitive advantages are: delivery reliability and minimizing costs. The previously mentioned can not be without (significant) affect to the latter. The state of delivery reliability is not completely hopeless, but it is surprisingly low, even though Finland is known as “Country of good quality”. By improving delivery reliability can some savings be reached, but even more important: when reaching better reliability can the whole company’s value be improved. Also, good way of conduct eases the problems when working on more hectic time-basis.

Delivery reliability can be divided to more precise parts, as follows:

- Delivery at right time
- Delivery at right content / delivered as ready
- Delivery to right place
- Delivered with proper documentation

In this thesis, the minimization of costs is considered only as what is directly affected by improvements on delivery reliability.

2 CONDUCT OF RESEARCH

2.1 Defining the research area

The business area became defined to the subject area simply due to the fact that the author has worked on these branches. It has been clear enough to see the similarities on practices as well as on problems. The time period of working with this thesis has been rather long and therefore the amount of involved companies is large. The author has worked on three companies during this time, but because of fact that projects are large, matrix-like systems, the total amount of companies involved is much larger covering almost completely Finland's companies working on these branches. This also clarifies the importance of having a network to work if wanting to be a successful project manager.

2.2 Preliminary assumption of development targets

Before actually beginning the research some assumptions can be made on the basis of basic experience. One problem is the documentation system. Is there a form for all the necessary documents? Are the documents similar for own use, for supervisors and for customers? Are all the documents available? At these times one can not start to work at site without first providing some documentation.

Another problem is how to manage supply chain. How to make sure that each delivery is at right time to minimize the waiting time, minimize storage area and to make sure it is delivered as late as possible to make sure that if revisions are done, they can be made at the factory. How to know exactly where the delivery items are and when are they at site? Are all the items ordered actually delivered?

Third problem, or to be accurate, challenge is to keep up required EHSQ system. This might not be directly related to delivery reliability, but is quite often

mandatory to be able to bid on projects, or at least, important to give advantage to other companies by being able to offer such a high quality EHSQ.

Other problems might rise up, but it would be surprising if even one of the abovementioned problems would not come up when doing the questionnaire.

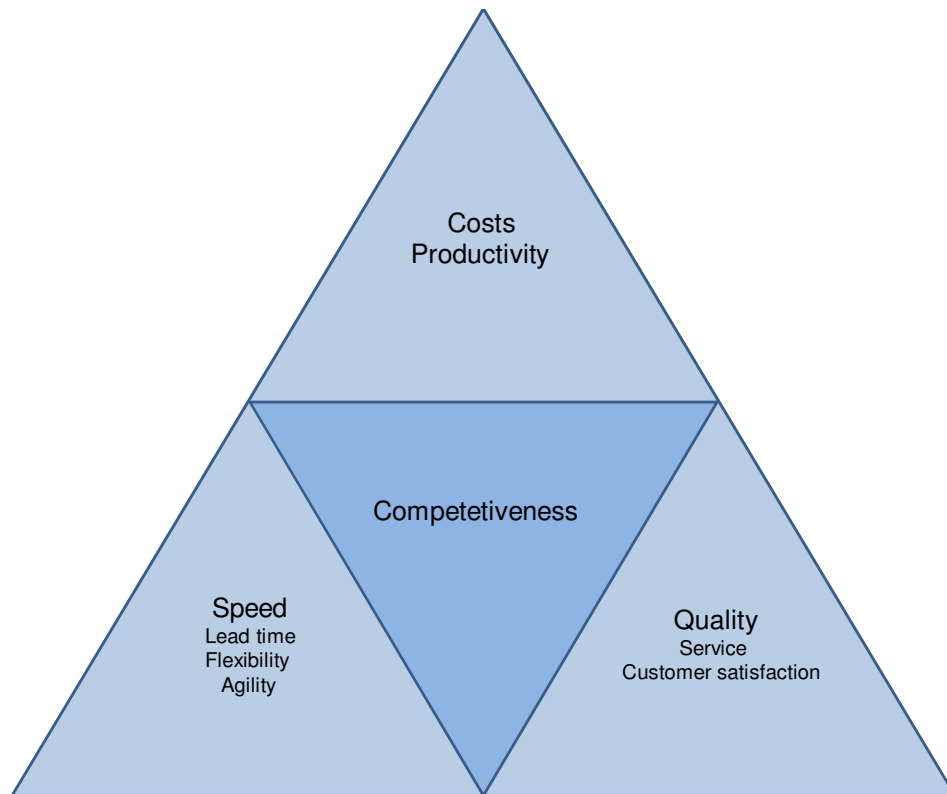


FIGURE 2. Factors for company's competitiveness (Sakki, J. 2001. p. 17)

2.3 Target

The objective is to find at least the largest problems in the delivery project. Next step is to find out, at least approximately the importance; hindrance caused by, and costs of the largest of problems. Finally, the aim is to find solutions to some of the problems, or methods to decrease problems and hindrances or costs of some problems.

If 20% - 80 % -principle is valid on this matter also, finding solution for 20 % of largest problems can savings up to 80 % be achieved (80/20-periaate like-

alämässä, Perplex Oy, 2.1.2010). The results would be good enough even if the savings would be only half of this.

2.4 Data gathering

2.4.1 Theoretical or researched information

Theoretical information will be searched from books, magazines and articles. Computer searches books by key phrases and either noticed problems or development tools will be collected to this thesis.

2.4.2 Experience-based information

Experience-based information is collected qualitatively on interviewing the subject group.

Interviewer will have a list of questions but mostly the interview is planned to be conducted via normal conversation instead of question-answer interview. If the information requires, the same persons may be interviewed again.

At the start-up meeting it was decided that project managers, quality managers and especially site managers and other relevant site personnel were to be interviewed. The presumption is that this is large enough sample to gather enough information about the problems occurring. The final conclusion of large enough sample will be reached when it is possible to see that answers have become saturated.

2.5 Testing the improvement ideas and evaluating results

Data from the interviews are summoned and grouped. When the groups of problems are seen, it will be tried to find out the causality or even the root cause.

After finding the cause to the problem, there has been searched an improvement method. In this it will be compared if anything is found via literature research and might be taken up to brainstorming together with colleagues.

The improvement solution will be tested in practice and re-evaluated. In re-evaluation the main emphasis is based on repeatability.

3 LITERATURE RESEARCH

3.1 Earlier researches, current situation and expectations

At the beginning it becomes clear that there are hundreds and hundreds of books about JIT (Just In Time), JOT (Just On Time) and other related acronyms. The electronics manufacturing and car industry have spent a lot of time and money to improve the tiniest flaws in supply chain. Unfortunately at the same time it seems that next to nothing can be found for larger delivery projects. Of course this is not completely true. As it comes up in chapter 5, Experience-based knowledge, every company at this branch has at least thought about these issues.

Also Sarmiento & al have noticed lack of studies and recommended using empirical evidence. They stated (2007, p. 367) that “A number of studies in the manufacturing strategy literature have dealt with several aspects of delivery reliability. Nevertheless, while some other authors have concentrated on reviews of the manufacturing strategy literature as a whole, to the best of our knowledge, no previous literature review has focused on delivery reliability and its relationships with other manufacturing capabilities.” Even their article fails to bring out anything new information than the obvious statement that there is deep need for study in this area and that there is no directly valid literal data about this subject.

However, after rather a large check on data it was possible to see similarities on both problems noticed and development issues to be used in this research. For example Jahnukainen states that “The problems on every company were actually same or quite similar to each other. Also the principles of solutions were the same which means that different companies can learn from each other.” (Jahnukainen & co. 1996. p. 162.) They had also noticed the same thing, as author, that “Developing practices suffers from too whimsical ideas and theories” (Jahnukainen & co. 1997. p. 99).

As talking about whimsical theories, lists of development targets and methods as following "The Critical Six Strategic Issues" can be found in dozens:

- Increasing efficiency requirements
- Making use of information technology
- Integration and consolidation
- Insourcing and Outsourcing
- Strategic cost management
- Network management

(Monczka & Morgan. 2000. p. 50 - 53.)

Unfortunately these are, again, top management and consultant strategic themes that neither say anything, nor can they be footed to operational level. Same is with measuring wrong things. In 1997 more than 83 % of the firms use performance measurements for cost reduction and supplier delivery adherence to standard, while indicators related to purchasing effectiveness is less common. (Gadde & Håkansson. 2001 p. 29.)

After dozens of previously mentioned lists and statements the hope is restored only by two sentences from Jahnukainen & co (1997, p.81) "The chosen development issues must be concrete and defined" and "Many of the solutions had been known for years but never taken into practice" (Jahnukainen & co. 1996. p. 162). As already mentioned, this thesis concentrates on pragmatic level of improvements.

The main issue in the project is that when a company delivers a product, whether it is on time or late, the quality of the product remains unaltered. The product is expected to work properly. As opposed to internal quality, it cannot logically be concluded that as external defective rates decrease, delivery reliability rates increase, since the customer will know if it is a good product only after it is delivered, either on time or late. (Sarmiento & co. 2007. p. 367.)

Hill writes that delivery reliability may in some cases be an order-qualifier instead of an order-winning criterion (Hill, T. 2000. p. 34). This is very true in

today's markets. First the company must fulfill certain requirements on EHSQ sector and have tax issues and financial issues on good shape. Then comes the price and quality of delivery and if the prices are at the same level, again comes comparison between quality issues. In other words, a high delivery reliability performance can make a company qualify for / win orders. (Sarmiento & co. 2007. p. 367.)

Besides winning the projects, rather a large amount of money can be saved and in that way increased the profitability. For example YIT started a project for years 2005 and 2006 to reach 2 % savings on purchases. According to Logistics Director Tutu Wegelius-Lehtonen, the saved 2 % on purchases did increase the profit by 21 %. (Tuisku, T. 2005. p. 18.)

Skinner takes the idea of increasing quality to too high when forecasting that the various manufacturing "tasks" inherit to a production system and that short delivery cycles, superior product quality and reliability, dependable delivery promises, ability to produce new products quickly, are performance areas which can be a source of competitiveness for manufacturing companies. Skinner, W. 1969. p. 136.) Not nearly that high a level need to be achieved. Lecklin's version is on the author's vision, more relevant:

The future company is flexible and agile. There are few organizational levels, few managers and directors and most of the people work in teams. Organization reforms itself according to the current task and IT has strong role. Customers, suppliers and team are more bound together. Commitment affects the whole organization. The thought of quality is expanded to performance excellence. (Lecklin, O. 2006. p. 22.)

Despite of this visionary statement, Lecklin has his feet on the ground as stating: Somehow bad quality is accepted as part of each project. Especially when there is hurry, it's easier to tolerate small fails (Lecklin, O. 2006. p. 214). Another example of feet on the ground is seen in Figure 3, where survival is only seen through profitability, which is correct, but that can not be reached without employee motivation, ability to react and image.

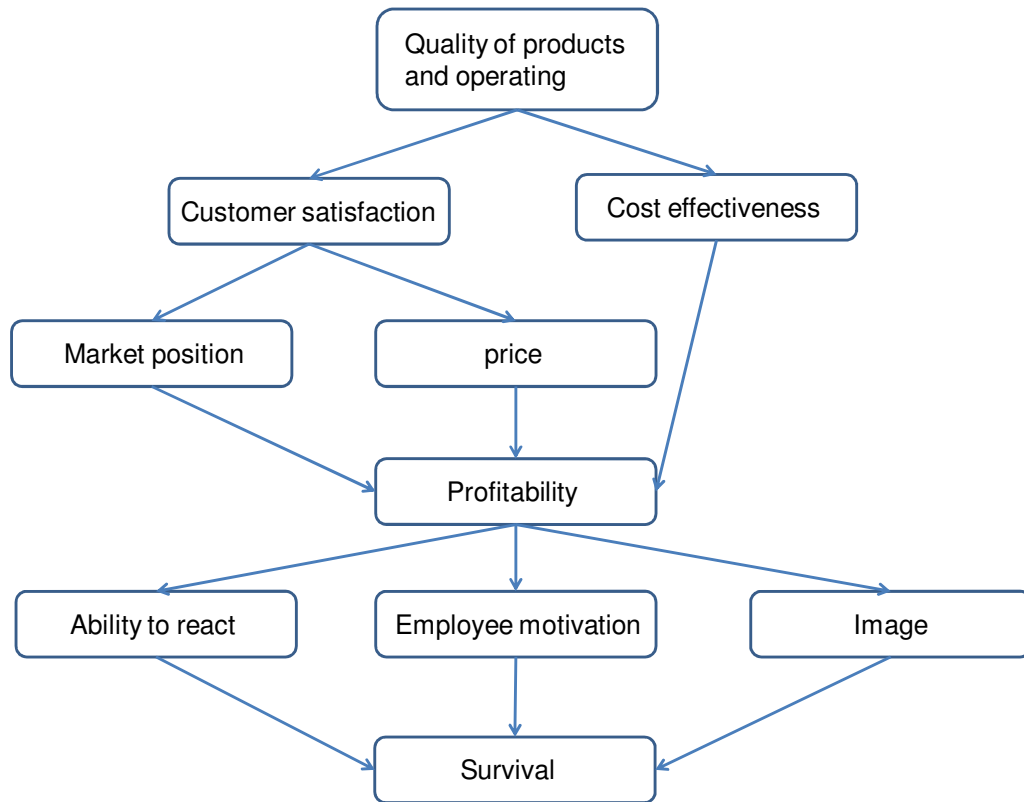


FIGURE 3. Meaning of quality (Lecklin, O. 2006. p. 25)

After all, several problems and solutions were found amongst literature and even main themes rose up. They are shown on following subchapters as

- Definitions
- Personnel's professionalism
- Supply chain management
- Goods delivery development
- EHSQ and
- Information sharing

These gathered items support well the data gathered via interviews which is good because Skanska's supply chain management team has come to a conclusion that developing efficiency starts from the site (Tompuri, V. 2006. p. 36). Also Peltonen (2002, p. 13) has noticed that "The meaning of experience-based knowledge (tacit knowledge) is great." All this leaves a lot of expectations

to experience-based knowledge and is seems quite sure it will not succumb under the literal material.

3.2 Definitions

A short look into definitions is acceptable here. This is for that there are several different opinions for terms used in quality or economical publishing. The terms and definitions presented below are the ones that the author considers best and most accurate when considering large delivery projects. Again, the applicability to practice is the decisive criteria. Also, these definitions tell what to reach, where the goal is. It also becomes clear how the different fails affect to quality and efficiency and why all the quality costs are not directly or even indirectly visible.

Quality is that each single product and the combination of individual products are within defined tolerances (Lecklin, O. 2006. p. 17). This definition of quality should always be in minds of every employee from white- to blue-collars. The work must be good enough to pass expectations but not too good. Producing too good work will rise costs but bring no gain. This means that the company's actions are qualified if customer is satisfied to the products received. Internal effectiveness and flawless products do not guarantee a good quality; the final decider is and should always be external evaluator (Lecklin, O. 2006. p.18-19). This makes sure that neither over quality is produced and that products are optimized, on Jura's terms, "Fit for use".

Delivery dependability is the ability to exactly meet quoted or anticipated delivery dates and quantities (Leong & co. 1990. p. 114 and Vickery & co. 1997. p. 321). For quality of products and work is to be within tolerances. For deliveries the primary demands are to make the right delivery at the right time. The third primary criteria seem to be so obvious that it is lacking from these studies. Even though being obvious, it is still too commonly failed. The third criterion is to be delivered to the right place.

- Internal faults are the faults that are noticed before the installation or delivery to the customer. Examples of internal fault costs
- Time spent making faults
- Repair costs
- Delay fines
- Waste time, Idle time
- Costs for solving claim, reasons for faults and reparative actions.

(Lecklin, O. 2006. p. 157.)

In most companies these internal faults build up the most or all of quality costs. This is mainly due the traditional idea of quality controlling, where external costs are not taken into consideration and remain completely forgotten.

External fault costs are the costs that are fixed after the delivery or after customer's complaint. Examples of external fault costs

- Warranty costs
- Insurance costs
- Delay fines
- Delivery costs for fast deliveries and for small cargo
- Waste time, Idle time
- Repair costs
- Costs for solving claim, reasons for faults and reparative actions.

(Lecklin, O. 2006. p. 156.)

In this case the internal quality assurance may have failed, or the fail is caused due the operations at site. Either way, external faults are the most dangerous to a company because fixing the faults is much more expensive and it also may have negative effect to company's image. On IT-business it is commonly known that fixing a fault on testing phase is 10 times more costly and in production 100 times more costly. In Delivery projects, the cost for fixing something at site is usually 4 to 20 times higher and if something fails during operation, a factor of 100 might not be enough due production losses and penalty fees.

Purchasing is the management of the company's external resources in such way that the supply of all goods, services, capabilities and knowledge, which are necessary for running, maintaining and managing the company's primary and support activities is secured at the most favorable conditions (Weele, A. 2005. p. 12). In other words, purchasing function should obtain the proper equipment, material, supplies and services of the right quality, in the right quantity, at the right price and from the right source (Aljian, G. 1984. p. 3). The meaning of this definition is that purchasing serves all primary functions, in other words takes specifications, both technical, commercial and delivery related, and produces best possible supply of needed products at best terms fulfilling the delivery reliability requirements.

Customer is who either purchases or uses the product. If someone of these or someone else will do the evaluation, should that one be considered as customer. (Lecklin, O. 2006. p.79.) In large delivery projects there is usually the final user of delivery (process personnel), the project organisation who is the customer, the external (consultant) supervisors who "speak in the voice of customer" and even a main contractor for subcontractors. The chain of customers is long and all of them must be kept happy.

3.3 Personnel's professionalism

As mentioned in chapter 2, the tasks at site are numerous. This sets many demands to site personnel. Surprisingly little notifications for middle management seems to be made when management and large companies employee analyses can easily fill a bookshelf.

Lecklin sees great possibilities on personnel's professionalism. Development process demands increasing employee's responsibilities and empowerment. Employee can improve both the process and the product. Conduct of work and problems must be solved and settled at site immediately. Especially independence must be highlighted. (Lecklin, O. 2006. p. 21.) In practice, the site

foreman knows best the situation and should be best for solving the problems immediately as they occur.

To see qualifications for a foreman, PA Consulting Groups made research within 532 companies from 15 countries. In this questionnaire the top 4 qualities preferred on foremen were

- Adjustability to changes (overall highest ranked skill by far)
- Team leader skills
- International experience
- Team member skills

(Lecklin, O. 2006. p. 247.)

At the same PA Consulting Groups research the most recommended ways to make a good foreman to grow up to his role are listed

- Start taking responsibility on young age
- Working close to highest management
- Experiencing new tasks within the company and
- Assuming new responsibilities at another company

(Lecklin, O. 2006. p. 247.)

Not encouraging but true is the fact that not always responsibilities and professionalism are appreciated enough. The site manager has strong responsibilities and power, but the salary and bonus system is usually everything but encouraging (Salminen, J. 2000. p.14). This well known fact don't increase the will to make career at site and brings on the problem when need for most qualified personnel to site is not met. One frustrating item is also decision making space, as seen in Figure 4, where there usually is not enough space at right place, in this case on site managers hands as (s)he is the one with best knowledge of situation at site.

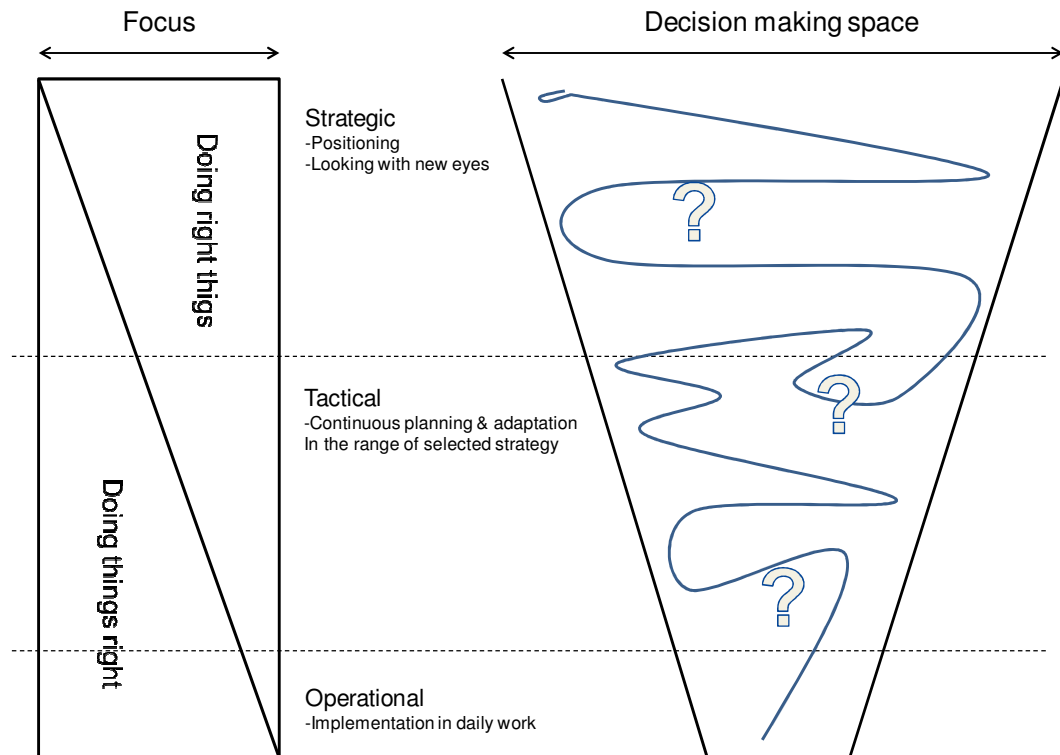


FIGURE 4. Decision Making Space on a Different Level (Talonen, T. 2008. p. 77)

3.4 Supply chain management

There is much information about supply chain management, and only the most essential parts of supply chain management of delivery projects are represented in this chapter. This is to stress out the main pragmatic problems and solutions without going deeper into subject.

An opposite opinion of amount of supply chain management theories comes when Gadde & Håkansson (2001, p. 53) claim that “Over the years, purchasing has not at all received as much attention as sales, despite the fact that for many companies it may represent a key factor to business success”, now over a decade after it we have seen the change in this with all larger companies decreasing the amount of suppliers and tightening purchase regulations. Small and mid-sized companies have minimized purchases since 2008, but these actions are simply based for savings instead of increasing delivery reliability.

It is understandable that so much effort on development of supply chain management has been made. For most companies the costs of purchased goods and services represent the dominant portion of total costs. Studies show that the portion is from 51 % up to exceeding 75 % in construction business. Small companies can easier develop a coherent way of working with suppliers but face problems with suppliers because they buy small amounts. Large purchasers have more managing to make all suppliers to work with their systems, but at same time they have a say with most of suppliers because of the large amounts of purchasing. Not only due the relative financial importance and monetary value but overall affect of suppliers input gives this a strategic significance. (Gadde & Håkansson. 2001. p. 4 - 6.)

Was the purchasing company large or small, a good co-operation with suppliers save money. In the construction industry it has been estimated that the cost of handling an invoice is around 40 – 50 dollars for the buying company. One of the main primary contractors in Sweden receives an average of 1 500 000 invoices in Sweden. (Gadde & Håkansson. 2001. p. 9.) No wonder why standardized forms and collective invoices are much appreciated.

The challenge on building good relationship with supplier is that on long logistical chain everyone does and thinks only their own task. Changing people and situations cause the logistical chain not to work properly. (Rytsy, A. 2005. p. 26.) This means that site-operations will suffer because problems primarily occur when material deliveries to site are poorly coordinated (Tompuri, V. 2008. p. 34). All forms of unexpected delay represent bottleneck issues. It is estimated that between 75 % and 95 % of all non productive delays result from unplanned queuing in manufacturing business (Bowersox & co. 2007. p. 92). When the relationship is established, the supplier's actions or punctuality didn't variate whether the order was made couple of days or couple of months before (Wegelius & Co. 1993. p.27). On the other hand, purchasers often announce delivery date earlier than needed just to play safe. Same might happen with suppliers logistics planner; if (s)he knows that there is not actual hurry for the delivery, s(he) might plan the production or the delivery later than ordered

(Jahnukainen & co. 1997. p. 61). The problem is that changing delivery time, place and consistency should always be mutual decision based on current situation and needs, not a game or best guess or, at worse, hustling the other party.

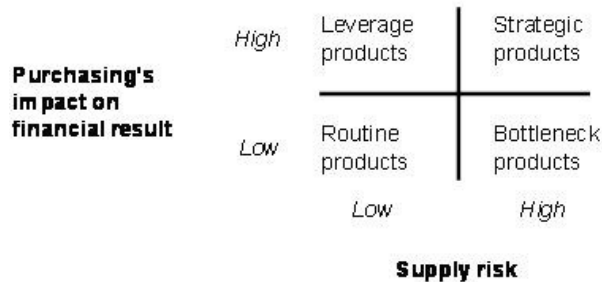


FIGURE 5. Kraljic's classification of purchasing situations

The base on all the supply chain management ideologies is that purchasing items are classified according to Kraljic's matrix, Figure 5. Problem is that in large delivery projects the key is to manage high risk high impact products, AKA "strategic products". Other purchases play a little role in this. Although they can't completely be disregarded, in this case they are left for little of interest.

Increasing reliance on co-operation with suppliers seems to be a prerequisite for successful implementation of the rationalization role (Gadde & Håkansson. 2001. p.31). However, it is not quite easy as they note further on their study, a company cannot handle too many high involvement relationships when exchange of information plays a significant role for network efficiency (Gadde & Håkansson. 2001. p.174).

Weele sees that apart from direct savings on purchasing prices, due to purchase management the following (non exclusive) list of improvements can be achieved:

- Reduction of quality costs. When products are delivered by suppliers, many companies conduct both an incoming and a quality inspection. The costs of the incoming and quality inspection of the purchased goods can

be reduced by selecting suppliers who have their production well under control and possess a sound quality organization.

- Product standardization. Purchasing can contribute to cost-price reduction by striving for reduction in product variety either through standardization of products and / or reduction of the number of suppliers.
- Contributing to product design and innovation. Today most innovations in industry do not come from large manufacturers but from their suppliers. Purchasing should encourage interaction between suppliers and buyers.
- Stock reductions. Stocks have been seen as an insurance against scheduling problems. Through imposing a solid discipline on suppliers and enforcing it through careful scheduling of deliveries, purchasing can significantly contribute to reduction of stock and hence capital employed.
- Increasing flexibility. By using ERP (enterprise resource planning) trying to implement kanban or just-in-time methods for manufacturing can the best performance from suppliers be achieved

(Weele, A. 2005. p. 18 - 19.)

Delivery projects differ from normal production and therefore not all of the following advantages can be received:

- Reduction in quality costs can partly be achieved by setting the initial responsibility to supplier. Part of supplier's quality assurance costs will be transferred to the price, but not all. However, this will not take away the responsibility to audit the supplier and have occasional quality checks just to be sure.
- Product standardization is hard to do with large delivery projects. The main equipment is specially designed for this compilation. On auxiliary products, tools and expendables this is a way to find savings and reach some state of standardization on site.
- Contributing to product design is normal in today's projects. When designing a large delivery project, the suppliers are given specifications and if necessary the devise or item is not found amongst portfolio, the process specifications are altered or a specific product for the purpose is developed.

- Stock reductions can not be reached anymore. The minimization of stocks has already been seen and even turn into having a bit more items on stock has been seen. Also, in large delivery projects the manufacturing happens just for delivery, not into stock.
- Increasing flexibility is the most relevant development method. When the design is changed, the information must be shared immediately and on right form so the possible changes can be made at factory. If the delivery time or specifications change, it can be taken into consideration when planning manufacturing and delivery so delivery reliability is reached. Currently this issue is on worst considering the above mentioned options.

Determining responsibilities is the key for good co-operation. Purchasing is a cross functional responsibility where there are involved purchasing department and one or several echelons. This demands adequate communication and cooperation among the disciplines involved. (Weele, A. 2005. p. 29.) In delivery projects the aspect should not just be between engineering department and purchasing to determine technical issues and between sales department and purchasing to see what the agreed delivery date is. See also definition in chapter 3.2. The most important shared responsibility holder should be the installations resource owner who needs to determine all the scheduling and deliveries of the project. Just one example was when purchasing department bought gratings for the whole factory which was to be delivered without consulting site manager. All the gratings were delivered before even foundations were ready. No changes could be done that became during the next 9 months. Just the direct costs to move all these gratings were over 25 000 € without counting costs for the modifications that had become between design revision A and D. Hopefully we will, at some point, reach this situation: “At least, as a whole, the main development in purchasing has been formulated as a change from product based acting toward supplier based acting” (Gadde & Håkansson. 2001. p. 54).

According to Weele (2005, p. 33), major bottlenecks and problems are

- Inadequate supplier selection
- Insufficient contracting experience

- Too much emphasis on price
- Administrative organization
- At this point no further comments are implemented as it is assumed that these issues will rise from experience-based knowledge data.

3.5 Goods delivery development

The problems on goods delivery have cost a lot of money from the beginning of ages. Unbelievable is that there are several, small problems that have never been either fixed or standardized, or that the work has just begun. For example as late as in beginning of the 21st century the Finnish ministry of transport and communications took up the initial to develop a standardized shipping form.

The target was to create a standardized form for shipping container that would include all the necessary data for each party and be easily readable. Most of problems are caused because of lacking information and unreadable markings. (Rytsy, A. 2005. p. 26.)

There is already a possibility to use RFID shipping container forms. The Ministry of transport and communications hopes that this technology will take place soon. (Granqvist & co. 2003. p. 21.) The use of RFID is also recommended by Bowersox (2007, p. 108).

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Lappeenrannan kemikaalituonti Oy		
c/o Tuontivarastohotelli Oy astiavarasto ovi 6		
Saimaankatu 12		
53300 LAPPEENRANTA		
Puh. - Tel. (05) 555 666 777		Läh.pvm. - Avs.dat. - Desp.Date
Lauri Lähettäjä		7.11.2003
┌ Minne - Till - To ┐		
Varsinais-Suomen Tuotetukku Oy		
Kemikaaliosasto		
Rautatehtaankatu 2		
20200 TURKU		
└ Puh. - Tel. (02) 888 999 000 Lars Larsson ┘		
Kuljetusohjeet - Transportinstruktioner - Transport Instructions		
Kuljetus Oy		
Puh./Tel. (09) 111 222 333		
Lähetys - Sändning - Shipment ID	Kolli - Item	Paino - Vikti - Weight
223344556	1/5	25/100
		
Kolli - Item ID (00) 97399991234567899		

FIGURE 6. Standardized Shipping Container Code Form (Granqvist & co. 2003. p. 24)

Even small faults and basic functions that take a longer time to handle than is suitable can soon cause problems. For example, in Sello 2 construction site the amount of trucks bringing steel was 200, for concrete elements 1 000 and for sandwich elements over 1 000 trucks. At some point there came several trucks to site every hour. According to logistics manager, there is no time to check the deliveries other than by eye. Neither is there space for storage at construction site, most of goods must be installed immediately. (Tuisku, T. 2004. p. 51.)

As soon as delivery is unloaded in a wrong place, or if the contents is not what was intended or the content is damaged and not immediately reclaimed, it is certain that some delays and bottlenecks will rise up at some point. Kari Hartikainen, project manager at Suomen Rakennuslogistiikka Oy states that “Exact estimation for costs of poor delivery reliability is hard to give, but we all believe that the amount is significant” (Tompuri, V. 2008. p. 34). Just for gypsum sheet panels at apartment construction site, at work site was caused 34 to 67 % of all logistical costs (Wegelius & Co. 1993. p. 25).

For development, how to minimize problems on deliveries, it is important to be involved from the beginning, e.g. to plan site’s internal logistics, storage sites and places for cranes (Tuisku, T. 2004. p. 52).

3.6 Environment, Health, Safety and Quality

As already stated, a good quality of conduct in company can also be a valuable competitive advantage. Usually, if a company has good quality it is reached to every, or almost every operation. For example, several researches show that delivery reliability and internal quality are compatible. The companies that have high levels of quality within their production processes, are usually capable of making reliable deliveries. (Womack & co. 1990. p. 25, Kim & Arnold. 1992. p. 25, Sweeney & Szwejczewski 1996. p. 40, McKone & co. 2001. p. 58)

ISO9000 standard requires a quality manual for company. Usually the operations on quality manual are written stiffly and on higher level guidelines. For improving quality on floor level it would be good to have a practical guide lines –manual to make the concept understandable to normal worker. (Lecklin, O. 2006. p. 31.)

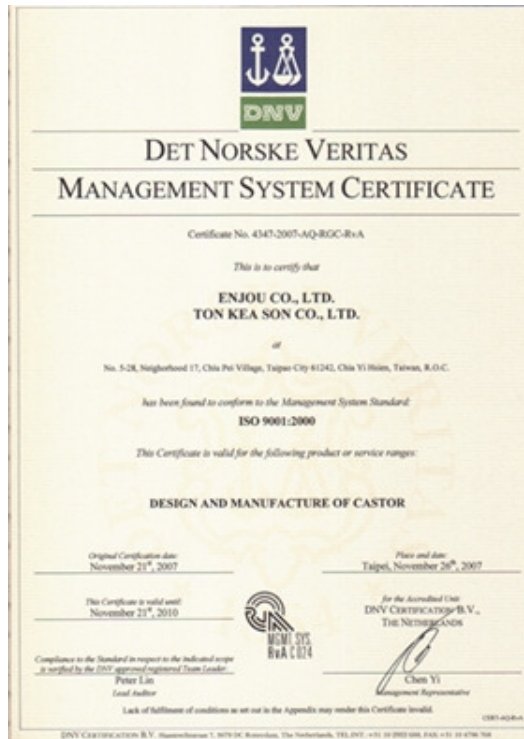


FIGURE 7. An example of ISO9000 –certificate by Det Norske Veritas

The following headlines are the unfortunate proves that no ISO-certification, example in Figure 7, is the assurance for quality and that though often stated, the quality in Finland is anything but on high level. First one is “Finnish work is mediocre at highest, seldom even that” from article about national quality strategy in Helsingin Sanomat, 9.2.1997 (Lecklin, O. 1999. p.9) and “Thin concrete at Olkiluoto nuclear power plant building site is killing Finland’s reputation as builder” from Kauppalehti 1.3.2006 (Lecklin, O. 1999. p. 13). Again, it seems that small improvements to ground-level work could bring out a lot of development. Only by using check lists would the worst cases be avoided and quality handbook be implemented to actual use. Quality was easiest evaluated by using check-lists (Salminen, J. 2000. p. 24). Lists help to assure that mistakes will not be repeated (Peltonen & co. 2002. p. 13). When operations are systematic, they are also more secured which brings out other improvements, not least organized and clean work site. An organized site is both safe and cost efficient (Tompuri, V. 2008. p. 35).

Besides lists and quality handbooks, the whole chain of handling faults and learning from them is important when developing quality and delivery reliability. Most essential for this is the attitude of the personnel and their commitment to work. If the attitude is right, for example, a customer complaint (reclaim) is a possibility to improve customer relationship. Complaining customer has not yet terminated the customer relationship. Discreet and fast handling of complaint together with fast repair / replacement of customer's complaint, possibly joint to a surprise bonus may overcome customer's expectations and make customer to assume positive attitude towards supplier (Lecklin, O. 2006. p. 104). Usually, the need is only to fix the faults as soon as possible because failing the delivery will lead to contract fines, or for example in maintenance projects, failing a delivery will directly cause losing future projects and therefore must be avoided at any costs.

3.7 Information sharing

As previously mentioned, the changes that happen when conducting a project should be shared amongst project organization. The good conduct for EHSQ sets a demand for having all the necessary information documented. Neither is it easy to run a delivery project if one does not have all the needed information. The saying goes "information is power". What is heard commonly, or actually always is that the amount of information shared is insufficient. Agility requires real-time information sharing to all the parties. (Iskanius, P. 2007. p. 9.)

One important notification on normal operations is lack of communications. Though there are several methods for information distribution; as

- Information happenings
- Team meetings
- Personnel magazines
- E-mail
- Notification boards
- AVACS (Television Info)

The individuals and teams still comment on lacking information. (Lecklin, O. 2006. p. 217.) Usually, the efficient use of ICT is the element that is lacking (Iskanius, P. 2007. p. 9).

Not always are nearly all the channels of communication at use, usually occasional newsletters come from higher level of administration and actual information changing is based to bilateral communications exchanging. This causes the quality of information to variate. Lecklin defines information requirements to be

- correct
- on unanimous form
- to be easy to use
- to have usability
- modifiable to different uses

(Lecklin, O. 2006. p. 256.)

It has been demonstrated in psychological tests that the quality of decisions decreases when the amount of information increases beyond certain level (Gadde & Håkansson. 2001. p. 51). This limit comes up even faster if the above mentioned criteria are not met.

The information of projects has several classes:

- Scheduling information. Knowledge about time consuming and project milestones.
- Budgeting and resourcing information. Knowledge about costs related to budgeting. Knowledge about resources.
- Culture and environmental information. Knowledge about work and contract culture. Knowledge about advantages and hindrances that weather and environment make.
- Party information. Knowledge about other parties at the project.
- The contract- and officials-juridical information about the project.
- Experience about all that has happened at project.

(Peltonen & co. 2002. p. 40 – 41.)

The usual problem is that not all of the needed information is passed to the needing parties. For example, often contract information is often held by some director who has signed the papers when the site management needs to know all the agreed terms and details to make the delivery to the point. Another issue is that to seal the contract it is usually useful to understand the local culture and “normal practices”.

Besides managing the project, another bottleneck for information sharing is between design, manufacturing and assembly. As Salminen notes, problems cause because preparation of project is not done clear enough, planning and design is usually late. The design isn't executable or don't comply with each other. Drawings lack details and measurements. (Salminen, J. 2000. p. 14.) Nowadays software and internet connections make it possible to share same information immediately to large groups. Also, if documents lack information or measures, at site the personnel can check it up from 3D-models. As Iskanius stated, the only problem is that efficient ICT use is the element that is lacking. (Iskanius, P. 2007. p. 9.)

At the worst the lack of information can be devastating. An organization is often considered to be more as a limitation instead of being supportive. This takes away motivation and decision making-will from workers and will affect decreasing the total quality. (Lecklin, O. 2006. p. 217.)

4 EXPERIENCE-BASED KNOWLEDGE

4.1 Gathering information

Experience-based knowledge is systematically gathering, analyzing, prioritizing and following up project related risks, opportunities, successes and failures in order to be used in future projects (Peltonen & co. 2002. p. 40).

Most of the actual data about problems occurring at projects and development targets was already at the beginning decided to be gathered by interviews. The method is strongly supported by several other studies. Core competence is mostly based on silent knowledge (tacit knowledge) amongst the personnel (Virolainen, V-M. 2000. p.18). However, the gathering and analyzing was expected to be hard in light of Peltonen's study (2002, p. 42 – 43):

“Experience-based knowledge was gathered, but it was difficult to analyze or use due fragmentation. Even document management software or other software couldn't help. Usually only way to pass experience-based information were the de-briefing meetings, if they were held.”

Experience-based information was collected qualitatively on interviewing the subject group. The interviewer had a list of questions but mostly the interview became a conversation. In the end, as time went by, the discussion and questioning became more and more free. The same persons were interviewed several times to make sure all the information was collected.

At the start-up meeting it was decided to interview project managers, quality managers and especially site managers and other site personnel. The presumption was that to be a large enough sample to gather enough information and that the final conclusion of large enough sample would be reached when seeing that answers had become saturated.

At the beginning all the interviewed personnel was thought to be either Normek Oy personnel or people from companies directly in co-operation. As the thesis

worker's employer changed and time passed since the start-up, the amount of personnel interviewed for the thesis has risen significantly.

The interviews were conducted in three different ways. At the beginning the questions were asked openly with a list of questions as a background help for the interviewer. Later on, every time something about problems or development possibility was mentioned, the author collected the information to "the black book off personal notes. At final phase, when the author usually just visited the project sites without personally being in charge, some brainstorming sessions around the coffee table were held. People who know the Finnish culture know that the latest can be the most effective way for information gathering, if handled properly.

4.2 Gathered information

During the interviews and brainstorming, the following items came up (grouped according to knowledge based on time consumption, see chapter 4.3):

Information and communication

- No software to check design / do project plan / open document etc.
- No, or not good internet connection
- Not knowing what will be changed
- Insufficient information about revisions
- Knowing personnel for project at the last minute
- New personnel
- New subcontractors or other parties
- Insufficient plans for manufacturing
- Insufficient plans for installations
- Partners who are unable to use computers / ICT
- Contradictory information
- Changes due to other parties at site
- Unclear organization – unclear responsibilities
- Insufficient information sharing between shifts

Goods delivery

- Need of goods that are not ordered
- Goods delivered without an order
- Not enough consumables, fasting supply etc.
- Goods delivered in wrong place
- Moving goods to other place
- Goods are damaged
- Goods are delivered in wrong quantities
- Takes time to solve what is delivered, delivery form is unreadable
- Takes time to make exclaim for damaged / wrong product
- Tools lacking. Local store had only 3 drill heads.
- Goods are stored further away; transportation to installation site
- Goods can not be unloaded to where they're supposed to; other items on way or no road to
- Orders / invoicing is handled outside the site -> causes problems
- Deliveries must apply also during weekends (Murphy's law)

Supply chain management

- The delivery is not according the last revision
- Delivery comes even if not ordered
- Wrong goods delivered
- Large quantities of goods waiting for installation
- Claims should be made immediately; should be documented
- Agreed delivery dates (and contents) can not be relied on
- Insufficient markings on goods and parts
- After-deliveries. E.g. If all the fastening supplies are ordered on one invoice and everything except 100 pieces of M20x200 bolts are delivered. If the bolts are needed, site manager makes everything possible to get them to use. After a couple of weeks come the after-delivery of the original invoice and the 100 pieces of bolts will lay on somewhere waiting for day to come.

Personnel's professionalism

- Contract management; what is included / excluded
- Tools lacking; insufficient preparations
- Project Manager and Site manager should be present at start-up meetings and on preparing phase of offering.
- Site manager must try to be at two places simultaneously; at meetings and at site.
- There is plenty of paperwork, enough for a project engineer, but tight economy doesn't allow it so Site Manager must do overtime.

Time & Schedule

- Schedule changes due fault delivery
- Schedule changes due lacking plans or goods or machines
- Time demand for repairs
- Checking invoices
- Weather
- Delay fines vs. cost for overtime work

EHSQ

- Checking that EHSQ rules are applied.
- Doing EHSQ check-ups
- Filling forms; additional work, site safety check, certificates, installation plan, lifting plan
- Attending to meetings; time spent

All the interviewed people agreed on that flow of information is always insufficient. The second commonly agreed issue was that at site the decisions must come fast because the conduct of operations is seldom exactly according to the plan.

4.3 Amount of spent time and resources

All the interviewed people agreed on that it was difficult to determine the exact amount of time and resources that are spent on faults in deliveries. Usually, some form of calculation was held, but the calculations were all different and “to be considered insufficient”. Neither did any site manager want to give original and exact calculations.

On every occasion, the estimated time spent on managing something unplanned on deliveries was estimated to be above 5 % of the working time for each of the categories:

- Information and communication
- Goods delivery
- Supply chain management
- Personnel’s professionalism
- Time & scheduling

The categories mentioned above have already been used in chapter 4.2 to group interviewed information. For EHSQ it is hard to give evaluation for its mandatory role.

TABLE 1. Part of an hour calculation for industrial building site in Finland.

	Hours	% of all working time
Fitter	81328	
Supervisor	7176	
Site Manager	2568	
Man h spent on moving goods	4483	5,51 %
Supervisor h spent searching goods	382	5,32 %
Site Man. h for claims and queries	218	8,49 %

According to the author’s surveillance, the 5 % rule can be considered the absolute minimum. As seen in table 1, the amount of time for “goods delivery” –

faults was above 5 % for each working group. As for personal knowledge, these numbers are likely to be rather under the actual hours because of the table is “as announced” and therefore not completely accurate.

If the 5 % sum for each of the 5 problem groups is counted together it sums up to 25 %. The hard boiled site supervisors said that it's between 25 and 50 % of the time spent for correction measures, rest is the normal work. These estimations and tablet data comply with each other quite well.

TABLE 2. Part of an hour calculation for an (originally small) industrial installation site in Sweden.

	Hours	% of all working time
Fitter	5880	
Supervisor	196	
Site Manager	196	
Man h spent on making changes	4200	71,43 %
Supervisor h spent on solving deliveries and transports for additional materials	22	11,22 %
Site Man. h for solving changes in design	160	81,63 %

Sometimes the problems culminate. Table 2 shows what happens when foundation designer, construction designer and lay-out designer do not communicate with each others. The foundation engineer had made preliminary design, other two designers had changed plans and foundation designer forgot to update design when doing final design. Basically all the junctions and joints to the foundation had to be remade at the site and half of the very basic building around the machinery had to be modified.

5 ANALYZING THE PROBLEMS

In this chapter the problems are presented in order that they were collected by interviews and analyzed and solutions recommended on basis of experience and study information presented in chapter 4. There is not much repeating and quotations but rather straight the solutions.

5.1 Information and communication

The problems caused by not being able to use computers and software are more of personal skills. Most likely the problem will be decreasing as the old site supervisors become replaced by computer time grown engineers. However, this is one clear indication that even, or especially at the site a person's professionalism must be kept up to be able to use new software and other ICT tools. When it comes to not having good internet connections or all the necessary software, it is saving in the wrong places and harshly underestimating the site personnel's capabilities and needs. If a modern 2D and 3D software is available at site, it is easier to plan installations and even to check details lacking from drawings. One example is Tekla software that can be used to check details and distances for installations in case 2D drawings are not providing enough information. Though a research says that the efficient use of ICT is the element that is lacking (Iskanius, P. 2007. p. 9), the problem is more because software and training is not purchased to site personnel.

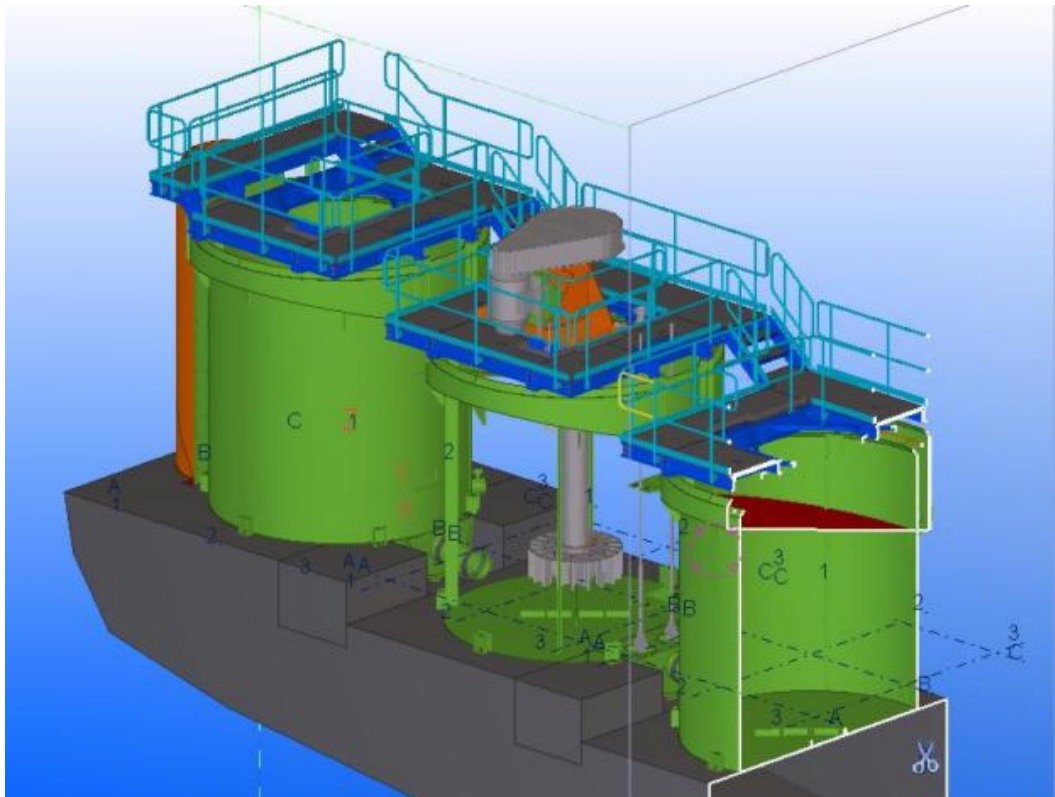


FIGURE 8. Tekla software (© Tekla).

A large deal of lack of information, or hearing contradictory information happens because of having unclear organization and divination of responsibilities. The more people within the same project organization know each other, the better they can communicate, and when the communication is easy and natural it is much easier to make sure all the information becomes shared. An open communication culture also makes it possible to inform about mistakes so they can be corrected, or at least the effects can be minimized. The same principle applies to relationships between contractor and customer and customer's supervisor, between contractor and subcontractors and even between site personnel and designers. If possible, the key persons of project should be involved at soonest possible moment to plan the project and to create network between parties. The project organization will also appreciate the sooner they know subcontractors, site personnel, contact persons etc. There are always more things to do towards the beginning of the installations and the earlier all the plans and changes are made the less there is to do at last moment. If there

is a lot of uncertainty, the only other way to ease up the beginning of installations is to have all as standardized (routine) as possible.

A notification should be made about that if there is work done in two or more shifts it is mandatory that the shift managers share information and go through all the done and upcoming works. This takes at least an half an hour each time, but it can actually take up to an hour. It is not overreacting to make shifts go parallel for 10 to 15 minutes to make all the detailed knowledge between fitters to get passed by.

Even more harmful than insufficient information sharing at the site is when information sharing between site and design does not work. Again, if the designers know the site personnel, it is easier to ask and to tell the changes. However, this does not solve the actual problem. There is no easy and omnipotent solution that assures all the information. Based on the collected tacit knowledge and author's notifications, the only way is to

- Document all the changes made to make it easy to check the latest changes.
- Release the revised design on agreed periods, e.g. weekly on Friday
- Share the revised design as packet to all parties.
- On urgent and important cases inform the person responsible for changes personally
- Keep everything and do everything systematically

What comes to information sharing, everything should be documented. All the important information and changes should also be given via e-mail to leave traces. When sharing information, the "rules of good information" by Lecklin should be in use as stated in chapter 4.7. Besides to be correct, modifiable and easy to use, it is necessary to understand to keep the information in a compact form. If the amount of information, even though being valid, becomes too large, it becomes more difficult to point out the most important information and to be able to determine best order of actions (Gadde & Håkansson. 2001. p. 51).

It is best to have as much decision-making-power at the site as possible because the best situation knowledge is at the site, and the decisions can be made faster. The most important is to make good enough decision and start acting and then to re-evaluate the situation and adjust actions again than use time to make best possible decision and to be too late to execute it (see figure 9).

Problems with insufficient information are often caused by upper management and happen surprisingly often. It happens when the contract information is held by some e.g. director who has prepared and signed the contract. Whether the contract is between the purchaser and the contractor or the contractor and subcontractor or relevant, the contract information is needed also at the site to make certain where the limits are. This shows again how multitalented the site manager must be.

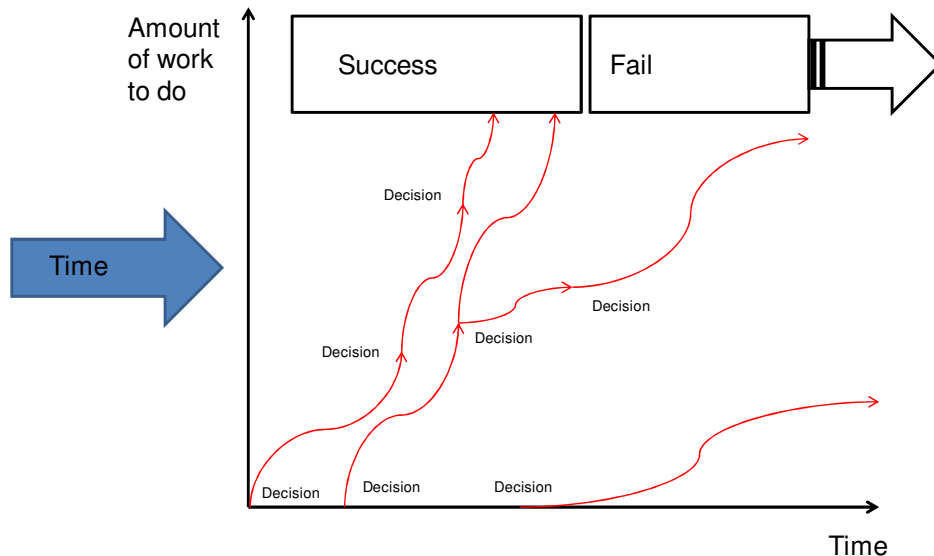


FIGURE 9. Relation between time spent on decision making and making the right decisions.

The most important issue about sharing information is to always try to do the best. Anyone that has ever been at site working can agree on Lecklin's notification:

At worst the lack of information can be devastating. Often organization is considered to be more as a limitation instead of being supportive. This takes away motivation and decision making-will from workers and will affect lowering the total quality." (Lecklin, O. 2006. p. 217.)

Figure 9 shows the principle in relation between time spent on decision making and making the right decisions. Time acts also as wind pushing the acts after made decisions further towards fail. Doing right enough decisions in fast enough time, and again adjusting the decisions fast enough can success be reached.

5.2 Goods delivery

The delivery must be

- Ordered (planned delivery time)
- On right place
- At right time
- Have all the ordered goods
- Undamaged
- Clearly marked to goods and to shipping container form

In addition to the above mentioned list that is on deliverers and producers responsibility, the delivery must also be able to be unloaded to right place. This is site personnel's responsibility. In any other case the delivery has failed.

The same conclusion has been reached by Wegelius & Co (1993, p.31) stating:

- The delivery transportations should be organized to rational blocks
- Products should be packed as rational batches
- All goods must be dropped at the exact location where they are needed.

- All batches and items must be marked clearly to ease up recognition
- Delivery must be timed exactly to the moment when they are needed.

The key for a good delivery is to have good co-operation with suppliers. The suppliers must be made clear what is expected and in case of deviations, immediately announcing the complaints. The practice must be clear –also on project management side. The order of delivered goods and preliminary schedule must be made on time, delivered to suppliers and updated constantly. Again, the sooner site personnel is involved, the better preparations and plans can be made.

The site personnel must work for to be able to unload every delivery exactly to the place where it will be installed. If such is impossible, should a storage area be available so the goods can be unloaded and stored protected in order without any unnecessary transportation. Every delivery must be checked immediately when arriving and for exclaims a easy-to-fill form filled.

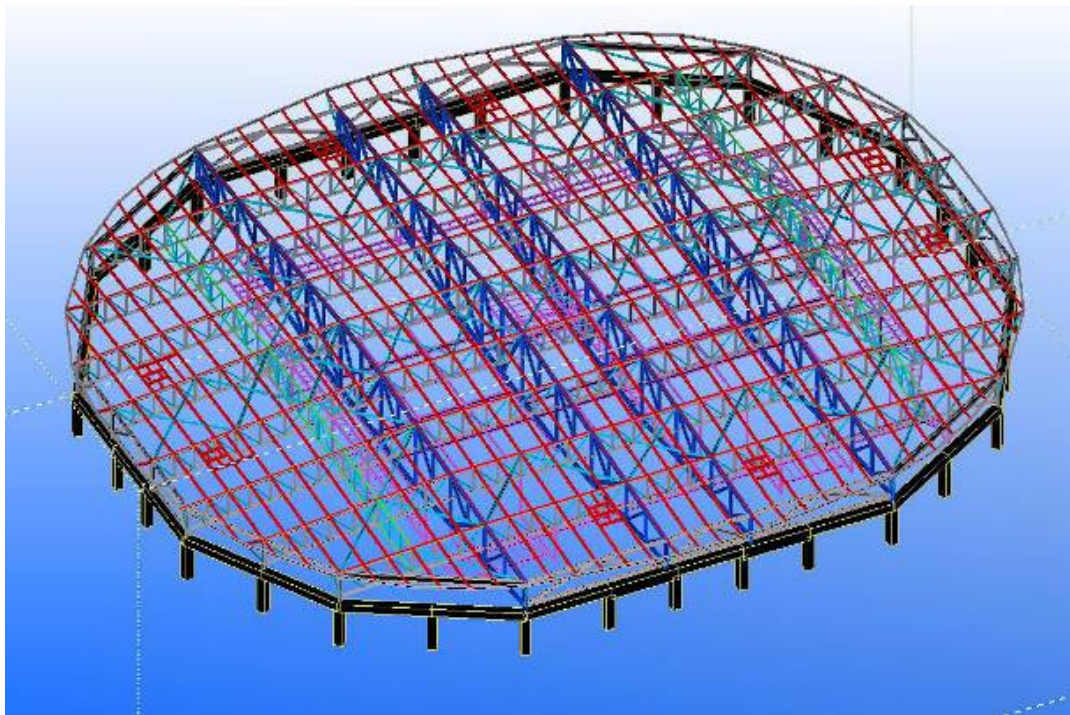


FIGURE 10. Tekla software can be used to mark delivery order for installations with different colors (© Tekla)

For tools and supplies, it comes to the site personnel's experience to be sure all the needed equipment is available when needed. Some special tools need to be ordered to the site and some tooling need inspection certificates. The only way is to be systematic when planning. It is also better to rely on reliable suppliers and do purchases as stock for tools and consumables. For example, in Sweden or in France it is completely possible that a large hardware store only has three drill heads, one grinding machine or one to two packs of welding electrodes. Easily the shop is "bought clean". If learned to buy things from Finnish hardware stores one will be rather disappointed abroad.

5.3 Supply chain management

The same solutions apply to supply chain management problems as to goods delivery problem solutions as presented in chapter 5.2: good co-operation, robust standardized practices and fluent information exchange between the parties. By this it can be made sure that the deliveries are done correctly and to right place at right time.

Even though quality control is put on the supplier's responsibility, the contractor must put effort to do official and unofficial auditions and inspections to check the products. This is even more important when there is hurry. In hurry corners are cut and the more of problems are found and fixed at factory, the more it saves time from site works. This applies even to relied partners.

When selecting the supplier, the only emphasis should not be the price. As stated also by Weele (2005, p. 33), the possibility for good co-operation and reliability should be the primary selection criteria if the price is on competitive level. If the supplier is reliable and understands the needs, there will be less after-deliveries that mix up the stock. A good supplier sends invoices as collected, for example a months purchases in same invoice. The smaller amount of invoices and that all of them have the identifying markings makes easier to check them and saves time and effort as said on chapter 3.4.

In one occasion at a large installation site a lot of small purchases were made in a local hardware store. At one point there were some changes in the personnel, and the store's new accountant started to send invoice of every pick-up from store, instead of agreed collected invoice every month. Had this been accepted, the invoice fee of 7 € would have been charged every time, even if the purchase had been 0,5 €. The total invoice costs would have been over 630 € instead of 7 €, not to mention all the time to check the invoices.

5.4 Personnel's professionalism

The work of the site personnel is essential to the success of the project. Having a professional team can decrease the negative effects that happen on other sectors. Then again, even though the project would work as well oiled machine but the site team would not be up to the task, the collisions can easily sink a project. For management, the most important task is to give enough empowerment to the site personnel and try to keep them as motivated as possible. When talking about independent, responsible, professional and committed personnel, the motivation is the difference maker.

It is difficult to find good site personnel. First of all, not even all can adjust to the site works; long days, several things to do at the same time, lot of responsibilities, sometimes difficult conditions and often being away from home for longer periods. The people that can work at the site are not all perfect. A good site supervisor or manager should be good with people, multitasked, understand both the technical details and contract issues and be able to handle large entities. When a suitable person is found, it would be good that an older and more experienced site manager would mentor the younger professional.

In larger projects, there should be a possibility to have a project engineer at the site to make sure that not all of site manager's time goes on paperwork. Besides empowerment, the site personnel should be involved to project preparations at the soonest possible moment.

5.5 Time & scheduling

Most of the time and schedule changes can be taken care of by handling supply chain and making sure the deliveries are made as planned. The development methods can be checked in chapters 5.2 and 5.3. The key to the previously mentioned solutions is constant vigilance, constantly checking and updating the plans and schedules.

However, a good site personnel prepares options in case of schedule changes. The better the options are prepared the less the changes can affect. The options must be prepared because not only human errors cause delays; weather does it even more easily.

One important factor on managing schedules is to see when it is necessary to start working overtime even if it costs more. If the delay fines come in hand it is not only the money but also about the reputation of the company. It can not be absolutely said when the time comes, but it must be calculated each time.

5.6 Environment, Health, Safety and Quality issues

As for the site personnel's opinion, EHSQ is the mandatory evil that takes a lot of time, but it is impossible to say what is useless. It is partly understandable because achievement-oriented people easily tend to see (too many) meetings and paper filling as badly used time. As in fact EHSQ is present in every operation within the project. Because meetings and paper filling is important both to the project and to EHSQ, the use of them should be as efficient as possible.

All the documentation should be

- Informative
- Clear
- Easy to use

- Include all the necessary and likely to be needed information but nothing overwhelming.

As a matter of fact, EHSQ is already present and will be even more present in every step of project. In the modern world one can not afford to have bad quality or bad reputation, and these two are linked. Actually good quality and good health and safety measures are tie breaker to win projects. Sometimes, when EHS has large role, it limits the competition a lot.

The key to EHSQ is total commitment. There are no half-ways. If a good level of EHSQ is wanted, all the personnel must commit to it at every level. An easy way to make sure that the right quality and EHS is reached is to use check lists. Check lists are a handy tool for every state of the project and make sure nothing is forgotten. This also means that both check lists and all the documentation is easy to use. If it is easy and fast, people will use it.

6 CONCLUSIONS AND RESULTS

In this chapter some case-examples give perspective to how much help the solution statements made in chapter 5 gave. The examples are grouped because most improvements were involved in to at least two of the subchapters. In any case, most of the “resources saved” are estimations due to the fact that no projects were exactly the same. However, again the evaluations are done by seasoned professionals and should be held rather accurate.

6.1 Case 1: Construction project

The case is about large, over 20 M € construction project covering several industrial facilities frames, roofs and other steel structures including beds for machinery. The project grew almost 50 % by additional, small, orders.

At the beginning the site was organized to two shifts each to have one site manager, three supervisors and a number of fitters in both shifts working for 14 days period at the time. Due to some larger scale organizational changes, one new site manager was nominated to the site to be responsible for both shifts instead of both shifts to have their own site manager. He was present during weeks and accessible via telephone and e-mail during weekends.

After a period of orientation, by using check-lists and systematic approach the time related to deliveries was decreased from 20 hours / week to 10 hours / week. After organizing more and additionally advancing planning for installations and deliveries, a half of supervisor resources could be nominated to another project. This brought remarkable savings. At the latest part of the project the site manager was essential both to the contractor and to the customer because he was the only one having full scale knowledge of how the project had advanced and how everything was linked.

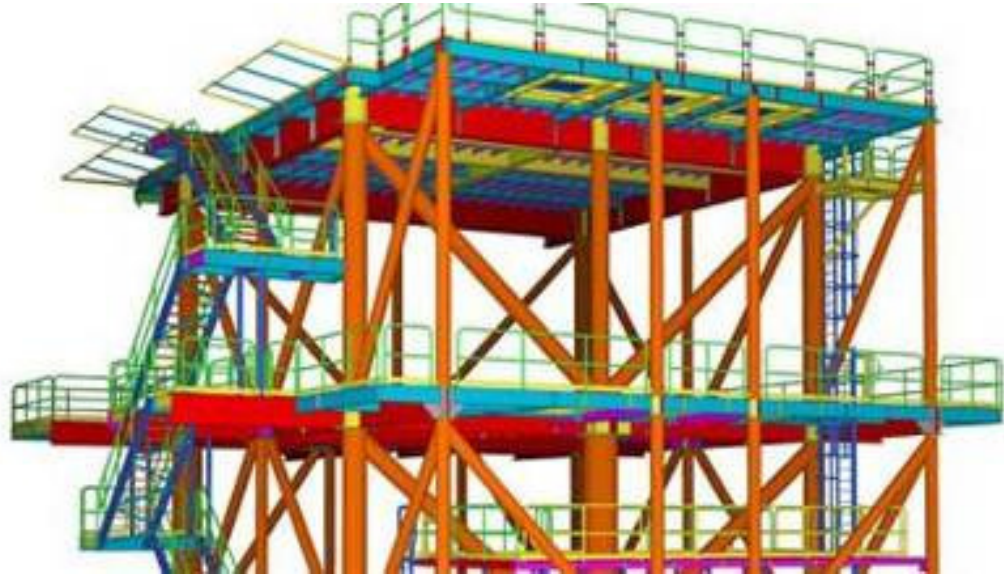


FIGURE 11. Tekla software can be used to mark advancing of installations with different colors. (© Tekla)

6.2 Case 2: Turbine overhaul

A certain turbine team has systemized their actions and preparations. All the tools and all the consumables are listed and have a certain place at tool container that is delivered to site. Everything that has a small chance to be needed on the project is on the list and in the container. Every time between the projects, the container is filled and the tools are checked and maintained. For each and every phase in the project, or to say, part to a steam turbine system, there is a check-list to mark when it is disassembled, cleaned, checked and reassembled.

The practice has been in use for a long time so it is difficult to estimate exact savings. Site managers state that it saves at least five to ten hours each week not to go and purchase something small but necessary from a local hardware store. However, as speaking of steam turbine systems that cost tens of thousands of euros every hour while in unplanned standstill, the checklists make it easier and more certain to know that everything is done correctly and make it possible to give guarantee to work.

6.3 Case 3: Wind turbine erection & installation

The case is about erection, installation and commissioning phase of eight 3 MW wind turbine units in Europe. This case is a good example because of good calculation of resources.

The first phase of the project was erecting, installing and commissioning 4 first turbines. During the planned break between the two phases, the author made a list and a plan for how much more installations could be done at the factory assembly and about the items that could be prefabricated further for faster site installations. This 72-paged list reduced the installation time with 720 hours per each of the following four units and raised factory hours by 43 hours per unit. The erection of wind turbine takes usually one day for preparation, one day for tower and nacelle and one day for blades. The after erection installations period was cut from three weeks to one week.

6.4 Case 4: EHSQ at Alstom Finland

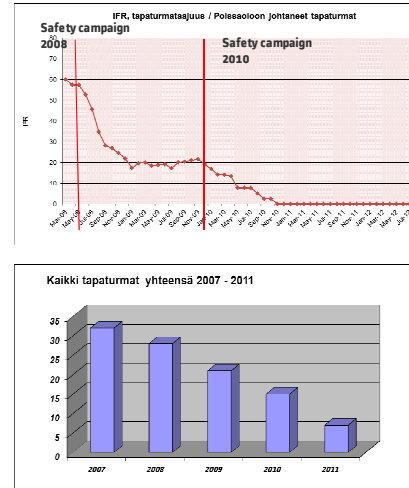
Alstom Finland has turned EHSQ to its most valuable selling argument after the technical competence. The project started with a safety campaign in 2008, a new safety campaign was launched in 2010, and by 23.8.2012 a 1 000 days without accidents that cause absence from work was reached. Few days after this 1 000 000 working hours were reached.

Alstom Power, Thermal Services Finland

23.8.2012
1000 days
without accidents
that cause absence

How did we get there?

- **Setting clear goals and commitment to them**
- **Clear communication about responsibilities**
- **ERP, rules and regulations**
- **Organization training**
- **Safety campaigns, e.g. in June 2012 launched "Alstom Zero Deviation Plan" that emphasizes on high risk works**



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ALSTOM

FIGURE 12. Result of commitment.

Alstom has reached the goal by setting the safe working environment standards as ultimatum; the work will not be continued before the working environment is safe. The focus is set on nine of the most dangerous phases at the work site and safety is ensured by check-lists. These lists are small notebooks, easy to keep in a pocket and fast to fill in when needed. The results are obvious.

Alstom Safety Directives and Alstom Life-Saving Rules



Life-Saving Rule no.1 **Risk Management**

ASSESS AND CONTROL RISK BEFORE STARTING WORK



Life-Saving Rule no.2 **Control of Contractors**

CONTRACTORS SHALL APPLY ALSTOM SAFETY RULES



Life-Saving Rule no.3 **Lockout Tagout**

ONE PERSON, ONE LOCK, ONE KEY



Life-Saving Rule no.4 **Electrical Safety**

CHECK ABSENCE OF VOLTAGE BEFORE WORKING ON ELECTRICAL PARTS



Life-Saving Rule no.5 **Machine Safety**

PREVENT ACCESS TO DANGEROUS PARTS



Life-Saving Rule no.6 **Work at Height**

HOOK ON WHEN THERE IS A RISK OF FALLING



Life-Saving Rule no.7 **Excavation Works**

PROTECT ANY EXCAVATIONS OR FLOOR OPENINGS



Life-Saving Rule no.8 **Lifting Operations**

MAINTAIN A SAFE DISTANCE FROM SUSPENDED LOADS



Life-Saving Rule no.9 **Vehicle Movement**

MAINTAIN A SAFE DISTANCE FROM OPERATING VEHICLES



Life-Saving Rule no.10 **Confined Spaces**

ENTER ONLY WITH PERMIT TO WORK

FIGURE 13. Alstoms 9 life saving rules in EHS

The situation in the industrial sector has taken into concentration to EHS issues to a rise. Especially large companies appreciate safety, especially to avoid negative publicity. This has made it easier for companies to purchase Alstom's services and for Alstom, this advantage is well used because it has been rewarded for being the safest supplier by e.g. Rautaruukki and Metsä Group.

Korkean riskin työ: Nostotyöt	Kyllä	Ei	Ei koske
1. Tiedätkö käytettävien laitteiden ja kiinnitysvälineiden suurimman sallitun kuormituksen, myös eri nostokulmilta?			
2. Onko kuorman paino ja painopiste määritetty ennen nostamista?			
3. Onko nostoalueen turvallisuus varmistettu?			
4. Onko kaikki nostovälineet ja -apuvälineet tarkistettu ennen nostoa silmämääräisesti?			
5. Onko käytettävän nostoapuvälineen tarkastusmerkintä voimassa, tarkastusväli 6 kk?			
6. Säilytetäänkö nostolaitteita kuivassa paikassa, etäällä kemikaaleista ja tulitoiden suorittamisesta?			
7. Onko työnjohtaja laatinut ja esitellyt nostosuunnitelman nostotyöhön osallistuville?			
Korjaavat toimenpiteet:			
Korkean riskin työ: Työskentely korkealla	Kyllä	Ei	Ei koske
1. Onko työ tai osa mahdollista suorittaa maantasolla esim. esivalmisteleamalla osat maassa?			
2. Arvioi, onko työvälineet turvaliset (potkulistat, kiinteät kaitteet)?			
3. Onko käytössä olevissa turvavaljaisissa voimassooleva tarkastusmerkintä? Valjaiden tarkastusväli on 6 kk.			
4. Onko turvavaljaat tarkastettu silmämääräisesti ennen käyttöä?			
5. Onko käytössä olevissa telineissä telinekortti ja merkintä säännöllisestä viikkotaisesta tarkastuksesta?			
6. Mikäli työmaalla työskennellään henkilönostimesta tai nostokorista käsin, onhan mahdollista käyttää turvavaljaita? (nostimessa tai korissa tulee käyttää turvavaljaita)			
7. Onko työmaalla olevat nostoaukot peitetty ja reunustettu kaitteilla ja potkulistoilta?			
Korjaavat toimenpiteet:			

Työkohtainen riskinarviointi
(TRa)

FIGURE 14. Alstom's check-list booklet

7 DISCUSSION

It took a much longer than planned to complete this study, but this was rather a good for the project. This way it gave time to gather more experience-based knowledge, to see various practices in various projects and most of all, gave time to try out the small improvements that make the difference.

Both the literature, AKA earlier studies and the experience-based knowledge support each other. However, it is good to remember that no earlier study was exactly or even close to the subject of this study. The gathered material was collected alongside the experience-based knowledge.

Since Taylorism, followed by Deming and Juran with Japanese manufacturers, the quality control has concentrated on measuring single products quality. Even though TQM (total quality management) claims to include “quality thinking” to the whole process including management and strategic decision-making and development, after making this study it seems rather clear that implementing TQM to companies business is nothing more than a wind whispering to actual quality work. The quality in the delivery project is made at the site and only by commitment.

The success factors for project, as defined by Salminen in his study, can be fully agreed on. They are as follows:

- A realistic and accurate plan is created and all are committed to it.
- Primary target for site management is to stay on schedule.
- All the plans and drawings are checked immediately when they arrive. All the plans are demanded to be delivered well on time. All changes are requested immediately.
- Costs are calculated and all forecasts are updated constantly
- The quality plan is made challenging but achievable. All timetables are based to this.
- The plans are gone through with personnel at start-up meeting.
- The activities are recorded weekly

- Site management is involved in start phases of project
- Rules for the whole “site community” are created and agreed on.
- Site management learns to know all the personnel and supports them on their tasks.

(Salminen, J. 2000. p. 26)

A list of best of the good practices includes

- Site personnel should have all the necessary tools including ITC (information technology and communications, in this meaning both hardware and software). They should be given training to get the best use of the programs.
- The project organization should be kept as similar as possible in different projects to assure good co-operation.
- Communication should be encouraged.
- All communication should be made also in written (by e-mail) with addressees as everyone who might need the information at some point.
- Key personnel should be involved in the project at the soonest possible moment.
- Systematical working and routines should be encouraged.
- Routines and standard practices with suppliers should be formed.
- Site personnel and project manager should have as much as possible empowerment and motivation.
- Site personnel should have time to react immediately when needed and delivery checks, claims etc should be made immediately.
- All paperwork should be in clear, easy-to-fill form.
- Quality control should be maintained by self in any case by auditing and supervising all suppliers at their factories.
- Preparations and plan-B:s should be made always, at least at level of thoughts.
- Key to everything is commitment and systematic work practices.

It is actually rather remarkable how small changes can make significant savings to a project, ease up stress from site management and most of all, affect to

achieve good quality and safe working environment. In several different kinds of delivery projects the problems and solutions are the same. Also, it is interesting that these problems usually are not one-of-a-kind and good practices are at least known, but still unused. As mentioned in chapter 4.1 about YIT's project, even 2 % savings are a success because it would increase the profit by 21 % (Tuisku, T. 2005. p. 18). Even the most modest evaluations that were given about implementing (most of) this study's notifications stated the savings to be at least 5 %, therefore this study can be considered as a success.

The main objectives for the study were

- Reach competitive advantages to help win projects
- Take off pressure from site- and project personnel to ease up stress and to make them better able to perform.
- Reach savings
- Deliver the project faster and on more accurate level to reach customer satisfaction.

These objectives were achieved.

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