Standard Operating Procedures at Skanska

Standardization and continuous improvement in the construction industry

KATARINA BERGEROVA

Master of Science Thesis
Stockholm, Sweden 2010
Dedicated to my mother.
Standard Operating Procedures at Skanska

Standardization and continuous improvement in the construction industry

Author: Katarina Bergerova
Commissioner: Skanska SXCR
Time frame: May ´09-January ´10
Supervisor at KTH: Anders Hansson
Supervisor at Skanska: Anton Leigard
Abstract

The construction industry has faced severe criticism against its inefficiency, high costs and insufficient quality. Besides, the building branch is one of the most dangerous occupations.

Skanska Sverige AB runs an international project focused mainly on improving safety, increasing overall process efficiency and providing customers higher value. A part of this project are Standard operating procedures. These are supposed to be the best practices known at the company and should be used on sites as stepwise work instructions.

The purpose of this study was to study the creation of Standard operating procedures and to propose a model for continuous improvement of the Standard operating procedures.

A theoretical review concerning standards, standardization and continuous improvement is presented.

Four case studies were conducted in the thesis in order to clarify what and how to improve. The case studies show that inspiration can be taken from organizations within or outside the building trade. An important new element in Standard operating procedures would be a risk analysis. The risk evaluation corresponds with Skanska’s safety strives. In order to guarantee that a Standard operating procedure really contains the best practice, the process of continuous improvement has to be well managed. The process can be stimulated by the implementation and improvement management at “Väg och anläggning” Skanska.

Based on the empirical study and the theoretical framework, a model illustrating continuous improvement is proposed. The never ending life spiral of a Standard operating procedure involves all the organizational levels. The model demonstrates that small stepwise improvements are more cost efficient than large radical changes.

Advantages and risks connected to the continuous improvement are described. The benefits would be both monetary and non-monetary. The key success factor of continuous improvement is the proper implementation of Standard operating procedures since it is up to individuals to keep continuous improvement alive. Both the managers on different levels and workmen must be trained and their importance in continuous improvement process must be deep rooted in their thinking. Proper training and excellent leadership would diminish worker´s resistance and prevent an unwanted phase-out.

Finally, Skanska is encouraged to trust its own research. The formal content of Standard operating procedures is good enough for launching.

Key words: Standard operating procedures, standardization, continuous improvement, construction industry, Skanska
Acknowledgements

This thesis was made in cooperation between Skanska Xchange Center Residential and The school of Industrial Engineering and Management at The Royal Institute of Technology in Stockholm. Writing a thesis is the final step in completion of a Master’s programme studies and therefore it plays a very important role in a student’s life. Since this paper is based on interviews and participating observations, there are many people who in one way or another contributed to the formation of the thesis.

My special gratitude is expressed to Anton Leigard, the supervisor at Skanska Xchange Center Residential. Anton Leigard helped me to create a network at Skanska; he introduced me to the world of Xchange and the construction industry. During our dynamic discussions he pointed out new dimensions of the topic and specified my concept with contributory ideas. It would have been very difficult to complete this thesis without his trust in me, his encouragement and his patience.

Appreciation belongs to all the colleagues from Skanska Xchange for their time and sharing their experiences during the interviews. Thanks to those people, it was possible to gather information about the current work with the Standard Operating Procedures. I never expected such a warm welcome at the office; I felt as a member of the team from the very beginning.

I would like to thank Anders Hansson, the supervisor at The Royal Institute of Technology, for his support, his friendly attitude and for both professional and private advice.

Tero Stjernstoft and Jens von Axelson deserve thanks for making my knowledge about continuous improvement and its meaning deeper.

Last but not least, I thank Christian Müllern for his help with the graphics.

Stockholm, January 2010

Katarina Bergerova
Table of contents

1 INTRODUCTION .................................................................................................................. 8
  1.1 BACKGROUND.................................................................................................................. 8
  1.2 PROBLEM STATEMENT AND RESEARCH QUESTIONS .................................................. 8
  1.3 PURPOSE AND OBJECTIVE ............................................................................................. 9
  1.4 DELIMITATIONS ............................................................................................................... 9
  1.5 METHODS ....................................................................................................................... 9
  1.6 STRUCTURE OF THIS REPORT ....................................................................................... 11

2 THEORY ................................................................................................................................ 12
  2.1 INTRODUCTION TO STANDARDS .................................................................................. 12
     2.1.1 Example of standards .................................................................................................. 12
     2.1.2 What are standards? .................................................................................................. 13
     2.1.3 What are advantages and disadvantages? .................................................................. 14
  2.2 STANDARDIZING .............................................................................................................. 16
     2.2.1 What prerequisites facilitate utilization of standards? .................................................. 17
     2.2.2 Process thinking ......................................................................................................... 17
     2.2.3 Management involvement ......................................................................................... 17
     2.2.4 Measurement ............................................................................................................ 18
  2.3 CONTINUOUS IMPROVEMENT ...................................................................................... 19
     2.3.1 Illustration of continuous improvement ...................................................................... 19
     2.3.2 Improvement concept ................................................................................................ 20
  2.4 IMPORTANCE OF LEARNING ......................................................................................... 21
  2.5 PRODUCTION PILOT MODEL ........................................................................................... 22
     2.5.1 Background to the project ......................................................................................... 22
     2.5.2 Principles ................................................................................................................... 22
  2.6 PRODUCT LIFE CYCLE ..................................................................................................... 24

3 STANDARD OPERATING PROCEDURES AT SKANSA ....................................................... 25
  3.1 SKANSA ........................................................................................................................... 25
     3.1.1 Company description .................................................................................................. 25
     3.1.2 Skanska Xchange Center Residential ....................................................................... 27
  3.2 ORGANIZATION AT SKANSA ......................................................................................... 27
     3.2.1 Central organization ................................................................................................... 28
     3.2.2 Site manager .............................................................................................................. 28
     3.2.3 Superintendent .......................................................................................................... 28
     3.2.4 Workmen .................................................................................................................. 28
     3.2.5 Information exchange ............................................................................................... 29
  3.3 ATTITUDE TO STANDARDIZATION AND CONTINUOUS IMPROVEMENT ..................... 29
  3.4 STANDARD OPERATING PROCEDURES ......................................................................... 30
  3.5 HOW ARE STANDARDS MADE? ..................................................................................... 31
     3.5.1 Order party ................................................................................................................ 31
     3.5.2 Customer focus ......................................................................................................... 31
     3.5.3 Component analysis .................................................................................................. 31
     3.5.4 Industrialized processes ............................................................................................ 31
     3.5.5 Beta projects ............................................................................................................. 31
     3.5.6 SOPs’ content ............................................................................................................ 31
     3.5.7 How SOPs are used ................................................................................................... 32
  3.6 OBSERVATIONS FROM THE XCHANGE DEPARTMENT .................................................. 34
  3.7 PRODUCTION VS. CONSTRUCTION ................................................................................. 35

4 CASE STUDY: STANDARDS IN OTHER BRANCHES ............................................................. 36
  4.1 “VÅG OCH ANLÄGGNING SKANSA” .................................................................................. 36
     4.1.1 Creation and implementation ...................................................................................... 36
     4.1.2 Content ...................................................................................................................... 37
     4.1.3 Continuous improvement ........................................................................................... 38
Appendix 1 Web Based Manual “BYGGAI”
1 Introduction

1.1 Background

Competition among companies becomes tougher and tougher in every branch, including the building industry. The current financial crisis stresses importance of every strategic detail that helps companies to do well on the market. It is natural that customers are forced to make a more rational choice in buying during a financial crisis due to limited resources. Clients put high pressure on the quality of products, on time delivery and low costs. The question is how construction companies will deal with the high demands on one side and the competition on the other.

The financial crisis can be seen as an advantage from another point of view. During last years, there has been no time for improving the current way of building due to the rapidly growing demand. It is statistically proved that construction trade has experienced a peak in demand. (Gerth, 2008) Now, when building tempo is slowing down, there is time for reconsidering old methods and trying new ways, a new strategy. Companies prepare for the next wave of growing demand by removing causes for present problems.

Problems governing in the building trade are common for all the big actors within it. Koskela (1992) summarizes that construction lags behind other industries in productivity, occupational safety and quality. The building industry has realized that the next station for successful future companies is named: ‘efficiency’.

The starting point of the new track, that Skansa wants to continue on, is Skansa Xchange. The Xchange project strives to secure safety at work, guarantee a high quality of building, take the environment into consideration and cut down costs. These goals should be achieved thanks to united platforms for design, integrated ways for procurement and planned processes. Standard Operating Procedures (SOP) give new opportunities for training and improving the best practice present at Skansa.

1.2 Problem statement and research questions

Workers involved in the building industry are usually competent and proud of their own skills. There is a problem to collect, keep and spread their knowledge within the company due to lack of documentation. Usually, the site manager documents work preparations but those differ from site to site. There is no connection among sites and it becomes difficult (if not impossible) to learn the best practice from others. It is the system that fails, not people.

Creating SOPs can settle the best practice and spread it through the company. The successful implementation of SOPs requires however, a united view on SOPs definition and its improvement in the long run.

To clarify the problem, following questions have to be answered:

- What is a standard and what are prerequisites of it?
- What is a SOP? What information does it contain? How and by whom is it used?
1.3 Purpose and objective
The purpose of this thesis is to express and describe a life cycle of a SOP. That includes their creation, deployment and continuous improvement. The main focus of this paper rests on the latter.

The objective of this thesis is to:
- Specify SOP and its contents
- Analyze and describe a lifecycle of SOPs at Skanska
- Compare Skanska’s approach to other companies, industries and methods
- Suggest a suitable model for continuous improvement of SOPs regarding the lean thinking principles

1.4 Delimitations
- The thesis stretches over 20 weeks fulltime work
- The Xchange project is based on the lean philosophy. However, detailed explanation of the lean philosophy is excluded from this paper. The title of this paper indicates that a specific part of the lean philosophy is going to be described. Repeating basic principles would take space that can be dedicated to enlarging knowledge about other aspects influencing use of standards at Skanska. Readers seeking deeper understanding of the lean philosophy are referred to papers that have been written on this topic.
- Although Xchange unites the Nordic countries, this study is limited to production in Sweden and can later be implemented on other Nordic countries regarding their specific features.
- The goal of this thesis is not to question the need for standards.
- When benchmarking, the company Scania is avoided. Scania has undoubtedly made a large step towards lean production but has already been described in many papers. Information about progress in other companies is of a higher interest.

1.5 Methods
The goal and the purpose of this thesis were not clear from the beginning. Interviews and participative observations during author’s presence at Skanska’s office in Stockholm led to formulation of the goals and the purpose. Figure 1-1 displays workflow of the thesis execution.
The choice of a method

The choice between the qualitative or the quantitative method has to be based on the purpose of the study. The quantitative method rests on formalized analysis, testing of results and often uses statistical methods (Holme & Solvang, 1996). Concerning the purpose of this paper, the qualitative method was chosen. Since the purpose was to gather knowledge about the SOP, its creation and deployment, the qualitative method raises the chance to cover the field and gain a deep understanding for the topic. As Holme & Solvang (1996) state, the qualitative method helps to investigate and explain the studied field thanks to gathering information. The typical feature for the qualitative method is a holistic view on the subject which was desirable in this thesis. It was required to see SOPs as a whole in context with its field of use. When benchmarking, it is more important to figure out what would enrich SOPs. The statistical data achieved by the quantitative method might be interesting in another kind of research.

Collection of data

One of the main data source was the theoretical framework. The main resources were recommended articles, books and lectures given at The Royal Institute of Technology. The final theoretical frame was shaped depending on the relevance grade.

The empirical study was formed via participating observations and case studies. Participating observations are a direct source of information because the researcher gains facts personally when participating in the studied events (Yin, 2003). Frequent presence at the Xchange office and a site visit were great resources of relevant information. In order to get a wide perspective on topic, people from different levels in organization were interviewed

- Managers
- Project leaders
- Workmen
- Scientists within the field of work preparations
In order to collect enriching info about possible improvements, case studies were carried out. Case study is used in order to understand the problems in a real-life context. Evaluative case study was suitable for the thesis since it forms evaluations and judgments about the studied area (Yin, 2003). Finally, analyzes of similarities and differences among the studied company and case studies was made.

**Validity and reliability**

According to Holme & Solvang (1996), the purpose of a qualitative research is to provide a better understanding for the topic. Hence it is easier to get valid information in a qualitative research. The thesis’s validity is high since both the author and interviewed people are familiar with the topic. The chosen reference specialists have years of experience within the studied field.

It can be difficult to measure reliability in a qualitative study since it aims on problem’s explanation. Due to that, it is difficult to get the same result after repeating the research. (Merriam, 1998) If someone else would perform the same research, different results would have been given. Reliability of this thesis is debatable since the thesis is based on participating observations, interviews and author’s perceptions. Both, observations and perceptions are always marked by the author’s interpretations. On the other hand, the study is based on reliable theoretical resources which raise the reliability. Besides that, interviews are documented and can therefore be checked in case it is necessary.

**1.6 Structure of this report**

*The first chapter* introduces the goal, the purpose and the delimitations of this thesis. The method is described.

*The second chapter* clarifies theory about standards, continuous improvement and learning.

*The third chapter* describes Skanska as a company. Readers will learn about the department Skanska Xchange where the thesis was written. Standard Operating Procedures; its purpose and creation are explained.

*The fourth chapter* provides case studies where standards from other branches are described.

*The fifth chapter* is an analysis of empirical study and case studies regarding theoretical background.

In *the sixth chapter* conclusions are listed.

*The seventh, final, chapter* discusses possible further research and criticizes work on this thesis.
2 Theory

“There can be no improvement where there are no standards”

(Imai, 1986)

In this section, theory about standards and standardization is explained. Connections between standards and continuous improvement are clarified. Later, knowledge about a suitable way for illustrating SOPs is given.

2.1 Introduction to standards

“Standard work is not a piece of paper;
It is the way to meet business needs by engaging the people that do the work.”

(www.trainingwithinindustry.net)

In this chapter we will show that standards are an inseparable part of our lives in various fields. An example will be given and theory of standards will be described. Positives and negatives connected with standards are explained.

2.1.1 Example of standards

This paper is focused on the SOPs therefore the examples were chosen as a relevant case to standard work instructions. In each of the examples, there is something inspiring. The main point is to indicate variety both in standards and in their look. In the theory section, only one example is given. Readers are referred to chapter Case study for deeper acquaintance.

ISO standards

One of the best known international standards are ISO standards. According to the website International Standard Organization (ISO) creates ISO standards in order to ensure that ”...materials, products, processes and services are fit for their purpose.” In this way, ISO certificated products are produced safely, efficiently and have high quality. ISO standards are updated at least every fifth year. (www.iso.org)

An example of standards used in the construction trade can be ISO 9001, which defines processes. Construction companies (among others Skanska) base their processes on this standard.
2.1.2 What are standards?
The Swedish national encyclopedia defines standard as an established norm; in the
technical context partly a result of standardizing in form of descriptions, rules and
recommendations for universal and repeated usage and partly a document which
contains this information. (translated from www.ne.se)

Brunsson & Johansson (1992) distinguish among three kinds of standards; namely
directive, norm and standard.

⇒ **Directives** are imperative rules, usually in a written form. Contravention against
them is connected to penalties. Due to the force applied, the creator of directives
must possess authority or formal power to execute penalty for violation against
it. An example of a directive is decisions made by the executives.

⇒ **Norms** are rules that have become such an obvious part of our lives that we do
not have to reflect about them anymore. E.g. cultural specific features and
habits, both national and connected to the working place. They are often
implicit. On one hand, they are not enforced, because there is no one who
officially wrote them down. On the other hand, person in question cannot choose
whether to use them or not.

⇒ **Standards** have an evident owner. Force is not applied when using standards
because they are of advisory character. The receiver is motivated to use them by
showing that it is in his/hers own interest. This being so, violating standards
brings no penalties. One example is the standards in health described later on.
No one must use them but the handbook is available when an instruction is
needed. If a doctor chooses to treat a patient in a different way, no punishment
follows.

Characteristic features of mentioned standards are summarized in Table 2-1. As it
appears standards are close to both directives and norms. It can be difficult to
distinguish between these. Directives might become so apparent that they are accepted
as norms. E.g. using of safety seat belts is a directive. Originally, financial fines
motivated drivers to use belts. Nowadays, most people take fastening seat belts for
granted. It has become an obvious part of driving. In other words, it has become a norm
to use seat belts. The only difference between the directive and the norm character in
this case is that the government is still an official owner of the law saying that seat belts
are obligatory. According to Brunsson & Jakobsson (1992) standards can shift into a
directive or a norm.

<table>
<thead>
<tr>
<th>Rules</th>
<th>Owner</th>
<th>Character</th>
<th>Penalties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Official</td>
<td>Imperative</td>
<td>Yes</td>
</tr>
<tr>
<td>Directive</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Norm</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Standard</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Table 2-1 Summary of typical features of the three kinds of standards. Standards differ due to their
owner, followers right of choice and penalties connected to violation.
The term “standard” is closely specified by Anders Kinnander from The Chalmers University of Technology. He extends it and adds the following points to define standardized work:

- There is a clear definition of a standardized work
- Each work moment is specified
- Work moments follow in a clear sequence
- The time for each moment is determined precisely
- Pace is settled
- The total result of work is defined (www.imit.se)

### 2.1.3 What are advantages and disadvantages?

Brunsson & Jacobson (1998) discuss both advantages and disadvantages connected to standards.

#### Arguments for standardizing

1. **Effective instrument for information transfer**

   Standards provide unspoken information about a product or a service. Reliability, environmental friendliness, quality, compatibility, preparation of a product etc. are guaranteed by a standard. A user does not need to have detailed information about the standard itself. The fact that a product or service meets standards raises its reliability.

2. **The method for coordination**

   As a certified producer, it is easier to settle contracts both with suppliers and retailers because standards help to avoid misunderstandings. There is a smaller chance to be misinterpreted or to misapprehend when there are clear rules. Since standards guarantee certain features, contractors can take these for granted, such as compatibility of two products like a plug-and-socket connection. In this way, standards lower the number of defects too. E.g. before manufacturing, one can be sure that the product meets customer’s expectations. Consequently, this leads to the lowering of costs. (www.iso.org) Besides that, standards are useful in organizations since they define roles and duties. An organization’s structure appears clearer and it becomes easier to communicate.

3. **Simplification**

   The number of possible choices diminishes. Both, the information transfer and the coordination will become more straightforward. Slack et al. (2004) confirm the same opinion. According to them, standardization reduces design complexity. They stress that there should be balance between offered variety and its impact on costs. This balance can be reached thanks to standardization.

4. **Best practice**

   It takes a lot of effort, time and money to create a reliable standard. The best practice is chosen carefully and conscientiously. Despite some less fitting standards, the goal is always to choose the top available practice. Spreading the best practice favors new actors on the market who avoid reinventing the wheel.
5. **Advantage of large scale**

Decreasing the number of solutions creates space for improving those existing ones. The standardized processes, methods, products etc then have the potential to produce more, better and with the same effort.

Training within industry ([www.trainingwithinindustry.net](http://www.trainingwithinindustry.net)) estimates that appropriately implemented Job Instructions can bring

- Reduction in defects of over 70%
- Reduction of costs exceeding 30%
- Increased productivity exceeding 50%
- Improved employee retention
- Improved safety

**Arguments against standardizing**

1. **Resemblance**

For different reasons, people tend to seek differentiation. They tend to be unique regardless the sphere of acting- in privacy or at work. Companies long for unique strategies and solutions that would guarantee them an irreplaceable position on the market. Individuals want to express themselves. Standardization prevents them from doing this.

2. **Stabilize the world too much**

Opponents to standardization claim that if everything is standardized there will not be any space left for innovation and creativity.

3. **Are standards really the best practice?**

This question appears naturally. There can always be doubts about people’s motivation to make a decision. Is it really the best choice for all parties involved? Or is it only for the company’s profit?

4. **Let the market decide!**

The market can determine whether the product is the best practice or not. Especially lean philosophy emphasizes the customer’s role in a production chain. Customer satisfaction should therefore be the most influencing factor.

5. **Does standardization mean innovation or codified established practice?**

Standards rarely conflict with casual solutions. Standards might contain some innovative variations of the established practice. However, it is less probable to establish an innovative standard.

Brunsson & Jacobsson (1998) warn about risks in the implementation of standards. There are some problems connected with convincing users to utilize standards. First of all standards are voluntary. As a consequence, the creator must indicate well-founded reasons for putting them into practice. Then, enthusiasm to use standards decreases because users are usually not a part of the standard’s creation. Last but not least, standards bring a lot of changes into the casual work day. The resistance to standards is therefore natural.
2.2 Standardizing

Since continuous improvement originates in the lean philosophy, it is natural to explain how standards and the lean philosophy are related. Fundamentals that make the process of standardization easier will be illustrated. Making basic terms clear should help to clarify several uncertainties about SOPs later on.

Reading about standardization and change management whilst having a deep rooted consciousness about the lean philosophy, it appears that the implementation of standards goes hand in hand with employment of the lean philosophy, especially when it comes to measurement, management involvement and leadership.

Connection between one of the lean methods and standardizing is displayed in Figure 2-1. The picture shows how standardization depends on challenge, measuring deviations and continuous improvement.

Figure 2-1 Standardizing starts moving when the two gearwheels spin. A well organized workshop is the ground of standardizing. Standardizing is achieved by continuous improvement. In this way standardizing can proceed and waste can be eliminated. (Petersson et al. 2008, translated and adjusted)

Standardizing starts to advance when the gearwheels rotate. The steady foundation of standardization is a well managed workshop. First after arranging organization into a system it is possible to implement standards and eliminate waste in processes. The upper wheel in the picture corresponds to Deming’s Plan-Do-Check-Act diagram as a tool for continuous improvement. Planning starts with analysis, goes over to doing. After an activity is performed, it can be improved. When the improvement is checked, it can be put into practice and becomes a new standard. Waste is removed from processes during the cycle. The cycle is accompanied by setting up and meeting challenges; measuring deviations and continuous improvements.
2.2.1 What prerequisites facilitate utilization of standards?
Anders Kinnander (www.imit.se) puts a finger on obvious prerequisites of standardized work. In order to create good standards, the originator has to have deep knowledge about work measurement, ergonomics and the process itself. Kinnander refers to the standardized work at Toyota. According to that, standards should be elaborated

- with scientific methods
- on lowest possible organization level
- under superintendence of a teacher (meaning a specialist within the field)

Petersson et al. (2008) analyze factors increasing a product’s quality. One of their conclusions is that it must be easy to do work right. It is understood that everyone should do their best. But it is very important to get proper support from work instructions, planning etc. It is the same when it comes to standards. Complicated standards stimulate employees not to use them. The conclusion is that standards should be easy to follow.

2.2.2 Process thinking
Koskela (1992) analyzes conceptual basis of the lean production philosophy. First of all, it is important to see production as a process that consists of activities. He divides production activities into two kinds; value adding and non value adding. The latter should be eliminated whereas value adding activities should aim on increased efficiency. The value of a process always reflects in fulfillment of customers’ expectations.

Berger (1997) mentions process orientation as a first step towards improvement principles. Thinking in processes dependent on each other is the same message Tero Stjernstoft (2009) shows at a lecture at the Royal Institute of Technology in Stockholm.

![Figure 2-2](image)

**Figure 2-2** Change from hierarchy to process on each level. Thinking in processes has to engage everyone in the organization. (Stjernstoft, 2009)

2.2.3 Management involvement
Management involvement and suitable leadership are a must for standardizing. Bicheno (2006) specifies pitfalls at lean implementation. Lack of management involvement is attached to one of pitfalls. Koskela (1992) indicates management commitment as implementation factor number one. Petersson et al. (2008) analyze the role of the management team. It is obvious that leaders and management determine the success of the implementation. Communication between white and blue collars has to be open in
both ways. It is up to management team to convey to workers why a new work approach is important and how it is going to be done. Workers need to get feedback on their performance and they need to feel that their effort influences the final result of the company.

On the other hand, Bicheno (2006) warns management for the belief that it is they who are the driving force. The real driving force is “gemba”, the real place where activities are carried out. Slack et al. (2004) describes the four perspectives of operations strategy. One of them is the **bottom-up perspective** which has the closest connection to actual circumstances. “The bottom” includes day-to-day experience, capabilities and potential of production. It shapes an emergent strategy which means that strategy is created gradually relying on everyday experience rather than on theory.

### 2.2.4 Measurement

What is the point of any change if we do not know its results? Measurement becomes more and more important in organizations. It crosses the border for control and stretches towards continuous development and decision-making. (Sinclair and Zairi, 2000) Both Petersson et al. (2008) and Koskela (1992) see measurement as a positive effect on lean implementation. Results from improvement measurement can be used as a clear proof of standard’s meaning and motivate employees to go on with efforts related to continuous improvement.

Horner and Duff (2001) are even harder by claiming “*the only way we can be sure that performance is getting better is to measure the improvement. If performance isn’t measured, it can’t be improved.*” In most cases we do not know when a process performs the best or the worst and what the best and/or worst performance is. This is mainly because of complicated interactions between workstations. Defining performance measures makes it possible to understand a process both in parts and as a whole. (Hopp and Spearman, 2000)

According to Parker (2000), companies can use measurement to:

- Evaluate progress
- Identify if they meet customers’ needs
- Better understand own processes (aware/unaware competence)
- Identify problems
- Ensure that decisions are based on facts not presumptions
- Show if improvements have happened

Tangen (2004) points out that there are many measurement matrices. It is difficult to choose proper ones. The rule of thumb is: it should always originate from company’s strategy.
2.3 Continuous improvement

"The struggle itself...is enough to fill a man's heart. One must imagine Sisyphus happy."

(Albert Camus)

Sisyphus is a hero in ancient myths. He is a symbol of never ending suffering. Because he had trespassed against gods, he was condemned to an eternity at hard labor. His task was to roll a heavy stone uphill and before reaching the top, the stone rolled back down. (http://www.mythweb.com/) Camus turns this negative task into something that can be seen as positive. It depends on people’s attitude.

This is not the case when discussing continuous improvement. It is easier to change mind set and see continuous improvement (CI) as a challenge leading to prosperity instead of seeing it as a burden.

2.3.1 Illustration of continuous improvement

Continuous improvement is often demonstrated as in Figure 2-3. An uphill slope symbolizes difficulties that a company has to face in strive for efficiency and quality. The ball symbolizes changes. Improvement means rolling the ball up-hill towards the goal. Every movement is supported by a wedge that prevents gliding backwards. This wedge is standards. Standards must keep tempo with improvement, i.e. be adjusted to new conditions.

![Figure 2-3 Continuous improvement (Stjernstoft, 2009)](image)

Koskela (1992) mentions Imai’s (1986) opinion “a key idea is to maintain and improve the working standards through small, gradual improvements.” This meaning that continuous improvement is a long term process and its feasibility is indirectly proportional to the speed of implementation.
2.3.2 Improvement concept

Deming redefined his own famous Plan-Do-Check-Act diagram several times. He warns that this model is inaccurate since the English word “check” means “to hold back”. In 1993, the new diagram was created and renamed to Plan-Do-Study-Act (PDSA). It is a flow diagram for learning and improvement of a product or of a process. (Deming, 1993) See Figure 2-4 below.

![Figure 2-4 Plan-Do-Study-Act diagram (Deming, 1993)](image)

Langley et al. (2009) extended Deming’s PDSA with the following three questions:

1. What are we trying to accomplish?
2. How will we know that a change is an improvement?
3. What changes can we make that will result in improvement?

This way, they created a model for improvement, exhibited in Figure 2-5. This model can be used for “developing, testing, implementing, and spreading changes that result in improvement. The model can be applied to the improvement of processes, products, and services in any organization, as well as improving aspects of one’s personal endeavors.” (Langley et al., 2009)

Tasks that have to be carried out during phases in the circle diagram are apparent:

**Plan:**
- Objectives
- Questions and predictions
- Plan to carry out the cycle (who, how, when)

**Do:**
- Carry out the plan
- Document problems and unexpected observations
- Begin analysis of the data
Study:
- Complete the analysis of the data
- Compare data to predictions
- Summarize what was learned

Act:
- What changes are to be made?
- Next cycle?

A new task appears in this model and it is prediction. During the study phase, one earns knowledge. As knowledge is built, it must be possible to predict whether a change will result in improvement under the different conditions you will face in the future. By answering the three questions above, this prediction should be possible to evaluate.

2.4 Importance of learning

Norman (2007) mentions “silent knowledge” or knowledge “sitting in walls”. Every member in an organization knows what he/she is doing and how. How goals are achieved, how cooperation takes place. When it comes to exchanging this information, the situation becomes complicated. The reason is simple: there is no documentation on routines or gained experience. Norman (2007) suggests a method for catching up this knowledge. Through analyses of the current situation, it is possible to put know-how on paper and create a structure of current practice even in complex organizations. After implementing this method, the first reaction usually is: “We have already known this all the time!” (www.astrakan.se) This kind of reaction means the implementation was successful. As a result, the organization receives a clear picture of its own processes and connections among departments.

Koskela (1992) writes about learning as an important factor for successful implementation of a new philosophy. Sources of learning are other pilot projects, benchmarking and continuous improvement. Bicheno (2009) distinguishes four phases in learning (see Figure 2-6)

![Figure 2-6 Learning as an evolution from unaware incompetence to unaware competence (an interpretation of Bicheno’s theory, Bergerova)](figure_url)
1. **Unaware incompetence**  
   We do not know about what we do not, but should know. Since we do not know, it is not urgent.

2. **Aware incompetence**  
   We gain insight into lacking knowledge. This might be followed by frustration and will to give up.

3. **Aware competence**  
   Purposeful learning leads to competence. There is a risk for arrogance.

4. **Unaware competence**  
   Competence has become an obvious part of one’s routine. It is then easy to suppose that everyone shares the same experience. At the same time, people can start to underestimate difficulties connected to learning.

The most problematic part of this model is to distinguish between unaware incompetence and unaware competence. Since both of them are unaware, it is not easy to figure out whether we work right or wrong.

### 2.5 Production pilot model

The meaning of this section is to show the reader how standards can be shaped and communicated.

#### 2.5.1 Background to the project

Production Pilot is a result of a ModArt project (Model driven parts manufacturing) that is run in cooperation between manufacturing industry and The Royal Institute of Technology in Stockholm. The main goal of this project is to “define a work flow and methods for creating and utilizing knowledge and digital models in a manner that makes manufacturing more efficient and open to new innovations.” ([http://dmmns.iip.kth.se](http://dmmns.iip.kth.se)) Developers of this project found that use of digital modeling in manufacturing process lags the extensive use of it in e.g. design industry. They saw the great potential to lower costs, decrease lead times and secure quality in manufacturing just thanks to digital modeling. Taking advantage of digital modeling, a company’s efficiency and adaptability to changes is estimated to increase by 30% ([http://researchprojects.kth.se](http://researchprojects.kth.se))

#### 2.5.2 Principles

The resource for this chapter because is [www.produktionslotsen.se](http://www.produktionslotsen.se). Some of personnel at Skanska Xchange took part in Production pilot model training. Information from it is presented here.

Production pilot can be understood as a digital handbook “that carries out experiences, routines and information in relation to a plain work process.” These models should serve as a help during the whole process when designing and managing a plant. Production pilot is based on the process thinking with clear work flows. Dependences on processes become visible and in that connection they appear clearer. The premise of the utilization of Production pilot is a consequent application of standardized vocabulary and models. Production pilot must cooperate with one information system. This system makes information exchange between different departments easier, since all the data are registered in the same system and besides that, in a standardized way.
As shown in Figure 2-7, Production pilot breaks down a process into activities. By clicking on an activity, a new model describing the activity appears. Description of each process is completed by indicating

- preconditions (what has to be done before the process is taken into action)
- support (equipment, IT)
- experiences and requirements (both internal and external)
- the result

![Figure 2-7 Example of Production pilot (www.produktionslotsen.se)](image)

Production pilot is a guarantee that knowledge is kept and spread out through the company thanks to easy access to information.
2.6 Product life cycle

This chapter is added since the reader should refresh knowledge about the finite life cycle. Later on in this paper, it will be shown that this model is not applicable in continuous improvement at Skanska.

The product life cycle illustrates how sales vary depending on time. Sales are growing until market reaches maturity and start to descend until it reaches bottom. (See Figure 2-8)

![Figure 2-8 Product Life Cycle Curve and its phases (Olhager, 2000)](image)

The life cycle is divided into four phases:

**Introduction**
Sales are small, unstable and grow slowly. The number of customers is low. The product has to be adjusted several times in order to increase its competitiveness.

**Growth**
Customers start to recognize the product and spread information about it. Curve raises steeper.

**Maturity**
The product has reached the top of sales volume. Growth stabilizes gradually. Customers are already satisfied and therefore the needs diminish.

**Decline**
The market has reached the saturation point. The demand gets lower and lower. Product heads towards the end of its life span.
3 Standard Operating Procedures at Skanska

In the beginning, Skanska as a company is introduced. Then, a description of the department Skanska Xchange is given. Empirical study brings information about Skanska from an organizational point of view. It will also be explained

- What are standard operation procedures?
- Who are standards meant for?
- How are standards made?

3.1 Skanska

3.1.1 Company description

History

Skanska was founded as “Skånska Cementgjuteriet” in 1887. The name “Skanska” was formed first in 1984. Originally, Skanska manufactured concrete products but during the 20th century Skanska enlarged its focus on infrastructure, building roads, power plants, offices and housing. Since the 1950s Skanska has been an active actor on international markets. Currently, the US is the largest market.

The 1990s were the most expansive period in Skanska’s history. In the 21st century, profitability rather than growth stand in the centre of attention. (www.skanska.com)

Organization

Skanska Sverige AB, from now on mentioned as Skanska, is a part of the international company Skanska AB. Skanska is divided according to function and geographic position. (See Figure 3-1)

![Figure 3-1: The structure of Skanska Sverige AB(www.forum.sverige.skanska.se)](image-url)
The cross functional departments “Technique”, “Stab” and “Development” support the organization in different functions: economy, IT, customer service, production development, purchasing, environment etc. (www.forum.sverige.skanska.se)

**Targets**

Skanska wants to be a “good society builder” who takes responsibility for employees, customers and environment sincerely. Therefore, the Five Zeros vision was defined (see Figure 3-2)

![Figure 3-2](Skanska’s qualitative targets: The Five Zeros (www.forum.sverige.skanska.se))

- **Zero loss-making projects.** Loss makers destroy profitability and customer relationships
- **Zero accidents**, whereby the safety of our personnel as well as subcontractors, suppliers and general public is ensured at and around our projects
- **Zero environmental incidents**, by which our projects should be executed in a manner that minimizes environmental impact
- **Zero ethical breaches**, meaning that we take a zero tolerance approach to any form of bribery or corruption
- **Zero defects**, with the double aim of improving the bottom line and increasing customer satisfaction ([www.skanska.com](http://www.skanska.com))
3.1.2 Skanska Xchange Center Residential

Skanska Xchange Center Residential is from now on mentioned as Skanska Xchange. From an organizational point of view, Skanska Xchange belongs to the department Technique.

Skanska Xchange is an international project involving three Nordic countries: Sweden, Finland and Norway. The purpose of Skanska Xchange is to create a competitive advantage by combining the strengths of the Nordic regions. The goal is to have more cost efficient products that can be sold at the market with a higher margin.

This should happen by industrializing and standardizing the products and by uniting the way of working. Standardized methods will improve the attractiveness and quality of delivered products. This will lead to lower and controlled costs, lower complexity, better use of resources and reduction of construction time. In final effect, customers´ need would be met more precisely.

3.2 Organization at Skanska

This chapter brings understanding for the organization from the author’s point of view, see Figure 3-3. It is divided into managerial and executing level due to different role and approach to continuous improvement.

![Figure 3-3](image)

*Figure 3-3 Skanska’s organization related to implementation and improvement of SOP (Bergerova)*

On **managerial level**, standards are created and communicated to sites. On **executing level**, standards are put into practice. Here is the source of the true information about the best practice.

This paper discusses continuous improvement of Standard Operating Procedures on the managerial level. That is why the executing level is not described in details but only portrays conditions on sites in brief for better understanding of the topic. The executing level is marked by some features that impact the approach to continuous improvement. This chapter enlightens how work is arranged within lines on both levels. Arrangement on managerial level will be used when explaining the SOPs creation. The exhaustive description of procedure creation is given in the following chapter.
At sites, cooperation with suppliers becomes an inevitable part of everyday life. Contractors are though excluded from the organizational picture due to their uncertain position in the continuous improvement process. In case that the contractor’s activity is defined by an SOP, they are due to keep these standards to guarantee required quality. The reason for that is simple: Skanska is always responsible for safety, quality, costs and time schedule. Collected knowledge at Skanska challenges suppliers to improve.

3.2.1 Central organization

*The Central organization* and site managers cooperate on managerial level. The central organization consists of representatives in each business unit. Since Xchange is an international project, there are representatives from all countries involved. David Jerhov, a project coordinator at Xchange, points out that their role is to support the project through its existence. A further task is to spread information about the project in respective country.

3.2.2 Site manager

The site managers’ function overlaps with both managerial and executing levels. Project leader at Xchange, Anton Leigard, explained, one of site the manager’s duties is to set up work preparations before construction work starts. Susanne Ericsson, a superintendent at the site “Järva fältet”, confirmed that this is a time demanding activity and requires a skilled manager. Usually managers use those work preparations they have already used on earlier project and add only adjustments specific for the project.

3.2.3 Superintendent

The executing level is completed by a superintendent and finally workmen. The superintendent might be included in a site manager’s team. There is nevertheless an important role the superintendent plays as a mediator between site managers and workmen. That is the reason why the superintendent gets a separate position in Figure 3-3. Close contact with the crew is guaranteed by the superintendent’s duties. Among other things, a superintendent is in charge of

- *The first run study meeting*, a regular meeting takes place two to three weeks prior to a new activity. The purpose of this meeting is to go through production process with the crew. Focus is put on safety, quality, materials, tools, stepwise procedure etc. The plan is to use this occasion for reflection on a recent activity and summarizing both long- and short-term solutions to deviations.

- *The morning huddle*, a regular morning meeting for crew. Work progress is evaluated with support of a visual control board during this quick meeting. Plans for the day are carried out. (SXC Planning Book, 2009)

3.2.4 Workmen

Groups of workmen can be divided into two main categories:

- *Specialists* carry out the same task in every project. (e.g. electricity)
- *Generalists* skilled in various fields. After finishing one activity, it might take one or two years until repeating the same tasks.
Groups change geographic position since they move from one site to another. This is considered as the biggest difference preventing application of the continuous improvement implied in plants.

3.2.5 Information exchange
SOPs are created at the Central organization and handed to site managers. Time saved by not setting up special work preparations each time is one of positive contributions to the construction process. Information is interpreted to workmen in cooperation with superintendents. Improvement suggestions are expected to come from the workmen. (Figure 3-4)

![Information flow and flow for improvement suggestions (Bergerova)](image)

3.3 Attitude to standardization and continuous improvement
From a managerial point of view, continuous improvement is necessary in order to:
- Guarantee best practice
- Keeping pace with regulations (from government etc)

The opinion of workers was interesting to examine. During site visit in “Järva fältet”, an interview with a production leader was made. Fredric Claesson answered a question about his reaction if SOPs would be put in practice. “I would get scared,” he says. “I would need time to sit down and think about the changes SOPs are going to bring into my work.” Fredric thought it would be easier if he could get proper explanation of how standards are going to influence his work; how they should be used in practice.

In Fredric’s opinion, standards have to be personal. Otherwise it will not turn out good. Workmen like to take responsibility for their own work. An attractive part of a workman’s job is creativity. Daily, they have to deal with new problems and sort them out in the best possible way. There is a risk that standards would take this creativity and responsibility from them. A possibility to participate in continuous improvement would increase Fredric’s interest in using standards. On the other hand, he is afraid of getting enemies if he improves someone else’s suggestion. He mentions that he is busy with his current tasks and is not sure if he would have time for improvement.
3.4 **Standard operating procedures**

“In an economy where the only certainty is uncertainty, the only source of lasting competitive advantage is knowledge.” (Nonaka, 1991)

Figure 3-5 displays the simple relation between the worker and appropriate tools resulting in a satisfied customer. Workers in combination with work preparations result in building on time, keeping quality, safety and cost requirements. Pay attention to the worker carrying plans under his arm and having a clear vision of his work’s result. To ensure the expected result, it is important to give workers necessary tools, give them instructions on how to carry out activities and provide a safe work environment. This is task for the company’s management.

![Figure 3-5 With the support from SOPs, workers would build houses according to customers’ expectations easier. (Bergerova)](image)

Standard Operating Procedures (SOP) stand for the best known practice within the company. The point is to use these SOPs in order to

- secure safety at work
- lower the costs
- increase quality and effectiveness of operations
- ease the daily work for workmen
- keep knowledge within the company
3.5 How are standards made?
Since there is no registered best practice at the company, creating SOPs is a creative process requiring many participants, meetings, time and costs. The work with SOPs is characterized by brainstorming, workshops and cooperation among experts. Information about activities in the respective stage was gathered thanks to interviews with employees at the Xchange department.

3.5.1 Order party
The internal order party of SOPs is Platforms Multi/Single. (Multi stands for more than two store houses; single includes less the two store houses). Their task is to choose components that are going to be analyzed and later used. That order is made on the managerial level and guarantees support to the executing side. Requirements from the order party are handed over to the Component group for an analysis.

3.5.2 Customer focus
The customers of SOPs are project managers, designers, foremen and “blue collars” at Skanska’s sites. The important task keeping SOPs alive, contributing to their development and improvement, lies on workmen’s shoulders.

3.5.3 Component analysis
When M/S initiates the need of an SOP, the component group makes research about the best solution. This happens via visits on sites watching processes and interviewing experts, foremen and workmen. The best solution is chosen by comparing technical features, costs and sustainability. Regards have to be taken to external standards, laws and supplier requirements. Safety is always the highest priority.

The component group documents activities by taking pictures. Another task is to measure time required for an activity.

The final decision is taken after feedback from the order party side.

3.5.4 Industrialized processes
The group Industrialized process is responsible for “fine tuning” SOPs they get from the component group. E.g. safety aspects are added. This group is in charge of uploading SOP on the intranet, evaluating improvement suggestions and key performance indicators. Workshops and training focused on SOPs are a part of the group’s duties too.

3.5.5 Beta projects
Beta projects are projects using first versions of SOPs. Projects apply for becoming “beta projects”. An agreement between the organization and the project is a commitment. It guarantees support from the Central organization’s side but it is a binding agreement for the project.

Beta projects have to stand for costs connected to use and CI of SOPs. This fact can advise projects against implementing SOPs since they are afraid of high costs. On the other hand, it will be beta projects that will get the benefits in form of higher quality and lower costs.
3.5.6 SOPs’ content
SOPs include the following information:

- Title and reference number
- Purpose of SOP
- Definition of detail
- List of materials and tools needed
- SOP is broken down into activities and steps
  o Starting point - what has to be done before the activity can be carried out
  o Next activity - what will be done afterwards
  o Stepwise description of the activity
- Every step is completed by a picture, personnel resources required and target time
- Reference to safety and process owner

3.5.7 How SOPs are used
Results from navigation work are translated to the internal webpage Link. Link is in principal a tool for communicating SOPs. (See Figure 3-6)

![Figure 3-6 The internal webpage “Link” is a tool for communication SOPs (Bergerova)](image)
A site manager is always involved in work preparation before the construction starts. The site manager has free hands to adopt SOPs to his own project and fill in the project’s specific gaps by himself. This has several positive sides:

- The unique character of each project is respected
- SOPs are adopted perfectly to a specific project
- Employees are given possibility to interfere and influence standards they use. From psychological point of view, feeling of “up – down rules” should diminish. Besides that, it would increase worker’s interest in continuous improvement and make evaluation easier.

It is the same case when using SOPs as standards.

When work crews prepare for the next activity, the superintendent with workmen go through the SOP. The safety aspects are highlighted first. The activity is explained stepwise and tools necessary for each step are mentioned. SOPs should always be easily available in case a workman wants to be sure that he/she is doing right.
3.6 Observations from the Xchange department

During the author’s presence at the Xchange office, several topics for discussion were observed.

First of all, employees at the department are very enthusiastic and aware of SOPs’ importance for efficient and safe building. These people are professionals in different branches with many years of experience. Colleagues with different backgrounds, both cultural and professional, create a dynamic team. All of them have at least some knowledge about the lean philosophy.

When talking about how standards and the continuous improvement are managed in other industries, it can often be heard that “the construction industry is so special.” Of course, conditions and tasks differ among diverse industries. Instead of trying to see some similarities, the differences seem to outweigh them.

Implementation of a new strategy, such as using SOPs, is a complex problem. There are doubts about how detailed SOPs should be. Opinions vary among the team members and especially among the participating countries. As Rickard Espling, a program manager at Skanska Xchange, summarized: “This is an old discussion!”

It is clear that SOPs have to be visualized in some way. The hot topic is whether pictures or technical drawing should be used. Kristine Torp, a communicator between Sweden and Norway, explained that workmen might feel humiliated by detailed pictures since workmen are known for their professional pride. Her experiences show that when looking at pictures, workmen tend to pay attention to the people in pictures instead of the activity displayed. This leads to distraction and the final effect of an SOP diminishes.

“Measure time or not?” belongs to another phrase often repeated. Since all activities take relatively long time, the meaning of time measurement is doubted. E.g. making parquet floor in one room might take a half of a day. What would change if it says 3,5 hours as a target?

“Is it good enough?” is another often repeated question when the implementation of SOPs is discussed. Are the form and the content of SOPs suitable?

“First Beta projects have to be stars” SOPs are at the moment used on voluntary basis. Xchange wants to motivate projects to apply for using SOPs. It is expected that after first projects will have shown positive results, the interest for SOPs will increase.

A member of the component group, Antti Palo-oja sees the need of SOPs in the generation gap. Because of the financial crisis there will be another gap. Due to lack of projects, the education will not be that good either. That is why it will be necessary to have instructions.

The lean philosophy recommends process thinking. There were doubts about craftsmen’s ability to translate charts showing work flows. It was meant that management team, having higher education background, might be more familiar with process charts and this being so makes understanding easier.
3.7 Production vs. Construction

In factories, personnel

- are responsible for a certain part of a line or activity. Their focus is completely on this activity which makes it possible to get deep into details and improve activities by seconds. One cannot talk about improvements of this size at sites. Not yet at least.
- have a place for regular meetings where whiteboards are placed showing team results. This simple fact supports team building. Operators can observe their results and improvement in the long run and are therefore motivated to advance even more. These conditions are unlikely for site crews that are moved to another place after finishing an activity most of the time.

During the visit at the site “Järva fältet”, the author noticed one significant difference between the construction and the manufacturing industry. In manufacturing, there are predictable repetitive conditions for work tasks. At the site, some activities are dependent on climate, like air humidity, rain or temperature. Weather can cause delays that are not easy to influence.

Mathias Wilhelmson is a specialist focused on standardization and continuous improvement at another department at Skanska. Mathias explains that there is a difference in the organization. In the manufacturing industry there is a clear line with repetitive tasks and organization of this line can be replicated in any factory. When it comes to development of a technology, it has to be implemented into, say 3 factories. A regional manager takes care of maybe 300 projects. The complexity in construction is of another kind. In the construction there is a higher variety of activities, the place is changing and with that even the work conditions.
4 Case study: Standards in other branches

In the theory chapter it was mentioned (in connection to implementing lean philosophy) that many organizations consider their projects unique. As Tero Stjernstoft confirmed, this is often the reason for not using experiences from other companies that tried to create something similar. Skanska is smarter in this meaning and wants to learn from other branches in order to avoid mistakes that can be avoided.

Since there is a high amount of standards all around it was important to reflect on relevant objects for comparison. The cases were chosen thanks to their relevance to the topic and the availability of data. Regards were taken to SOPs’ special characteristics and purpose. One would think that only standards from the construction industry are relevant. This was though considered a mistake. The point of the author was partly to demonstrate the diversity in standards. Readers will in the following pages see that the topic defined by a standard does not matter. It is more important to put focus on a standard’s structural content.

Four work instructions were chosen as a reference objects. These are

- Väg och anläggning (VoA) Skanska
- ByggAi
- Medical instructions
- IKEAs manuals

These standards will be studied with focus on their content first of all. If information was accessible, the process of creation, implementation and improvement were considered. The purpose of this case study was to find some common pattern that would lead to conclusion about important features of a standard. This, in turn, will serve for evaluation of new standards in future.

4.1 ”Väg och Anläggning Skanska”

The main resource for this paragraph is an interview with Mathias Wilhelmson, project leader at Stab Produktion Skanska. His team works on united WI for all departments included in Väg och anläggning Skanska (VoA). At Stab Produktion standardized work instructions are called “best practice”. These should guarantee that the building process is as profitable as possible. (www.forum.sverige.skanska.se)

4.1.1 Creation and implementation

In the beginning ten work instructions were selected. Teams consisting of experienced site managers were built. They compared different methods for respective activity and they agreed on the most profitable method that guarantees quality as well. One of these team members was elected as owner of one “best practice”. Owner’s responsibility is to take care of the continuous improvement for that work instruction. Cooperation with site managers is favorable since each of them has their own network of skilled leaders who can positively contribute to “best practice” growth.

Wilhelmson thinks that implementing ”best practice” at VoA is easier since line organization demanded work instructions. It would be different in case of up-down strategy, i.e. if management initiated this program.
As he says, communication is an essential success factor. Wilhelmson accelerates implementation and improvement. He supports site managers; they have frequent regular meetings and keep in tight touch.

4.1.2 Content

“Best practice” is displayed on Skanska’s intranet and consists of two main parts:

- **Video and basic information**
  - Capacity
  - Prerequisites
  - Tips
  - Process owner
  - Contact person

- **Work instruction with a checklist**
  - Title
  - Critical moments (identified in risk management)
  - Valid design, rules etc
  - Resources (tools, material, personnel)
  - Safety
  - Sequence of operations
  - Control
  - Participants at run through
  - Result
  - To think about next time

It this case, activities are visualized by a short movie. This is considered to capture an activity as a whole best. The work sequence leaves no question marks about how to execute work. Figure 4-1 shows “best practice” on the intranet.

![Image of the intranet page](http://i.imgur.com/123456789.png)

**Figure 4-1** The VoA best practice on the intranet. (adjusted from www.forum.sverige.skanska.se)
4.1.3 Continuous improvement

Wilhelmson and his team spread the message that “best practice” is the best method known at the moment. (www.forum.sverige.skanska.se) The need of lifting up knowledge sitting in walls (as Norman writes about) is stressed. This should encourage work crews to contribute with their own experiences to the continuous improvement of work instructions.

If someone has improvement suggestion, it will undergo the following steps:

- Contact production leader. He/she contacts Stab Produktion.
- If possible, make a movie documenting your proposal. Otherwise Stab Produktion visits the site and takes care of documentation.
- The owner of the “best practice” convenes his team and they together reconsider the suggestion. After a decision is taken, the initiator of improvement is informed about it. The rule of thumb is to get an answer within two weeks after contacting Stab Produktion.
- In case of a positive verdict, Stab Produktion uploads the new version of the “best practice” on intranet.

Users of “best practices” became enthusiastic about continuous improvement and they send videos with improvement suggestions. According to Mathias Wilhelmson it is better to start with a film even though it is of a low quality. This film will start discussion among workmen and they will come with upgrading propositions.
4.2 ByggAi

ByggAi is a web based handbook focused on "the detailed planning of work activities on construction sites - buildings and civil works." ([www.byggai.se](http://www.byggai.se)) The main goal of ByggAI is to achieve more efficient construction. Positive expected side effects are "motivated personnel, less quality faults, accidents etc." (Persson & Bergh, 2006) At this time, there are 127 work instructions available. Appendix 1 exhibits the ByggAI webpage.

An interview was made with the founder of ByggAi, Mats Persson.

4.2.1 Pre study

Persson (2007) investigated what kind of help there is on sites for coaching and describing construction activities. It might be interesting for the reader to know that Skanska was one of the participating companies at the research. Interviews and studies showed that there is a lack of structured educational material for workmen at sites. As Persson & Sigfriied (2008) write, there has already been a trial to systemize construction routines in 70s. Despite bringing positive results in form of higher efficiency, this stream has died out. Therefore, the authors asked how the current situation with work instructions looks like now. They identified a need for work instructions since present routines’ descriptions are insufficient. Interviewees were especially interested in directions regarding safety at work with heavy load and with new materials. Via interviews Persson (2007) specified the following deficiencies of work instructions:

- **Structure**
  Instructions in use are neither standardized nor systemized. Information varies in scope and in structure. Consequently, it becomes more difficult to supervise workmen.

- **Accessibility**
  The form of work instructions has to be reconsidered. Participants expressed desire to register instructions on internet or on a DVD. Material that is not on site is of no use.

- **Language**
  Due to changes in nationality of work crew and their ability to communicate in Swedish or English fluently, language becomes a trouble. Persson & Bergh (2006) argue for pictures "When looking at pictures together, we are talking about the same thing". Pictures help to avoid misunderstandings between architects and crews.

It is even important to think about how information will be communicated. Persson & Bergh (2006) talk about “work accustomed education”. This means that workmen should get instructions connected to tasks they are going to carry out. It is up to every site to manage education of work crew as good as it gets. A strong back up from company’s side is required.
4.2.2 Implementation

During pre study phase, Persson and his team first created a trial version of one work instruction. They presented a short PowerPoint presentation and four minutes long video. The audience consisting of sixty workmen was very positive. This was a clear sign to continue on the project.

Figure 4-2 displays the project plan for creation and implementation of the first fifty work instructions.

![Figure 4-2 Plan Schedule for first fifty ByggAi work instructions. These were made during two years. (Bergerova)](image)

**Step 1:** Building reference and work groups from the construction trade.
**Step 2:** Choose suitable projects that will be studied. Set up 50 prior work instructions. Set up a plan for describing those.
**Step 3:** Combine information from participating sites and existing work instructions. Formulate first drafts of work instructions with support from experts in fields of communication and pedagogy.
**Step 4:** Reconsider the structural content of work instructions.
**Step 5:** Discuss work instructions’ future distribution and development.
**Step 6:** Revise form of work instructions. (Persson & Sigfried, 2008)

4.2.3 Content

ByggAi is significant by its structure and high level of user friendliness. (See Appendix 1) In the front page users can choose issues of interest. The user is supposed to adjust instructions to own project by filling in work preparation sheets. Each issue is divided into activities. In turn, each activity is described from four points of view.

- **Requirements**
  - Requirements from AMA and suppliers
  - Risk analysis (described in separate paragraph)
  - Protection equipment
General protective measure

- **Preparatory work**
  - Check prerequisites
  - Check equipment
  - Check material
  - Check delivery

- **Self control**

- **Completion**
  - Putting up
  - Work moments and montage
  - After work

Pictures are a significant part of ByggAi instructions. Numerous pictures and drawings explain activities and their flow.

### 4.2.4 Continuous improvement

Feedback and improvement suggestion are communicated via internet or direct contact with ByggAi creators. Giving feedback becomes very easy thanks to the user friendly webpage. Every user is welcome to contribute with own experiences to improvement of ByggAI.

Board meetings (members who are responsible for ByggAi) takes place regularly. It is an opportunity for dividing tasks among members and taking decisions on improvement of work instructions in question. The responsible person is entrusted by a research and a common decision is taken.

The improvement happens even by challenging colleagues from the construction branch to go through work instructions and to give feedback.

### 4.2.5 Risk analyzes

Persson (2007) count risk as a multiplication of a probability that an accident occurs and the consequence of the accident.

\[
\text{Risk} = \text{Probability} \times \text{Consequence}
\]

Persson (2007) see risk analyzes as a combination of experience based probability that some accident will happen and the expected consequence of an accident.

Table 4-1 and Table 4-2 show rates defined for the probability and the consequence. Since values are experience based, these tables should be used as an impulse for discussion in teams; not taken for given.
<table>
<thead>
<tr>
<th>Value</th>
<th>Probability that an accident occurs</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>Very improbable</td>
<td>&lt;1 time/10 years</td>
</tr>
<tr>
<td>1</td>
<td>Improbable</td>
<td>1 time/10 years</td>
</tr>
<tr>
<td>3</td>
<td>Low probability</td>
<td>1 time/3 years</td>
</tr>
<tr>
<td>10</td>
<td>Relatively probable</td>
<td>1 time/year</td>
</tr>
<tr>
<td>30</td>
<td>Probable</td>
<td>1 time/month</td>
</tr>
</tbody>
</table>

Table 4-1 A guideline for defining values for probability (Persson, 2007)

<table>
<thead>
<tr>
<th>Value</th>
<th>Consequence of a problem is</th>
<th>Nr of days in the sick-list</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>A trifle</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>Very little</td>
<td>1-2</td>
</tr>
<tr>
<td>5</td>
<td>Little</td>
<td>3-7</td>
</tr>
<tr>
<td>15</td>
<td>Considerable</td>
<td>8-29</td>
</tr>
<tr>
<td>70</td>
<td>Serious</td>
<td>30-299</td>
</tr>
<tr>
<td>500</td>
<td>Very serious</td>
<td>&gt;300</td>
</tr>
</tbody>
</table>

Table 4-2 A guideline for defining values for a consequence of an accident (Persson, 2007)

After identifying risk values for respective problem, risks are ranked in descending order. Activities with risk value higher than 100 have to be examined and the reason eliminated.

Persson (2007) leave it up to the organization to decide which risks are acceptable and which are not.

4.2.6 Notes

During interview, Mats Persson commented on objections mentioned in the theory chapter about standards. He claims that work instructions ByggAi require filling in preparation sheets. In this way personnel’s engagement to standards increases. He makes the same conclusion as Training within industry that standards help to diminish the amount of faults. Besides that, standards contribute positively to continuous improvement.

Persson described the first reaction of workers when they come in touch with standards. They are afraid of improving something that well educated experts have defined. To overcome this respect towards authorities, workmen have to be encouraged to trust their abilities and suggest improvements.
4.3 IKEA

It can be assumed that almost everyone has seen manuals similar to the one displayed in Figure 4-3. The Swedish company IKEA is a shining example of well managed standardization work. IKEA is famous for its flat packaging that makes transportation both easier and cheaper. That kind of packaging shifts responsibility for assembly on the customer. IKEA dealt with a problem how to explain to customers (any customers, even to those who lack professional carpentry experience) assembly of a product they just bought. Manuals are simple, easy to understand and follow.

![IKEA Assembly Instruction](image)

**Figure 4-3 IKEA's assembly instruction for a famous bookshelf Billy is a brilliant example of a standard. Manuals are significant by simplicity, limited need for lingual description which makes them usable all over the world. By using only pictures, the customer gets necessary information about safety, required tools and assembly. Parts that might cause difficulties are marked in order to secure efficiency and to avoid damages on products. (www.ikea.se)**

In comparison to ByggAI or SOPs, IKEA manuals are simpler and less exhaustive. Manuals contain the following information:

- **Title**
- **Components**
- **Tools**
- **Very basic safety**
- **Stepwise WI**

Special about these manuals is the way they convey the message to customers. Visualization is essential for IKEA manuals. Thanks to that, manuals can be used regardless of country or language. Manuals show clearly items necessary for assembly. Simple images communicate all necessary information; a picture of respective furniture serves as detailed description. Images guide the user through the assembly. Parts that can cause troubles are marked by circles and magnified in order to avoid faults. Pictures express which tools are needed for assembly.

On the other hand, there are no recommendations on e.g. place of assembly. It is up to the customer to estimate how large space is necessary for the assembly. This can turn out to be a problem to some less experienced clients.
4.4 Standards in health care

Work at emergency department differs among hospitals as well as practice at any other office. Taken as a whole, patients get similar treatment in each hospital. Work routine can though vary in a certain stage. Darviche & Stevenow (2007) saw enormous pressure at emergency departments in hospitals. High demands are put on doctors due to a high number of patients and necessity to act fast. Besides that, work at the emergency requires wide knowledge within the medicine field. Darviche & Stevenow (2007) strive to collect and formalize the best way of treatment. They therefore elaborated a handbook for emergency personnel. It gives guidelines that should make work at emergency departments easier and more efficient. The handbook has an educational, not a directive purpose. The user is not expected to follow the instructions absolutely. On the contrary, the user is expected to see patient’s symptoms as whole and to apply his/her own judgment and logic. An extract of the handbook is shown in Figure 4-4.

The instruction manual contains
- Categorization of possible diseases according to different symptom groups
- Well arranged schemes helping doctors to set up diagnoses
- Specified laboratory tests and examination
- Concise description of examinations and stepwise treatment.

No figures accompany instructions. Simple but exhaustive explanation is given to user instead.

Different from other cases is that prerequisites for work are not given. A possible reason is that every hospital has standard equipment and it is understood that this equipment is easily accessible.

Figure 4-4 An example of an instruction in health care. (Darviche & Stevenow, 2007)
5 Analysis

Now, when building on the background of theory and rising experience, answers to queries observed at Skanska will be given.

How detailed should standards be?
What can be learned from other branches?
How can standards be continuously improved?

In principal, the following paragraphs outline answers to questions “What and how to improve” and “How to communicate this improvement?”

5.1 How detailed should standards be?

The customers of SOPs are foremen at Skanska sites. Their expectations, needs and knowledge have to be taken in regard. Here is a factor causing most problems and discussions; how detailed should SOPs be? Which information should they include? It can help to decide when the customer remains in focus!

Kristine Torp talked about humiliation in case SOPs are too detailed. As she said, pictures of real people might be distracting when preparing for an activity with SOPs. She had observed that workers get interested in knowing a certain person. If SOPs do not include pictures, we have to face the risk for misunderstandings. Taking IKEAs manual as an example we can see that an inexperienced customer has to read the manual in details. On the contrary, skilled customers jump over some steps. Perhaps, they do not have to check the manual at all, but it is there in case of doubts. It is the same case with SOPs. In order to have some system when evaluating SOP content, case studies were analyzed in the next paragraph.

5.2 What can be learned from other branches?

Selected reference objects were studied with general approach. Focus was on structural solutions, not on specific technical answers provided in studied standards. The start point was Kinnander’s definition of a standard work instruction. Regard to possible desired information for SOPs was also kept. Common pattern between chosen standards was found. Table 5-1 exhibits the results of analyses. The first column demonstrates characteristics of interest.
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>VoA</th>
<th>ByggAI</th>
<th>Medicine</th>
<th>IKEA</th>
<th>SOP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition of task</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Detail description</td>
<td>Yes</td>
<td>Not always</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Start value</td>
<td>Yes</td>
<td>Not always</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Prerequisites</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td>Yes</td>
<td>Yes</td>
<td>No*</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Tools</td>
<td>Yes</td>
<td>Yes</td>
<td>No*</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Place</td>
<td>Yes</td>
<td>Yes</td>
<td>No*</td>
<td>Partly</td>
<td>Yes</td>
</tr>
<tr>
<td>Quality/self control</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>External standards</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Stepwise WI</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Empirical data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk analysis</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Time estimation</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes**</td>
</tr>
<tr>
<td>Visualization</td>
<td>Video</td>
<td>Pictures</td>
<td>No</td>
<td>Drawings</td>
<td>Pictures</td>
</tr>
<tr>
<td>CI</td>
<td>Teams</td>
<td>Public</td>
<td>-</td>
<td>-</td>
<td>Teams</td>
</tr>
</tbody>
</table>

*Not necessary to mention in a health standard
**ongoing discussions whether to include or not

This table can be used when comparing SOPs to a new standard. The new standard will simply be added as a new column. A new characteristic can be added as a row.

A new item can be considered (or an old revised) depending on

1. how many Yes/No certain characteristic gets. If an item gets 75% Yes, it might be interesting for Skanska to reevaluate the topic.
2. if a certain characteristic receives only one Yes, it can also be of interest
3. if there is only 25% Yes in a column, there might be something special about this standard

SOPs meet the first point in most of characteristics. Where there is 75% Yes in a row, it also says Yes at SOP. It means that the SOP contains a comparable level of information as the other work instructions. From this point of view, the content does not have to be reevaluated.

According to the second point, risk analysis at ByggAi, can be interesting to study. Is it something Skanska wants to add to SOP? There are two facts to be regarded:

- One of Skanska’s main goals is “zero accidents” at work. Safety at work is taken seriously.
- Building trade has dangerous work places.

Therefore, it is recommended to analyze how risk factors are evaluated at ByggAI. Instead of stating that safety goes first, a small table could show how big the risks are at
certain activity. This would help workers to rank advice and divide their focus proportionally.

*The third point* becomes valid in the case of IKEA manuals. There are only some Yes at some answers. Examination of manuals brings understanding why it is so. The extremely clear picture might be an inspiration for Skanska. IKEA manuals use images as the only communication tool. To reach the same simplicity seems to be impossible. But IKEA also stood in front of such problem and managed very well. Although their complexity is much lower than SOPs, Skanska can get inspiration about how to illustrate their work instructions. There were doubts about humiliation when using too many pictures but these examples should show otherwise.

In the author’s opinion, there is no reason to hesitate whether SOPs are good enough or not. The table shows that SOPs are on a comparable level with other standards in use.

It is recommended to work on risk analysis since the goal to be a “good society builder” is a part of Skanska’s overall strategy.

### 5.3 Production pilot in practice

Method for systemizing and presenting SOPs plays an important role in both implementation and improvement process. Petersson et al (2008) wrote it should be easy to make it right. The simpler the method is, the more information is communicated correctly without any disturbance. Inspiration can be taken from the Production pilot when it comes to Link look. Figure 5-1 exhibits this transformation. In this case, the SOP is exhibited as a process and consists of three main activities. Further information is displayed by clicking on an icon of interest. Every activity is completed by directions about

- starting point
- required material, resources, tools etc
- targets, information about SOP
- result of activity

![Figure 5-1 On the left: webpage Link displaying a SOP](image)

*On the right: SOP overwritten into a Production pilot (Bergerova)*
There are several reasons why Skanska might have a great use of SOPs looking like a Production pilot.

**Advantages**

The Production pilot lies in one line with *process thinking* that is important for gratifying the implementation of standardization which is indirectly connected to lean philosophy (In theory part described by Koskela, Petersson et al., Stjernstoft).

The Production pilot gives this explanation method an easy-to-understand look. The design agrees with the planning system used at Skanska since it supports the long term view. Workers should understand that delays in their task cause a series of further delays in following activities. Here, output for one step is a starting point for the next one. A user of the Production pilot sees clearly dependences between activities and steps.

In chapter 3.2 it was explained that the site manager always is involved in the work preparation. The site manager has free hands to adopt SOPs to his own project and fill in project’s specific gaps by himself. In case SOPs would look like the Production pilot, it would become clear which parts are missing and have to be filled in by the site manager. The organization provides rules used in general cases and site manager secures that project specific information is a part of SOPs. (See Figure 5-2)

![Figure 5-2 SOP in use of the Production pilot (Leigard, 2009)](image)

From what is written above, the Production pilot lowers risks of negative affection of standardization that are explained by Brunsson & Jacobsson (1998), namely *resemblance, excessive stabilization and doubts if it really is the best practice*.

Petersson et al. (2008) warns that it must be easy to do it right; standards should be easy to follow. The Production pilot is user friendly; the order of activities is obvious. Besides that, people remember pictures easier than text.

Common IT support could be a solution to updates from the supplier’s side. There is a risk that SOPs will not be updated in case of changes in delivery. If information from the supplier is directed straightaway to the Production pilot, the user can evaluate the
situation faster. The Production pilot supports models that are currently used for design, calculating costs, estimating time consumption etc.

**Disadvantages**

There were doubts about craftsmen’s ability to translate charts showing work flows. It meant that the management team, having higher education background, might be more familiar with process charts and this being so makes understanding easier. This objection is not seen as relevant. One should not underestimate worker’s intellect. Fredric Claesson, group leader at Järva staden, says that the only fear he sees with SOPs is that he needs time to absorb and understand new information. With appropriate explanation, using of SOPs should not be a problem.

**5.4 Learning and continuous improvement**

Bicheno (2006) divides learning process into four stages. These are exhibited in the figure below. In case of Skanska, learning should happen via SOP. The goal is to achieve unaware competence. This means that best practice should be deep embedded in everyday work life. Unaware competence resembles a norm; rules are then used unconsciously and voluntarily.

![Figure 5-3](image)  
*Figure 5-3 The shift from unaware incompetence to unaware competence is affected by SOPs and the continuous improvement.*

The picture above shows SOP partly as a mediator between unaware competence and aware competence. Work crews should improve their performance when using SOPs in practice. First, they have to find out what they do wrong and then learn how to do it better.

But SOPs have another mission. SOP means to “hear the walls talking” (Norman, 2007). In other words to catch up knowledge present at sites. When creating a SOP, the task of the organization is to summarize and evaluate skills at sites. This leads to the first conception of a SOP. In principal, the process of SOP creation has the same
purpose as continuous improvement. The continuous improvement too should include current best practice in SOP. Continuous improvement can then be seen as a tool for improving aware competence.

5.5 How can standards be continuously improved?
As explained in the previous paragraph, continuous improvement should lead from unaware incompetence to aware competence.

As it was mentioned in chapter 2.3.1, improvements should be small and gradual. No one is expected to change a SOP completely. Vice versa, small improvements (symbolized by a ball) are easier to handle and implement. If changes become too large, they require deeper anchorage in standards and in this way movements will become rigid. This principal is shown in Figure 5-4.

Figure 5-4 Pushing the boll uphill symbolizes changing process. There is a difference between small and large changes since it takes longer time and more effort to roll the bigger boll. Besides that, to stabilize such a process requires strong wedge that stops the ball from gliding. (Bergerova)

Brunsson & Jacobsson (1998) mentioned a risk for resemblance which contributes to people’s reluctance to follow standards. Petterson et al. (2008) write about the necessity to make standards as simple as possible and choose proper information for standards. If standards become too comprehensive, a repulsive reaction from the user side can be expected. With regards to these factors it should be of high priority to make standards as simple as possible. This in turn will make the continuous improvement easier as well. Besides that, small steps will help to keep on track. The purpose of an SOP might deviate from the right direction by long jumps (huge improvements).

5.6 Model for continuous improvement

5.6.1 Difference between lifecycle and *life spiral*
In the theory chapter, the product life cycle was illustrated. As it appears the life cycle is finite, at some point, it reaches its end. The goal of SOPs is to develop endlessly i.e. continuous improvement of SOPs should never stop. That is the reason why it is preferred to use the word ”life spiral” instead of “lifecycle”.

5.6.2 Life spiral of SOP
The reader might recall Figure 3-4 from chapter Organization at Skanska. In the picture below, several projects were put in a sequence.
SOPs are prepared in the Central organization. Afterwards, they are handed to a site manager who has to fine-tune SOPs to the specific project. After that, SOPs are interpreted to workmen through a superintendent. Workmen use SOPs in practice. After finishing a certain activity, performance is evaluated and improvements suggested. When an improvement suggestion arrives to the Central organization it has to be evaluated. At Decision point (DP) conclusion is made whether a suggestion is approved or not. That leads to a new improved version of the SOP.

As it was mentioned in chapter 3.2 about Skanska organization, there is no channel for sharing information and knowledge with other projects. This spiral fulfills a role of such a channel.

It is desirable to involve workmen in continuous improvement to such an extent that they would initiate creation of new SOPs. SOPs would lose the character of an obligatory directive and hence they would face lower resistance. Mathias Wilhelmsson has experienced that it is easier for workmen to respect SOPs as a standard when workmen themselves experience the need for an instruction.

5.6.3 Division of responsibilities

The division of responsibilities is inspired by the Model for improvement by Langley et al. (2009). This model should secure that improvements move the organization in the proper direction. In combination with small stepwise improvements, there is a low risk for deviation from the main course. Figure 5-6 exhibits the division of responsibilities.
The Central organization is

- **Process owner**; including responsibility for existence of the process and its running. Responsibility for areas that a project cannot take care of by itself. (e.g. purchasing, which is controlled by the organization due to supplier agreements)
- **Accelerator** that makes the improvement process faster
- **Decision maker**; at a decision point, it is Central organization that gives go/no go sign to a suggestion.
- **Supporter**; Central organization must provide support for sites when it comes to the Act and Plan parts of the PDSA cycle. This help concerns implementation of improvements in practice and planning for continuous improvement activities.

Central organization should have in mind the three questions stated by Lanley et al. (2009)

1. What are we trying to accomplish?
2. How will we know that a change is an improvement?
3. What changes can we make that will result in improvement?

The first question touches overall strategy for SOPs.

Regarding the second question, measurement starts to have a role here. The Central organization has to set up rules signalizing that a suggestion is an improvement. The choice of proper measures depends on the company’s strategy as Tangen (2004)
pointed. The Central organization must evaluate which improvements are more important; those regarding safety, costs or time.

The third question should be answered with help from sites since it is they who own knowledge.

In the role of decision maker, there are two perspectives:

1. short term
2. long term

As it was said in the chapter about organization, workers are divided into specialists and generalists. Generalists, who will repeat the same routine in a couple of years, will join the ‘long term’ system. The administrator does not have to answer that quickly.

On the other hand, in case a specialist comes with an improvement suggestion and still is in the project, the administrator has to deal with it promptly. Workmen’s motivation to take part in continuous improvement should increase when getting fast response. In case of fast decision, improvement can be implemented directly and perhaps at the same project. Decisions at VoA is taken within two weeks from the moment when an improvement suggestion registered. This is recommended as an appropriate time horizon in the case of SOPs.

Sites are responsible for the PDSA part of Lanley’s Improvement model. Since it is up to sites to study SOPs and suggest new ways of working, they have to be responsible even for the Study part of the PDSA cycle. The Central organization participates on studies of continuous improvement and is therefore partly in charge as well. Sites have to use SOPs and improve them. Existing meetings, like morning huddle or first run study meetings are suitable occasions for continuous improvement.

Continuous improvement is often regarded as extra and often irritating work. Tero Stjernstoft emphasizes though that improvement has to become a natural part of work. It should be so embedded in company’s culture that it becomes a part of duties. For example interview with Fredric Claesson shows that a clear line between work duties and continuous improvement was drawn.

5.7 Costs for continuous improvement

Supposing projects get involved in the process of continuous improvement. The life spiral of SOP then grows from project to project. This means that improvements are slowly rolling uphill as in Figure 5-4. Quality can be defined as a function of the spiral’s circle area. When looking at raising accumulated costs, the reader must all the time be aware of savings that SOPs are going to bring.

Costs connected to continuous improvement of SOPs have to be divided between the Central organization and a project. At first, the Central organization stands for all fixed costs for the creation of SOPs. Fixed costs in later projects cover project support, handling improvement suggestions and taking care of decisions. Variable costs appear when a project contributes with some improvement proposal. Variable costs are dependent on how many ideas are created, how many people are involved, how long
time it takes to manage an idea. Figure 5-7 exhibits this division. Costs should always be seen as investment into learning and spreading knowledge.

![Figure 5-7](chart.png)

**Figure 5-7** Quality as function of marked area; division of accumulated variable costs among projects. Savings and safety at work growing over time. P-project, Q-quality (Bergerova)

Here, another meaning of small improvements appears. If someone wants to achieve improvement from point P1 to P3, it even means that a project has to stand for much higher variable costs then when going from P1 to P2.

Figure 5-7 displays how savings grow from project to project over time thanks to continuous improvement. Savings are expected to be higher than accumulated costs for continuous improvement otherwise it would not be profitable to work with this initiative.

Safety is the highest priority of Xchange project regarding the overall Skanka’s strategy “Zero accidents” which was named in chapter 3.1.1 about Skanska. SOPs would undoubtedly increase the safety at work.

### 5.8 Successful implementation of continuous improvement

#### 5.8.1 Requirements

The *management support* and a united strategy are necessary. Some doubts and uncertainties about implementing SOPs in the company can be observed at Skanska. The question is how to spread SOPs in a persuasive way so that they become an undoubted everyday tool for employees on sites. The managerial level has to decide
whether SOPs are going to be implemented as a directive or as a standard. The goal in both cases is to achieve the state of norm, when SOPs become a natural part of everyday routine. (see Figure 5-8)

![Figure 5-8 Shift from a directive to a norm (Bergerova)](image)

In case of directive implementation, Skanska Xchange would need a deep routed support from the board. An execution of such an extensive change would face strong reactions from organization.

In case of advisory implementation as a standard, there is a risk for low interest in using SOPs from the executing level.

It is positive that Xchange started in accordance to Koskela’s recommendation to see the whole construction as a flow process. This view gives structure to the organization and seeing construction as a sequence of processes creates a sort of “well organized and functional workshop” shown in Peterssons picture (Figure 2-1).

In the same figure, it is obvious that clear goals and measurement move standardization process forward. There have been doubts whether or not to measure the time an activity requires. As Kinnader pointed out, measurement has to be a part of standard. Without measurement, deviations cannot be defined and performance evaluated. Consequently, it becomes difficult to conclude whether goals are achieved or not.

“One can often hear this Toyota phrase at Skanska Xchange. On the other hand, the same questions are discussed over and over again. The strive after perfection slows down the implementation process. Instead, first SOPs should be used as a spring-board that would initiate continuous improvement. For ByggAi, it took only two years to put 50 work instructions into practice.

5.8.2 Risk factors
We are unique

There are some differences between the manufacturing and the construction industry. Different prerequisites are often misinterpreted and it can often be heard “We are special.” According to what Peterssson (2008) says this is a very frequent mistake that companies make. Peterssson (2008) claims that no differences can prevent anyone from implementing the lean philosophy or standards. If the “unique feeling” at Skanska preserves, it can influence both the implementation and the improvement process negatively; e.g. by ignoring learning from other organizations.
Workers’ resistance

Brunsson and Jacobsson (1998) explained that people’s resistance to standards is natural. As Fredric Claesson expressed, he would be afraid of using something unknown. Besides that, SOP deployment would bring a lot of changes into casual work day. Therefore, proper explanation and support from the Central organization’s side are a must for diminishing the resistance. Since standards are of volunteering character, successful implementation of continuous improvement requires skilled leaders who are able to communicate the meaning and well-founded reasons why to use standards.

Mathias Wilhelmsson decided to let appointed people reflect over suggested solutions. By his leadership skills, he managed to convince workers that it is up to them to improve standards. Leaders should be able to deliver responsibility to workers. Kinnander claims that standards should be created on lowest possible organization level. In the case of Skanska, suggestions should come from workers on sites. Their involvement in SOPs removes the expected opposition to obligatory tasks.

Unwanted phase-out

Even if the continuous improvement started with enthusiasm it is natural that people’s interest weakens after some time. Great leadership is the only possible solution to an unwanted phase-out. It is an incredible challenge to keep people motivated and active. But as it was said, continuous improvement has to become a natural part of one’s duties. It might take years before that happens.
6 Conclusions

6.1 SOP´s definition and life spiral
Standard operation procedure is the current best practice known at Skanska. At the moment, it is a standard. The purpose of SOP is to

- secure safety at work
- lower the costs
- increase quality and effectiveness of operations
- ease the daily work for workmen
- keep knowledge within the company.

Continuous improvement is presented as a spiral since the process should never end. Responsibilities are divided among organizational levels depending on their function and purpose. (See Figure 6-1)

![Figure 6-1 Life spiral of SOP and division of responsibilities among organizational levels. (Bergerova)](image)

6.2 How to succeed with SOPs
Skanska started to move towards lean construction in the right way. Process thinking is being implemented through the whole organization. There is an obvious process from buying land to handing over keys to a customer.

Support from management. The first step in successful implementation of the lean philosophy is the back up from the board. There should be no doubts about using SOPs. If there are doubts whether to use SOPs or not, it indicates that SOPs are only a short term solution. Unsurprisingly, employees show disgust to change routines if they get vibes that this is a short term solution.

Decide whether SOPs are standards or directives. This influences implementation strategy. As a standard, SOPs are used voluntarily and the user cannot be forced to use them in a certain way, extent nor perfectly. On the other hand, if SOPs are directives it becomes compulsory to use them. This gives the owner (currently Skanska Xchange) to put demands on users. As a consequence, resistance from the organizations side can be expected. The final goal is to achieve norm status when SOPs become a natural part of everyday professional life; in other words SOPs will become unaware competence.
Do it! How often is this said at the office? Still, there are too many question marks about extent and content of SOPs. There will be no perfect solution. Skanska can use critics of standardization for own profit: Let the market decide! The market in this meaning are employees. Let them decide what information they are interested in. Let workers take part in CI and you will get a win-win situation: increase workers interest in SOP since they get a chance to influence it. At the same time, get hot information about what is necessary to improve. Both ByggAI and VoA have shown that this attitude works.

Trust yourself! Skanska Xchange is doing a great job. Of course there is a fear that the first SOP project will end up in red numbers. But SOPs have been created responsibly. The author is not competent to judge the technical content of SOPs. But when it comes to SOPs formation and the sort of information it contains, it definitely is ready for publishing. There is no reason to doubt own work. SOPs do not have to be perfect from the beginning. They have to be implemented and improved.

The message throughout Skanska should be: this is not an extra work task. This is a part of your job. If users contribute to continuous improvement of standards, it affects standards positively. This was confirmed by Persson and Willehlmson.

Do not expect any fast progress in continuous improvement. The steeper the improvement slope is, the tougher it gets to roll SOPs up. Start with a small stone and enlarge it successively, having time for ensuring quality.

As it was shown, Skanska is not the only one aiming at standardization of work procedures. There are many examples of companies, both internal and external, that have successfully implemented standards. The challenge is to learn from these in order to avoid repeating obvious mistakes. Learn from other organizations.

- Risk analysis used at ByggAI
- Simple pictorial communication from IKEA manuals
- Continuous improvement management from VoA
- Clear visualization structure from production pilot
7 Discussion

During my master studies, the lean philosophy was illustrated with examples from the manufacturing industry. It has been interesting to apply the lean philosophy on another kind of industry. Although there undoubtedly are some differences between the manufacturing and the construction industry, it became obvious that any company can become “lean”.

One can question why it is so difficult to implement standards. From the customers’ point of view, standards are of low significance. Consumers take for granted that when they buy e.g. a Lan cable, it will fit to their computer and router. In the professional sphere, there is a high awareness of standards. Only producers know how many man-hours dedicated to research, cooperation and compromising are hidden behind the simple fact that any Lan cable suits any computer.

People always strive after perfection. To find the line of balance, where the result is good enough, is very difficult. Either the result is overworked or not sufficient. According to the lean philosophy both of these cases are some kind of waste. Especially in real life it takes long experience and self criticism to find the balance.

7.1 Suggestions for further research

This paper does not discuss continuous improvement on executing level. Obviously, continuous improvement especially on executing level is an essential part for keeping the best practice in-house. Focus on that would be an interesting topic for another thesis.

Research taking regards to cultural differences would bring more understanding for different reception of SOPs in the countries participating at the project.

Leadership skills would influence both the implementation and the continuous improvement. Therefore, it would be worthwhile to carry out a study about connections between leadership and risks for successful implementation of SOPs.

Since Skanska wants to be a good “society builder” focus on safety at work is a natural part of the company’s strategy. A research about the risk analysis, perhaps inspired by ByggAi, would be of a high interest and importance.

Some inefficiency was observed on sites. It would be interesting to improve efficiency by a better organization of material flow and logistics on site.

7.2 Critique to own research

Originally, the focus was on the continuous improvement on the executing level. During the presence at the office, it became more urgent to react on current needs. These were specified as the content of SOPs and the continuous improvement on managerial level replaces the original goal.

In this paper, a table summarizing characteristics of standards was created. It would be better to prove validity of suggested comparison table by testing it in practice. Due to the lack of time, it was not feasible.
As human beings, our work lives are inseparable from our privacy. The tight interaction between those two lives causes that if one goes bad, the second one is influenced as well. If something negative happens in the private sphere, it is better to take some weeks off, interrupt the research and continue first after gaining power enough. This is a future challenge for the author to become an understanding leader and colleague.
References

Literature


**Articles**


**Handbook**

*SXC Planning book, The story of balanced and reliable planning done in collaboration* (2008), Skanska AB, Stockholm

**Lectures**

Stjernstoft, T. Value Flow Analysis, Royal Institute of Technology, 28/9 2009

**Internet**


IKEA, [www.ikea.se](http://www.ikea.se) 13/6 2009
Model driven parts manufacturing,

http://dmms.iip.kth.se/current-programs/modart, 23/6 2009


http://researchprojects.kth.se


Skanska intranet,

www.forum.sverige.skanska.se

http://skanska.com/en/About-Skanska/Our-history/

http://skanska.com/en/About-Skanska/Our-targets/

Training Within Industry, http://www.trainingwithinindustry.net/JI.html, 15/5 2009

**Interviews**

von Axelsson Jens, Swerea IVF, May 2009

Claesson Fredrik, Superintendent, Järva fältet, May 2009

Ericsson Susanne, Superintendent, Järva fältet, May 2009

Espling Rikard, Program manager, Skanska Teknik, May 2009

Fritzon Mikael, Program manager, Skanska Teknik, May 2009

Groth Patrik, Department manager, Skanska Teknik, May 2009

Jerhov David, Project coordinator, Skanska Teknik, May 2009

Koppinen Tiina, Program manager, Skanska Teknik, May 2009

Leigard Anton, Project leader, Skanska Teknik, May 2009

Lundholm Thomas, KTH, May 2009

Palo - Oja Antti, Project leader, Skanska Teknik, May 2009

Persson Mats, Project leader, Malmö, May 2009

Pilipenko Olga, Project leader, Skanska Teknik, May 2009

Sievard Gunilla, KTH, May 2009

Stjernstoft Tero, Swerea IVF, May 2009

63
Sätheråsen André, Project leader, Skanska Teknik, May 2009
Torp Kristine, Project leader, Skanska Teknik, May 2009
Zachrisson Carola, Executive program director, Skanska Teknik, May 2009
Widerberg Clara, Project leader, Skanska Teknik, May 2009
Wilhelmsson Mathias, Skanska Stab Produktion, June 2009
Appendix 1 Web based manual “ByggAi”
Definition of task is on front page of ByggAI instruction

Detail description helps to ensure working with proper product
Table with simple calculation on risks

List of materials and tools
Egenkontroll

Mall och instruktion

<table>
<thead>
<tr>
<th>Nr</th>
<th>Kontrollpunkt</th>
<th>Metod eller utrustning</th>
<th>Frekvens</th>
<th>Resultat</th>
<th>Datum</th>
<th>Signatur</th>
<th>Avvikelse/åtgärd Godk./ej</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Följande, märkning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Sprickläggning</td>
<td>Okänd</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Lyftredskap och montageutrustning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Ingåtgångsrad</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Kommunikationsutrustning och signalutrustning</td>
<td>ASS anvis. nr 58</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Transportväg och uppställningsplats</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Stäpp, slag, kolvning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Template for control of own work performance

Genomförande

Fogning

Understopning
Det är lämpligt att lägga ut bruk innan elementen monteras som syns nedan till vänster.

Direkt efter monteringen släsas bruksolen till och överflödigt bruk tas bort.