Supporting production system development through Obeya concept

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Abstract
Manufacturing Industry as an important part of European and Swedish economy faces new challenges with the daily growing global competition. An enabler of overcoming these challenges is a rapid transforming to a value-based focus. Investment in innovation tools for production system development is a crucial part of that focus which helps the companies to rapidly adapt their production systems to new changes. Those changes can be categorized to incremental and radical ones. In this research we studied the Obeya concept as a supporting tool for production system development with both of those approaches. It came from Toyota production system and is a big meeting space which facilitates communication and data visualization for a project team. Four lean companies have been studied to find the role of such spaces in production development. Results indicate a great opportunity for improving those spaces and their application to radical changes in production development projects

Key words: Production system development, Obeya, Kaikaku, Kaizen, Data visualization

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Chapter 1: Introduction
This chapter is an introduction on Obeya concept and following discussions about where, why and how such concept is required within industries. Then research questions, problem statement, and objectives are demonstrated. At last, delimitations, thesis outline and area of relevance is described.

In the last 50 years, by the trend of globalization, manufacturing companies has struggled to compete and dominate other companies around the world. Consequently, companies’ capabilities in different areas such as production, deliveries, logistics, and supply chain are the key factors to overcome the rivals.

On the other hand, companies need to be as agile as possible in order to respond the changes that happened in different parts; otherwise they would lose their market.

The project includes a survey of current Obeya or similar meeting/working spaces in Swedish as well as international industries, which are located in Sweden and then direct experience and observation of authors about implementing an Obeya in MDH and in a manufacturing company is described, compared and analyzed.

Problem statement
By increasing the trend of lean production systems adoption and its related concepts in new-fashioned industries especially in Sweden, requirements of such concept has been set up. However, Obeya as a working space integrated to lean production system has not been well conceptualized. On other hand, meeting places in factories and manufacturing firms play a crucial role within production efficiency and product quality however, it has not been paid attention as much as it should be. As a result, this thesis is concentrating of these meeting areas to find out how much effect do they have on production process, product development and competitiveness of companies. Consequently, a question can be appeared as: while there is a huge demand in product development, why Obeya concept as a main product development tool in lean system is not well conceptualized among literatures and also is not utilized among non-Japanese manufacturing companies.

Objectives and expected result
Regarding to background and mentioned problems in pervious section, objective of thesis and expected result are addressed as follows

The first objective is to gather information and analyze current practice of using Obeya and similar meeting/working spaces in Swedish as well as international industries.

The second objective is to reach a better understanding of possible uses of Obeya in change projects with both radical (kaikaku) and incremental (Kaizen) approaches. Also investigating opportunities for improving Obeya to support such changes in a more effective way is included in this objective.

Research questions
Considering the objectives and expected result, this thesis is broken down to four questions to be answered. The first question is intended to provide a background about Obeya in order to be used as an input for next questions. The first question is connected to the first objective and the last three questions are designed to accomplish the second objective.
Literature reviews as well as case studies were done to answer the first three questions. The last question has been answered according to the results acquired from case studies and observations of authors from those cases.

Here are the research questions:

1- Study the concept of Obeya as a part of lean production system.
2- How obeya or similar meeting/working places can affect daily production tasks including Kaizen tasks?
3- How Obeya concept can help Kaikaku (radical change) projects?
4- What improvements can be achieved through digitalization of meeting/working places?

Delimitation
Since this thesis is based on a Toyota Production system (TPS) and lean manufacturing industry, case studies were chosen among manufacturing companies, which have applied lean system. As a result, the focus was just on the lead companies in Sweden that have global manufacturing footprint.

The aim of thesis is neither designing a room/space nor designing software or hardware to be used in this room/space. Focus of thesis is on how digitalization and lean tools like visualization can be used to improve the Obeya.

Since the study has been done in Sweden, number of international companies is less than Swedish companies, however, BT trucks as a part of Toyota, is a leading company in TPS and lean around the world.

Finally, Obeya was developed to help product development process in Japan; however the real Obeya room does not exist in Sweden according to investigation of authors. Consequently, besides of Obeya, daily meeting places were involved in this thesis to increase the validity of thesis and variety of case studies.

This thesis is compare manufacturing industry and academic area in Sweden, whereas further studies can be performed in other industry and academic areas.

Outline of thesis
Here is the brief description about each chapter
CHAPTER 1: Recount problem statement, objectives and expected result, research questions and delimitations of this thesis.
CHAPTER 2: Research methodology and its validity is described
CHAPTER 3: Respected Lean areas are characterized in details according to previous researches and literature reviewed
CHAPTER 4: Case studies are presented and analysis is performed.
CHAPTER 5: Results, conclusion and future work is suggested
APPENDIX: Related papers of authors are given

Area of relevance and contribution
Several areas is involved in this thesis as follows
Lean system
   Visualization tools
   Continuous improvement (Kaizen)
   Radical improvement (Kaikaku)
Project management
  Product development
  Production development
  Competitiveness

Other areas which is not included in this thesis can be studied for future development such as interior design of Obeya, develop a software or hardware to increase the performance of communication in Obeya, visualization or saving data and etc., innovation and problem solving methods inside the Obeya like brainstorming, knowledge sharing between involved people in Obeya and green systems due to digitalization.
Chapter 2: Research methodology

This chapter describes authors’ scientific views and presents the methodology deployed in this thesis. Moreover, aim, reasons and motivations of using such peculiarly research approach and data collection is discussed. At last, reliability and validity of such approach and process is discussed.

Method

State of the art is reached at the highest level of existing knowledge in order to make advancements by fully comprehending requirements, predecessors, techniques, implementation and latest methodology deployment.

The Production System Development research area is congenitally dependent on the close communication between academia and industry and the research purpose of this thesis is to present results that are valuable for both academia and industry. As a consequence, in order to achieve the objective, theoretical and practical research was constantly carried out with a close collaboration with industry (Fagerström, 2004). Moreover, research result has a direct influence on implementations, long-term learning, and recruitment and future development in industries. On the other hand, collaboration of academia with industries leads to significant impact on education, industrial and knowledge deployment, student recruitment within academia, long-term learning for both sides, initiating research project and quick implementation of researches results. In other words, research problems are formulated and solve by academia stand on industrial issues while research results are approved and confirmed by industries.

Since the aim of this research is to add knowledge and provide a result both for academia and industry, theoretical development was performed along with employing case studies as the data collection method for this thesis. Selection of case studies plays crucial role in research result. Consequently, authors’ experience and information about case studies due to previous student projects, helped to select them. In this research each case study followed the same overall purposes as the others did (Yin, 1994). Besides, as the research is performed at Mälardalen University and the bases of the subject is on lean manufacturing industries, case studies were chosen among international leading lean manufacturing companies in Sweden. The expected result includes cross-analysis of companies as well as analyzing the differences of Obeya’s practice in industrial and academic field. In order to get the precise result, close connection between manufacturing industries and academic area was created i.e. practical and theoretical point of views were put together to achieve the best result (Fagerström, 2004).

Research approach

Augmentation to knowledge is the primary purpose of scientific research (Arlbjørn and Halldorsson, 2002) and all research approaches try to promote knowledge.

Generally speaking, research approach imply as a conscious scientific reasoning. Furthermore, there is various research approaches within production and logistics including mathematical modeling, simulation, survey, case studies and interview (Mentzer and Kahn, 1995). Likewise, various data gathering and analysis methods including qualitative and quantitative are performed in production and logistics. Obviously, quantitative techniques swing with numerical data analysis while qualitative techniques work with non-numerical
data. Notwithstanding, qualitative and interpretative research is rarely done (Arlbjørn and Halldorsson, 2002, Mentzer and Kahn, 1995, Näslund, 2002). According to Kova´cs and Spens (2005), research approach is divided into three main category consist of deductive, inductive and abductive. Differences among these three approaches have been indicated in research process, research purpose and time-wise hypothesis and premises. According to Spens and Kova´cs (2006) in order to evaluate the research method couple of specifications is required including

- What is the start point of research process, theoretical or empirical study?
- Research aims to develop or assess a theory
- Hypothesis and proposition time-wise introduction
- Research method

Regarding to argumentation in deductive approach, direction is from a general law to a specific case and then to the result(Andrewsky and Bourcier, 2000, Danermark et al., 2001, Taylor et al., 2002) This research approach is a theory analyzing process to evaluate the existing theories has been developed before. Deductive approach begins with generalization to find out if the theory employ to particular cases. Deductive approach Browse the literatures strongly, derives some hypotheses and propositions, empirically assess them and finally conclude it according to the result(Kovács and Spens, 2005, Arlbjørn and Halldorsson, 2002)

On the other hand, inductive direction is from a certain empirical case or observations collections to a general law and then to the result(Andrewsky and Bourcier, 2000, Danermark et al., 2001, Taylor et al., 2002) This approach is a theory development process, which commences with empirical observation or facts on the particular cases to generalize a phenomenon. Hence, it is suitable to develop a new theory(Arlbjørn and Halldorsson, 2002). As a consequence, qualitative research is not inductive per definition. In inductive approach, early literature review is not necessary however; hypotheses are derives from the observation, which later lead to theories(Flint and Mentzer, 2000, Andrewsky and Bourcier, 2000, Kovács and Spens, 2005, Glaser and Strauss, 1967). According to this research approach, empirical study in the earlier stage leads to develop propositions.

Abduction is defined as the systemized creativity or intuition in research to cultivate a new knowledge(Andrewsky and Bourcier, 2000, Taylor et al., 2002) and crucially, the creativity makes the difference between last two approaches and abduction. The abductive approach direction is from law to result to case(Danermark et al., 2001). Abductive approach helps to consider actual phenomena in a new viewpoint by using different theories from other fields(Arlbjørn and Halldorsson, 2002, Kovács and Spens, 2005). What’s more, according to Spens and Kova´cs (2006), abductive research may begin with two variant starting points:

1. A “puzzling” and inexplicable observation or an anomaly, respecting to established theory
2. The deliberate application of an alternative theory to explain a phenomenon

Nevertheless, as mentioned before, both cases begin with a real-life phenomenon and observation.

Using theories and real-life empirical observations as well as data gathering simultaneously in abductive approach, generate an iterative loop between theory and empirical study that lead to learning. This process is called “theory matching” or “systematic combining” according to Dubois and Gadde (2002) and is used in case study researches. Usually,
research is started by pre-perception and theoretical experience whereas, in some cases prior theories does not match with empirical observation. Therefore, a creative iterative process is performed to find a new framework or broaden the earlier observations and theories (Andreewsky and Bourcier, 2000, Taylor et al., 2002, Kovács and Spens, 2005, Dubois and Gadde, 2002)

Ultimately, abductive and inductive approaches aim at developing theories however, the first objective of abductive approach is to develop a phenomenon in new perspective in the form of hypotheses whereas the purpose of inductive is to get a result from empirical data (Andreewsky and Bourcier, 2000, Kovács and Spens, 2006). Figure 1 demonstrates three mentioned research approaches and their differences in a very comparable way.

![Figure 1 - Different research approaches, (Kovács and Spens, 2006)](image)

By incremental trend of qualitative techniques in production and logistics, case studies are becoming more fashionable. A common mistake in this regard is to just connect case studies to qualitative techniques whereas literature indicates quantitative methods can also be linked to case studies (Näsland, 2002, Kovács and Spens, 2006, Ellram, 1996). Many case studies are failed to evaluate their conclusion development due to their failure in research method phase. As a result, many of them were labeled as inductive approach while there were deductive. But surprisingly, literatures revealed that majority of qualitative studies and several case studies have followed abductive approach in spite of the wrong belief in using inductive approach. However according to Yin (2003), case study is a research study not a method (Yin, 2003, Kovács and Spens, 2005). Case study allows researchers to keep a holistic and considerable characteristic of real events including organizational and managerial process, neighborhood changes, international connections and advancement of industries (Yin, 2003).

At regular intervals, a characteristic of case study is data collection from various resources and data analysis simultaneously to present the case in detail in a special subject (Yin, 2003, Ellram, 1993). Nevertheless, case studies do not apparently indicate which research approach has been utilized. But in some case studies, interviews and observations, qualitative research methods are used which can be considered as an inductive approach (Flint and Mentzer, 2000, Glaser and Strauss, 1967). Generally, case studies and action research utilize abductive by ordinary owing to data gathering and theory development concurrently (Kovács and Spens, 2005, Dubois and Gadde, 2002).
On the other hand, in different categorization, Arbnor and Bjerke (1994) divided the research approach into three approaches. The analytical approach is mainly positivistic as it is demonstrated in figure 2. Positivistic approach itself deals with realities and uses quantitative techniques like mathematical and statistical methods. In comparison with Kova´cs and Spens results’, positivistic approach is a deductive approach and move from object/low to research/case or reality. Consequently, this approach is mostly utilized for natural science, which base on systematic experiences tries to empirically test existing theories. Moreover, the positivistic approach is a demonstrative knowledge, which is in contrast with hermeneutics approach (Arbnor and Bjerke, 1994).

In contrast with analytical approach, actors approach is hermeneutic and deals with social construction of reality where culture and time are effectual while uses interpretive science. In contrast with Kova´cs and Spens results’, this approach is inductive, foremost utilizes for non-quantitative data and research direction is from cases to a general law (Arbnor and Bjerke, 1994).

The system approach is an approach between actors and analytical while it is more crocked to positivistic while suppose the reality is impartially obtainable. This approach takes more comprehensive aspect in compare with analytical approach and tries to describe in a system theoretical viewpoint (Arbnor and Bjerke, 1994). It is usually used in complicated frameworks where connected activities ought to be assessed (Salloum, 2010).

In the figure 2 the relationship of mentioned approaches is illustrated.

![Figure 2- Different research approaches (Arbnor and Bjerke, 1994)](image)

Choosing what approach is completely appropriate for a research is somehow challenging since various elements are involved, particularly the authors points of view, research questions types and problem formulation.

Therefore, according to the above definitions and descriptions about three different research approach by Kova´cs and Spens, abduction research approach is taken as this research is followed the abductive approach principles. This research neither intends to test and assess an existing theory, which is the aim of deductive approach nor to deal with quantitative techniques like mathematical and statistical models, which is a bases of analytical approach. Furthermore, this thesis uses empirical cases and observation collection to get the result but with an iterative direction between literatures and case studies. Thus, this research does not either follow inductive approach or actors approach. The authors do not attempt to characterize hermeneutical or positivistic elements respecting to their definition.
On the contrary, in this thesis by prior theoretical knowledge in combination with real life observations in different case studies, led to a repetitive loop between theoretical framework and cases study. As a consequence, this loop caused generating new hypothesis and proposition and eventually tests and evaluates each of these suggestions during the thesis. The other reason can be summarized in data gathering and theory development simultaneously is the typical sign of abductive approach (Kovács and Spens, 2005, Yin, 2003, Arnbor and Bjerke, 1994). On top of all, this thesis is dealt with product and production development. Various elements, information and knowledge are used in product and production development such as project management, lean production, process development, visualization and so on. Since, all of these areas ought to be covered during the research and according to the above-defined approaches, abductive approach is the ultimate proper approach in authors’ perspective in order to analyze the subject.

Research process

Research process is defined as the concise of sequential steps that a researcher takes respecting to the research approach. Put differently, research process is the indicator of utilized research approach (Kovács and Spens, 2005). According to the chosen research approach, an iterative process was used. In the process various theoretical aspects were studied in parallel with empirical observations and data collection. As mentioned before this process is called “theory matching” or “systematic combining” according to Dubois and Gadde (2002) and it is mostly used in case study researches and leads to broaden the earlier observation and theories (Kovács and Spens, 2005, Andreewsky and Bourcier, 2000, Taylor et al., 2002, Dubois and Gadde, 2002). As a result, research questions, title and objectives were reviewed during the research conduction. For instance at the early phase of the research, authors concentrated mainly on the Obeya room as a lean tool. However by the progress of the research it became clear that an Obeya room, which completely follows the Toyota’s principles, is not available or at least accessible for data gathering in Sweden. Consequently, the authors began to broaden the research area by including meeting places that exist in each simple company.

Before the thesis started, broad literature study about Lean manufacturing had already been done and authors have reviewed available literatures about Obeya and general perspective of the subject had been grasped. Number of students participated and gave their ideas and viewpoint about implementation of Obeya room at Mälardalen University in the framework of XPRES lab, an ongoing project to support innovation in Swedish industries. Those discussions led to develop the idea to take the first steps. As a consequence, XPRES lab project discussions motivated the authors and gave them a deeper insight about the subject in order to commence the thesis. Number of lean companies was contacted as potential case studies and finally four companies were selected as case studies A, B, C and D according to their capabilities and appropriateness to the topic. Respecting the research approach, an iterative process was performed between literature reviewing, visiting the case studies and empirical data collection. Meanwhile holding XPRES lab meetings at Mälardalen University with other students helped and expedited the procedure. Further ideas regarding the Obeya implementation problems were expressed and discussed. The result was sharing of knowledge between several projects that have something in common with Obeya room. In conclusion, a loop was created consisted of theoretical research, direct observation of case studies and experience by holding meetings at Mälardalen University.
In order to answer the addressed questions, literature studies along with empirical studies were performed. Four companies as A, B, C and D were visited and interviewed. They have been selected according to their commitment to implementing and using lean production tools and methods. Sweden was selected as geographical limiting criteria for case selection. Companies A, B, C and D respectively produce material handling equipment, construction material, powertrain systems and parts and trucks’ mechanical parts. Number of employees of the plants ranges from 160 to 1800 people. At each company production processes observed directly and meeting places were visited and in one case, company C, authors participated in a morning meeting. All meetings, interviews and visits were documented through voice recording and written documentation.

So as to answer the first research question, a literature review was conducted. The purpose of literature review was to present a complement the fragmented view of Obeya or meeting places described in scholarly and non-scholarly literatures. The number of literature that has thoroughly studied the Obeya was profoundly few. Number of books and articles about lean production, has described the Obeya very briefly. However, in some books such as The Toyota Way, the formation of Obeya along with its reasons has been described. Moreover, due to uniqueness of the subject, visualization and innovation inside the Obeya room has been studied by couple of scholars. Nevertheless, regarding the first three research questions and first objective of the thesis, literature study was conducted to review the theories about the subject in order to conceptualize the Obeya room, describe the concept in a more understandable way and finally investigate the effect of Obeya or similar meeting spaces on continuous improvement (Kaizen) and radical changes (Kaikaku). In order to answer questions two and three, empirical study in conjunction with theoretical study was performed. Considering mentioned lack of literatures about Obeya room, literatures about meeting spaces used for production support have been also reviewed. The other related areas about Obeya room such as project management, lean production, Kaikaku, Kaizen, visualization and etc. have been studied as well. In the last step, the analysis and comparison between the case studies and studied literatures were performed in order to conclude a valuable result both for academia and industry.

**Empirical data collection and case study**

Acquiring knowledge about a subject in a direct or indirect observation or experience called empirical research and it is mostly used when inadequate data or information is found in literature(Yamamoto, 2010). According to Yin (1994), there are five ways of empirical data collection included

- **Experiments:** suits for contemporary occurrences in controlled environments when questions stand on "How" and "Why"
- **Surveys:** focuses on contemporary events when it deals with "Who", "What", How many", "How much" and "Where" questions
- **Archival Analysis:** it is appropriate for contemporary and historical cases with "Who", "What", How many", "How much" and "Where" questions
- **Histories:** obviously is perfect for historical cases based on "How" and "Why" questions
- **Case study:** it is proper for "How" and "Why" questions in contemporary actions where there is no control or little control(Meredith, 1998)
Research question type, investigator’s control on the subject and concentrating on contemporary or historical part of the occurrence are the main conclusive factors of choosing the strategy as Yin (1994) stated. The favored benefit of case study, however, is to achieve an integrated and complete overview of the event by studying it from different perspectives (Gummesson, 2000). According to Meredith (1998), empirical study can build or verify a theory while case studies are perfect to generate or broaden a theory.

Since the aim of this research is to broaden the knowledge about the concept and provide a result both for academia and industry, theoretical development was performed along with employing case studies as the data collection method for this thesis. Thus, empirical collected data from case studies analyzed in parallel with analysis of the theoretical foundations. The goal of such approach was to insure providing practical and theoretical result for academia as well as industry in the whole process of the research. Consequently, literature study’s result has been written in the second and forth chapter. Project management, Lean production, Kaikaku, Kaizen and Visualization are included in them. Moreover, according to Yin (1994) and Kova’cs and Spens (2005), the start point of case studies was theoretical framework of existing knowledge. Therefore, when an apparent perspective of the subject was formed, the flow of research was directed to the case studies. Eventually, the authors enter into the iterative loop between theory and case study as it was mentioned in the previous sections.

The data collection analysis in this research consists of categorizing data, evaluating them, and cross-case analysis of the cases. Afterwards, the theoretical framework is compared with achieved results from case studies. In this process, organizing and analyzing the data is an essential part of the research since without it researcher would encounter huge amount of information during the research that obtained from different sources.

As Yin (1994) stated, researchers have six primary resources of evidence to utilize while none of them has complete advantage over the others. As a consequent, they can be used simultaneously and case study ought to utilize them as much as they are relevant to the research. These resources are documents, archival records, interviews, direct observation, participant observation, and physical artifacts.

Interviewing is the most substantial and common resource to gather information in case studies by letting the researcher fully concentrates on the study. However, it has its disadvantages by selecting wrong or inadequate respondents, choosing poor questions, misinterpretations, incomplete collection and reflexivity as interviewee asserts the things that interviewer wants to hear. Direct observation happened when researcher visits a place and gather data. It helps to cover the context in real time although it is time consuming. Occasionally observer’s existence might lead to change the situation and reality. Participant observation is another way of observation that researcher takes a part in a specific activity. For example, visiting meeting places in different companies for this research is considered as direct observation. However, participating in the meetings is “participant observation” that by some means it has the same pros and cons of direct observation. As a result, three above-mentioned techniques were used for this research and case studies to gather the data, although participant observation conducted for just one case study according to companies’ restrictions.

An interview aims to smooth the way that theory can meet practice (Salloum, 2010).
Interview can be conducted in various forms such as open-ended, focused, structured and semi-structured. In open-ended interview, investigator can ask for interviewee’s opinion on the subject and this method is served to approve previously information. In focus method, interview takes only a short time and questions might come from a case study protocol. Structured interview mostly used in studies of neighborhoods where a formal survey is needed.

However, the semi-structured interview was chosen for this research due to flexibility, allowing discussing and causing to come up with new questions during the interview, which according to Carlsson (1984) leads to increase the validity but might decrease the reliability (Söderberg and Alfredson, 2009). The questions asked during the interviews were based on literatures review, objectives and research questions and classified into four general following questions

- How the meeting space is used?
- For what purposes is it used?
- What are the specifications?
- What kind of improvements can be applied to? What weaknesses have been detected?

Questions asked considering the purpose of using meeting places, its usage, who participate in the meetings, what kind of information are displayed or used in the meeting space, who use the information in the room, how the information is managed and visualized and finally perceived benefits and drawbacks. Furthermore, interviews began with introduction of general goals of the research. Small parts of the interviews were dedicated to the company presentation and production process observation. According to the agreement between authors and interviewees, voices and interviews were recorded as an audio file, were stored on computers and finally were transcribed. Two of the four interviews were in Swedish that got translated by authors to English in the later phase of research.

After visiting all companies, input analysis, information organizing and data reduction were fulfilled to cluster the crucial and related data from the interviews. Afterwards, a cross-case analysis was done in order to compare the different information and data from companies (Eisenhardt, 1989, Lindlof and Soderberg, 2011). At last, the theoretical framework was examined in contrast with results achieved from case studies.

To obtain an extensive input and different perspectives on the subject, involved interviewees had different job positions and professional background according to the organizational system of each case and differences between them. But all of them had comprehensive information and experience about the studied meeting spaces as well as their uses.

The interviews were approximately two hours long and since it was a semi-structured interview, various questions in a wide range of fields were asked, which led to opportunities of capturing different and new aspects of the subject that have not been planned previously. Moreover, in order to ensure the data collection quality and validity, both authors participated in all studies and both of them asked their questions from different perception and perspectives, analyzed the data and took notes of important information lied in the interviews (Lindlof and Soderberg, 2011, Eisenhardt, 1989). To be more precise, as mentioned above, direct observation i.e. participating in some morning meeting and documenting the gathered data and also recording the voice were done. Observation by both participants leads to perceive the reality from different perspective although it may
increase the risk of bias (Yin, 1994).

According to the direct observations, different approaches are followed for holding meeting in each case. However, it might be because of different organizational structure and dissimilar requirements in managing. Nevertheless, the general idea and purpose of the meetings were mostly the same.

**Reliability and validity**

Validity and reliability of a research implies the quality of the research that ensures the correctness of the result. In other words, it indicates how the research is applicable in the real world or if other scholars can confide in the result (Gummesson, 2000). It implies that approximately the same results should be achieved if different researchers investigate the same issue with the same purposes (Yin, 1994).

Moreover, as stated by Yin (1994), the result should be generalizable in either of following ways: Statistical generalization or Analytical generalization. Statistical generalization employs the number of samples. The more the samples are, the more data collection would be possible and as a result the research would be more precise. Analytical generalization deals with the deepness of studies. It means how far a researcher focuses on the subject and its features. Hence, few numbers of samples might be covered by quality and in-depth study of issue instead (Yamamoto, 2010).

According to Salloum (2010), the validation of a research stands on five standpoints.

- Internal logic: the research result is formed on previous approved theories exist in the whole work
- Truth: both theoretical and practical aspect of research result should be able to explain real phenomenon
- Acceptance: utilized theories ought to be approved by other scholars
- Application: existence of connection among quality of result and its application
- Innovative thinking: coming up with new approaches or solutions

All above aspects are covered in this research. The Obeya is approved as a standard of development process in Toyota (Liker, 2003). Since Obeya as a working space integrated to lean production system has not been well conceptualized, it can be assumed as innovative approach in production development. Meeting places in factories and manufacturing companies play a crucial role within production efficiency and product quality.

In consonance with Westbrook (1994) while authors were benchmarking the companies, visiting meeting spaces and production processes and interviewing, voices were recorded as audio files and then interview conversations were written down as memos for future utilization. Besides, at each case study, collected information was frequently written down and afterwards taken notes were organized to use in report, analysis and future studies. Moreover, due to documentation and recordings, more reliability is obtained since hearing problem no longer exist and hesitations are prevented (Gummesson, 2000). Furthermore, besides visiting the case studies, other informal information out of the interview was collected through previous company visits as a course project for case B and case C. Moreover, relevant information about the subject was searched on companies’ website and related Internet pages. However, among above efforts, authors’ technical background, experience and skills that led to provided significant insight, might also get involved in comprehending and interpretation of the cases (Gummesson, 2000, Westbrook, 1995).
To look from another perspective, the reliability of a research may not be formulated as true or false but as adequate or inadequate. In this regard, the three preliminary chosen case studies became four to validate the obtained information. However, more companies were contacted but the either did not fulfill the research qualifications or could not participate according to their restrictions. Companies were chosen from different manufacturing industries varied from automotive to construction material industry, in order to cover different aspects and areas. These companies can also be differentiated according to their size, product, culture and manufacturing process, which lead to maximize the learning throughout the research (Stake, 1995, Andersson Schaeffer, 2011). As it mentioned in the previous section, in order to support the objective of the research, variety of interviewees with high experience and knowledge about the subject were involved including. In addition, along with interviews, in all cases production lines and processes were observed, meeting spaces were carefully visited and questions regarding the meeting places were asked in order to increase the validity of the research.

There were at least two-week intervals between each company benchmarking in order to document and organize the previous achieved data from past visit. Meanwhile, authors tried to cover the problems or forgotten questions regarding the each case study and improved and prepared themselves for the next case study. In this way, as it mentioned in research approach section, an iterative loop between case studies performance and theoretical study produced, which led to a better understanding of the subject, covering mistakes or forgotten questions and solving difficulties during the research. Consequently, as the time went on, the procedure of the research got developed and negligence was covered for the next company visit. To prove the procedure, Westbrook (1994) states that there are several opportunities to correct the misunderstandings or wrong assumption during the research.

Afterwards, all gained result of four case studies and theoretical obtained information were compared in all related fields such as visualization, project management and so on.

Over and above, at least twice in a month other master students and a supervisor at XPRES lab discussed all gathered information. These meetings also helped the authors to become more confident about their research by getting feedbacks from the other students and their supervisor. Therefore, it can be assumed that reliability and validity of this research is covered from different aspects and viewpoints.

Furthermore, a paper has been published in an international conference on advances in production management systems (APMS, 2012). External reviewing of the paper by experts and other academic professors from universities or industries, confirm and verify the result of this thesis.
Chapter 3: Frame of references

This chapter reviews previous literatures about integrated subjects in the production system development before addressing the main argue of Obeya in production system development.

Obeya and meeting spaces

The word Obeya in Japanese simply means “big room”. Obeya as a product development supporting tool was introduced by Uchiyamada the project chief of Hybrid car development project in late 90’s (Liker, 2003). This new tool was a part of Toyota’s success in achieving a shorter time to market with reduced cost. Obeya also named by authors and scholars with different words such as “war room”, “program room”, “control room” and “the pulse room”. By any name, Obeya is an advanced visual control innovation room (Liker, 2003) that activities and deliverables are outlined and depicted in a visualize format to be discussed in frequent meetings (Lindlof and Soderberg, 2011). However, in despite of many advantages and application of Obeya in product and production development in industry, Obeya has not been discussed comprehensively in academic literature (Lindlof and Soderberg, 2011).

Since Prius development, Obeya has become a standard supporting tool for vehicle development process in Toyota (Liker, 2003, Andersson Schaeffer, 2011) and one of the first steps toward lean product development at various companies (Lindlof and Soderberg, 2011). Oppenheim (2004) states: “One of four success factors and metrics for lean principle is availability of a large comfortable ‘War Room’ suitable for VSM, for the Program duration”. In the previous vehicle development projects, the chief engineer had to go around the people’s offices in different departments (virtually or physically) to conform to others about a subject (Liker, 2003). Conversely in the new system, cross functional group of expert from various divisions like production, purchase and product development gather on a regular basis in a big room to review the progress and discuss key decisions (Liker, 2003, Andersson and Bellgran, 2009, Söderberg and Alfredson, 2009). Andersson Schaeffer (2011) states that Obeya saves the time since you don’t have to move to conference room or walk to others room since you have the name and face in front of you to ask your questions. In Obeya it is not just the chief engineer who controls ongoing affairs and decisions but all the involved people contribute in managing them together(Liker, 2003), which consequently leads to higher level of cross-functionality in the company (Söderberg and Alfredson, 2009).

Additionally, the obeya’s walls are covered by different types of data to help the project team make more informed decisions through simple and instant access to all required information on the spot and real time. According to Liker (2003), Obeya’s purposes are easier information management and on the spot decision-making.

Obeya accelerates the process of making decisions and consensus by facilitating communications, direct information sharing, team integration sense and maintaining alignments (Anderssson and Bellgran, 2009, Liker, 2003). Olausson and Berggren (2010) states that Obeya makes managers to be able to prioritize tasks and causes more involvement in the decision-making process i.e. higher level of decentralization.

Oppenheim (2004) describes Obeya as an program room which Value Stream Mapping (VSM), all integrated activities and events, program notes, takt times and lean product development flow should be demonstrated on the walls and even other separated meetings ought to be linked to program room. Likewise, smaller rooms are required nearby for breakaway discussions whereas the main room should consist of some facilities such as
networked computers, printers, projectors, ample writing materials along with a big conference table with enough chairs to accommodate the team members. Furthermore, Andersson Schaeffer (2011) mentions that interior design and even size of such room can influence the communication and efficiency of the room.

Obeya can be used to indicate different ongoing projects in the company in order to control the progress and support any further effort (Söderberg and Alfredson, 2009). Andersson and Bellgran (2009) describe that some companies are using a room similar to Obeya in order to check various similar development projects. The aims of such rooms are to integrate product development and production to have better and more production-friendly products. Those companies named following benefits for such room

- Efficient communication, cross functional work and accurate decision-making
- Empowering the project identity
- Facilitating the project manager’s responsibilities
- Time reduction in information flow by visualization
- A possibility to live and breathe the project
- Shorter lead times for development projects
- Positive inspiration for company and its employees
- Achieving and absorbing knowledge
- Reinforce the impression of professionalism

Andersson and Bellgran (2009) conclude that:

“Obeya can be used to reduce waste in the form of unused creativity, long PDCA cycles, low motivation, complicated communication, low dedication or weak representation of the company identity.”

Obeya’s benefits according to their study are:

- Helping to make plan, do, check and action (PDCA) cycle shorter through gathering all decision makers in a single place
- Facilitating communication between team members through face-to-face daily contact
- Supporting the product development through combination of effective communication and proper technology
- Providing an infrastructure for idea generation and development not only for new products, but also for cost reduction.

Information sharing among people with different background and knowledge is problematic. Since in production system design, a cooperation of different functions is necessary, comprehending and using of information by all members is considered as an essence. People with same level of knowledge and background can understand each other much easier. Through Obeya, team members would achieve the common understanding of the project procedures and progress, necessary information and what other functional team are occupied with in an easy and fast manner (Söderberg and Alfredson, 2009, Osono, 2008). Moreover, having different processes or/and projects in parallel might cause difficulties to handle the information. In production systems, empirical findings of Brunch (2012)
determined that high information quality assists the progress of designing and support extensive justifications for each decision even though there is not a specific approach to achieve that. Hence, inadequate information quality causes confusion and delays. It is also said that concurrent engineering increase the risk of information overlapping, which would affect information quality.

Obeya as a powerful tool in capturing and maintaining information from different projects and processes would reduce the risk of information affection as much as possible, since variety of engineers and managers from different segments participate and continuously review and validate the received information to see if there is bias or error. In addition, applied visualization tools of Obeya help to reduce information loss or misinterpretations. According to Bruch (2012), obtaining, sharing and utilization of information are continuous required processes in the entire process of production system design. Obeya is a place where all managers and engineers can get together in the whole process of production system design to constantly update each other’s experience, information and knowledge while it helps supports the documentation of these activities. Besides, Obeya is capable of facilitating personal interaction and communication, which accelerates the information sharing by visualization, clarifies undefined or unclear issues and supports easier consensus and approval. Obeya enables information sharing both inside and outside of the project team which leads to more data exchange and multifunctional discussions. Bruch (2012) explains that availability of information on digital networks like intranets is not enough since it might not be accessible for all members. It is not clear where to find the right data and it is far from imagination to have all design information of production systems available, for instance late decisions.

Information that can be visualized in Obeya varies from design graphics, manpower charts, quality information or financial status to any other crucial performance indicator related to the project (Liker, 2003, Andersson Schaeffer, 2011).

In this study we categorized the visualized information in Obeya into six groups named respectively.

<table>
<thead>
<tr>
<th>Group</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product specifications</td>
<td>- Project goals and main characteristics</td>
</tr>
<tr>
<td></td>
<td>- Drawings</td>
</tr>
<tr>
<td></td>
<td>- Virtual prototypes</td>
</tr>
<tr>
<td>Project plan and schedule</td>
<td>- Project plan and Gantt chart (e.g. MS project or primavera)</td>
</tr>
<tr>
<td></td>
<td>- Project milestones and deadlines</td>
</tr>
<tr>
<td></td>
<td>- Alert board (e.g. delayed critical tasks or incoming deadlines)</td>
</tr>
<tr>
<td>Project organization</td>
<td>- Project organization chart</td>
</tr>
<tr>
<td></td>
<td>- Team members and assigned tasks and responsibilities</td>
</tr>
<tr>
<td>Resource management</td>
<td>- Budget control</td>
</tr>
<tr>
<td></td>
<td>- Man, machine and other resource availability and schedule</td>
</tr>
</tbody>
</table>
Above information can be reviewed by any involved member. As a result, any deviation from the standard, schedule or performance goals appear as soon as possible.

**Documentation and communication**

Bruch (2012) states:

“In order to accomplish the interdependent work activities, design information was shared among the representatives from the various functions involved in the design of the production system”.

Information sharing can be performed by written documents (digital or physical ones) or by communication (face to face or digital). Communication supports resolving complicated affairs due to faster feedbacks and confirmation (Bruch, 2012). On the other hand, written documents are more proper to get customers point of view (Bruch, 2012). Obeya is capable to handle both kind of information sharing. Written documents are mostly in the form of A3 report, which has a standardized format for any kind of information. Such reports are posted on the walls and boards (Söderberg and Alfredson, 2009, Osono, 2008). According to Söderberg and Alfredson (2009), A3 reports are not fully comprehensible without Obeya room. In Obeya, involved people would talk about issues written in the reports and untangle the problems. Consequently, it would be easier to find the subject while you are looking at A3 report and listening and watching the facilitator or responsible person. Moreover, Andersson and Bellgran (2009) confirm that standing beside of visualization on the wall, looking, discussing and indicating things make it easier and quicker to grasp the project. As it was mentioned before, documentation is an essence for companies in their learning process from prior mistakes for future projects. Moreover, as stated by Brunch (2012), documentation and information collection regarding to functions, properties, and capabilities of the technical, material supply, human, and control subsystems is vital to design production system as well. However, researches of Söderberg and Alfredson (2009) and Bruch (2012) indicate that, many companies do not concentrate adequately on documentation. In production development, there is a lack of prioritization and documentation of information related to above areas in early phase of concept generation in industrialization projects (Bruch, 2012). This information is only transferred orally throughout meetings without any standard or routines. Therefore, these experiences and information is not established in an inclusive standardized written format whereas, Bruch (2012) declares that the formalization level is vital for information sharing. When a product or production is developed, various technical methods are tested to get the particular savory
solution. The process of evaluating and testing all those options i.e. why those ideas got failed and why this particular one was accepted need to be documented in order to use in the similar future projects. Optimistically, only the successful idea is documented in some companies while in the next future projects wrong ideas might be again evaluated, which lead to time and cost waste. Generally, when the problem is solved it is moved out from the board or system. If there is no system to recall the grasped knowledge about the problem, there is a risk of losing the information and knowledge about the problem. As a consequence, perhaps the same mistake will be repeated in future, which comprise both money and time waste for the company. Besides, high turnover rate of personnel between projects or among companies makes this matter worse since experiences were not documented and involved people might not be available anymore. On the other hand, perhaps the failed idea in one project is the right idea for another project, which justifies the importance of documentation. As Bruch (2012) states, replacing production system becomes more complex with absence of information from previous existed production systems. Thus, regarding to requirement of a system to store A3 reports from variety of projects (Söderberg and Alfredson, 2009), Obeya is the best tool to collect information and experiences in a standardized format, save them, reuse them whenever they are needed and retrieve them in visualize way in future for further development or improvement.

Information sharing in term of communication can also be conducted through face-to-face meetings or digital equipment installed in the room to communicate with people in other physical places especially for projects like global product development.

**Lean production**

During the last decade, globalization has been increased and various companies around the world try to dominate different part of the global market. But what makes some companies successful and different form the others is their ability of competitiveness and flexibility. Nowadays, Lean production system is the most valuable tool to achieve mentioned capabilities, as it has a huge impact on production process (Liker, 2003). Less than twenty years ago, a book named The Machine that Changed the World was published and inform all western manufacturers that Toyota is far advance than any other company in the world with sense of producing cars with less time, energy cost and more efficiency and quality (Söderberg and Alfredson, 2009, Kennedy, 2003, Womack and Jones, 1991). Although many companies right after tried to copy and apply Toyota’s system, they could not and still cannot reached what exactly Toyota is doing (Söderberg and Alfredson, 2009, Liker, 2003). Nevertheless, some scholars distinguish Toyota’s production method from others with just their intensive tendency to keep looking for improved solutions (Warnecke and Hüser, 1995).

Toyota has utilized lean production system as a revolutionary approach, which is known for Toyota Production System or TPS. Toyota’s exclusive approach is applicable in any organization and process, no matter if it manufactures or services. The key factor of Toyota’s success is owing to operational excellence, which is basic part of lean tools such as JIT, Kaizen, Kaikaku, Jidoka, Heijunka and one piece flow. These techniques along with Six Sigma are the implementation tools of lean production although lean thinking plays the most substantial role in this philosophy (Liker, 2003).

Lean manufacturing is a philosophy that concentrates on adding value to the customers by eliminating wastes and ineffective works. However, value is defined as any process in production that costumers favorably accept to pay for it. Moreover, lean is combination of
various tools such as Kanban, 5S, Just In Time, etc. with the main goal of increasing the efficiency as much as possible base on optimization of flows. To put differently, manufacturing industries have understood that lean is not couple of techniques and mentioned tools but a philosophy that ought to be grasped by whole involved people in organization or company (Andersson Schaeffer, 2011). Therefore, spreading lean thinking among workers, employees, managers and suppliers is an ultimate goal of lean to maintain a learning organization (Liker, 2003). Besides, lean product development tries to broaden lean thinking through clarifying responsibilities, standardization learning mentality and visualizations (Söderberg and Alfredson, 2009).

According to Womack and Jones (1991) lean can be divided into five levels consist of customer value, the value stream, flow, pulling from customers and perfection. Lean production yield for concentrating on flows by adding value in each step without any stoppage and pull customers demand to replenish regarding to the next station requirement while the whole system should be comprehend the continuous improvement and learning. Moreover, changeovers, standardization and error proofing are the essence of flow concentration (Womack and Jones, 1996). In other words, Lean can be defined as reducing lead times by eliminating wastes of processes that lead to high quality, low cost, high safety and high spirit within company from product design to deliver the product (Womack and Jones, 1991). However, Warnecke and Hüser (1995) defined lean as a system of methods and measure that together lead to competitiveness not just in manufacturing part but in the whole company. According to them four individual aspect in lean is defined as product development, supply chain, shop floor management and after sales service (Warnecke and Hüser, 1995).

Surprisingly, lean production has its fundamentals in mass production and the idea of removing non-value added works in process, comes from scientific management at Henry Ford’s times in 1920s (Andersson Schaeffer, 2011, Liker, 2003).

Sweden as a country with number of high technological production industries, particularly car and trucks manufacturing such as Volvo, SAAB, Scania, has invested a lot on lean production systems in the last decade and lean implementation tracks are visible in majority of big companies with worldwide reputation. As a result, the Swedish industrial research institute, Swerea IVF, couple of years ago started a project to identify what is lean production and what benefits is achieved through implementing it. Couple of companies who were interested in lean approach got involved and they were financed by Vinnova.

Furthermore, various researches and investigations have fulfilled to get more clear vision of lean process in order to reduce the gap between Japanese and Swedish industries.

Consequently, involved companies in this thesis are chosen among lean manufacturing companies in Sweden, which are absolutely at top of ladder of their proficiency.

According to Liker categorization, wastes are divided into eight or sometimes seven non-value adding wastes that the companies studied in this thesis continuously try to remove them by having morning meeting in their meeting places. In those meeting places, problems are shared and discussed with different experts from different segment of company in order to continuously eliminate them. Those wastes includes overproduction, waiting, unnecessary transport, over processing, excess inventory, unnecessary movement, defects and unused employee activities (Liker, 2003). However, each company has its own way to hold meetings with the sense of meeting’s time and frequency of meetings.
Trying to eliminate wastes, improving communication among different segments, brainstorming to solve problems and etc. can be done in such meeting spaces or Obeya room if we disregard some special features of Obeya definition.

Obeya means big room in Japanese and for the first time it were used to develop Pirus. Experts from different departments got together in a big room to review the progress of the project, discuss cross functional and make decision on the spot and since then it has become a product development process in Toyota. Obeya gets help of visualization tools to show information as clear as possible in the room to accelerate the decision making process (Liker, 2003).

The purpose of Obeya is to ensure project success and shorten the plan-do-check-act cycle by improving information management, reduce time and bureaucracy, increasing team integration, making problem visible and better understanding of the project goals.

**Kaizen**

Global competition among manufacturing companies around the world makes companies to deal with fluctuations in products demand, volume, variation, life cycle and technologies. As a consequence, to keep being competitive among others, continuous development in process and production is the most significant requirement (Yamamoto and Bellgran, 2009).

Kazien, Japanese for continuous improvement refers to incremental improvement approach in process in order to enhance the production performance (Liker, 2003). International Research Community considers Kaizen as the main reason of high competitiveness of Japanese manufacturing companies (Yamamoto, 2010). Whether it is a small or big improvement, it should be incessant and follow the philosophy of lean and Toyota Production System which lead to organizational learning (Liker, 2003, Imai, 1986). However, it does not mean that just Toyota performs it. Kaizen has become a characteristic at top companies in Japan. This concept is well recognized by most companies around the world as well and various tools and techniques have been developed and are being applied to support Kaizen such as quality control circle, policy development, Mottainai and Muda (Yamamoto, 2010, Liker, 2003).

Mostly Kaizen consist of effective group working, problem solving, data collection, analysis and documentation and finally process improvement. Kaizen is based on Deming Cycle or Plan-Do-Check-Act Cycle (PDCA) (Liker, 2003). In another way, Kaizen process can be defined in three steps as see, think and act. In the first step, shop floor is carefully observed by severe eyes to identify problems. In the next steps, solution is defined and implemented (Yamamoto, 2010). Additionally, Kaizen characteristic can be considered in three perspective including process orientation, people orientation and small step improvement. Process orientation refers to process development while good result automatically will appear. People oriented means all involved people from top manager to simple employee should believe it continuous improvement (Berger, 1997, Imai, 1986).

Similarly, Brunet and New (2003) defined almost the same features for Kaizen including continuous, incremental and participative. All these activities implemented by holding decision-making sessions and group consensus (Brunet and New, 2003, Liker, 2003).

Moreover, whenever a waste appeared, all employees have to eliminate it by using Kaizen. One impartible technique within Kaizen is 5whys to get deeper level of problem. It means when a waste expose, the root cause of the problem should be found by keeping asking whys continuously until the main reason become clear (Liker, 2003). According to Yuji, severe eyes or Gemba eyes are crucial in Kaizen to find any kind of problem at the shop
floor, get a holistic perspective of operation management and keep improving the shop floor. Furthermore, improvement can be performed by using simple but creative things such as pen and cartons (Yamamoto, 2010). In addition, the time between recognition of the problem and taking action is important. Sometimes regardless of risks and uncertainties, improvements ought to be initiated in order to obtain further and better ideas even with small changes. With the perspective of performance enhancement and organizational learning, faster reactions lead to learning by doing approach (Yamamoto, 2010).

On the other hand, Kaizen or continuous improvement is not achievable until the process is standardized. First it should be standardized and stabilized in order to implement Kaizen. Consequently, typical activities become part of the standard process and evenly decrease the wastes (Imai, 1986).

According to Yamamoto, in order to engage Kaizen in industries, 8 guidelines have been developed (Yamamoto, 2010):

Problem discovery by severe eyes:
1) Observe a shop floor with severe and critical eyes in perspective of 5S, visual control, 7 Muda and so on.
2) Never be satisfied with current operation
3) Repeat why when one sees abnormalities
4) Do not blame operators, but blame system or standard

Generating simple but creative solutions:
5) Use wisdom thoroughly before using money, use simple handmade devices or solutions
6) Create temporary solution even if the optimal solution is unknown or takes time to be implemented

Taking immediate actions:
7) Initiate change right away when a solution can be implemented immediately. Small improvement can be performed on the spot especially 5S problems.
8) Initiate change even if there is an uncertainty. More improvements will be found after the change. Small changes can be undone simply enough.

As it was mentioned before, Kaizen has been well established among scholars, managers and practitioners. But it is still a long way to fully implement Kaizen within industries although Japanese manufacturing companies such as Toyota comprehend and utilize the concept. As a result, despite of well conceptualize definition of Kaizen in the literature, practice of Kaizen is not well performed within the manufacturing industries (Liker, 2003, Yamamoto, 2010, Yamamoto and Bellgran, 2009).

Obeya as a lean tool in manufacturing industries can accelerate the trend of implementing Kaizen in industries. Within Obeya, all other lean tools can be considered and questioned if they are implemented good enough or not. Obeya is a room where people from different part of company such as production, quality control, product development and so on get together. It can help to shorten the decision making time between problem recognition and taking action since all necessary people are there. On the other hand, it helps to standardize the process and things since it is a place to show whatever is going on in the company.

Combination of Obeya and Kaizen can be referred to Kaizen corner, which was built for education, short time daily meetings with managers and group leaders and engage the labors through training and morning meetings (Liker, 2003). Consequently, integration of kaizen and Obeya as Kaizen corner at case study B as described in the next chapters.
**Kaikaku**

Kaikaku is a Japanese translation of drastic improvement (Yamamoto, 2010) and it refers to improve the production in a frequent radical way in compare with Kaizen which is small, graduate and continuous. Kaikaku mostly follow top-down approach and is initiated by top management since existing practices is changed fundamentally within a new knowledge, technology, method or strategy. The result of Kaikaku, obviously is higher than Kaizen, between 30% to 50% according to Yamamoto (2010) However, in other literature, Kaikaku has been defined as Kaizen blitz that a profound improvement in a limited area as well as limited time duration is performed by small group of people (Bicheno, 2004). By any definition, the best example of Kaikaku can be found in mobiles phones. Competition among phone manufacturers started in the late 1990 when almost all mobile phones manufacturers started to combine the functions of a personal digital assistant (PDA) with mobile phones. Then during a very short time from 2000 to 2005 different new functions were added to mobile phones that respectively made the users be able to listen to radio, take a picture or capture videos, listen to music, use touchscreen display, be able to read office files and hundred more functions. All those improved functions can be considered as Kaizen. But suddenly in 2007, Apple Inc. introduced their first mobile phone with multi-touch screen instead on typical smart phones with different type of keypad and displays. Apple dramatically changed the market's requirement and caused all mobile phones manufacturer to change their direction toward this new requirement. At that point, mobile phones manufacturers needed a huge change in their companies to focus on innovations and new ways of competitiveness. And Kaikaku happened in most of them by putting away the traditional mobile phones and starting to produce brand-new smart phones that can answer the new appeared requirements in market.

Moreover, it can be mentioned that Kaizen is considered as a part of Kaikaku, besides of Kaizen’s utilization to maintain improvements of implementing Kaikaku(Imai, 1986).

What’s more, according to previous literature studies, companies who are capable of implementing continuous improvement and Kaizen during their daily production are more prepared to handle Kaikaku projects and sustain their competitiveness. Brunet and New (2003) assert that Kaizen make it easy to conduct a Kaikaku project within a company by preparing mindsets for a radical changes. Likewise, as people of an organization are vital and the most value (Liker, 2003), companies who could prepare mindsets of workers, inventors and managers in earlier stages, are more successful than whom just focused on technological aspects(Dilokpimol and Surasawadi, 2012). Besides, it is emphasized that
radical improvement needs a change and readiness in all areas not just production system. Changes in workplace, involved people, structure of organization etc. is essential to support Kaikaku.

Furthermore, Yamamoto’s model (Figure 4) helps to comprehend Kaikaku by diving it into four different types that can occur within a company.

Kaikaku can be new for a company or entirely new for industry. As a result the horizontal axes of the above model consist of:

**Incrementally innovative**: When a new production system is result of Kaikaku for a company while this system is already exists, i.e. it is new just for the company not industry, for example implementing Six Sigma or Lean or even 5S in a company.

**Radically innovative**: This type of Kaikaku means when a very new system is introduced to company as well as industry, i.e. it is new for both sides.

Area of changes can be also different, so we have two types:

**Structural**: This changes are more basically and often hard to undo them like automation, production capacity and volume per year.

**Infrastructural**: Those changes that happen continuously and need improvement during the time such as cost control and maintenance.

However, one thing that should be considered is when and what type of Kaikaku is suitable for company. It is said that infrastructural changes should be performed first. Moreover, improvement of operation and layout should be done before thinking about new equipment or automation. As it mentioned before, incremental Kaikaku is also required before a radical Kaikaku. Anyway, the best practice of Kaikaku is to implement according to below sequences.

1. Kaikaku type II, infrastructural change” like TPM.
2. Kaikaku type IV, or I which are respectively infrastructural change beyond the state of the art and structural change, depending on company’s conditions,
3. Kaikaku type III, structural change beyond the state of the art.
The most important thing is how Obeya would help Kaikaku? According to this categorization, Obeya as an existing tool cannot be placed in radically innovative Kaikaku. On the other hand, Obeya concept can be placed in infrastructural since regarding to the description of structural, it tends to have long-term impact, it is difficult to undo, requires an investment and works like a facility or an equipment. As a result, Obeya fits into Kaikaku type II, structural change. Fortunately, Kaikaku type II is the most common Kaikaku among companies which all companies have experienced it, although it is the most common one, majority of companies prefer not to report it in public. Nevertheless, respecting to the trend of lean transformation in companies around the world, especially in Sweden, the need of Kaikaku activities cannot be neglected and consequently the Obeya.

**Visual management**

Visual management tools along with computer-assisted design are utilized in Obeya to support the meetings and consensus. Visual management tools help the team to check the schedules, checkpoints and in general different aspects of the project in the shortest possible time (Liker, 2003). In other words, it is mostly said that visual management is the fundamental tool in Obeya that charts and graphs are demonstrated everywhere in the room in order to increase the communication and information sharing (Andersson and Bellgran, 2009). Obeya is capable of holding stand up meetings in mornings and sit down meeting in afternoon. Stand up morning meetings supports above mentioned issues. Activities and critical issues that ought to be addressed including production goal, resource assignment, previous problems and at last quality, delivery and cost difficulties can be discussed in such meetings. On the other hand, sit down meeting is held after shifts following up the morning meeting to discuss matters such as status of delivery, production disruptions, scrap parts and defects and finally safety issues of the day that results in action lists for next day or shift. Nonetheless, constant meetings help team members to achieve higher level of efficient information (Bruch, 2012).

Moreover, visualization and attractiveness of such common space enhance the “proximity or exposure to one another”, which provoke face-to-face communication (Andersson and Bellgran, 2009). Physical proximity increases the information exchange by enhancing frequent information sharing in an informal and face-to-face contact (Bruch, 2012) and facilitating understanding of each other (Bruch, 2012). In addition, informal communication even in halls or lunch and coffee breaks leads to better collaboration in process and less uncertainty. As it mentioned above, by gathering all involved engineers and managers in a single room and illustrating different information everywhere in the room, the requirements of walking around is disappeared. Therefore, distance is shortened and walls and upper lower management are broken between involved people in order to have higher level of cooperation and on the spot decision-making. Furthermore, in production process and development, communication medium plays an indispensable role that controls the information transfer (Bruch, 2012). During the production system design, information regarding to problems and challenges is shared and risk of delays, lost and changes is reduced. Communication allows quicker feedback, discussions, elucidation and solving unclear issues by for example having a face-to-face meeting. Hence, Obeya provides the place for frequent face-to-face meetings and even facilitates the communication among involved people.

Furthermore, Obeya is a capable tool in supporting Kaizen and eliminating eight wastes in
production (see chapter 2). Illustrating different information in the company makes sales data, costs and quality visible and might enhance the involvement. Visualization tools inside the Obeya make problems to be localized immediately (Andersson Schaeffer, 2011). Moreover, Obeya leads to production improvement and Kaikaku in industries (Andersson Schaeffer, 2011).

Visualization is a strong tool in lean implementation as it is one fourteen principles of Toyota, “Use Visual Control So No Problems Are Hidden” (Liker, 2004). This key makes the process transparent and enables all involved people from shop floor to senior management see the various aspects of the process and its situation at any time. Therefore, quick feedbacks of real status are given to fulfill the requirements (Parry and Turner, 2006, Andersson and Bellgran, 2009, Womack and Jones, 1996). Visualization implies any communication tool at work place that helps team members to understand immediately whether the work is performed in a correct way and if it is deviated from the standard. It indicates the exact status of the process with various type of information that is vital for workflow and certifies a fast and suitable execution of the operation and process (Andersson and Bellgran, 2009, Liker, 2003). Visual management guarantees that the organization’s goals are apparent and all essential information is accessible to do the work as efficiently as possible. Visualization helps to compact the data into visible format that is controllable, manageable and easy to discuss (Sobek and Smalley, 2008). It simply assures communication and increases the knowledge sharing among involved people (Lindlof and Soderberg, 2011). Visualization systems increase productivity and safety, decrease mistakes, defects and costs, facilitate communication, leverage investment or resources and provide more control over the work environments (Liker, 2003). Furthermore, visualization helps to reduce eight wastes by supporting fruitful communication, cross-functional work, and decision-making procedure, strengthen the project identity, facilitating project management, reducing lead time for development projects and finally inspire workers in a positive way (Andersson and Bellgran, 2009). The best way of visualization consists of graphical representations, posters, pictures, symbols, transparencies and color-coding along with audio signals (Bilalis et al., 2002). Human brain processes the pictures much more easily than a text. Researches indicate that human automatically pay attention to mobility and visual things (Andersson and Bellgran, 2009). It is believed in Toyota system that visual management would complement human since human brain is audibly, tactilely and visually oriented (Liker, 2003).

Since a common problem among managers and engineers is information overload, sharing knowledge and information in a visual approach leads to simpler, quicker and a more effective results rather than reading long documents full of texts (Parry and Turner, 2006, Martin and Remo, 2007). Literally the most time consuming way to express the ideas is to present them in a lengthy report with technical descriptions and data. Variety of methods is utilized to help this principle in order to smooth product development and production process. The most important tools in visual management are the meeting rooms, A3 reports, whiteboards, Andon boards, updated standard work charts etc. (Andersson Schaeffer, 2011, Liker, 2003, Parry and Turner, 2006, Oppenheim, 2004, Sobek and Smalley, 2008).

It should be mentioned that, this section does not attempt to explain or review all the visualization tools in the lean practitioner’s package. The concentration is on visual control tools inside the Obeya/meeting spaces. Other tools such as Kanban, the one-piece-flow, 5S and shadow paint of tools, associated with lean production to improve and facilitate the flow in order to make any deviations from the standard visible are not mentioned in this
research.

By visualization, team works are affected and improved since project teams obtain higher level of knowledge transfer within the projects (Lindlof and Soderberg, 2011). In the current literature knowledge is separated into two types: Tacit knowledge and Explicit knowledge (Söderberg and Alfredson, 2009). Explicit knowledge is “knowing about” i.e. facts and theories while tacit knowledge is “knowing how”, i.e. skills in how to do things. However, transferability is the main distinctness between them. Explicit knowledge can simply be documented and spread in an organization through reports and illustration while tacit knowledge is achieved through practice and often transfer expensively, uncertainly and it is time consuming (Söderberg and Alfredson, 2009, Jugdev et al., 2011). It supports and promotes tacit knowledge transfer in term of quality and speed (Lindlof and Soderberg, 2011, Martin and Remo, 2007).

That information ought to be displayed that add value to the process. Common information in production areas includes production output rate, safety issues, defect rates, quality information, human resource leveling, activity priority, delivery schedule and production system of that company. In order to manage all this information about different activities in various projects and processes in different divisions, an usual approach is utilization of software-base tools to handle this huge amount of information (Likker, 2003). One of the goals of information technology and automation is to make offices and factories paperless. Internet and computers make it possible to call for large amount of information both in written and visual as quickly as possible and then share them through email or software. Despite of above requirement, most companies still using physical visualization rather than digital ones. The answer lies on usage of digital visualization. Extravagance use of software leads to local and relational differentiation and increase the requirement of information processing capabilities (Lindlof and Soderberg, 2011) and it means less communication among engineers and even managers, which is against lean principles in some aspects. Furthermore, physical boards might be easier to display and overview data in comparison with software-based systems (Lindlof and Soderberg, 2011, Parry and Turner, 2006). According to Parry and Turner (2006) physical limitations of the physical visualization boards make better concentration on quality and information illustration. Likewise, software or computer-based systems inevitably make operator experts though cause inherent drawbacks. Moreover, looking at screens makes isolation and removes workers attention from where the real work is being done (Likker, 2003). By electronic boards, just few numbers of employees take control of the boards and it leads to loss of the group ownership. In contrast, all team members can change the physical boards, which make an equal authority among members. Although electronic data can be projected and illustrated on screens, they cost more both for shopping and maintaining (Parry and Turner, 2006).

On contrary of above statements, the disadvantages of physical boards and notes are:

- It gets more difficult and time consuming to update the current situation precisely due to the fact that boards and sticky notes are artifacts
- Owing to being artifacts, usually they are not documented for saving historical data relating to project progress or for later follow-ups and knowledge sharing
- As soon as a note is moved out or erased, any link doesn’t exist anymore to show how the moved task would have impacted the other things in the project or team members work
• Amount of documentation in practice is limited
• Due to multiple sites, it is difficult to connect the boards to each other
• Connecting causal link among activities is problematic

All above disadvantages expected to be solved by using digital or software-based visualization technology (Lindlof and Soderberg, 2011). Oppenheim (2004) asserts “The wall layout is preferred to an electronic implementation, because it enables the Core Team members to read all tasks, brainstorm, and negotiate in real time the task parsing, precedence, concurrency, synchronicity, scope and effort, inputs and outputs, and waste, to finally reach a consensus.” However, being unlimited to save documents may lead to overwhelm, confusion and probably prevent reviewing and controlling all information (Parry and Turner, 2006, Taxén and Lilliesköld, 2008, Bruch, 2012). Nevertheless, avoiding information technology is impossible and no one can hide it. The challenge is to find a balance to use an available technology in the best way to support employees by improving the visual control. This balance might be a combination of both approaches as Toyota uses wall-sized screen to show 3D images of vehicle in the service parts warehouse in Hebron along with physical visual signals (Liker, 2003).

As it mentioned previously, boards are one of the most common and simple tools in visualization (Andersson and Bellgran, 2009) that is used in various environments especially offices and floor shops. Standing beside of a visualization tool like board and looking at it, discussing and showing different aspects (Andersson and Bellgran, 2009). Boards help to enforce a continuous flow of work within a day by displaying the real status of the operation in a determined period or by showing pace of operation, progress of process and takt time (Liker, 2003). As a consequence, visibility to the progress of each task or/and being behind of the schedule is immediately indicated to provide extra effort. In some companies, “dashboards” demonstrate information about the current situation of service provision, production and process in a graphical outputs and performance indicators (Parry and Turner, 2006). Furthermore, placement of the boards is a crucial issue since it supports interaction and leads to exchange actual planning information. According to Liker (2004) and Anderson Schaeffer (2011), the best place to visualize is right at the site, which by sound or sight let operators and production technicians understand the deviation from the standard. In addition, crucial problems or unclear issues can be attached on the boards to be discussed and elucidated. Boards are used to hold meetings in center of production to check the daily progress, Kaizen activities and review the state of the process. Absence or presence of labor is also displayed on the magnetic boards to indicate the current availability of individual workers, departments or divisions in the firms (Parry and Turner, 2006). This feature leads to easier workload leveling during the shifts. Boards become more advantageous by using colorful notes to distinguish different issues such as problems, deliveries, defect’s rate and production ratio of a day in each division (Lindlof and Soderberg, 2011, Parry and Turner, 2006). Team members at Toyota constantly update visualization white boards called process control boards (Liker, 2003). The purpose of such well-designed boards with charts and graphs is to indicate the current status of the projects and workers’ workload, inform what’s going on in plant, demonstrate a desirable view of the project and support the project teams to have a better perspective of project progress. Additionally, cameras can be installed to capture the information on boards. Later the captured information would be displayed on a sheets or screens in another division. Some companies go further and use a completely
electronic visualization in a room where team members standing around a big board. This big board gives a higher feeling of ownership as they stated (Parry and Turner, 2006). It is often said that each team ought to develop its own visual management boards to have full authority and control on them. Different teams have different knowledge. They might also use different kind of information with different standard. Level of benefits by using the board can also be different. Thus, various standards, information and levels require higher ownership and “one size fits all” boards need to be avoided since each team, division or department has its own objective. Having a different board in different part of firm drives some principles (Parry and Turner, 2006):

- Concentrating on the delivery in a form of time, quality and cost
- Guaranty efficient resource utilization
- Bottleneck and work in process (WIP) identification
- Showing key performance indicators which are affected by activities and focused on Kaizen
- Creating cross functional communication through boards

In another perspective, information availability is not a problem but communication of information is often not efficient enough (Bilalis et al., 2002). Communication is essential to provide new knowledge and solve problems among involved actors (Andersson and Bellgran, 2009, Taxén and Lilliesköld, 2008). Real time data on the boards lead to efficient communication by reducing the amount of exchanged information via emails, papers, reports and discussion, which were caused time wasting (Lindlof and Soderberg, 2011). Communication in form of holding frequent face to face meetings and cross-functional conversations leads more information flow among team members as well as displaying holistic view of the project progress (Lindlof and Soderberg, 2011). This communication helps to identify problems in earlier phase of the project, level the workload and manage tasks more efficient. Furthermore, clear communication guarantees above mentioned information to be understood across the company (Parry and Turner, 2006). Visualization boards support possibility of spontaneous argument about the demonstrated information on the boards in daily work (Parry and Turner, 2006, Olausson and Berggren, 2010).

As it was mentioned, possibility of problem solving in early phases is another benefit of visualization. This can be due to frequency of meetings and visualization tools usage. By visualizing the activities, deliveries, problems and so on, involved people get more tendencies to discuss their problems with the others. Moreover, through visualization tools, manager can prioritize the activities in an easier way and engineers get more involved in decision making process, which implies a higher degree of decentralization (Olausson and Berggren, 2010).

A very common tool in Toyota is that managers and engineers put information on an A3 piece of paper. A3 report is one sheet standard report documenting process by demonstrating graphs and charts as well as texts or pictures in order to maintain and develop the obtained experience. A3 is in easy format to be understood by all members in contrast with difficulties in written reports, which lot of information should be browsed to find the right information. Sharing information with others on A3 reports leads to information quality, receiving right inputs and achieve consensus. By having inadequate information quality, the risk of inabilities to find the right information or to use the
information in the task, would be raised (Bruch, 2012). An A3 report would concisely mentions the problem, current status, root cause, suggested solutions, chosen solution and even cost-benefit analysis (Söderberg and Alfredson, 2009). The basis of A3 report is based on Deming’s Cycle (PDCA- Plan, Do, Check, Act). However, A3 report starts with deeply understanding of the current situation. Moreover, A3 report can even be consider as a learning process that helps to hold effective meetings in term of quickness and being interesting (Söderberg and Alfredson, 2009).

In order to design, develop, manage and improve a process, Value Stream Mapping (VSM) is a fundamental technique in lean manufacturing. The objective of VSM is to eliminate non-value- adding activities, decrease resources, delete wastes and reduce the time operation (Parry and Turner, 2006). Another lean tool that can be used in meeting spaces is Andon board, which is utilized to provide information about the status of production and its problems.

All these visualization tools are used in the form of data communication in meetings. These meetings facilitate the communication process by helping employees’ actions toward desired consequences. Meetings are held in a regular period around the boards to evaluate the progress of each project in each division. They might be held in different level in term of participants and period. At the meetings, people update each other about the statue of their division, which lead to facilitating the knowledge-sharing loop (Parry and Turner, 2006). There is couple of requirements to hold an effective meeting that without them, meeting would be pointless, time consuming and ineffective to consensus (Liker, 2003)

- Clear objective before the meeting with clear tasks and deliverables
- Right people at the meeting
- Each participant should prepare necessary documents for meeting
- Powerful visualization tools
- Information sharing prior to the meeting
- Determined meeting duration

Meeting is the best place to discuss problems and projects’ contents. Group meeting is also considered as the most intuitive way of sharing knowledge (Söderberg and Alfredson, 2009). Some meetings are held in floor shop to handle daily short tasks in a project. Bigger meetings are held occasionally with project leaders to handle parallel projects. However, some companies use “technical meetings” to obtain higher level of standardization. Obeya can handle all above kind of meetings in order to accelerate the decision-making process.

Visualization is inseparable part of Obeya room and is one of the first steps toward lean implementation in various companies (Lindlof and Soderberg, 2011). In Obeya deliveries, activities, outlines, project goals, characteristics, milestones and deadlines can be displayed on a physical or and digital boards while discussions along with brainstorming sessions can be held. Obeya, war room or program room is a strong visualization tool in lean that illustrates information in a visual, living or and electronically searchable format in a room as well as gathering engineers and managers to expedite the decision-making process and consensus (Morgan and Liker, 2006a, Andersson and Bellgran, 2009, Söderberg and Alfredson, 2009, Oppenheim, 2004). This room by the help of mentioned visualization tools, controls proceeds of the projects, facilitates cross functionality and information accessibility, accelerates consensuses’ procedure and helps to understand what the other functional
teams are doing (Söderberg and Alfredson, 2009, Morgan and Liker, 2006a). The same concept is occasionally used as Lean corner or Kaizen corner to show information.

**Project management**

Generally speaking, projects are defined in term of plans, tools, organizations, and resources with a certain objective. Project management is about arranging, modifying and constituting all related matters to contribute in order to obtain the goal within some limitations (Taxén and Lilliesköld, 2008). Usually, projects are assessed according to the tradeoffs among time, cost and scope aspects. Optimization of each criteria lead to entire project optimization and that’s what all managers try to achieve. Project management process has been receiving more attention in last decades since it is a powerful tool in firms’ competitiveness (Jugdev et al., 2011). However, complexity of projects caused managers to have a holistic view of the projects and make them disable to go through the details such as individual work tasks and their relations. It is mostly tried to develop allocated resources to shorten the activities. However, long-term development in production and product got less consideration (Söderberg and Alfredson, 2009).

One of the essential problems in project management is how to facilitate sharing of tacit knowledge. As mentioned previously, tacit knowledge is shared informally by social exchanges and practices (Söderberg and Alfredson, 2009, Jugdev et al., 2011). Obeya through regularly gathering engineers, managers and even some workers from different division helps to spread the knowledge by exchanging ideas and practice of communication. As a result, beside of explicit knowledge sharing, it would lead to tacit knowledge sharing among team members. Obeya through removing the wall between offices lead to easier communication to see what others do, where the problem is, who is struggling with is and make it simpler to go and talk about the problem. Furthermore, Obeya provides a place for project participants to prioritize the project (Andersson and Bellgran, 2009). Moreover, coffee breaks or “Fika” can be done in Obeya, which absolutely help informal knowledge and experience transfer between involved people. Andersson and Bellgran (2009) explain that Obeya affects work organization by increasing the operators’ and production technicians’ interest to spend more times in such meeting space to socialize and gaining technical information. Moreover, in order to facilitate and coordinate the communication in projects, images, graphs and charts are utilized. To achieve above purpose, the common tools such as Gantt charts, PERT (Program Evaluation and Review Technique), CPM charts (Critical Path Method), WBS (Work Breakdown Structure) and network diagrams can be visualized (Taxén and Lilliesköld, 2008) in order to facilitate the projects management.

Additionally, here is couple of learning process from project (Söderberg and Alfredson, 2009), which Obeya is able to handle any of them

- Post-project appraisal: A group of specialist in organization after completion of the project starts to examine and analyze the project in order to write a report about what have been learned from the project.
- Project Audit: A cross-functional group from outside of the project starts to interview project members in all levels in different areas. Afterwards, audit group analyze and identify the weaknesses and strengths of each area. At last, recommendation is given for improvement for future.
- Post control: According to the defined process and prioritized tasks, project manager
chooses the members and functions involved. The result will be documented for future improvements.

- After-action review: 20 minutes to 2 hours review the project by asking couple of questions included
  1) What was supposed to happen?
  2) What actually happened?
  3) Why was the cause of differences?
  4) What can you learn from this experience?

The result is converted into flip charts to handle next similar projects.

A critical issue in project management is to make project members able to get involved and follow the project in order to gain experience for future projects. This improvement is obtainable even from other projects that are being done in parallel. Consequently, experiences as an input and suggestions help to develop the way that the work is being performed.

White book is a document consists of projects' experiences. It is mainly written at the end of the projects and includes projects mistakes or successes and all gained experiences during conduction of the projects. It might be written in different ways such as bullets points or storytelling, depending on project manager who is regularly responsible for it. It is considerably useful for next projects to learn lessons from previous experiences and take advantage of it. Learned lessons are mainly written about the problem, taken actions and how problem was solved. Since it is mostly written at the end of each project, after typical project time, which is 2-4 years, lots of information is missed. Moreover, there is always a tendency to remember good things rather than mistakes. Accessibility and reliability are also big problems for this database. If someone take a look for hours and doesn't find the answer, for the next time he/she will probably not try it again. In another point of view, turnover rate of personnel between projects or among companies lead to losing project experiences and knowledge in production development, product development and so on. During each project, there is possibility of exchanging project leader or other members. Consequently, there might cause new objective, schedule and resources. Therefore, Obeya can help to keep all these kind of information in itself to show and present it to the proper person and in appropriate time. Obeya as a tool to keep current information of different projects covers all above problems of white book. This daily updated white book can be exchanged between projects through Obeya and its visualization tools regardless of turnover rate of the company. This tool leads to reliable knowledge sharing between different projects in different divisions through supporting various type of documentation such as Micro articles, RECALL/Wiki, white book and A3 reports. The ability of transferring knowledge among different projects might enhance the international competitiveness (Söderberg and Alfredson, 2009). Obeya allows all people in the company or organization to change, add or reduce the information. It can be considered as forum to communicate; share new knowledge and experience while let people understand what others do, who owns a specific knowledge, which to talk to about special issues and who to get help. Regular meetings by the visual boards would definitely increase the efficiency of the projects. In regular meetings, you get involved in different projects, so members get something in common with what others working with (Söderberg and Alfredson, 2009). In this way, experience and knowledge is moved forward and members improved and developed (Söderberg and Alfredson, 2009). Furthermore, problems will not just store on personal hard drives but on a network, which is available to everyone.
Chapter 4: Empirical studies

In this chapter information about the case studies is presented. Table 2 shows the summary of information about the four cases. Afterwards, a cross-case analysis is performed in order to compare the cases and finally based on case study results, recommendations are given.

Case studies

In this research four cases were selected for study to gather information about their current use of Obeya and similar meeting spaces. The studies are limited to the uses of the meeting spaces in production system development activities and product development-related activities are not included because of irrelevance to the subject of the research and also limited access to product development-related activities and data. Cases are selected based on the following criteria.

- The geographical location of the company: All the selected cases are located in Sweden. This criterion helps to minimize the influence of working culture and other cultural differences to the minimum level. Easy access to the production facilities were another positive effect of this criterion. This factor also assures a certain level of quality and working standard regarding the Swedish legislation and standards as one of the leading countries in such issues.

- Global footprint of the company: To avoid negative effects of having all cases in a single country, a broad and considerable global footprint of the companies was established as another criterion. In this regard, all selected manufacturing facilities are a part of a leading international company in their respective industry. This criterion insures that the selected cases consider the global requirements and standards in addition to the local ones. Also it is an indicating factor of the position of the company in the market and its involvement in highest level of global competition which in its turn assures the validity of the results from this aspect.

- Application of Lean production: All of the cases are using lean production system and its related tools and methods and have been practicing it for at least 4 years. This criterion is critical because of necessity of having same general frame of process and development in all the cases. Since Obeya and similar meeting spaces are an integrated part of lean production system, they cannot be studied out of the related context which is lean production system. In this regard all of the selected companies are committed to implementing lean production system while each case has its own customized interpretation of lean production system according to its requirements and specifications.

- Size of the companies: to capture the effect of size of the companies in their uses of meeting spaces in their production system development activities, 2 cases were selected from medium-size companies and two others are large companies. Small-size companies were excluded because of high level of customization in their processes and lack of global footprint in most of the cases. Diversity in size of the companies makes the authors able to investigate the practice of using Obeya in
different companies with different sizes and compare the differences according to their respective characteristics.

- Product: While all the cases are selected from manufacturing industries, authors tried to keep the diversity of the companies regarding their products. This criterion established to avoid neglecting some aspects of the research topic because of special nature of some products or they respective production system. Different level of automation in the production process, different product size and different production rates are some of the aspects which are covered in this regard in the selected cases.

Case A, BT trucks

Company description
BT is a leading manufacturer in lean production. It is also part of a leading international group within material handling equipment industry with 1800 employees. The yearly production volume is 52000 and almost all of the products are sold in European market. Daily production capacity is 250 and there are 250 product variants which all produced in the existing production and assembly lines. The production facility consists of 5 assembly lines, a welding and a painting department where all 8 product groups off the company are produced. These product groups are hand pallet trucks, pallet trucks, power stackers, reach truck, counter balanced electric BT cargo, counterbalanced IC BT cargo, order picking and very narrow aisle trucks. Interviewee in the company was a production engineer and has been in the company for approximately 6 years.
The company is enjoying lean production system and TPS since it was acquired by Toyota about 15 years ago. As a result, people follow the principle of continuous improvement (kaizen) as a part of their daily work. In the shop floor level a considerable part of Kaizen activities are involved with improving developing production processes as a part of production system.

Meeting spaces
A Single meeting place is used in BT trucks to manage daily production problems and these Kaizen projects in the whole factory. Every line has its separate 6-minute morning meeting for related problems and projects. Meetings are held to discuss problems of the day before the meeting and defects of the related line with attendance of the responsible people. Problems are described briefly in the meeting and documented in a predefine form. Responsible and related persons are assigned to the problem solving process according to the nature of the problem. For instance if the problem is caused by one of the welding stations, the welding department supervisor, the operator of the station, the customer of the process (even out of the department if required) and responsible maintenance technician can form a team to find the root cause and the solution to the problem. The detailed follow up of the problem and the solution remains for a meeting between assigned persons. The semi-filled form stays on the board for future follow up.
Usual process includes 24-hour time for finding the root cause and suggesting a temporary or permanent solution for it by related group under the supervision of related line or department supervisor. A specific section is assigned to the 5Whys analysis in the predefined
form. After developing the solution, it is documented in the respective part of the form and discussed briefly in the meeting next day. Finally the fully completed form is placed on the board as lesson learned and for documentation.

There are specific tools used in the meeting space including predefined A4 forms on the meeting space board for registering the problem. The general thought behind these forms are the same as Toyota A3 reports, but they have are more structured and for some there is a template. The structure or template has been developed during the course of time according to repetitive and common characteristics of occurred problems in the respective department. In this regard the departments which are newer to the process or having less common characteristics in their problems, use less or unstructured forms which in some cases is a blank A4 paper. Pictures or other visual tools like charts and diagrams are used freely in the reports to simplify the understanding process and facilitate development of the solutions.

The forms stay on the board in the related area of the respective department. Each department has its own space on the board for documenting and discussing problems but they are all in a single room to be available for people from other departments. This feature seems to help facilitating data sharing and using process among different departments and daily common meetings help to transfer generated knowledge more easily through the whole factory. Along with mentioned A4 forms whiteboards are also used as a support for instant visualization or ideation.

Data registration and visualization process are totally manual and there is no indication of using digital tools in the environment. According to the interviewee’s answers, the whole process is kept manual to avoid disadvantages of digital documentation such as easy modifiability, less interaction of the user with document and risk of intended or non-intended data loss. In this regard, all of the forms are filled with handwritten text and kept as physical documents on the room walls on the assigned space to each group as a visualization tool for follow-ups and periodically archived to free the space for new documents.

**Interview details**

The interviewee at BT (Toyota Material Handling in Sweden) in Mjölby was customer relations manager and had sufficient knowledge and experience in material handling production to guide authors and answer authors’ questions. She has been working for BT for more than 10 years and not surprisingly was the only interviewee who knew about Obeya and its advantages. As it indicated in research approach, semi-structured interview was performed at BT to be flexible and let authors to come up with new questions and ideas throughout the interview. Interview took around 2 hours including production line and meeting place visit. However during the visitation, questions regarding Obeya and research objectives were asked, recorded and documented. Predefined general questions were formulated according to thesis objectives, research questions and literature study that had been done previously. These questions were approximately about the meeting place and its usage at BT, number of participants and their positions at BT, duration of meetings and information type that is visualized in the room.

**Case B, Volvo GTO in Köping**

**Company description**

Volvo Köping is large size company with around 1300 employees. It is part of international automotive manufacturer, Volvo Group, which is the biggest manufacturer in Europe and
the second biggest world manufacture in their business area, with different global brands such as Volvo trucks, Renault trucks, and Mack trucks. Volvo Group Technology Organization in Köping manufactures Heavy-duty engines, gearboxes and driveshaft.

The studied production factory produce has 3 main types of gearboxes including gearboxes to trucks and busses, gearboxes to construction equipment and the marine drivelines; gearboxes for trucks and busses stands for the most part of the production. These gearboxes are manufactured in a number of different variants, depending on final product requirements. The total yearly capacity of the facility is approximately 132,000 products. In addition to production and assembly lines for each main 3 production area, there is also a maintenance department which supports all of the lines.

Meeting spaces
Each production area has its own meeting place but there is general design for meeting places in production and assembly departments. This general design includes a meeting corner near the related line and a visualization board which shows the information about problems and ongoing kaizen projects, quality measures and safety issues. Maintenance department has it own special room design refers as Kaizen Corner. There are number of customized visualization tools including different schedules and reports for ongoing maintenance kaizen projects.

Generally same process as company A is followed in company B. Short meetings about 10 minutes are held every morning with main actors to follow up problems from last day. Case B in contrast with case A meeting has an agenda regarding the problem category: quality and product defect, direct problem in production system and safety issues. To follow up the problem almost the same process as case A is followed to find the root cause and the solution. A team of related people is assigned to the problem solving and to follow it up in a more detailed level. The main difference is that no formal deadline established for the team for coming up with a solution. But the general informal expectation is completing the process in a week.

Again the basic thought behind the reports in the meeting spaces is Toyota A3 reports and report templates are used for production and assembly lines in the production facility. Since every department has its own meeting place customize visualization tools can be introduced according to their needs such as tools used in the maintenance department. In production and assembly lines reports templates are used for documenting and following up the kaizen projects. But in maintenance department different and more sophisticated tools are used according to the needs of this department. Some examples are resource charts, simplified project schedules and a traffic light status viewer of project goals. In this departments some indications of use of the meeting space for more radical change projects was visible.

There were no digital visualization tools in any of the spaces but the interviewee believed that “One of the future steps in improving these spaces is digitalizing part of the visualization tools” to increase efficiency and ease of knowledge sharing and using.

Interview details
At Volvo Powertrain in Köping, the interviewee was management trainee/project manager. He has been working for almost 4 years at Volvo in Köping and he had good knowledge and experience about production lines and different departments in Volvo. Thus, he was able to
answer authors’ questions regarding the Objective of research and meeting places/Obeya at Volvo.

Semi-structured interview were conducted at Volvo because of flexibility and discussion during the interview. Interview took approximately 2 hours and 30 minutes including Volvo presentation at the beginning, interview, production lines visitation and maintenance department visitation since each of them has its own meeting places. Questions that were asked during the interview were all prepared according to previous literature study and previous experience from last interview and case study. Authors tried to cover all aspect of Obeya in the interview in order to answer research questions and fulfill the research objective. Predefined questions were almost about characteristics of meeting places at Volvo in Köping, duration of each meeting, type of visualized information, type of discussion at meeting place, number of participants and their positions, purpose of having such meeting place and at last advantages and disadvantages of meeting places. Like the last case study, the whole interview was recorded and notes of authors are documented in order to not losing a point or for further uses.

Case C, Gyproc

Company description
Gyproc is a medium size company and produces construction material, as a part of international leading group in construction material industry. Company C has about 360 employees, with production facilities in Scandinavia and around 100 employees in the studied facility.

Company C is one of the lead companies in World Class Manufacturing (WCM) since 2004. WCM enable them to increase their productivity, environmental improvement as well as product quality. The “best practice” helped them to reduce the costs and risks in production process which led them to be the first in their branch. World Class manufacturing has 10 pillars and each pillar has its own method to identify the best solution regarding to improvement. Each problem is treated like a project to demonstrate what were the results and how much money would they saves. They have also done a revision in the whole company in order to improve their WCM’s status to silver level.

The production facility consists of a single production line with high level of automation and less direct human interference in the production process comparing to the other three cases.

A World Class Manufacture Champion was the interviewee in this case. Her job is integrated with different areas in companies organization since WCM pillars is about different 10 areas including Safety, cost deployment, focused improvement, autonomous maintenance, workplace organization, quality control, logistics and customer service, early equipment management, people development and environment. As a result she could answer different question regarding research objectives. As it mentioned before, interview were held in semi-structured way in order to come up with new topics and questions about Obeya or the meeting space. The interview took around 2 hours including morning meeting and line visitation. Questions asked during the interview were formulated according to research questions, objectives and literature study about Obeya. Questions asked were mostly about characteristics of their meeting space, its usage, number of participants in every morning meeting, type of discussions, and duration of the meetings, information visualization and pros and cons of such meeting space. The voice of interviewee and written notes of authors
Meeting spaces
A single meeting place is used for morning meetings which are less structured and limited. The meeting place located near to the production manager office, almost in the middle of the production line. Those meetings can take up to 30 minutes like the one that authors have participated in. Around 8 people with different specialty from different department such as maintenance manager, production manager, World Class Manufacturing (WCM) responsible, logistics manager, technicians and sale manager participate every day to discuss problems and solution or to follow up new events and activities. However, production problems and solutions, defected products and root causes of them and kaizen projects follow ups are the most important topics of such daily meetings. In general, everything from participants, position of participants and level of discussion (organizational or operational) is the same approximately in comparison with other mentioned companies. The only difference is the amount of time dedicated to meetings which is almost 30 minutes. It helps engineers and managers to go into more details about their production problems or kaizen activities. As authors participate in one morning meeting, all engineers get involved in daily discussion about problems and solutions and future plans even though there are not specialist in that area. Swedish is the spoken language among engineers which is the official language in the company as well.

Same usual visualization and follow up tools and techniques are used in this meeting space like A3 reports, follow up forms and boards. It is almost the same in above mentioned companies. A3 reports is the main report tool in Lean and Toyota Production System (TPS), however it can be the main reporting tool in WCM. Boards and sticky notes were used to write the topics and agenda of meeting. Results of the meeting are also attached and written on boards and sticky notes and then afterwards is moved to suitable papers and reports. In addition to conventional visualization mentioned before tools improvements tags are also used to mark problem source in the line. One version of the tag is also to the problem source (machine or station) to mark the most problematic stations. Moreover, a digital screen is used for visualizing general information about company introduction and current situation of production. It should be mentioned that morning meetings were held informally.

Interview details
A World Class Manufacture Champion was the interviewee in this case. Her job is integrated with different areas in companies organization since WCM areas or pillars is about 10 various areas including Safety, cost deployment, focused improvement, autonomous maintenance, workplace organization, quality control, logistics and customer service, early equipment management, people development and environment. As a result, she was able to answer different question regarding research questions and objectives of this thesis. As it mentioned before semi-structured interview was chosen in order to be flexible and be able to come up with new topics and questions about Obeya or the meeting space during the interview. The interview took more than 2 hours including morning meeting and line visitation. Questions asked during the interview were formulated according to research questions, objectives and literature study about Obeya that had been performed previously. Questions asked during the interview were mostly about characteristics of the meeting space in Gyproc, its usage, number of participants in every morning meeting, type of discussions, and duration of the meetings, information visualization and pros and cons of such meeting space. The voice of interviewee was recorded and written notes of authors are documented separately.
should be mentioned that both authors participate in interview, meeting and production line visitation which increase the validation and quality of the research.

Case D, Fuji Autotech

Company description
Fuji Autotech is a medium size company with about 160 employees that manufactures automotive parts for heavy vehicles. It is an integral part of an international Group called “Fuji Kiko Group” in commercial vehicle business which is one of known companies in lean manufacturing and high quality. The company has almost the 60% of the European market share of its respective product.

According to the interviewee, company have got inspired by the Japanese quality thinking whereas working with FMEA-analysis, poka yoke solutions, physical testing, virtual testing and vision cameras.

The total production volume is 500,000 units per year. The production facility consists of 5 assembly lines and it is part of an international company with several facilities around the world.

Meeting spaces
Each production line produces product for different customer and consequently each production line have its own meeting place where the morning meetings are held. Meetings take basically 10 minutes and participants are the line operators, safety technician, group leader and quality technician. However, depending on the meeting’s topic other related people may participate. Meetings begin with controlling the presence of personnel of the respective line. After that the deviations of last day production from the production goal will be discussed and the first level cause will be followed. But there are no indication of following up the root causes of problems and documenting them. Then possible safety issues are discussed and solutions and prevention methods for them are suggested by participants. In this regard this case is in the very basic level of using of such meeting spaces. Meeting spaces are not used for implementing or following up any improvement projects in production system. They are only a place for daily control of production volume and deviations from planned volume.

Respectively visualization tools are also basic. Usual visualization tools are used in meetings like whiteboards, forms, and other basic tools. The meetings and visualization tools are only utilized for basic controlling basic measures like production rate of the day before and deviation from planned production. Also safety issues are discussed during the meetings. A table of present persons of every shift is used on the board. Also simple charts are used to show weekly and daily production plan and deviations. There is also a safety corner on the board and pictures, information and preventing methods of the incidents are visualized. These issues are the only instances which followed up and documented through this meeting spaces in the factory.

Interview details
At Fuji Autotech, process development manager was asked to be the interviewee. He was working for Fuji Autotech more than 5 years and had a good knowledge and experience about production and its problems in different areas. He was one of the main participants of meeting places at Fuji Autotech.

Semi-structured interview was performed like the other cases but with process development
manager. Flexibility and discussions during the semi-structured interview are the main reasons to choose this type of interview for this research. Interview at Fuji Autotech took about 1:45’ minutes including interview, production line visit, meeting spaces meeting as well as company presentation for almost 10 minutes. However, while production line and meeting spaces were visited, process development manager were explaining the structure, goals and application of such meeting places at Fuji Autotech. Questions asked throughout the interview and company visit were chosen according to research questions, objectives and literature study about Obeya that had been done previously. At each case company authors tried to cover new ideas along with last experiences from previous interviews and visits to improve the quality of interview and research. Questions asked during the interview were mostly about specification of the meeting spaces in Fuji Autotech, their usage, number of participants in every morning meetings, type of discussions during the meeting, duration of the meetings, information visualization format along with advantages and disadvantages of such meeting space in viewpoint of the process development manager. The whole interview was recorded just like the other case studies and written notes of authors are documented. What’s more, both authors participate in interview and production line visitation in order to increase the validation and quality of the research.

Table 2 - General info about case studies

<table>
<thead>
<tr>
<th>Company</th>
<th>Number of departments/lines</th>
<th>Nr. employee</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5 assembly lines</td>
<td>1800</td>
<td>Material handling equipment</td>
</tr>
<tr>
<td>B</td>
<td>3 main and 1 maintenance departments</td>
<td>1300</td>
<td>Automotive</td>
</tr>
<tr>
<td>C</td>
<td>Single production line</td>
<td>360 in Scandinavia</td>
<td>Construction material</td>
</tr>
<tr>
<td>D</td>
<td>5 assembly lines</td>
<td>160</td>
<td>Automotive parts</td>
</tr>
</tbody>
</table>
Cross-case analysis

The table N shows the summary of the gathered data about all four cases

Table 3 - summery of gathered data

<table>
<thead>
<tr>
<th>Company</th>
<th>Meeting place type</th>
<th>Purpose</th>
<th>Visualization tools</th>
<th>Meeting time (Minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Single place for all lines</td>
<td>Kaizen projects</td>
<td>Predefined A4 forms, A3 reports, boards</td>
<td>5 – 10</td>
</tr>
<tr>
<td>B</td>
<td>Multiple customized places for each department</td>
<td>Kaizen projects, General development projects</td>
<td>Predefined A4 reports in the lines, customized reports, schedules and charts for maintenance department, boards</td>
<td>Up to 10</td>
</tr>
<tr>
<td>C</td>
<td>Single room for single production line</td>
<td>Kaizen projects</td>
<td>Predefined A4 reports, problem reporting tags, digital screen for production status, boards</td>
<td>Up to 30</td>
</tr>
<tr>
<td>D</td>
<td>Multiple places for each assembly line</td>
<td>Production, quality and safety control</td>
<td>Simple quality and production A4 reports, boards</td>
<td>Up to 10</td>
</tr>
</tbody>
</table>

Meeting space use

As the summary of the results indicates the main use of the meeting spaces in first three cases is managing and following up incremental improvement projects in production system. These types of projects are usually initiated by defects in the products or error in the process. Such defects can be reported by either internal and external customers or the line operators themselves. Comparison between the four cases shows that reveals that there is huge opportunity to benefit more from the potentials of the meeting spaces.

In company D, as the less advanced case the meeting spaces are only used controlling the production and safety issues and no improvement is followed up directly in the meeting space. It is only used to send signals about deviations from production goals to management and production planners. In this regard it seems this company can benefit more from such meeting spaces by using them at least for incremental projects like other cases.

In contrast in the maintenance department of the case B some activities were observed which can be interpreted as Kaikaku supporting activities. Specific visualization tools are used for supporting daily meetings of implementing new maintenance system in the factory. The new maintenance system was a part of implementing lean production system in the company. In this regard the project can be considered as a radical change because of total change in the system in a relatively short time.
In general the results show that such meeting spaces have a vital role in following continuous improvements in production facilities and sharing the data about the process, result and lessons learned.

**Number of meeting spaces**

Regarding the number of the spaces, none of the cases use same system. This could be because of differences in their products, production system, number of lines and departments and organizational differences.

Company A uses a single meeting place for all of 5 assembly lines, while company B and D are using different spaces for each line or department. Although using different meeting spaces can make each department able to customize its space according to its specific requirements, company B and D did not use this benefit except in the maintenance department in case B.

In General, following benefits have been considered for a single meeting space:

1. Easier information sharing about problems, solutions and problem solving process
2. Higher level of cross functionality in the meetings
3. Reduced time of problem solving partially because of better information sharing
4. Using other departments experiences in developing visualization and documenting tools
5. Easier access to internal customers or other internal related actors.

But there are also some disadvantages with using single space like reduced degree of customization and details in visualization which in its turn can lead to reduced creativity in problem solving methods in some cases.

The maintenance department in case B is a good example of such customization which seems necessary in such cases. Especially when it comes to larger and more radical improvements such as maintenance system development in case B, more detailed visualization and follow up seems inevitable.

**Visualization tools**

Following visualization tools are found as common tools for representing improvement processes and results in production systems of the cases:

1. A3 reports: In all first three cases A3 reports or a type of report with a similar function is used for documentation and follow up the problems. They are also used as visualization tools and stay on the boards both during and after the problem solving or improvement process. The most complete version of it is used in case A with 7 sections in most cases. Background of the problem, current condition (the way it is done currently), goal, root cause analysis, countermeasures, effect confirmation and follow ups. Following these steps, the involve people map the problem and its background, try to find the main cause of the problem using methods like five whys and fishbone diagram, and finally suggest a solution for it. After implementing the solution, effectiveness of it will be controlled and necessary follow up actions are implemented to assure that proper solution is developed and implemented. The process of using it is almost conforms with suggested method in literature (Liker, 2003)
2. Whiteboards: They are inseparable part of visualization methods in those meeting spaces in all cases because of their flexibility, ease of use and cheap price. They are used for various functions such as listing ideas in short brainstorming sessions, visualizing simple sketches of parts and machines, message boards etc. Whiteboards are basically a place for visualize temporary but very useful information. In some cases they also fill the gap of not using digital tools in the spaces to show such changing or temporary information and in some cases they are more successful than simple digital screens because of higher level of interaction with users, simplicity and very cheaper price.

3. Problem reporting tags: These tags are utilized to mark the source of the problem. Every tag has two copies in form of 18*12 papers which summarize the problem and cause of it. One copy is attached to the board in the meeting room and the other is attached in the station or machine which was the source of the problem. In this way the stations or machines which cause the most problems are easily marked as “Christmas trees” with lot of tags and responsible people can easily find which station or machines require improvement. This tool is only used in company C and one factor which makes the company able to use such tool could be high level of automation in the line. High automated line and having few operators helps the company to use the problem reporting tags without increasing tension in the work environment. In this regard using this tool in other companies needs more consideration and more staff training to prevent possible tensions.

4. Digital screens: Digital screens are basically used to show some frequently changing data. In case A and C such screens are used to show data like daily production rate, stop time in the line and elapsed time since last safety incident in the factory. No further use of any digital tools was observed in the case studies.

5. Customized tools: There are number of customized tools especially in the maintenance department in case B which are used for following up larger improvement projects. As it is mentioned before, this case was the only one with improvement projects which can be considered as radical ones. The tools are also designed to support such projects. Some instances of such visualization tools are going to be described briefly.

Simplified Gantt charts: a wall was assigned to represent a large scale, simplified Gantt chart of the project with highlights on important delivery times and stage gates, main activities behind the schedule and some other critical information.

Resource allocation chart: there was a resource allocation chart on the other wall to visualize the status of resources, especially human ones to highlight the resource bottlenecks and other resource related status.

For such tools mentioned above, using more advanced and interactive digital tools seems really helpful and supportive. Digital visualization tools can support easy on demand access to different level of details, managing multiple projects in a single
space and better information flow. Such issues are discussed more in recommendations section.

Meetings’ time
Finally the time of the meetings was another considered factor in this study. In all of the cases except case C the time of the meeting are limited to 10 minutes and they start in the morning/before the beginning of the shift. The limited time helps to keep meetings brief, simple and goal oriented. Also it prevents waste of time of non-related people to the problems or details of it. Any details of problem or solutions are discussed later after the meetings and only with related people. But the necessary details are documented in forms and reports which are visualized in the meeting space for access of other people.

In this way all the people in the meeting have the general data about the problem and have the access to solutions through documents and people. So they do not need to know all the details, but they have access to them any time to use them as learned lessons and as benchmarks in similar cases and problems.

In company C there is no specific limit for time of the meetings. This could be partially because of having a single production line with high automation level. Having only one highly automated production line allows the people in the meetings to focus only on that line and there are no non-related people to almost any issue comparing with the other three cases. However, experience of participation of the authors in the meetings in that company indicate that long meetings in that company can lead to decreased efficiency of them and deviation from the main goal of meetings with having peripheral and in some occasions unrelated discussions and limited time can be a positive factor to limit the discussions to the most important ones and lead the participants to reach an agreement as soon as they can regardless of unnecessary details.

Recommendation
As it was mentioned in analysis section use, using Obeya or similar spaces for developing and supporting radical changes in the companies could be an opportunity for companies to facilitate and speed up such projects.

Having common meeting spaces for all departments or at least departments with similar functions can facilitate the knowledge and experience flow in the companies. This leads to faster accumulation the results and experience and make them more accessible for more people in the companies. However having customized and separate spaces for specific departments in some cases is inevitable.

Limiting the time of meetings to have a better concentration on the topic of the meeting with related people is another point which can be recommended according to the results and analysis.

The last but not the least point is considering use of digital tools to facilitate the data transfer and knowledge sharing. Using such tools can increase the efficiency of the meetings and make that possible to use a single meeting space for different purposes. Although some interviewees pointed out some advantages of handwritten documents and notes, others have the same idea as authors that combination of digital tools with current traditional tools can boost the meeting spaces effectiveness. This issue will be discussed more in the next section on discussion and conclusion.
Chapter 5: Discussion and conclusion

At first, his chapter presents a discussion around the research. Discussion is started with comparing the results of performed literatures review by authors and the results of 4 case studies from manufacturing companies in Sweden. Afterwards, conclusion of the research and answering the formulated research’s questions are presented. At last, possible future work about Obeya or similar meeting spaces would be proposed.

Here is the comparison between literature study and case studies about Obeya or meeting spaces in Sweden. As it mentioned before, the research were performed in closed loop between theoretical framework and real life observation at case study companies. This loop is called theory matching and it means to validate the information that has been found in literature by investigating among real life case studies. According to the research questions and objectives of this thesis, four main subjects from literatu are chosen to cover different facts about Obeya. These chosen facts are Obeya’s type, usage of such meeting spaces at manufacturing companies, applied visualization tools inside the Obeya and meeting’s duration. Afterwards these facts that have been found in literatures were compared with real status and usage of meeting places or Obeya at manufacturing companies in Sweden. The comparison demonstrates that what have been described in literature and what are being done at manufacturing companies in Sweden have approximately the same direction expected from two elements that would be described later. On one side, it shows the case studies verifies the results of literature and in other side, it validates the quality of the conducted research.

The four main chosen facts about Obeya or similar meeting rooms are shown briefly in table 4. These facts were chosen in order answer the research questions and fulfill the research objectives. However, these four defined areas can be divided further into more details to get more precise results.

Types of Obeya

The first fact was chosen according to the first objective of this thesis and the first research question. Authors tried to formulate current practice of meeting spaces in term of number of projects and problems that is discussed in such meeting spaces.

The majority of literature discusses about a single room that group of expert from various departments get together frequently to review a project and discuss key decisions about that single project. However, few authors has written about the usage of Obeya or meeting places not just for one project but for some parallel projects that are being run simultaneously at company (Söderberg and Alfredson, 2009, Andersson and Bellgran, 2009). Hence, two different types of Obeya or meeting spaces was defined as follow

- Single for whole company: as it mentioned majority of definition of Obeya is about a single room for a single project. A concert example is the Pirus project at Toyota that the only use of Obeya was to develop the Pirus and introduce it to market with shorter lead time.
Multiple for each department or production lines: For example Andersson and Bellgran (2009) describes about a meeting place in one of her cases as

“The Project studio was created in 2006. The project studio was originally created in order to let different development projects sit closely to each other and to the production. The aim was to improve the integration between construction and production in order to develop better and more production-friendly products.”

Additionally, Söderberg and Alfredson (2009) describe a meeting place in Scania as

“Another Lean tool that has been implemented is visual planning; Scania has a room called “the pulse room” where the status of all the projects currently running in the company is shown. This is a very powerful tool, since Scania need a way to easily show which projects are going according to schedule and where effort needs to be put. It also shortens meetings substantially and a meeting dealing with more than 100 projects can be over in half an hour. One advantage with having this visual planning is that there is a clear ownership of the projects.”

**Purpose of using Obeya or meeting rooms**

The second fact was selected in order to answer second and third formulated questions and fulfill the second objective of this thesis. As a result, according to performed literature study four features were selected for this fact. These features are

- *Incremental improvement or Kaizen* (Andersson Schaeffer, 2011, Oppenheim, 2004): It refers to use Obeya or meeting spaces in order to support daily Kaizen activities and eliminating eight wastes in production or Muda. Kaizen concept is well recognized by most companies around the world and various tools and techniques are being developed and utilized to support Kaizen (Liker, 2003, Yamamoto, 2010). Nevertheless, despite of well conceptualize definition of Kaizen in literatures; practice of Kaizen is not well performed within manufacturing industries out of Japan (Yamamoto, 2010). Therefore, Obeya as a lean tool in manufacturing industries can accelerate implementation of Kaizen in industries. Within the Obeya room, all other lean tools can be questioned if they are implemented good enough or not. Obeya as a room where people from different part of company including quality control, production, product development get together, would lead to shorten the decision making time between problem recognition and taking action since most involved people are there. Combination of Obeya and Kaizen can be referred to Kaizen corner, which was built for education, short time daily meetings with managers and group leaders and engage the labors through training and morning meetings (Liker, 2003). According to conducted
case studies 3 out of 4 cases use their meeting’s rooms for solving their daily 
production problems and Kaizen activities. For example Obeya as Kazien 
corner in maintenance department at Volvo Powertrain at Köping.

- **Radical improvement or Kaikaku** (Andersson Schaeffer, 2011): It refers to use 
Obeya or similar meeting spaces for handling the radical changes within the 
company. As it explains later, Obeya as an existing tool cannot be placed in 
radically innovative Kaikaku. On the other hand, Obeya concept can be 
placed in infrastructural. As a result, Obeya fits into Kaikaku type II, structural 
change. Fortunately, Kaikaku type II is the most common Kaikaku among 
companies which all companies have experienced it. Thus, respecting to the 
trend of lean transformation in companies around the world, especially in 
Sweden, the need of Kaikaku activities cannot be neglected and consequently 
the Obeya. None of the case study uses their meeting places for such 
purpose. This can be considered a big question to answer for further 
research.

- **Product development** (Liker, 2003, Andersson Schaeffer, 2011, Lindlof and 
Soderberg, 2011): Since Prius development, Obeya has become a standard 
supporting tool for product development process in Toyota. In the previous 
vehicle development projects, the chief engineer needed to go around the 
people’s offices in different departments to conform to others. Conversely in 
Obeya, cross functional team of expert from production, purchase and 
product development gather in a big room to review the progress and discuss 
key decisions. The aim of such room is to integrate product development and 
production to have better and more production-friendly products. Case study 
companies was not using their meeting spaces for such objective, however 
Volvo Powertrain at köping use its meeting places for general development 
projects in a very low level.

- **Others (for example: Safety control)**: This option was added for probable use 
of Obeya or similar meeting spaces that was not mentioned in literature. In 
one the case studies, meeting spaces are being used for putting and showing 
safety issues as well as controlling whether all workers follow it or not.

**Visualization tools inside the Obeya**

Visualization tools were chosen because of second objective and fourth research 
question. This part consists of various tools within continuous improvement like 
boards and charts as well as tools within project management such as WBS, Gantt 
charts and network diagrams. However, below list of tools are the most important 
one of tools that were mentioned in almost all of the literatures or tools that are necessary 
and common in any kind of meeting spaces like video projection.

- Video projection (Parry and Turner, 2006)
- Problem report tags

**Duration of meetings**

Eventually, the last fact was chosen in order to answer question four and fulfill the second objective. Duration of meetings was not exactly studied and considered in previous literature. It was generally mentioned that Obeya is an advanced visual control innovation room where cross functional group of expert from various divisions gather on a “*regular basis*” to review the progress and discuss key decisions (Liker, 2003, Andersson Schaeffer, 2011, Söderberg and Alfredson, 2009). Nonetheless, in few literatures it was mentioned that meeting have to be held in at least every other day to get the suitable result.

All case studies of this thesis use their meeting spaces every day. In three cases the duration of each meeting was around 10 minutes and in one case it was up to 30 minutes. Anyhow, in accordance with literature the vital thing about Obeya is the frequency of meetings which was absolutely followed by all case studies.

**Table 4 - comparison between literature and case studies**

<table>
<thead>
<tr>
<th>Literature study</th>
<th>Case studies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Obeya type</strong></td>
<td></td>
</tr>
<tr>
<td>Single for whole company</td>
<td>Single for whole company (Gyproc and BT)</td>
</tr>
<tr>
<td>Multiple for each department or production lines</td>
<td>Multiple for each department (Volvo: production and maintenance) or production line (Fuji: 5 line)</td>
</tr>
<tr>
<td><strong>Purpose of using Obeya or meeting room</strong></td>
<td></td>
</tr>
<tr>
<td>Incremental improvement or Kaizen</td>
<td>Incremental improvement or Kaizen (BT, Volvo, Gyproc)</td>
</tr>
<tr>
<td>Radical improvement or Kaikaku</td>
<td>Radical improvement or Kaikaku (None of them)</td>
</tr>
<tr>
<td>Product development</td>
<td>Product development (None of them but Volvo for general development)</td>
</tr>
<tr>
<td>Others (for example: Safety control)</td>
<td>Others (for example: Safety control) (Fuji Autotech)</td>
</tr>
</tbody>
</table>

**Visualization tools inside the Obeya**
As the results indicate, in all cases the meeting spaces are used only for performing incremental changes (Kaizen activities) which are basically minor modifications in production systems. These modifications are mostly initiated by occurrence minor problems in production process, defected products or safety issues and solutions are developed using lean tools like 5whys and 5 Ws which are main tools for preparing A3 reports. Currently there is no indication of using such meeting spaces in radical changes (Kaikaku) in production system development such as developing and implementing new production system or general modification in current production systems in those companies. In such cases production system development is mostly considered as a part of product development process according to its dependence to developing new products (Bruch, 2012). But in practice it is a huge complex separate project. Obeya meeting spaces can be used for acquiring and generating production system development information like idea development sessions and designing production system. It can also be a very useful tool for sharing and using information especially during the implementation of radical changes in production systems. In addition, current meeting spaces are not adequately capable of transferring data and results to involved internal actors like people in other production sites as well as external ones like suppliers. This could be mainly because of total dependence of those spaces to non-digital tools.

As Bruch (2012) explains, design information management as a critical part of production system design and development consist of three main parts: acquiring, sharing and using design information. Obeya or such meeting spaces can be used for these purposes in production system design and development process. Using digital tools can help the two latter parts through facilitating sharing and using acquired data in a faster and more effective manner. In summary, review of the Obeya concept, its advantages and its current practice in industry shows that it can be applied to other purposes than product development projects. The case studies show that similar meeting places are already used for incremental production system development projects. Radical improvements can even benefit more from this concept because of their nature that needs to
implement great changes in a short time which usually demands considerable amount of close teamwork. But to maximize the benefits methods and visualization tools used in a conventional Obeya should be customized to be adapted to this purpose.

**Fulfillment of the research objective**

In this study both research objectives were covered though the used methodology based both on current literature and empirical data. Comprehensive study of current literature has been done about current uses of Obeya and similar meeting spaces. Also 4 case studies have been done to gather empirical data and compare them to the results from studied literature. The empirical data support the results from the literature that such meeting places are utilized for daily follow up of incremental improvements in production systems. Such improvements are almost always Kaizen projects and start and be followed up on daily basis by line operators, supervisors and other directly related people of the production line or department. In one case partial use of such meeting spaces for radical change projects were also observed. But using these meeting spaces for Kaikaku projects in production system developments have not been generalized yet.

In addition some suggestions for improving the use of the meeting spaces are provided according to gathered data and cross case analysis in this study. The suggestions are described in recommendations section including limiting the time of the meetings, centralizing meetings in a single space as much as possible and combining current traditional visualization tools with digital ones to facilitate data sharing. Also broad opportunity for further research in this field has been identified which is described in the next section.

**Future work**

This research is only an opening to study the supporting role of Obeya and similar meeting spaces in production system development. Few directions for further work in this field are identified by the authors including:

- Deeper study of the role of meeting spaces in Kaikaku projects in production system development and opportunities that such spaces can provide in radical development projects.

- The influence - both positive and negative- of using digital visualization tools in the meeting spaces on the efficiency of the meetings and facilitating data sharing and using. The degree of digitalization of visualization tools which can lead to optimum combination of traditional and digital tools to support the meetings could be the specific focus in this topic.

- The role of the meeting spaces as a common forum for product developers and production system developers to support easier and more effective flow of the required information in both processes.

- This thesis has been based on four case studies and their regulation on holding meetings. However, to draw generalizations from this research, the sample needs to be much larger. Perhaps more cases should be considered whether in Sweden or in other countries.
There are certainly many other opportunities to broaden the knowledge about Obeya and similar meeting spaces which can be covered by future researches which can be the topic of the future studies in this field.
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