

Scrum in Traditional Industrial Projects That Contain Internet of Things Solutions

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<p>This thesis describes how and why companies should invest in Internet of things solutions. Two project management methods are described, the traditional Waterfall project management methodology, and the Scrum agile project management framework. Both project management methods were studied to create a manual on how to start the transition from traditional project management to agile Scrum. It is further explained why this transition is needed to start creating internet of things solutions in industrial projects.</p> <p>The work was started on October 2015 and ended on may 2016. An extensive desktop study was performed to gather a wide enough knowledge on theoretical concepts that were requested by the commissioning company. In addition to a desktop study a series of informal observations and interviews were done, as well as four official interviews.</p> <p>The project was complex and for this reason a non traditional research methodology was used. Abductive grounded theory methodology was used to find the real problems and challenges that CompanyX had. A surprising finding was made on the company. CompanyX operates in engineering project consultancy, and the assumption is that companies in engineering project consulting know how to manage projects. The surprise was that this was not the case, and there was a lack of project management skills in the studied business unit.</p> <p>The outcome of the study suggested that companies that wish to have internet of things solutions should manage their projects using agile methods. Also it was found that companies should start investing in, and moving towards internet of things solutions, for there is huge potential in them.</p>	
Keywords Scrum, Traditional Project Management, internet of things,	

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1 Introduction

Internet of things is a new concept that will revolutionize different areas of business and industries. The possibilities on this ground-breaking technology are endless and by such companies at large are very interested in it. McKinsey & Company projects that the Internet of things business will have a potential value up to 11 trillion US dollars (McKinsey. 2015)

The aim of this thesis is to find out how implementing **internet of things** and Big Data effect the requirements on project management of an industrial site. This thesis will follow the normal structure, where the theoretical concepts will be discussed first, and the empirical part will come afterward.

This thesis is commissioned by CompanyX and the company is interested in developing their service portfolio in the area of internet of things. To help the company improve their service portfolio, a current state analysis is done to map what is the situation of the company's project management at the moment. Based on the current state analysis **a best practice model** is created based on the theoretical framework and the empirical studies.

CompanyX is an engineering consultancy company, which is specialized in industrial projects. These projects range from Greenfield factory building to optimizing the security of an industrial process, and designing automation solutions. The company itself does not build anything, but is specialized in creating designs, papers and industrial drawings etc. needed to implement a project.

1.1 Study methodology

Abductive grounded theory methodology was chosen for this study as the topic for a thesis was not clear for the commissioning party. The commissioning party had ideas too wide to start a typical thesis process, for this reason an abductive grounded theory study was performed. Abductive reasoning was first used to find out the relevant problems. The research question was formed from this, and after the abductive process; a grounded theory study was performed.

Abductive reasoning was a research methodology introduced by the American mathematician, philosopher and pragmatist Charles S. Pierce. In abductive reasoning the rea-

soning process bounces back and forth from observations to theory and vice versa. The basic idea is not to use either inductive reasoning or only deductive reasoning, but combine these two to create new theories on pragmatic bases. (Tavory & Timmermans 2014, 4-5.)

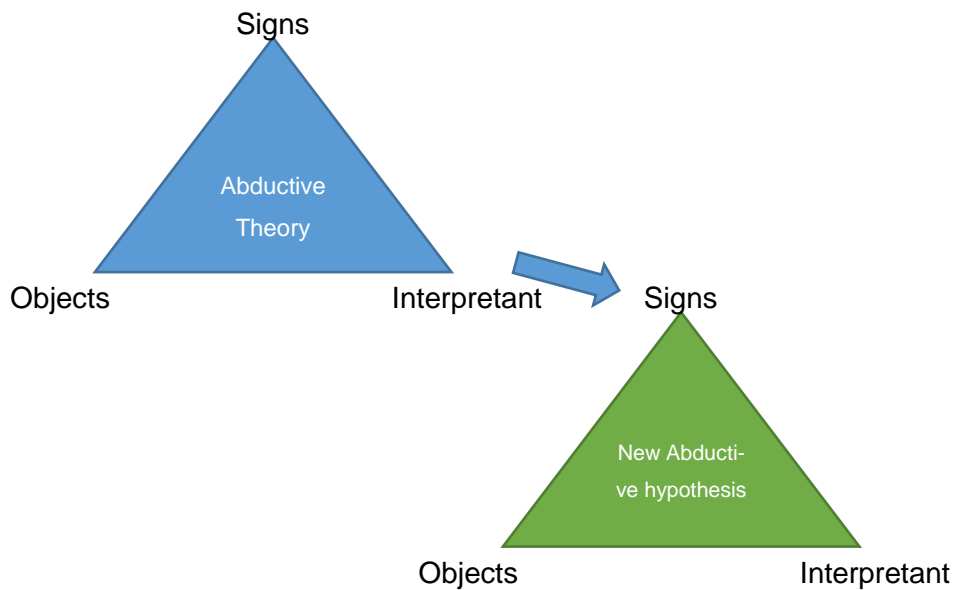
Abductive reasoning consists of three parts: signs, objects and an interpretant.

Signs are phenomenon and behaviors that are linked to a concrete thing in the world, which are the objects. Smoke is the sign of fire. In a way a sign is the shadow of an object, a shadow cannot exist without an object that the shadow is a projection of. **Objects** are ideas, individuals, creatures, goods, and things that affect the surrounding world by creating signs of its existence. Objects can exist without the signs itself, so objects are not projections of something else. (Tavory & Timmermans 2014, 22-23.)

The key insight in abductive study comes from the role of the **interpretant**. The interpretant creates meaning from observations and theories. According to Tavory & Timmermans, "*the Interpretant is a transformation that the interpreter undergoes while making sense of a sign*". So in a way an Interpretant is a hypothesis done by studying a sign and an object. (Tavory & Timmermans 2014, 22-23.)

Further on as seen in the following figure, Interpretant can be a part of a following study or reasoning. An Interpretant can become a sign in a following reasoning or study, thus creating a "*semiotic spiral*". This semiotic spiral can be used to find new theories or to understand complex pragmatic issues. (Tavory & Timmermans 2014, 22-23, 28-29.)

FIGURE 1 Pierce's Semiotic triad modified



(Tavory & Timmermans 2014. 23)

The base idea of an abductive study is to find a surprising observation during field study. The authors of abductive analysis explain the basic process like this:

“The surprising fact C is observed.

But if A were true, C would be a matter of course. Hence, there is a reason to suspect that A is true”.(Tavory & Timmermans 2014, 37.)

So the most important first step is to find a surprising observation.

Grounded theory is an extensively used framework of qualitative research. The basic idea is to gather field data and create theory from it. The basic tools of grounded theory are theoretical sampling, coding, theoretical saturation, and constant comparison. (Bryman & Bell 2007, 584-586.)

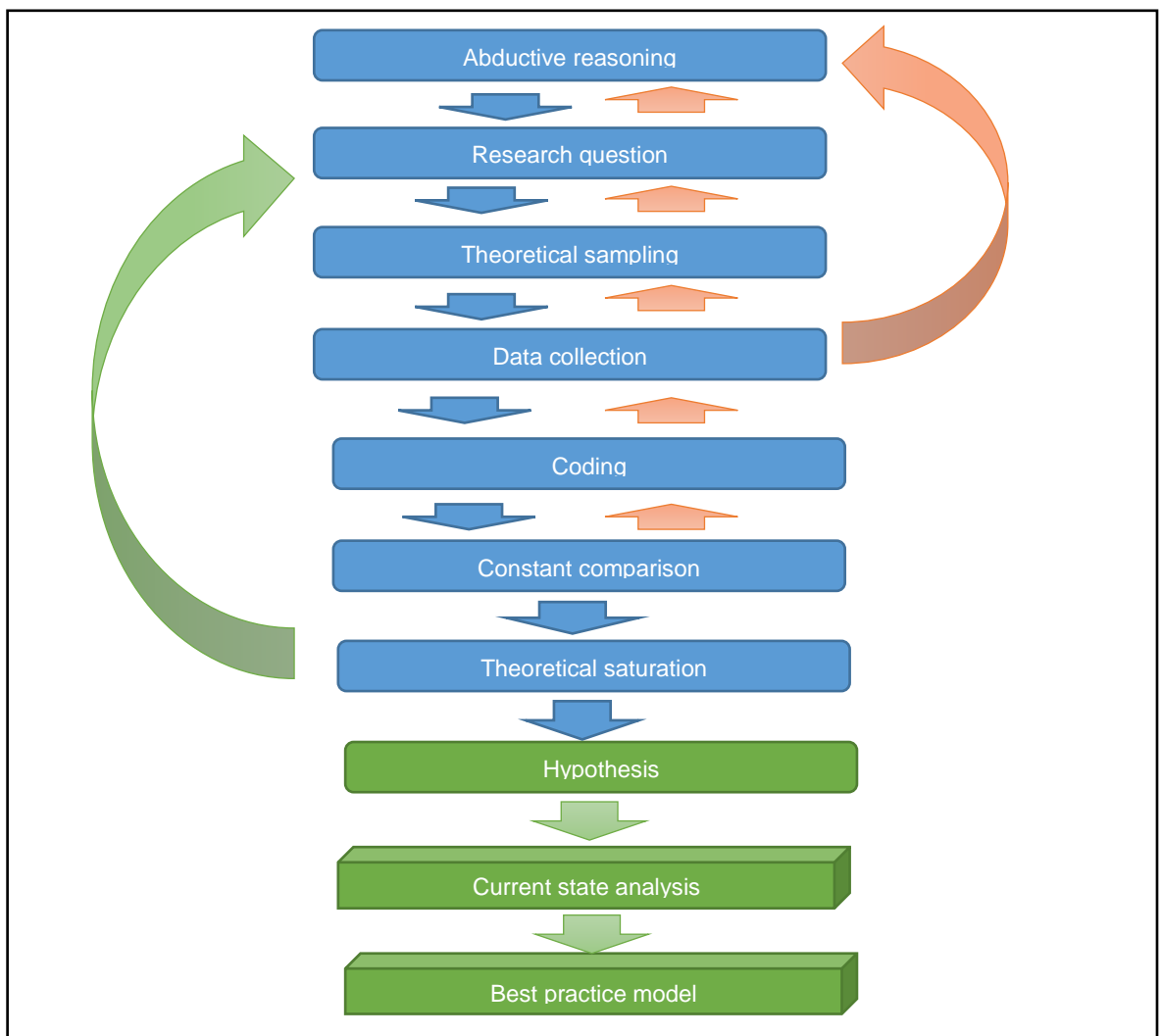
Theoretical sampling is the action of data collection to create theory. The process is ongoing and the researcher analyses what kind of data should be gathered next by reflecting on the data gathered so far to the theoretical framework. (Bryman & Bell 2007, 459.)

Coding is the art of breaking data into its fundamental parts. The aim is to give names or labels to the components that might have theoretical significance, to find possible categories of information and to find common behaviours. **Theoretical saturation** explains a

point in the study that no new relevant information is produced, or that the data gathering starts showing repeatedly the same concepts that were already coded. **Constant Comparison** is the action of constantly compare the gathered data to the theoretical framework and let the framework fluctuate by the upcoming data, so that the field data leads the used theories, and their use. (Bryman & Bell 2007, 585-586.)

In this study, the grounded theory process went as follows in the following figure. Steps from abductive reasoning to constant comparison were repeated to find the right research question. Steps after the constant comparison were performed swiftly, as the theoretical saturation was reached. When the theoretical saturation was reached a final research question was formed, and the process went through to the hypothesis state. Based on the hypothesis and the study itself, a best practice model was made. (Bryman & Bell 2007, 588-589.)

FIGURE 2. Grounded theory process edited with abduction and specialities of the project. (Bryman & Bell 2007, 589)



1.2 Delimitation of study subject

The demarcation process started in October 2015 when discussion of a potential thesis project was held with the commissioning party. The discussion was held on three different meetings with the head of manufacturing industry business unit. The company wanted a “shippable” service in the area of industrial internet and internet of things (Haravuori, P. October 2016.)

In the beginning the project dealt with improving a customer’s supply chain management by implementing internet of things on its value chain. The commissioning party was interested also on their value chain documentation and on their company’s needs. The preliminary studies done according to the wishes of the commissioning party were on the subjects of supply chain management, value chain management, project management, quality management, service development, internet of things, industrial internet, and big data. The resulting project would have been too wide for a single thesis study. (Haravuori, P. October 2016.)

Informal observations and informal interviews were held during autumn 2015. The informal interviews were not planned but followed an instinctual format. In addition the offices of CompanyX were observed for signs and objects of the theoretical concepts that the commissioning party was interested in.

1.2.1 First iteration of the study and research problem

The subjects that were discussed in the first meeting were the following: supply chain management, internet of things, value chain documentation, internet of things in industrial projects, how to create value with supply chain management and IoT in traditional projects, and how to use supply chain and IoT to decrease the operating costs of clients by spending money on designing projects that have investment costs. (Haravuori, P. October 2016)

The first iteration of the research topic was the following: **Improving the Value Chain Documentation of CompanyX using Supply Chain Management Theories, Interwoven with Internet of Things Solutions.**

The first iteration of the research question was: **How to improve the Value Chain documentation of the company and create an internal guide how to use the documentation itself?**

The subject was quite wide, so an untraditional study methodology for a bachelor level thesis was chosen as stated before. In abductive reasoning a surprising fact is tried to find, and the fact is a sign of an object, or an object that is surprising to the observer. (Tavory & Timmermans. 2014, 24, 37.)

TABLE 1. List of signs and objects in the company on the discussed topics

Object	Potential Signs of the object
Supply Chain Management	<ul style="list-style-type: none"> • Flow charts • Quality following • Balanced Scorecards • Kanban boards
Value Chain Documentation	<ul style="list-style-type: none"> • Organizational trees • Clear definition on responsibilities • Value Chain maps
Internet of things	<ul style="list-style-type: none"> • Knowledge on IoT issues • Knowledge of big data
Traditional industrial projects	<ul style="list-style-type: none"> • Gants Charts • Maps of industrial site • Network diagrams • Use Ms. Project • Milestones
Internet of things project management	<ul style="list-style-type: none"> • Agile project management practices • Usage of post it tags for project management • Members of projects know their meaning in the big picture • Kanban boards

The starting hypothesis was that as CompanyX is a company that specializes in projects and project consulting, the company itself would use common project management methods. The working hypothesis was that there would not be need to do a study project management on the company. The beginning aim of the study would be about supply chain management and internet of things

1.2.2 Second iteration of the study & research problem

During visits to the commissioning company's offices, informal observations were conducted. Observations on the physical surroundings and graphical presentation of artifacts

and objects were performed in an instinctual level. Signs of agile project management nor traditional project management were not present, but there were maps of industrial sites etc. Gantt charts or network diagrams were not present.

During informal interviews on autumn, the junior engineers as well as some of the more experienced engineers felt that they didn't know the meaning of their work in the greater picture of projects. Many of them complained about the pressure they felt in some projects.

These experiences during autumn brought a surprising observation needed for abduction. The observation was that there might be challenges on project and team management in a company specialized in projects. After this observation, signs of the truth of this were searched from theoretical sources as well as the signs found this far.

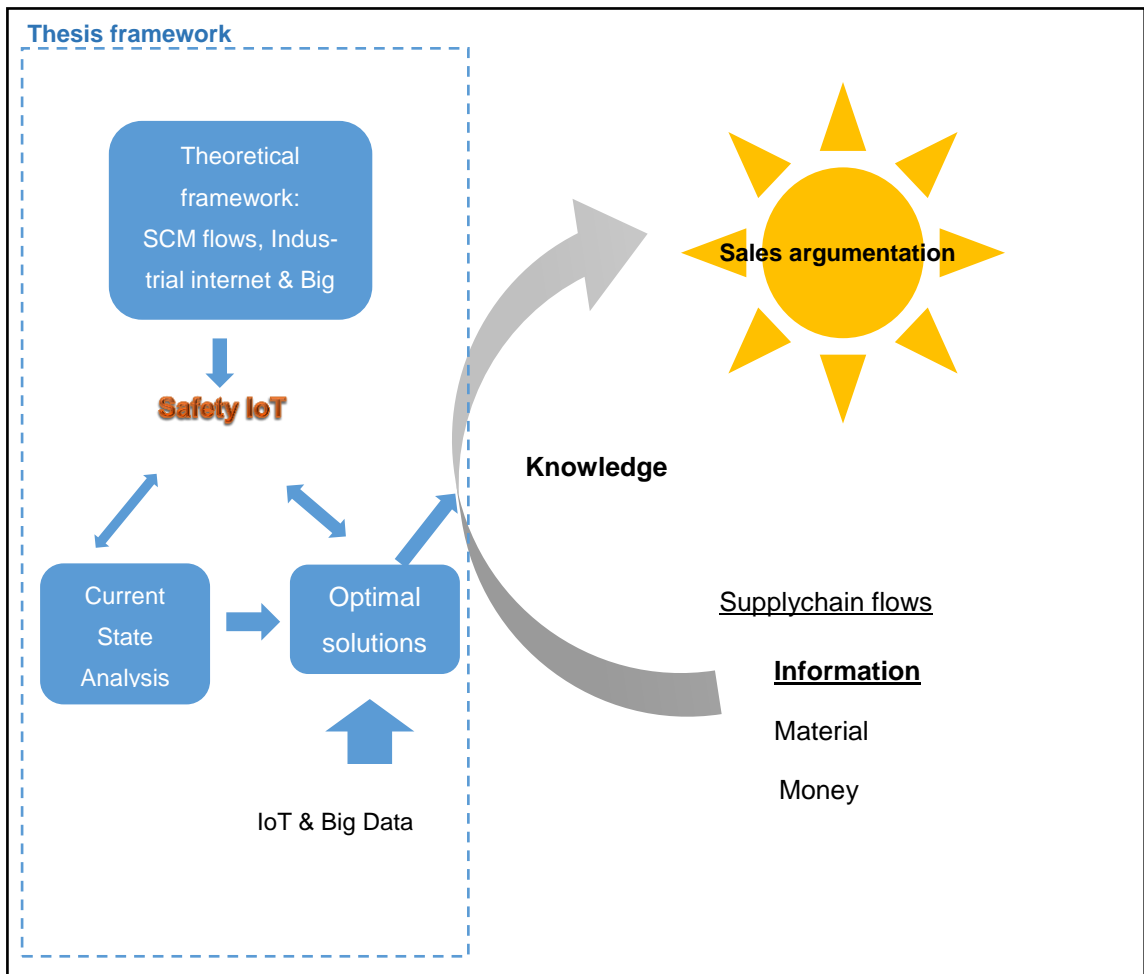
The signs were

- No project management artifacts on the walls
- Team members didn't know their own role in the bigger picture
- During talks with commissioning party "Sprints" were mentioned
- Agile and Scrum was not commonly known.
- Internet of things in safety automation was an interesting concept to the company
- Internet of things was an interesting concept to the company

The thesis topic on this iteration of the thesis process was modified into: "**Implications of Using Supply Chain Management Theories, Industrial Internet and Big Data in a Projects Feasibility Study Phase**". The thesis topic changed one more time after the empirical study phase when more in-depth information was gathered on the company in formal interviews.

The following figure explains the framework of the thesis discussed with the company in the second iteration. The thesis would be inside the blue dotted line. The idea was to create new possible value to the sales argumentation with the thesis study, by creating the thesis study on the theoretical framework of supply chain management flows, industrial internet, and internet of things, big data, and project management. Sales argumentation was an offshoot from the thesis, and the thesis was about the information flows of projects, and how to take internet of things into account in them. (Haravuori, P. January 2016.)

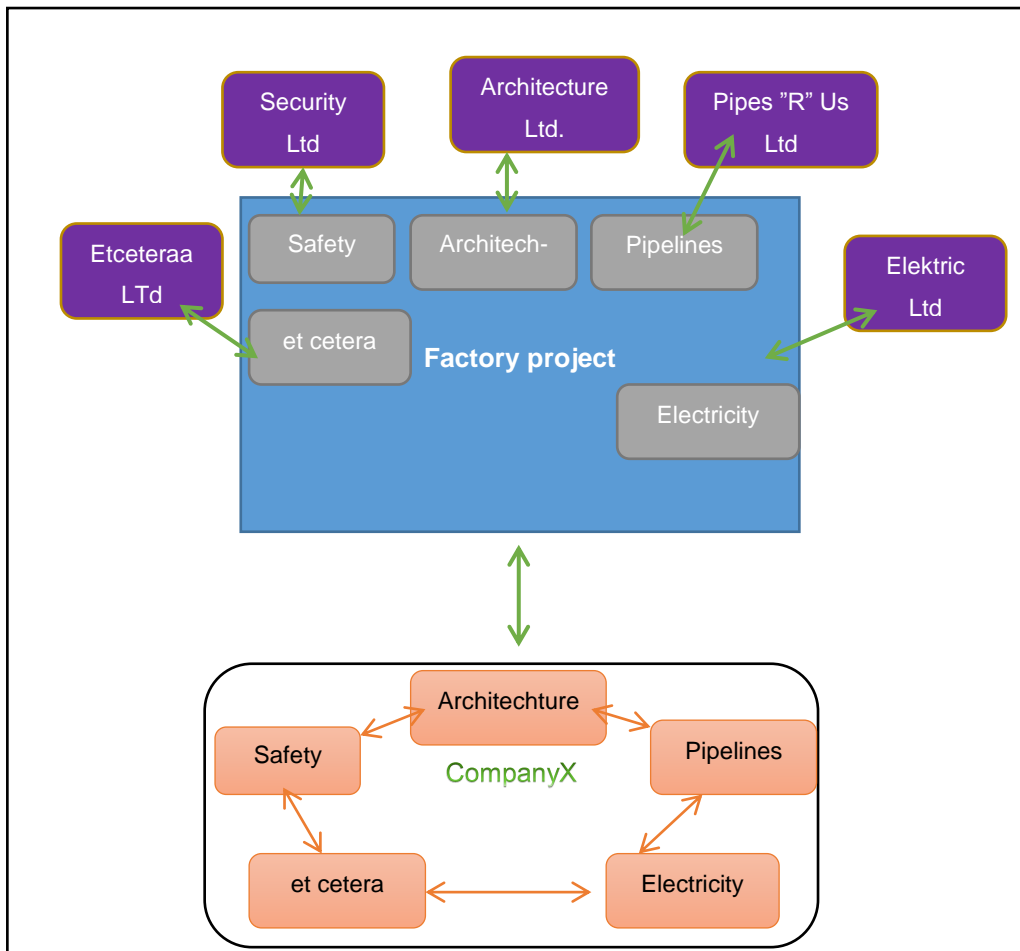
FIGURE 3. Thesis framework and scope 2nd iteration (Haravuori, P. January 2016.)



Further on there was a need to get facts to show a potential customer company why to choose CompanyX to design a project from the beginning, and why to unify the project designing and implementation, instead of distributing it to various subcontractors. (Haravuori, P. January 2016.)

The following figure shows the idea that the commissioning party wanted to presents to its customers. The main challenge in many industrial projects was that there were many operators and subcontractors in the same site. There were also many different companies doing architecture consulting and factory design. According to CompanyX when there is many operators in a project, there is issues that easily are oversighted between the “responsibility boxes” of each company. Things that later on might be critical and it is not clear whose responsibility it is to solve them. The commissioner wanted the thesis give solutions also these challenges. (Haravuori, P. January 2016.)

FIGURE 4 Challenges the company was facing on projects. (Haravuori, P. January 2016.)



The scope of the project was still too wide and unfocused, but there were no clear solutions on how to move forward, as it was impossible to create a research problem with the information so far. Internet of things was clearly one of the topics that the commissioning party wanted to keep in the study. This meant that there was a need to go to a third cycle of abductive reasoning and Grounded theory research, to find the final research problem and solutions to the issues that it brought up.

1.2.3 The third and final iteration

The final research topic and final research question were created after formal interviews were conducted. The interviewees were one junior engineer, one experienced engineer, and one veteran engineer. In addition Mikko Aro the chief of internet of things and big data solutions of Solita Oy was interviewed. The questions asked in each interview can be seen in the appendixes 2 to 5. The questions asked were quite wide in subjects, but were precise enough to find what the needed theoretical framework was. The interviews were

consulted from the most senior interviewee first to the most junior last, and the interview to Solita Oy was performed last.

During and after each interview the abductive process was done, signs of objects were searched and these were both interpreted to create a new Interpretant and thus an intermediate abductive hypothesis.

Grounded theory was used in these interview cycles to focus the research scope, and to find the right target theories and questions to ask the next interviewee. The cycle comprised a **quasi-research question** that was presented as the wide topics of the interview questions. This was followed by **theoretical sampling**, where the answers gotten from the interview were compared with the theory. **Coding** happened also after each interview, as answers were analysed and divided into themes and concepts. **Abduction** was used after Coding to find out **Signs** and **Objects**, and using them create an **Interpretant** of the situation. With the Interpretant, the set of questions was focused and modified after each interview.

The relevant results for the study are presented in the chapters that discuss the theoretical concept that is appropriate for the study. The results on the issues that missed the study subject are not discussed in depth. The topics can be found in the interview questions asked from the interviewees.

A researcher's decision was made to study project management, and further concentrate on visual and simple concrete ways to manage a project. Keeping in mind that internet of things would have different needs from the usual projects the company has. As the company is trying to use the Scrum methodology, but it is not well understood in general, Scrum was elected as one of the project management methodologies studied.

1.3 Research problem

After the long demarcation process a conclusion with a research question and inquisitive questions could be done. As the commissioning party was vague in the requirements on the project, this study has moved forward in a slightly different pace. The questions were the following.

Research question: **How to use Scrum in traditional industrial projects that contain internet of things solutions?**

Inquisitive Questions

1. What is the internet of things?
2. What solutions internet of things could offer to industry?
3. What are the special requirements that an Internet of things project bring to an industrial project?
4. What is the traditional “waterfall” project management method?
5. What is the Scrum project management methodology?
6. What is the current situation of the company’s project management practices?
7. How could Scrum methodology improve the company’s Project management practices situation?

1.4 Definition of key concepts

Internet of things is an umbrella that has underneath it things like big data, industrial internet, machine learning and machine to machine communication. The concept describes how business can use technology and internet to automatize operations, by adding sensors to different machines and things, that gather information and helps calibrate machines and processes. (Salo. 2014, 18-22.)

Big data is the gathering and analyzing data from various sources on huge volumes. The main idea is to use computers and algorithms to find phenomenon, risks, potentials etc. that a human can’t see from the huge amount of information (Salo. 2014, 26-29.)

Traditional project management is *“the application of knowledge, skills, tools and techniques to project activities to meet the project requirements”* (Cecil,Bozarth & Handfield 2013, 444).

Scrum is a project framework where series of events called “Sprints” follow each other. These Sprints are from one to four weeks and they are always of a fixed length. The main idea of each Sprint is to get a potentially shippable product or service out. (Larman & Vodde. 2009, 308.)

Project network diagram is a tool to improve Gantt charts. A Network diagram shows the association of each activity in a project. Using Project network diagrams different actions can be taken during a project and when managing the whole picture.(Cecil,Bozarth & Handfield. 2013, 449.)

2 Internet of things

Internet of things is built upon the industrial internet. In the heart of internet of things is the machine-to-machine communication, first introduced in industrial internet. Another essential part of internet of things is data and data transfer. The size and price of sensors have come down exponentially, in the same time the speed of data transfer has increased in the same exponential way. (Stackowiak, etc. 2015, 20-21; Greengard 2015, 51,53.)

Adding to these two is that the prices of data bank services have also decreased and their service portfolios increased. The emerging of big data has created possibilities and solutions in machine learning and near instantaneous data analysis from massive data flows. At the moment the internet of things is concentrating on optimization of plants and processes, but in the coming year's machine learning and extended reality will create new business opportunities. (Stackowiak, etc. 2015, 20-21; Greengard 2015, 51, 53.)

At the moment internet of things and big data is mainly used in consumer solutions, sales and marketing, and industrial internet and banking. Open source Hadoop based data analysis solutions have brought the price of data analysis down to levels that even normal consumer can utilize. The essence of the internet of things is data and creating value from this data. To create value from raw data computer algorithms are used to make sense of the terabits of information that can be created in mere hours. To create value models need to be created and tested. In the best situation these models and algorithms can forecast future actions, like when a customer is changing to another bank or when a person is beginning to look for a new car. In the best situation these forecast can be so good that the person is not aware of the coming need. The same goes to predictive maintenance. A good algorithm can predict when a piece of a machine might break down long before there are any signs of it on the piece itself. (Greengard. 2015, 51, 53-55.)

2.1 Evaluating the “Art of the Possible” - What should be taken into account in IoT projects?

There is a great drive to find new and differentiated internet of things and big data solutions in the market. The main reason is the fear of being left behind the competitors, and the possibility to gain market share with a new product. (Stackowiak, etc. 2015, 29-30)

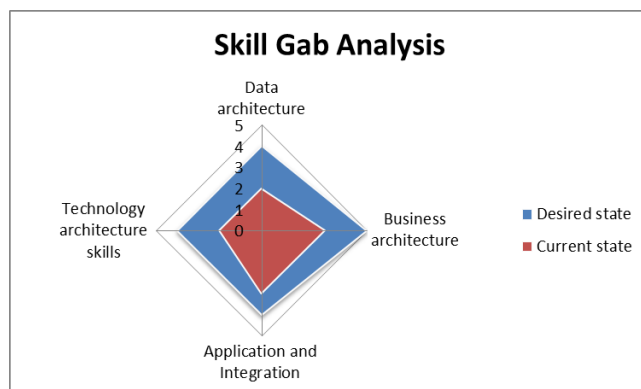
Before creating any solutions, the company needs to know its own situation. A current state analysis on the information architecture, data points, and the business information

need, should be done. The current state analysis might spotlight a situation that the company is not mature enough in its information architecture to start an internet of things project. In this situation the company will get more benefits in solving these maturity issues. (Stackowiak, etc. 2015, 31)

When the maturity of the data architecture is mapped, the company needs to understand the level of the company’s organizational skills. The skill sets can be divided into business architecture skills, data architecture skills, and technology architecture skills. **Business architecture** skills are associated with business management skills. These are business strategies and plans, and basically all that is needed to run a successful business. **Data architecture skills** are needed to create useful knowledge from the data. Skills needed are know-how of creating algorithms, and using relational databases, NoSQL databases, and Hadoop etc. **Application and integration** skills are the skills needed to create working software, or translating business need into requirements for outside business development. And finally **technology architecture skills** are the skills needed to implement the hardware needed, but also a wide array of variable information technology skills. (Stackowiak, etc. 2015, 99-108)

To find out if there is a skill gap between the needed skills and the existing skills, a skill gap analysis can be done as seen in the following figure. Finding out the relative value of each skill set in the company, helps finding the need of training, hiring and outsourcing.

FIGURE 5 Example of a Simple Skill Gap Analysis (Stackowiak, etc. 2015,109)



After knowing the technological and skill level of the company, there needs to be an understanding of the business itself before any solutions can be offered. Knowing the strategies and business processes of the company as well as the business intelligence needs, help find problems and solutions in the company. Knowing what are the needs and plans

of the company management considering different areas of the business, helps target the visioning process of creating an internet of things solution. The needs and challenges might come from marketing, cost reduction and margin improvement, process efficiency gains, additional capabilities etc. Knowing what the company wants in business, allows creating Internet of things solutions.(Stackowiak, etc. 2015, 49-53.)

When the business needs are found out, critical success factors and key performance indicators are listed. Finding out these business drivers helps finding out what kind of data is found out or created in potential internet of things solutions. Realizing what kind of data is created, and in what area of business operations it is created, allows creating visions for possible solutions. (Stackowiak, etc. 2015, 55-57.)

As important as the mapping the capabilities of the company and the business needs of the company are the key to create internet of things solutions is vision. A vision creates a concrete idea on the thing created and allows it to affect people on an intellectual level as well as on an emotional level. To create a vision, a cross functional visioning session could be arranged. The most valuable solutions come from people who are concretely working on a business process. These persons might be factory line workers to business managers. Finding the business case or problem in the process, is the way to tailor solutions using internet of things.(Stackowiak, etc. 2015, 29-30)

2.2 Internet of things solutions

The internet of things solutions are based on generated data and knowledge and business value generated from this data. The data is generated by input points connected to computer systems. These data points are diverse and include things like geolocation, GPS, barcode scanners, various sensors, cameras, audio and video monitors, radars, sonars, and light detection ranging devices etc. The data gathered from these data points is analyzed with computers so that sense can be made from the gathered data, and that the connected devices can be managed. The computers can be situated in another continent, and relay the knowledge generated to mobile devices.(Greengard. 2015, 54-58)

Possible solutions for various internets of things solutions are close to limitless. Some solutions are in the area of augmented reality, locational awareness, enhanced situational awareness, sensor-based decision analytics, and automation & control. The challenge is to find which ones of these solution groups bring most business value to the company. (Greengard. 2015, 58-59, 60, 64, 67, 69)

All in all the challenge in internet of things is not the lack of technology but the lack of vision. Companies that aim to implement internet of things solutions should know themselves and know the business they are in. When this is done the most important is to have a vision on the problems they want to solve. A consulting company should know the business of its client company to create useful and valuable solution.

3 Traditional- or Waterfall project management

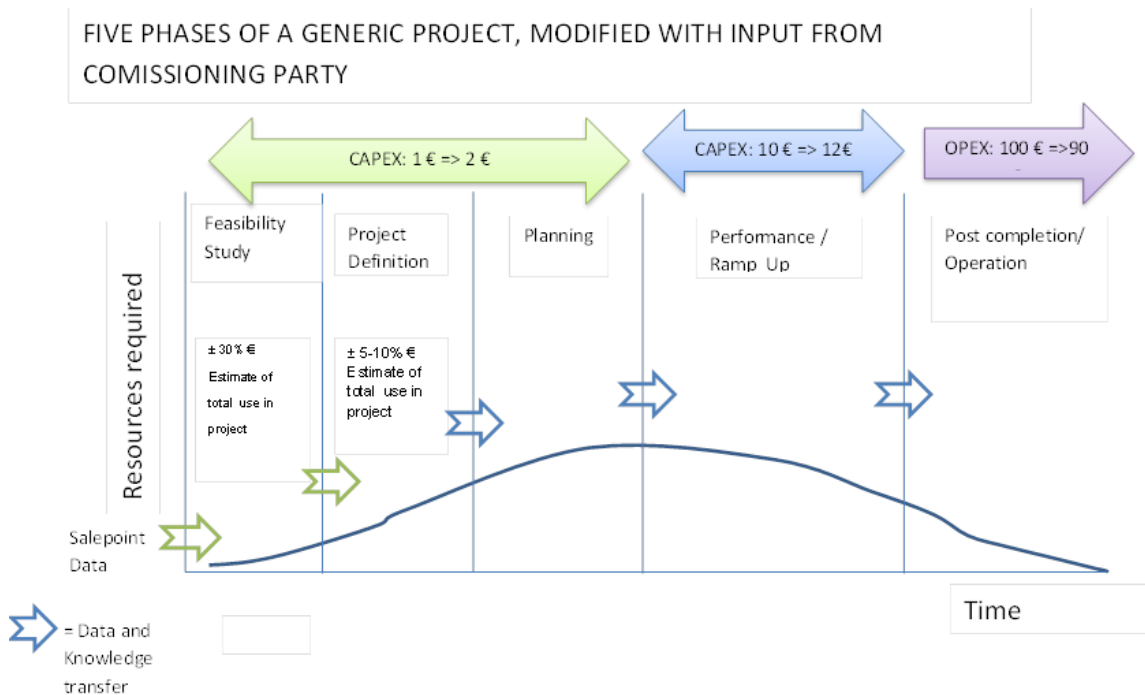
Project management is the art of creating a working environment where a product, service is created. (Cecil,Bozarth & Handfield. 2013, 443; Larman & Vodde. 2009, 73.)

Projects are seldom business as usual, and have a clear starting and ending point. Further on, projects might have significant impacts on the future of the company, as they may make or break the company. A project might have cross functional teams, and a person working on a project often answers to managers from different areas of the project. As every project is somehow different from the other, predicting the exact costs and end results is difficult. (Cecil,Bozarth & Handfield. 2013, 444.)

Project management has become a critical aspect of company life and middle management, as there is an ever increasing pace of strategic change. Further on the commissioning party is a company in construction consulting, where all business as usual is a project. (Cecil,Bozarth & Handfield. 2013, 444)

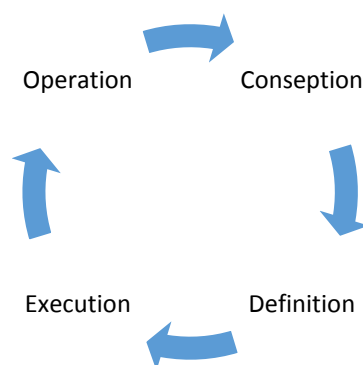
A project can be divided in five phases, concept/feasibility study, project definition, planning, performance/ramp up, and post completion/operation. In the following graph one can see the resources required by the project marked with the blue line. Often a projects resources needed are presented by a bell curve. The big arrows on top of the graph symbolize the sales argumentation most consulting companies have to the end customer according to the commissioning party. Spending more money in the beginning and thus increasing the capital costs (CAPEX) bring savings in the post completion phase of the project, thus decreasing the operating costs (OPEX). (Cecil,Bozarth & Handfield. 2013, 444-446; Haravuori, P. January 2016)

FIGURE 6 Project Phases with goals for a consulting company (Cecil,Bozarth & Handfield. 2013, 445; Haravuori, P. January 2016)



Another way to visualize project phases is the systems development cycle introduced by John M. Nicholas in his book Project management for Business and Engineering. The author emphasizes that projects are man-made systems that imitate biological systems. Because of this, every project or system has a life cycle, a beginning and an end. In each step of the cycle there is a different level of activity, as seen in the previous bell curve. In each step various professionals are needed and the level of activity is different. Even as projects change from project to project and phase to phase, three variables can be identified, time cost and performance. (Nicholas. 2004, 88)

FIGURE 7 Project lifecycle (Nicholas. 2004, 87.)

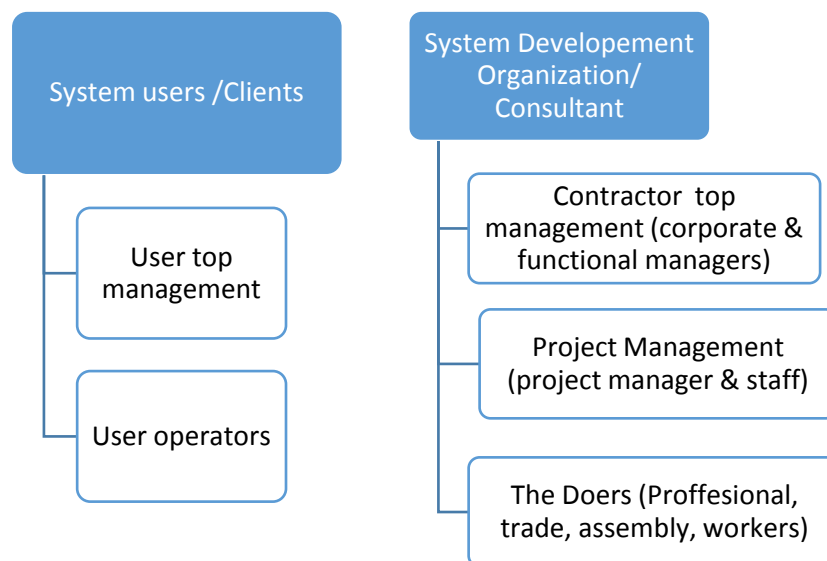


The systems development cycle or project life cycle can be divided to four phases, and each phase has its own activities that are generally done in each project. (Nicholas. 2004, 90)

1. Conception phase
 - a. Initiation stage
 - b. Feasibility stage
 - c. Proposal preparation
2. Definition phase
 - a. Project definition
 - b. System definition
 - i. User requirements
 - ii. System requirements
3. Execution phase
 - a. Design state
 - b. Production/build stage
 - i. fabrication
 - ii. testing
 - c. Implementation stage
 - i. Training
 - ii. Acceptance tests
 - iii. Installation
 - d. Termination
4. Operation phase
 - a. System maintenance and evaluation
 - i. System improvement (Start the cycle again)
 - ii. Or system termination

After the execution phase the project is done a project ends to exist, and becomes an operational entity (Nicholas. 2004, 90)

FIGURE 8 in a project development one can find several main interested individuals. The main parties in a project are the following. (Nicholas. 2004, 90)



3.1 Feasibility study

Projects are always a pursuit to solve a certain problem. If you build a bicycle factory, you are solving the problem of how to produce more bikes better or cheaper than the competition. The main step when starting a project is to recognize that there is a problem that needs to be solved. The second step is to find out who can solve the problem, and send them a request for proposal. So in this way there is two parties the “customer” who has a problem and the Consultant/contractor who can solve this problem. (Nicholas. 2004, 91)

When a project is in its infancy, several steps are taken by the contractor/Consultant

Inspect the clients environment and objectives. (Nicholas. 2004, 91.)

1. find out other solutions, needed resources, organization and strategies
2. Figure out the technical, economic, and environmental feasibility of initiating the project
3. Present a “letter of interest” or a “formal proposal” describing the possible solution and the consultants/contractors means of completing the project

The most challenging aspect in doing a feasibility study is that the companies in the project are still operating in a pre-contractual situation. A request for proposal has been sent and received and the bidding is going on. The challenge is that the possible contractors are not yet getting revenues from planning work, and the customer might not have the “real problem” to solve. The steps of the former list, one to two, are basically pre-feasibility study steps and steps three and four are the de-facto feasibility study. (Nicholas. 2004, 101-102.)

Throughout the material studied, an emphasis on the concreteness of definitions of the project is emphasized, warning on the dangers of making general specifications. Important is also to find out who are the real users of the end product of a project. If the wrong end users are stated in the project feasibility study phase, wrong solutions will be offered to the customer, and the customer will not be happy with the end product. (Nicholas. 2004, 101-102; Cecil,Bozarth & Handfield 2013, 445.)

Further on studies show that a budget estimate made on this phase of a project is $\pm 30\%$ correct. Without the right specifications and without the “right problem” the risk of an incorrect budget grows. A badly inaccurate budget might bring financial loses to either the contractor, if the price of the bid is set too low, or to the customer if a contractor is able to

sell an expensive project that the end user does not even need. (Nicholas. 2004, 101-102; Cecil,Bozarth & Handfield 2013. 445)

According to the proponents of traditional project management, a well done feasibility study phase with clear definition of the problems that need to be solved, and the true needs of the customer is critical to manage a successful project. In the final documents of the feasibility study should be the following:

"Summary of the data collected, description of the existing system, statement of the problem, criteria and methods used to evaluate alternatives, preferred solution(s), and reasons for its selection."(Nicholas 2004, 106).

These documents are added to the final project proposal, in addition to the project plan, bid price, and contractor qualifications. A statement of the analyzing process might also be added if the customer wants to see the way a conclusion was reached. (Nicholas 2004. 106.)

After these steps come the final steps which are project proposal mentioned in the last paragraph. In addition to this a contract is fashioned based on a statement of work. A statement of work is the division of work needed, that is stated in the project proposal. With the statement of work a price can be calculated and the contract fashioned. (Nicholas. 2004, 104-107.)

Important documents on this phase

- Request for proposal
- Project proposal
- Statement of Work
- Project plan addressing time, cost and performance/requirements of the project
- Work Breakdown Structure documentation to find out the work needed to achieve requirements, work schedules and cost estimates

(Nicholas. 2004, 104-107.)

As important as the feasibility study phase is, one needs to keep in mind that there is no influx of funds during this phase (unless someone has been contracted to do a feasibility study) and too much should not be revealed in this phase, just enough that a comprehensive contract can be made. (Nicholas. 2004, 104-107)

3.2 Project definition

If the customer has decided to use the consultant/contractor that has prepared a proposition in the feasibility study phase, a deeper study on the subject is performed. The project team is bolstered and detailed plan is created with the entire minutia the project needs, from support systems to necessary resources and time management. (Nicholas. 2004, 104-107.)

The first stage of the project definition phase is the creation of user requirements. As stated before that the price estimate of the project is $\pm 30\%$ correct in the feasibility study phase, in the project definition phase the price estimate is more accurate. Generally the exactness of the budget is from $\pm 5\%$ -10%. Estimate of resources used in the project; affect all three variables of projects dimensions, time, cost and requirements. For these reasons it is important to do this part carefully and with forethought, with attention to avoid costly misunderstandings. Questions such as the ones in Appendix 2 could be asked from a potential customer to improve the quality of requirements. (Cecil,Bozarth & Handfield. 2013, 445-446; Nicholas. 2004, 120-122.)

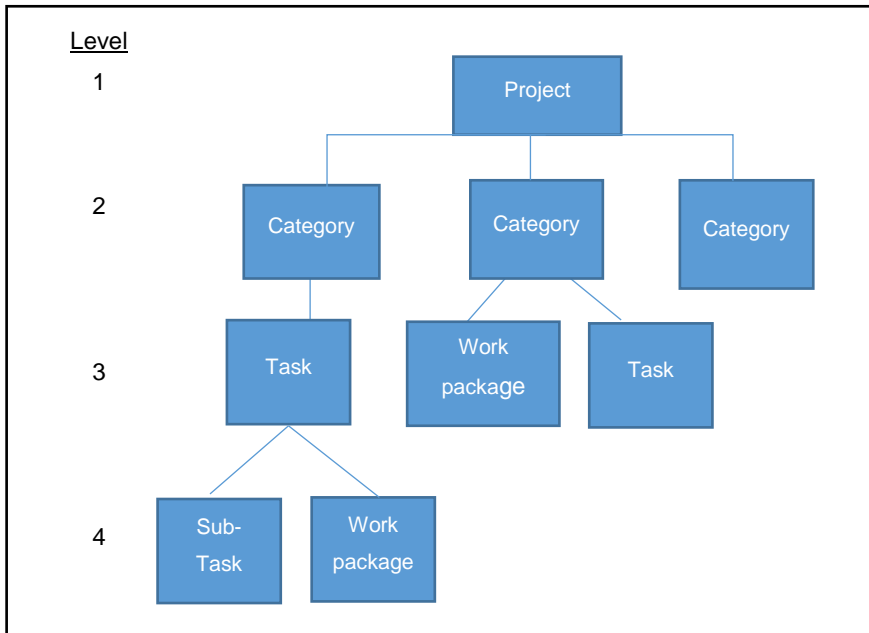
There are risks if the requirements are not done well. A project might become irrelevant if at the end of the project the requirements set, were not the ones that would fulfil the needs, or solve the problem, defined in the feasibility study phase. In the same time as the requirements are critical to the task at hand, creating them is not an easy task. Often the problems in requirement setting are the following:

- Requirements need information from different areas of business, like marketing and engineering.
- Definition phase lacks the knowledge needed to explain the product or project?
- A habit on using imprecise terminology like "Modern" etc.

(Cecil,Bozarth & Handfield 2013, 445-446; Nicholas. 2004. 120-122.)

According to the authors Nicholas and Steyn, a work breakdown structure is one of the first things that should be done on the requirements phase. Work breakdown structure contains normally four levels as shown in the following figure. Level 1 the project level, level 2 Sub-project, level 3 activity, and level 4 work packages and tasks. Each higher level explains and divides the tasks and requirements into smaller pieces. When creating a work breakdown structure, one should limit the amount of levels created so that the charts and documents are readable. (Nicholas & Steyn. 2012, 169-171.)

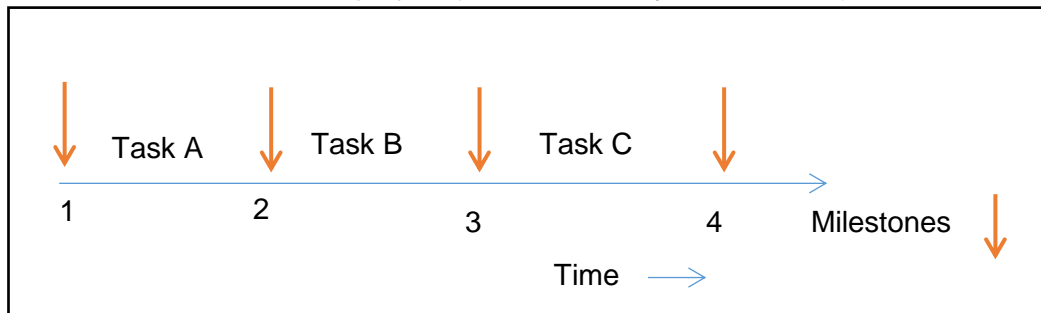
FIGURE 9 Work Breakdown Structure (Nicholas & Steyn. 2012, 169-170.)



3.3 Planning, Network Diagrams & Gantt Charts

In traditional waterfall type project planning the planning of a project starts after the project definition is done. After the requirements of the project have been defined a “road map” is created for the project. Important events and milestones are defined and marked before the project starts. The following figure shows one of the simplest forms of roadmaps one can have in a project. The tasks in a roadmap are either in level 2 or 3 of the work breakdown chart from the previous chapter, so each task in the project roadmap are either categories or tasks, that needs to be completed. Each sub-task and work package are not normally mapped in a project roadmap, for in traditional project management there are precise documentation for each level. (Nicholas & Steyn. 2012, 180.)

FIGURE 10 Milestones of a project (Nicholas & Steyn. 2012, 180.)



One of the most common tools of planning in the traditional project management is the Gantt chart. A Gantt chart can be created after the work breakdown structure has been

done and the general roadmap has been figured out. A Gantt chart shows the schedule of different work packages and when their projected completion date should be. An interactive Gantt diagram can show what the situation of a project is, and if a work package is late or completed earlier than planned. (Nicholas & Steyn. 2012, 181-185.)

When creating a Gantt chart one needs to know when to start a work package and when it needs to be completed. The work breakdown structure can be used to define which work packages need to be completed before others can be started. The definition can be as simple as creating two columns in which the left side column shows the work packages, and the right side shows which tasks must be completed before the left side ones can be started. The following table shows an example how this can be achieved. (Nicholas & Steyn. 2012, 181-185.)

TABLE 2 Work sequencing table (Nicholas & Steyn. 2012, 182.)

These can be started	When these are ready
Task A2, A3,	Task A1
Task B1,B2	Task A3

A simple Gantt chart could be as easy as creating a excel sheet where the time table and schedule is broken down using the previous work sequencing table. The following table 3 shows a Gantt diagram in its simplest form. (Nicholas & Steyn. 2012, 185.)

TABLE 3 Simple Gantt chart

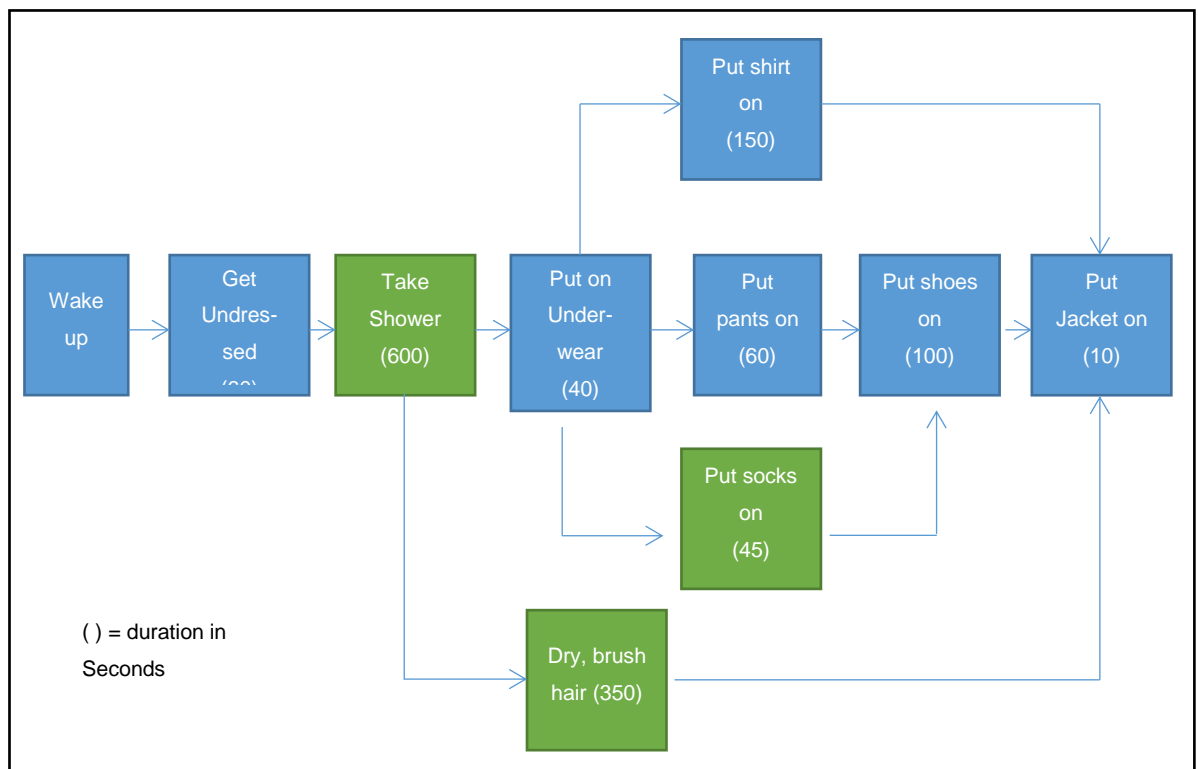
Work Package	Week number									
	1	2	3	4	5	6	7	8	9	10
A1	■									
A2		■								
A3		■	■							
B1				■	■	■				
B2					■	■	■			
C1							■	■		
C2							■	■		
C3									■	■

The disadvantage of Gantt charts is that it does not show easily how a late work package affects the whole project. According to Nicholas and Steyn it is not capable to handle a

project by its own. A Gantt diagram is good showing the project schedules, but is not good as a planning tool or showing how tasks are related to each other. Network diagrams are another way to plan and map projects (Nicholas & Steyn. 2012, 185.)

With a network diagram the relationships of activities can be mapped and their interdependencies are shown. The work breakdown structure is usually used to create the nodes of the network diagram. A network diagram can also show important events and milestones. There is two ways of building a network diagram, activity on node method or AON, and precedence diagramming method or PDM. Of these two the activity node method is more used and is discussed in this thesis. The following figure is a representation of a simple AON diagram model. In it is shown in blue the critical path that is explained later in this chapter. (Nicholas & Steyn. 2012, 197-198.)

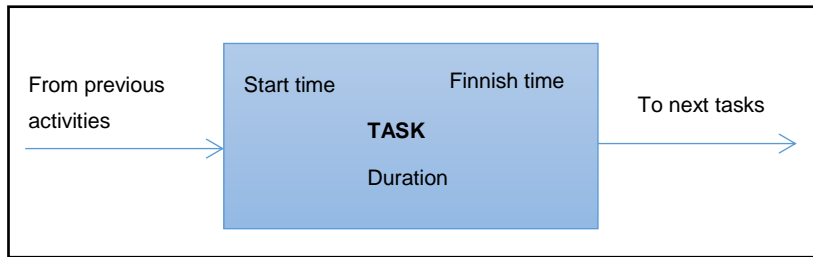
FIGURE 11 Network diagram for getting up and getting dressed (Nicholas & Steyn. 2012, 198.)



A node of a network diagram generally shows how the node is connected to previous tasks and how it is connected to following activities. In the node usually is also stated the activity done, start time, finish time, and duration. When creating a node, it is crucial to think if the node is mandatory or discretionary. Mandatory nodes need to be done exactly in the order stated. Discretionary nodes can be later on overlapped or eliminated to speed

up the project. The following figure shows a simple representation of a typical node in a diagram.(Nicholas & Steyn. 2012. 198-199.)

FIGURE 12 Typical Network Diagram node (Nicholas & Steyn. 2012, 199.)



A network diagram is a good tool in traditional project management to establish how long a project takes. The length of a project is calculated by adding the durations of each node in the longest path of the created network diagram. This path is called the critical path, and in this path only those nodes that are essential to finalize the project in a minimal level are elected. In the previous figure 10 the critical path is represented by blue boxes and the non-critical nodes, or discretionary nodes, are in green boxes. A project might have multiple critical paths explaining different scenarios. There might be an early start & early finish path, or a late start & late finish path. Different calculations can be done by re planning the critical path of a project, but they are too various to explain in this study. (Nicholas & Steyn. 2012, 202-207.)

There are many other planning tools, like combinations of Gantt charts with network diagrams, and resource constraint planning etc., but these mentioned here are the most common tools. Network Diagrams are criticized for being too unrealistic in the mentality that all can be planned in advance. (Nicholas & Steyn. 2012, 225.)

3.4 Performance/Ramp up

Generally the performance phase of a project is the step taken after all the planning and definition is done. In concrete projects it means that something is build or produced, in consulting project it generally means that the research or report is done and presented. In the project performance phase usually the following steps are taken. (Nicholas & Steyn. 2012, 225.)

1. Design stage
2. Production/build stage

- a. Fabrication
- b. Testing
3. Implementation stage
 - a. Training
 - b. Acceptance tests
 - c. Installation
4. Termination

In the design phase specifications and plans done in the previous steps of a project are broken down and formed into concrete documents and plans. These documents can be technical drawings, schematics, blueprints, and flow charts etc., everything that is needed to start the production stage. Usually in the design process two models are prepared in addition to the documentation. First is the functional model that shows the components of the end product, and how they associate with each other in the end. The second model is the physical design that shows what the end product looks in the end. The relative size of components, the locations and shapes of pieces, are shown in this last model. Together with all the papers and documents, as well as the two models, production phase can be started. The reason for the two models is that changes can be done to the designs and to the plans, before the project itself starts. Changes done in the production phase is costly. (Nicholas & Steyn. 2012, 389-392.)

The next step in the performance phase is the fabrication phase. When all the needed design work is done, the act of fabrication or producing starts. In this stage traditional management practices are used. Cost management, time management, and quality management are the rule. These methods of control are company specific, and are not the main theme of this study so they are not discussed further. (Nicholas & Steyn. 2012, 393-394, 402-416.)

After fabrication phase comes the testing phase where the fabricated product is tested. The testing is done to make sure that the end product meets the requirements stated in the beginning of the project, so that the customer is in accordance with the end product, and that the producers can comment and modify the product before the release. (Nicholas & Steyn. 2012, 394.)

Implementation phase is the last step in a project. In this phase figuratively keys are given to the customer. Depending on the project the implementation phase might be an instant, or it might take more time, depending on the extent of the project. Implementation phase might need user training, acceptance testing, system installation, and conversion. (Nicholas & Steyn. 2012, 448-450.)

Project termination is often overlooked in projects, as there might be other projects starting. Termination process is important for it is a good way to learn about the past project. Also if the customer is included in project ending reviews, invaluable information can be obtained. This final mile is also important to finally closing the contract with the customer. A project manager can find out if everything went as expected, and if there is need for adjustments or other activities. Some times in a well performed project termination, a new project can arise. (Nicholas & Steyn. 2012, 450-453.)

3.5 Summary on traditional project management

Traditional project management practices are often complicated, but produce impressive looking graphics and plans. Often testing and communication in traditional projects is done in the beginning of the project and in the end of the project. Agile project management methods have influenced traditional project management and some project managers have taken as best practice to communicate and iterate the project plans and definitions during projects. All in all the project management tools used in traditional project management are robust and sometimes time consuming. Criticism on the error rates in Gantt diagrams and Network diagrams has been also stated in the theory books.

4 Scrum agile project management

Scrum project management was created by Jeff Sutherland and Ken Schwaber in 1993. The founders were frustrated that projects were late and did not meet the quality requirements predefined in the project planning phase of traditional project management methods. Scrum was first used in software and product development, but as it is a lightweight framework for solving complex problems, it is used in many other projects also. Scrum is generally lightweight and easy to understand, but it is difficult to master. (Lacey. 2016, 6-7; Sutherland & Sutherland. 2014, vii)

Jeff Sutherland was a fighter pilot and the OODA loop intensively used. The OODA loop means a continuous cycle of; observing, orienting, deciding, and acting. Scrum is based on this “inspect and adapt” cycle, which is also the base of empirical study. Without transparency it’s impossible to do empirical studies as well as scrum. Transparency in scrum is achieved by having fixed length sprints and fixed end result goals, as well as keeping all possible information as transparent and visible as possible.(agile42. 2014a, 7; Lacey. 2016, 7-8; Sutherland & Sutherland 2014, 24-25.)

Scrum has also roots in the Toyota production method or Lean. In Lean the object is to get rid of three wastes, which are muri, mura, and muda. Muri is overburden or unreasonableness, the situation where a process or person is overburdened with work. Muri can be avoided by planning. Mura in unevenness or inconsistency, a situation where processes or work activities have peaks and calms, which make planning and improving processes difficult. Mura can be avoided by doing and performing evenly. (Sutherland & Sutherland 2014, 33-36, 87; agile42.2014a, 10-11.)

The last waste of Lean is muda which is further divided in seven sub categories: transportation, inventory, motion, waiting, overproduction, over processing and defects. This last waste is the simplest to tackle since most of the seven sub categories have a concrete monetary value. All of these wastes don’t add value to the end product or to the process, so they should be avoided. Muda can be avoided by checking the items and process systematically. (Sutherland & Sutherland. 2014, 33-36,87; agile42. 2014a, 10-11)

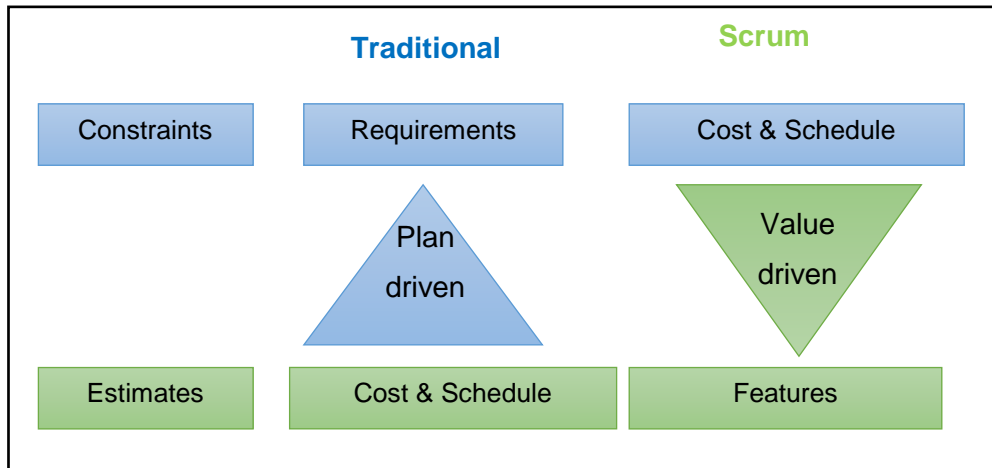
Toyota method or lean uses the “Plan Do Check Act” cycle invented by William Edward Deming. This PDCA cycle is very similar to the US air force OODA loop, and an essential part of the Scrum framework. Each action of both cycles is a place where the wastes of Lean can be identified and removed. Also as it is a loop or a cycle, the wording communi-

cate that it is a constant effort, not just done once. Lean has a word for this continual improvement, Kaizen. In the previous chapter was discussed how muri can be avoided by planning, mura can be avoided by doing and working evenly, and muda by checking the results and the process. Kaizen comes from the last part of the PDCA cycle, acting. All the parts of the parts of the PDCA cycle are useless if there is no action accordance to the findings done in each of the previous part of the cycle. Kaizen is an essential part of Scrum.(Sutherland & Sutherland. 2014, 33-36,87; agile42.2014a. 10-11.)

Continuous improvement is a part of Scrum, but continuous improvement is difficult or impossible to achieve without measurable metrics. Measuring means reliable statistics and following them. To measure change, there has to be constraints so that the effect of the change can be measured. In Scrum the constraints are the fixed length sprints, the Scrum team that is optimally as stable as possible and the goal to produce a potentially shippable product. (Sutherland & Sutherland. 2014, 34-37; agile42.2014b.6, 39.)

Maybe the simplest way to compare Scrum and traditional project management is to use triangle of constraints shown in the following figure. A project has generally three constraints and three possible estimates. These constraints and estimates are requirements, cost, and schedule. In traditional project management the constraints are requirements, and costs and schedule are estimates. In Scrum the constraints are cost and schedule, and the estimate is features/requirements. The challenge with traditional project management is that projects might get easily “*Triple constraints*” or an “*iron triangle*”. In these situations when anything changes during the project, the project fails. Scrum as a framework has rules that don’t let “*iron triangles*” appear. The features & requirements are done incrementally, and change can be done mid project. (Lacey. 2016, 11; agile42.2014b. 6-7.)

FIGURE 13 Constraints and estimates in projects (Lacey. 2016, 11; agile42.2014b. 6-7.)



Without transparency there are no empirical processes, and thus no Scrum. In the optimal solution everything in the process and the company is transparent to all the members of the organization. Often this is not the case, and it is not clear what employees in the company are working on. Without transparency there is a risk of hidden agendas and failure hiding. As everything is transparent optimally, there is a need of a company culture where mistakes and discussion is not penalized. This is maybe the most difficult part of Scrum, as it often needs a change in company culture.

(Sutherland & Sutherland. 2014, 153.)

Implementing needs a change in mindset in the company and the team. Albert Einstein once told “we can’t solve problems using the same kind of thinking we used when creating them” (Lacey. 2016. 9). The rules of Scrum are simple, and might seem too simple to many projects. But many companies and teams have failed their projects because they have not followed the rules in the beginning. It is possible to modify the rules of scrum, but it takes experience to do so, and as stated earlier Scrum is easy to understand but difficult to master. For any team or company planning to use Scrum, it is important to understand the values and the rules first. Implementation and modifying comes later. (Lacey. 2016, 8-9.)

The values of Scrum are: focus, respect, commitment, courage, and openness, and the values are mirrored in the rules of Scrum. The rules of Scrum consist of roles, events, and basic artefacts, and the requirement of each of them is clearly defined. The Scrum team consists of the developing team, product owner and Scrum master. The events in Scrum are the sprint, sprint planning, daily Scrum, sprint review, and sprint retrospective. The artefacts of Scrum are: the product backlog, sprint backlog, and increment. All other tools

and methods are optional and can be added on top of the basic structure as needed. The rules of Scrum can be easily visualized by the following table. The rules are explained in depth in the following chapter. (Lacey. 2016, 8; Agile42. 2014b, 10-27.)

TABLE 4 Rules of Scrum (Lacey. 2016, 8; Agile42. 2014b, 10-27.)

Scrum Roles	Scrum Events	Scrum Artefacts
Development team	The Sprint	Product Backlog
Scrum Master	Sprint Planning	Sprint Backlog
Product Owner	Daily Scrum	Increment
	Sprint Review	
	Sprint Retrospective	

4.1 Scrum roles

The Scrum team is self-organizing and does not need a traditional project manager. Each role of the scrum team has their own part of responsibilities traditionally assigned to the project manager. The Development team manages itself, the Scrum Master facilitates the process, and the Product Owner manages the product and the return on investment of the project. In addition to the Scrum team roles, there are stakeholders and customers who might be interested of the project, but don't have responsibilities in it in the Scrum framework. These stakeholders can follow the progress of the teams but don't have the right to directly influence it. (Agile42. 2014b, 10-14; Lacey. 2016, 428.)

The development team is the "machine" that creates the product owners vision. The development team is a cross functional team that contains professionals of their own fields of expertise needed to produce a product defined by the product owner. The ideal size of a Development team is 7, plus or minus 2 people, and the team manages its own work, responsibilities, and execution of the project. Basically in the simplest way the development team is responsible on "**How**" the vision of the product owner is achieved. A list can be created to describe the responsibilities of the development team. (Agile42. 2014b, 10-14; Lacey. 2016, 428.)

- How the tasks are performed
- How many tasks are performed each sprint
- Tracking the work progress

- Ensuring quality
- Communicating with the product owner
- Working with the product backlog items together with the Product owner, so that each item is clearly understood.
- Sprint backlog

The product owner is responsible of getting the maximum return on investment of the product. The product owner is in a way the driver of a car, if the project is a car. The product owner has the vision of the product, and ensures that the product is the one that the end user needs. The Product owner is responsible on the “**What**” is produced. The product owner’s main responsibilities are the following. (Agile42. 2014b,10-14; Lacey. 2016, 428.)

- Product vision
- Product backlog
- What are the features and requirements of the product
- What features and requirements should be done first
- What is the most valuable product and return on interest
- Informing & managing stakeholders
- Ensuring that the right product is produced

The Scrum master is not the project manager of the Scrum team, but the coach of the whole team. Scrum master is a “servant leader”. Scrum masters responsibilities are to facilitate the work of the team, make sure that the scrum rules are followed, and basically do his best that the team can improve its effectivity incrementally, and solves impediments and issues of the whole team. The Scrum master leads by influence not authority, and this might be difficult to understand in traditional organisational cultures. Responsibilities are the following (Agile42. 2014b,10-14; Lacey. 2016. 428.)

- Coaching the team
- Protecting the development team from impediments
- Manages the Scrum process and rules
- Helps the team improve its work process
- Helps solve arguments and challenges
- Facilitating Scrum events
- Presenting Scrum to the organization, stakeholders, and customers
- Etc..

The roles that are not part of the Scrum team are the **customers** that co-operate with the product owner and optimally participate in the Sprint Review event. The Customer is the money and resources. **Users** are the persons who will use the end product in the end. Users might work with the development team to help the team understand the needs and opinions of the user of the end product. Users might work also with the product owner to

create better user stories and tasks. User stories are explained in the optional tools chapter. **Managers** and other company stakeholders are usually communicating with the Scrum master. The Scrum master helps them understand why things are done the way they are, and the benefits of using the Scrum framework. (Agile42. 2014b,10-14.)

4.2 Events in Scrum

There are five essential events in Scrum: the sprint, sprint planning, daily scrum, sprint review, sprint retrospective. These events are part of the Scrum rules, and without them Scrum does not work properly. (Agile42. 2014b,15-22; Lacey. 2016, 427.)

Sprint planning is the first step in the Scrum cycle. Sprint planning is done before every Sprint. Sprint planning is often held in two parts. During the first part of the Sprint planning the development team pulls tasks from the top of the product backlog to the Sprint backlog. The Development team decides the things which will be done during the next Sprint. During this pulling the team asks questions from the product owner to understand better these pulled stories or potentially pull able stories. The team decides what is achievable, taking into account absences and vacations etc. (Agile42. 2014b, 17-18.)

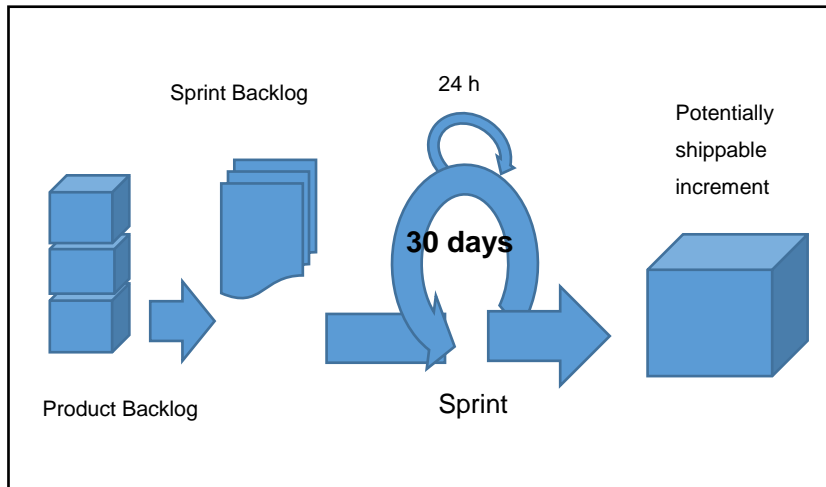
In the second part of Sprint planning the question “How” is answered. The development team discusses how they can achieve the tasks and stories elected. Important during this part is also to define what is the definition of done. The development team decides together what the level of quality of the items is and tasks must have before they are considered done. This is called the definition of done. (Agile42. 2014b,17-18.)

All the events in Scrum are time boxed and have always a definite duration. The Sprint planning has duration of one hour for every week of the Sprint. So a one week Sprint has a one hour Sprint planning event. The end product of the Sprint planning event is the sprint backlog, which is often represented by a physical task board. (Agile42. 2014b,17-19.)

A Sprint lasts normally from one week to a maximum of one month. As seen in the following figure, a Sprint is an event where the work itself is performed. Work tasks are taken to each Sprint from the product backlog, maintained by the product owner. The amount of tasks or stories that are taken to the sprint backlog is decided by the development team. The rule that the development team needs to keep in mind when deciding the amount of work is, that the tasks or stories elected need to be completed at the end of the Sprint.

Also the team needs to take enough stories to the sprint backlog, that the results in the end of the Sprint produce a valuable increment of the product. (Agile42. 2014b,15-22.)

FIGURE 13 Scrum Process (Lacey. 2016, 427.)



The Daily Scrum is a ritual that is held every work day by the Scrum master and the development team. The Scrum master makes sure that the daily scrum is held each day. The daily scrum or stand up is always held standing up and the duration is exactly 15 minutes. The meeting is also held always in the same location, to help reduce thinking and planning. During the daily scrum three questions are answered (Agile42. 2014b.19-20; Lacey. 2016. 432)

1. *What have you accomplished since the last meeting?*
2. *What will you accomplish today?*
3. *What impediments or obstacles are in your way?*

(Lacey. 2016. 432)

Sometimes specially in new teams a fourth question is added “*What is my confidence, on a scale of one to ten, that the team will accomplish the goal of this Sprint*” (Lacey. 2016, 220).

The daily scrum is an “inspect and adapt” tool that can be used to improve the overall process in the project. Nothing more is discussed during the daily scrum, but the Scrum master makes sure that all the impediments stated will be resolved. The first questions also shows easily if some team member has problems, if he has not accomplished anything. If a team member is struggling on a task, it is the team’s responsibility to make sure that the task is done. The development team can offer help or find other solutions to the problem. But in situations when there are impediments and challenges a new meeting is arranged after the Daily. (Agile42. 2014b,19-20; Lacey. 2016, 432.)

The Sprint Review is the second to last event in a Scrum. During the meeting that lasts one hour per the week length of the Sprint, the produced “product” is examined. Stakeholders and the whole Scrum team participate in the meeting. During the meeting the Development Team shows the work they have done. Co-operation is recommended in this meeting with the customer, users and all that have any stake in the project. This part of the project provides an opportunity to give feedback on the project and make changes if it is seen that a change would be in place. This is one of the benefits of Scrum for there is the possibility to change the direction of a product early on in the project. Any new request that come from this meeting should be added to the product backlog, and the Product owner is responsible of arranging them in it, so that the most valuable are first in the backlog. (Agile42. 2014b,20-21; Lacey. 2016, 433.)

The Sprint Retrospective is the last event in a Sprint that also lasts exactly one hour per a week of Sprint. The whole Scrum team participates in the retrospective. All other persons are not allowed to participate unless there is a consensus of the whole team that an outsider of the team should be invited. During this meeting two questions are answered (Agile42. 2014b, 21; Lacey. 2016, 433.)

1. *What went well during this sprint?*
2. *What could be improved in the next Sprint?*

The Scrum Master works as a facilitator in this retrospective and follows how the improvement have been working, and makes sure those new improvements are implemented. During this retrospective the whole Scrum team tries to find out how they could work better in the future, and the things that need to be removed or tackled. The end product of this meeting is a prioritized improvement list for the future sprints, and concrete action plans how the team could work even better. (Agile42. 2014b, 21-22; Lacey. 2016, 433-434.)

4.3 Scrum artefacts

Product Backlog is an ordered list of user stories or tasks. The stories and task are ordered by the business value and risk. The most valuable items that create true value as soon as possible are ordered first. Also tasks and stories that have risks associated in late completion are ordered in the top. The tasks and user stories that are in the top of the product backlog are more detailed and divided as small as is viable. The further down the user stories or tasks go in the product backlog, the more general and broad, the product backlog is not static and it should be reviewed. (Agile42. 2014b, 23; Lacey. 2016, 429.)

The product backlog is reviewed in refinement sessions that are held with the Scrum team. The product owner is responsible of this refinement, but should use the help of the whole Scrum team. The top of the product backlog should contain only those tasks and stories that the end users really need and bring true value to the end product. (Agile42. 2014b.23; Lacey. 2016, 429.)

The **Sprint Backlog** is visualized list of tasks and stories that are pulled from the product backlog by the development team. User stories are the tasks and features that need to be done during the Sprint. The following figure 14 is an example of how a sprint backlog can be constructed. The example sprint backlog is based on the Lean tool called Kanban. It is a clear visualization of the work that is done and completed. This board should be visible to the team and the stakeholders. Using simple visual tools and tokens is in the DNA of Scrum and assures transparency, which is essential in empirical processes. (Agile42. 2014b, 25; Lacey. 2016, 430; Sutherland & Sutherland. 2014.155.)

FIGURE 14 Sprint Backlog (Sutherland & Sutherland. 2014, 155.)

	Sprint Backlog (Tasks)	To Do	In Progress	In Review	Done
User Story 1					
User Story 2					
User Story 3					
User Story 4					

In the Sprint backlog column user stories are pulled from the product backlog. The “To Do” column is filled with concrete tasks and steps that need to be taken in order to complete the user story. In progress column contains the tasks that are worked on, normally it contains approximately enough tasks for one work day. In review column holds the tasks that are completed, but not yet checked for quality. In the done column come the tasks that are done and checked for quality. A task can be done only when it fills all the definition of done defined by the development team. A story gets done when the acceptance criteria defined by the product owner are filled. (Agile42. 2014b. 25; Lacey. 2016, 430; Sutherland & Sutherland. 2014.155.)

Increment is the objective or goal of each Sprint. An increment is all the added Stories and tasks done during a sprint. Each Increment should be able to be sold or shipped to the customer if the product owner so decides. An increment can be anything from a concrete product, to a detailed plan how to build a part of a factory.(Agile42. 2014b, 25.)

User Story is a specific feature or requirement that brings real value to the product. Normally task lists only answer the question what need to be done? But user stories are deeper. A user story answer three questions “As a <Who?>I want <What?> so that <Why?>”.(Agile42. 2014a.40). A User story is not ready when these three questions are answered. The Product Owner needs to discuss with the Development Team so that each story is understood correctly. Also the Product Owner needs to create acceptance criteria to each story. Acceptance criteria are requirements and features that the product owner has decided the end product and the story needs. The acceptance criteria should also be discussed with the development team so that it is understood.
(Agile42. 2014a. 40-41; Lacey. 2016, 306-307.)

4.4 Conclusion and challenges of Scrum

Scrum is a light framework so companies can add tools and practices to it if needed, as long as those practices fit with the values and rules of Scrum. When creating practices and tools they should be transparent and simple. Occam’s razor is a good principle to use, “*When given a choice between functionally equivalent designs, the simplest design should be selected*”. (Pichler. 2015, 31.)

Scrum is a simple framework, but in all its simplicity, it is difficult to master and sometimes hard to implement. Scrum makes the defects and shortages in an organization painfully obvious, so obvious that they need to be fixed, or Scrum should be jettisoned. Scrum needs a change in mindset and a change in company culture, and sometimes this is not in the interests of the persons who benefit of the status quo. Companies might have also employees who are cynical and have seen dozens of new management methods introduced by consultants, and none of them have stuck. The resistance to change is an issue which needs to be taken care of, when implementing Scrum. This is the work for a Scrum Master.(Lacey. 2016. 9,15.)

5 Interview results and the fruits of the study

Abductive grounded theory method was used in this study for the needs of the company were unclear and wide. The final research topic came after doing interviews for the empirical part and using the abductive reasoning methodology together with Grounded theory work. The exact study methodology is explained and justified in the beginning of the thesis. The methodology used is not traditional for a bachelor's thesis, but it was the only option for this thesis. In depth justification can be read in the study methodology in chapter 1.

The target of this study is to create a best practice manual explaining agile tools that can be used in traditional project management. Also the leaflet will show a simple framework to create internet of things solutions.

The final research question is: How to use Scrum in traditional industrial projects that contain internet of things solutions?

The inquisitive questions were created. Some of the questions were mainly answered in the theoretical part of the report. Inquisitive question 6 and 7 are exclusively answered in the empirical part of the thesis report. The other five are answered partly in the theoretical part and partly in the empirical part.

Inquisitive Questions

1. What is the internet of things?
2. What solutions internet of things could offer to industry?
3. What are the special requirements that an internet of things project bring to an industrial project?
4. What is the traditional "waterfall" project management method?
5. What is the Scrum project management methodology?
6. What is the current situation of the company's project management practices?
7. How could Scrum methodology improve the company's Project management practices situation?

5.1 Opinions of a professional in internet of things

The head of internet of things solutions of Solita Oy Mikko Aro was interviewed to get a professional opinion on internet of things. The questions asked are found in the appendix

2. The interviewee was on the opinion that Internet of things is not an optional solution for companies, but a future imperative if a company wants to operate successfully. His opinion on “what internet of things is” was that, it is a phenomenon that combines big data, industrial internet, and business intelligence solutions. (Aro, M. April 2016.)

Industrial processes can be improved by gathering real life data. Using this data a company can improve its processes but also create new business models and monetization models. New causal effects can be identified and utilized to create either value or to decrease costs. (Aro, M. April 2016.)

Mikko Aro identified monetization or business models in internet of things. The first is to streamline processes, making them faster, cheaper, and with better quality. The second business model that internet of things offer is the analyzing of the gathered information for business intelligence and business usage. For example a machine seller might use the operation data gathered from a machine, to better understand the needs of the customer, and by using these needs create better solutions. Both parties win in this situation, for the customer gets what it truly needs, and the seller does not waste time on developing and selling solution that the customers does not want. (Aro, M. April 2016.)

The main challenges in internet of things projects that Solita Oy has faced with industrial customers has been that the customers don't really know what all this means for them. The customers don't know the working methods and practices in digital business. But the main challenge has been the lack of vision. Companies don't know what their capabilities in these new business models are. Also the agile project management methods of software companies might be totally unheard of. (Aro, M. April 2016.)

Internet of things solutions need incremental testing to find the real value offered. When creating internet of things solutions, communication between the customer and the software company is needed. Many things can be done, but few things are worth doing. Incremental development brings most value in the end, for technology and business environment changes quickly. In some waterfall project management method projects that lasted more than a year, requirements and features were pre-defined. In these projects often was the case that the features planned beforehand were not the features needed, and money was spent on wrong things. (Aro, M. April 2016.)

The best way to manage projects according to Mikko Aro is to use agile methods. Transparent development with constant communication in short maximum one month cycles are

optimal. Traditional waterfall project management methods work very badly in software and information technology development, for the problems are complex. For traditional methods to work, everything should be estimable in the beginning, and no changes or obstacles should come during the project. (Aro, M. April 2016.)

The main challenges in the working methods between traditional engineering companies and software companies come from cultural differences and the differences in the speed things are made. In software development one month is a long time; when at the same time in traditional engineering one month is a too short time to decide things. The challenges and requirements in internet of things project don't come from technology or physical objects, but mainly from company culture. (Aro, M. April 2016.)

5.2 Project management in CompanyX

Three persons were interviewed in the study. The first interviewee was a senior engineer and project manager closing retirement age. The second interviewee was a project and team manager in the company. The last interviewee was a junior engineer. Interviews of various levels of seniority and responsibility were elected to get a wide view of the practices of the company, and how the practices worked in different levels. The interview questions can be found in the appendixes 3 to 5. In addition to the interviews, the company's project management portal was examined. (Pelkonen, J. March 2016; Tomma, M. February 2016; Silvennoinen, M. March 2016.)

5.2.1 Company's project management practices

Teams and projects have various tools to use in the company but the main project management tools used are meeting memos, email communication, excel tables, Dropbox, and project documentation. The employees have the option to use Ms Project software and share point, but they are seldom used to anything else but project planning or data exchange. The company does not use visual artefacts to manage and commit team members to projects. The project manager is responsible to assign tasks as they come. The engineers and architects don't generally know in what situation the project is, or where the work they are doing fits in the grand picture. The project management in CompanyX is very much a push type process, and strongly in the traditional waterfall system. (Pelkonen, J. March 2016; Tomma, M. February 2016; Silvennoinen, M. March 2016.)

Even as the company uses traditional project management practices, in the interviews was clear that many of the tools used in traditional project management were not known of. Gantt diagrams were familiar as were milestones, but the interviewees had little knowledge of the other tools or practices. (Pelkonen, J. March 2016;Tomma, M. February 2016; Silvennoinen, M. March 2016.)

Network diagrams, work breakdown charts, or other tools described in the theory, were not systematically used. The senior engineer and the project manager told that key performance figures were used in meetings and planning, as well as checklists, but the junior engineer did not know about them, or about their usage. (Pelkonen, J. March 2016;Tomma, M. February 2016; Silvennoinen, M. March 2016.)

The project management portal was extensive, but instead of visual simplified tools, it contained report forms and checklists for different projects and official papers. The portal was apparently rarely used for anything else but document production. The junior engineer told that there was a common opinion that the project management portal was a graveyard of information and knowledge. (Pelkonen, J. March 2016;Tomma, M. February 2016; Silvennoinen, M. March 2016.)

All in all the answers gotten from the interviews told a story that the project management practices were a bit haphazard a lacked a systematic approach. When telling about project management frameworks and tools to the interviewees, interest was obvious. Doubts were aired that some of the simple methods might not work in the company, but the interviewees wished for better practices and were generally open for ideas. Most of the engineers had a purely technical background, and the company had a project management unit, but it was physically in a different location and apparently the business units had little co-operation. (Pelkonen, J. March 2016;Tomma, M. February 2016; Silvennoinen, M. March 2016.)

The project manager and the junior engineer both hoped for more training in the use project management and quality control. They wanted to learn to use project and team management tools and software to get rid or to help in the challenges they were facing in every day operations. (Pelkonen, J. March 2016; Silvennoinen, M. March 2016.)

5.2.2 Challenges in company's projects

The interviewees were asked about challenges that they had faced in projects, and the answers were similar. Communication breakdown as well as misunderstanding was common. A sense of urgency and pressure was common in projects, and this was combined with the recurring situation when there was nothing to do. (Pelkonen, J. March 2016; Tomma, M. February 2016; Silvennoinen, M. March 2016.)

In the informal discussions described in the study methodology chapter, some engineers in the company felt that they were over encumbered and stressed. In the same time there were also engineers who complained that they did not have enough work, and were stressed and worried of their own future in the company.

In my opinion these challenges faced, might grow grave if not tackled. There might not yet be an urgency to change things, but like a leaking roof, these communications, transparency, and visualisation problems will rot the organization from within if nothing is done. Scrum as a framework is designed and optimal to solve these problems, and the company can still keep the documentation and practises they use.

6 Summary

It is not a question why companies should invest in internet of things solutions, but when. Internet of things has a possibility to change whole business models, and can bring a cumulative saving in processes. Companies that are “early adopter’s”, will have a significant competitive edge, to those who don’t adopt internet of things. The telephone and internet spread to all business, so will internet of things. Companies should think how and when to get internet of things solutions to their business, and adopt the capabilities preferably early than late.

6.1.1 Best practice model -“Scrum under a Waterfall” in industrial internet projects

The research question “**How to use Scrum in traditional industrial projects that contain Internet of things solutions?**” is answered more in-depth in the manual created to the commissioning party. The manual can be read in appendix 6.

Scrum can work under traditional project management practices if the roles and methods are changed moderately. The values and rules of Scrum should not be changed, for these are the reasons why Scrum works well. Simple and easily implementable tools and methods should be introduced first. But the company will need also a Scrum master to coach the product owner and development team.

The product owner’s role can be taken by a project manager responsible of the project. The Scrum master will help him understand his new emerging role, as well as the benefits of following the rules. The development team would contain in CompanyX the engineers needed to fulfill the project. Skillsets should meet the needs that the project has. If the project needs electrical engineers, automation engineers, architects etc. all of these positions should be present in the development team.

The Scrum master should be a person with the needed knowledge in Scrum, preferentially also a certified Scrum master. In addition as the company is an engineering consultancy company, it would be beneficiary if the Scrum master would have a business degree, and knowledge on business practices. A Scrum master with both Scrum skills as well as business skills can coach the project manager/product owner to create better value in the project.

The transition from waterfall to Scrum will be incremental. The product backlog items come generally from the task lists and work breakdown structures in traditional project management. These tasks will be transformed into User Stories by answering the questions who, what, and why. The Development team will also learn to manage itself step by step, and the whole Scrum team will learn to live with the Scrum values.

The best practice model will show these steps in a simple and visual fashion. In addition to the shift from traditional project management to Agile project management, a basic framework for creating internet of things solutions is provided using the knowledge gained from theory and the interview. This best practice model will be presented to the commissioning party after the thesis has been graded.

6.1.2 The inquisitive questions

What is the internet of things?

Internet of things is an umbrella that has underneath it things like big data, industrial Internet, machine learning and machine to machine communication. The concept describes how business can use technology and internet to automatize operations, by adding sensors to different machines and things, that gather information and helps calibrate machines and processes. (Salo, 2014, 18-22.)

What solutions internet of things could offer to industry?

Possible solutions for various internets of things solutions are close to limitless. Some solutions are in the area of augmented reality, locational awareness, enhanced situational awareness, sensor-based decision analytics, and automation & control. The challenge is to find which ones of these solution groups bring most business value to the company. Tools to define requirements can be found in the manual in appendix 6 (Greengard 2015, 58-59, 60, 64, 67, 69.)

What are the special requirements that an internet of things project bring to an industrial project?

The main requirement is cultural. Internet solution needs incremental testing to find the real value of the solutions offered. Creating internet of things solutions, communication between the customer and the software company is needed. Many things can be done,

but few things are not worth doing. Agile project management is a must.(Aro, M. April 2016.)

What is the traditional “waterfall” project management method?

Traditional Project Management is *“the application of knowledge, skills, tools and techniques to project activities to meet the project requirements”* (Cecil,Bozarth & Handfield 2013. 444) A project can be divided in five phases, Concept/Feasibility study, Project definition, Planning, Performance/Ramp up, and Post completion/Operation. Project management has become a critical aspect of company life and middle management, as there is an ever increasing pace of strategic change (Cecil,Bozarth & Handfield 2013. 444-446;)

What is the Scrum project management methodology?

Scrum project management was created by Jeff Sutherland and Ken Schwaber in 1993. The founders were frustrated that projects were late and did not meet the quality requirements predefined in the project planning phase of traditional project management methods. Scrum is based on “inspect and adapt” cycle, which is also the base of empirical study. Scrum has also roots in the Toyota production method or Lean. In Lean the object is to get rid of three wastes, which are Muri- overburden, Mura- unevenness, and Muda-waste. (Sutherland & Sutherland 2014. Vii, 33-36,87; agile42.2014a. 10-11; Lacey. 2016. 6-7.)

What is the current situation of the company’s project management practices?

The project management practices were a bit haphazard a lacked a systematic approach. When telling about project management frameworks and tools to the interviewees, interest was obvious. Doubts were aired that some of the simple methods might not work in the company, but the interviewees wished for better practices and were generally open for ideas. Most of the engineers had a purely technical background, and the company had a project management unit, but it was physically in a different location and apparently the business units had little co-operation. (Pelkonen, J. March 2016;Tomma, M. February 2016; Silvennoinen, M. March 2016.)

How could Scrum methodology improve the company's Project management practices situation?

Scrum as a simple and light framework for agile project management is the right tool to offer companies that feel that they are ready for the transition. No transition is painless or free. This is why investing in agile know how and a change of mindset is imperative to companies using traditional project management. Scrum could make things visible, transparent, and easily manageable.

Companies offering internet of things solution use agile project management methods, and as the speed of change has increased, traditional project management methods are too slow for software and information technology. It has been clear in the study that the biggest obstacle to companies adopting internet of things is not technological, but cultural. Traditional companies need to adopt a more agile way of working, which means also transparency and vision. Many companies are not ready to admit that there is something in their company culture that could be improved.

7 Discussion

The research started from a very broad theoretical framework, and sublimated to a manageable size during the study. Even as some of the observation and discussions were unofficial, all of them contributed to the end results and the surprising Interpretant that a company specializing in projects has problems with project management.

The official interviews confirmed the unofficial findings and observations done during the autumn and winter months. In addition a discussion with employees of another consulting company were held, and they confirmed that the issues found in CompanyX are not limited to the commissioning company, but that there is a general lack of project management knowhow in engineering companies.

This study has been important for traditional engineering consulting companies, as well as any company that wishes to implement internet of things in its business. Not knowing the exact specifics on how to implement a journey in internet of things is not important. Knowing the mindset one needs to take when commencing the journey is, and many companies are not ready for the journey.

When I started my journey with CompanyX, I was not ready. The project management practices learned in school is not enough to manage complex problems. Too much credit is given for Gantt charts and project definition before the project even starts. In polytechnics clear and beautiful project plans are created which seldom are realized. Tools for planning are given, but tools for change management, and how to deal with changing situations are not.

I started using Scrum practices in the thesis project as well as other school work during the spring of 2016, and I am of a strong opinion that my studies would not have ended in time, have I used the project management methods offered by the school. Scrum visualizes everything and makes obstacles and procrastination so painfully visible that one has to do something to fix it.

There is a need to further study implementation and solutions design in internet of things, for it was not studied profoundly enough in this thesis. This thesis was about project management methods, especially traditional methods and the Scrum framework. There is much more to learn from both methods. Traditional project management has been criti-

cized of being rigid and creating false expectations, but there are some good practices and frameworks that function well with agile methods. Scrum is twenty year old framework, and much has been written and many tools have been created to facilitate agile teams.

In all of the study subjects there is still plenty to study. And it is possible that some thesis student could implement Scrum practices in a company. The field is ripe for more study, and few traditional companies have realized the value of agile project management.

All in all, the entire journey has been challenging, but I have learned much of project management practices. I have also learned about value chains, supply chain management, information management, quality management, sensor technology, online safety etc. For the study subject was surprisingly wide, and when narrowing things down you need to know what you are leaving out. I have gathered material for two more theses' or a master's paper, but this knowledge I can use in my future career.

In the end I want to also thank my thesis adviser for the help offered in the thesis. Without her help I would not have found the correct method to study the complex problem faced. Her expertise and flexibility helped me achieve the thesis on time, and with a quality one can be proud of.

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Appendices

Appendix 1: Feasibility study questions by J. Davidson Frame

Questions one should ask a potential customer

1. **Ask the user to state the needs as clearly as possible** (If an Request For Proposal has been prepared, check that the needed deepness on the definition is in it)
2. **Ask the user a complete set of questions to further elicit the needs.**
 - a. Are these the real needs?
 - b. Are these the needs important enough to pursue?
 - c. Are we capable of fulfilling these needs, or is someone else better suited?
 - d. If the needs are fulfilled, will they give rise to other needs?
 - e. Will satisfying these needs also satisfy others, or instead, would satisfying other needs indirectly fulfil these, also?
3. **Conduct research to better understand the needs** (“Research” means probing to gain the best understanding possible. It involves gathering whatever information necessary to understand the needs, define the problem, and propose a solution. Sources include interviews, organizational reports and memos, observations, modelling, and analysis of technical data or empirical test results.)
4. **Based on information from steps 2 and 3, restate and document the needs**
5. **Give the restated documents to user** (if the user disagrees with the restated needs, repeat the previous steps as often as necessary to reach agreement. The process should conclude with a statement of needs that the user agrees to and that best represents the user’s interest (rather than the interests of the contractor or other parties)

Questions to define the needs of the customer and the types of needs

1. **Some needs are ever changing.** they represent a moving target. Thus for each need the question must be asked “is this likely to change?” If the answer is yes, the solutions and plans addressing the need should be flexible and easy to change.
2. **Some needs are only vaguely perceived.** It is a fact that most needs are vaguely perceived, at least initially, and the user requires assistance in identifying and clarifying them. Part of the role of the contractor is to help the user turn vague feelings about needs into definitive statements
3. **Solutions are confused with needs.** Attempting to state a need, the user or contractor states a solution instead. For example “we need a new building” is not a statement of the need. True, maybe a new building will be required, but that’s only one way of satisfying the need to, for example, overcome a space shortage.). By confusing solutions with needs, a solution is selected prematurely and other, potentially better solutions, are precluded from consideration
4. **The needs identified are for the wrong user.** Who is the user? Is it the party that actually feels the need and is most affected by it, or is it the party who pays to resolve it? They might be different. The needs statement should reflect the opinion of the party to which the solution will be directed. Do not be content with what one party tells you is the need of another. Talk to the other party too
5. **There is more than one user, and their needs differ.** When the user embodies several parties, all with valid needs, issues arise such as “can all of their needs

be addressed?” and “Do their needs conflict?” When multiple needs exist and all are valid an attempt must be made to organize and classify them, such as into needs hierarchy.

6. **User's needs are distorted by the “experts”.** Either inadvertently or intentionally the contractor can lead the user into a distorted statement of needs. This happens in at least three ways
 - a. The contractor suggests the list of needs is much broader than the user thought. This increases the magnitude of the problem, and of course, the amount of work the user will have to pay the contractor to do.
 - b. The contractor reframes the needs in terms of what he, the contractor, is (perhaps uniquely) best suited to do. This increases the likelihood that the user will hire the contractor (the need and the contractor are a perfect fit), and that the contractor will be able to easily fulfil the stated needs.
 - c. The contractor doesn't bother to ask, but rather tells the user what he needs (after all the contractor is the expert)

(Nicholas 2004. 102-104)

Appendix 2. Interview questions from Solita Oy

Kysely Solita Oy

Taustakysymykset

Mitä Solita tekee?

Mikä on asemasi yrityksessä?

IoT, Industrial internet Ja Big Data/Industry 4.0 yleiset kysymykset

(käytän kysymyksissä lyhennystä IoT kuvaamaan koko pakettia, sillä kaikki kolme ovat vahvasti sidoksissa toisiinsa)

- Miksi teollisuusalan PK yrityksen kannattaisi sijoittaa IoT. ratkaisuihin?
- Miten IoT jne. Voivat tehdä teollisuus prosesseista tehokkaampia/halvempia?
- Miten IoT jne. voivat tuoda lisäarvoa yrityksen tuotteelle /palvelulle
- Minkälaisia haasteita on ollut IoT projekteissa?
- Minkälaisia IoT jne. ratkaisuja voisi tarjota teollisuuden yrityksille?
- Kuinka nopeasti siitä että tehtaaseen asennetaan anturit ja IoT ympäristö on valmis, saadaan konkreettista tietoa tehtaan prosessien optimoimiseksi?
 - Kuinka pitkältä ajalta tarvitsee historia dataa?
 - Kuinka usein analysointi algoritmi pitää päivittää?
 - Kuinka kauan kestää algoritmien päivitys?
 - Kuinka vaikeaa sen päivittäminen on?

IoT, Industrial internet Ja Big Data/Industry 4.0 projektin suunnittelussa/hallinnassa

(käytän kysymyksissä lyhennystä IoT kuvaamaan koko pakettia, sillä kaikki kolme ovat vahvasti sidoksissa toisiinsa)

- Millaisia vaatimuksia IoT projektit tuovat mukanaan projektin suunnittelussa?
- Millaisia vaatimuksia IoT jne. projektit tuovat mukanaan projektin hallinnassa?
- Miten IoT jne. vaikuttaa asiakkailta ja yhteistyökumppaneilta tulevaan tietoon ja dataan?
- Miten tietoturva voidaan varmistaa jo projektin suunnitteluvaiheessa?
- Miten tehtaan esisuunnittelussa olisi hyvä ottaa huomioon IoT jne. ratkaisut?

- Miten algoritmien räätälöinti kannattaa ottaa huomioon suunnitteluvaiheessa?
- Voiko teknologian kehityksen ottaa huomioon jo suunnitteluvaiheessa?
- Millaisia etuja on siitä että teknologian kehityksen ottaa huomioon suunnitteluvaiheessa?
- Miten eri palveluntuottajien projektille/lopputuotteelle tarjoamat palvelut tulee ottaa huomioon suunnitteluvaiheessa, jos halutaan luoda yhtenäinen IoT toimintaympäristö?
- Miten big datan 3V:ä :”Variety, velocity, volume” Pitää ottaa huomioon projektinhallinnassa/suunnittelussa?

Lisäkysymykset (jos aikaa)

- Soveltuuko ns. ”augmented reality” IoT ratkaisuihin?
 - Miten se vaikuttaa ylipäättänsä suunnitteluun?
- Taipuvatko Hadoop-pohjaiset ratkaisut teollisuuden tarpeisiin?

–

Projektinhallinta (jos aikaa)

Käytättekö Scrum metodologiaa (ketterä) projektinhallinnassa?

Onko teillä käytössä Kanban tyyppisiä ratkaisua projektinhallintaan?

Käytättekö projektiverkkodiagrammeja projekteissa (Project network diagram etc)?

Mitä projektinhallinnan työkaluja käytätte?

Miten toivoisitte että asiakasyritykset ottaisivat projektin hallinnan huomioon?

Erotatteko tiedon ja datan eron?

otetaanko tätä huomioon projekteissa?

Appendix 3. Questions asked from a Senior Engineer and Project manager

Tiedon ja informaation kulku

- ❖ Miten saatte tiedon myyntivaiheesta "feasibility study" vaiheeseen?
- ❖ Millaisessa muodossa tieto tulee projektiin?
- ❖ Minkälaista tietoa saatte asiakkaalta, miten asiakas on mukana "feasibility study" vaiheessa?
- ❖ Miten myynti on mukana projektin suunnittelussa?
- ❖ Onko aikaisempien projektien kulusta tietoa ja käytetäänkö sitä hyväksi
- ❖ Miten asiakas on mukana projektin suunnittelussa?
- ❖ Miten tieto ja informaatio liikkuvat asiakkaan ja CompanyXn välillä projekteissa?
- ❖ Onko tullut esiin projekteissa tilanteita jossa informaatiologiikka ei ole toiminut?
- ❖ Miten otatte huomioon projekteissa eri ammattilaisilta tarvittavan tiedon?
- ❖ Onko teillä systemaattista paikkaa tai kirjallista järjestelmää missä tätä tietoa säilytetään
- ❖ Miten tieto liikkuu CompanyXn sisällä eri ammattilaisille?
- ❖ Miten saatte tarvittavaa tietoa jota teillä ei vielä ole?
- ❖ Miten otatte "Hazard and operability study"n (HAZOP) huomioon projekteissa?
- ❖ Miten Hazard and operability study (HAZOP) vaikuttaa tiedon tarpeeseen?
- ❖ Tunnistetaanko informaation ja tiedon ero?
- ❖ Huomioidaanko projekteissa informaation ja tiedon ero?
- ❖ Kuinka informaatio ja tieto kulkevat projektin eri vaiheiden välillä

–

– Laatu ja projektinhallinta

- ❖ Onko teillä projektin laadunvalvonnan keinoja käytössä?
- ❖ Jos on, niin millaisia projektin laadunvalvonnan keinoja teillä on käytössä? (Root Cause analysis eli kalanruotomalli, Balanced Scorecard, DMADV eli Define-Measure-Analyze-Design-Verify yms)
- ❖ Onko teillä mikään seuraavista laadunvalvonnan periaatteista tuttu: Total Quality management TQM, TOC (kapeikkoajattelu), Six Sigma, Lean?

- ❖ Käytetäänkö edellä mainittuja laadunvalvonnan periaatteita projekteissanne?
- ❖ Käytättekö projektinsuunnittelussa hyödyksi ”projekti verkko diagrammeja” (Network Diagram for a project)?
- ❖ Onko teillä MS Projektia tai vastaavaa työkalua käytössänne?
- ❖ Käytättekö aiemmista projekteista opittua uusissa projekteissa systemaattisesti?
- ❖ Minkälaisia projektinhallinnan työkaluja teillä on käytössä?
- ❖ Minkälaisia projektinhallinnan työkaluja tai lisä tietoa toivoisit?

Big Data ja teollinen internet

- ❖ Miten näet että Big Data voisi tuoda parannusta projekteihin?
- ❖ Käytättekö hyödyksi Big Dataa projekteissanne?
- ❖ Oletteko huomioineet Big Datan käyttöönoton erityistarpeet projektin suunnitteluvaiheessa?
- ❖ Miten näet että Big Data voisi kehittää CompanyXn projektinhallintaa?
- ❖ Ovatko vanhojen asiakkaiden toiveet otettu huomioon Big Datan suhteen?
- ❖ Käytättekö teollista internetiä (tai – intranetiä) projekteissanne?
- ❖ Miten näet että teollinen internet voisi kehittää CompanyXn projektinhallintaa?
- ❖ Onko teillä suunnitelmia tai jo käytössä teollisen intranetin porttaaleja?
- ❖ Millä tavalla on teollisen intranetin turvallisuustekijät otettu huomioon projektin suunnitteluvaiheessa?

Appendix 4. Interview questions from a Project Manager

Taustakysymykset projektinhallinnasta

- Onko teillä käytössä Scum metodologia
- Onko teillä käytössä Kanban Metodologia
- Onko teillä Kanban tauluja käytössä virtuaalisesti tai fyysisesti
- Miten asiakas on mukana projektin suunnittelussa?
- Miten otatte huomioon projekteissa eri ammattilaisilta tarvittavan tiedon?
- Kuinka informaatio ja tieto kulkevat projektin eri vaiheiden välillä?
- Millaisia projektin laadunvalvonnan keinoja teillä on käytössä? (Root Cause analysis eli kalanruotomalli, Balanced Scorecard, DMADV eli Define-Measure-Analyze-Design-Verify yms)
- Onko teillä mikään seuraavista laadunvalvonnan periaatteista tuttu: Total Quality management TQM, TOC (kapeikkoajattelu), Six Sigma, Lean?
- Käytetäänkö edellä mainittuja laadunvalvonnan periaatteita projekteissanne?
- Käytättekö projektinsuunnittelussa hyödyksi ”projekti verkko diagrammeja” (Network Diagram for a project)?
- Onko teillä MS Project tai vastaavaa työkalua yleisessä käytössä?
- Onko teillä sharepoint käytössä?
- Minkälaisia projektinhallinnan työkaluja teillä on käytössä?
- Käytättekö aiemmista projekteista opittua uusissa projekteissa systemaattisesti?
- Minkälaisia projektinhallinnan työkaluja teillä on käytössä?
- Minkälaisia projektinhallinnan työkaluja tai lisätietoa toivoisit?
- Käytättekö aiemmista projekteista opittua uusissa projekteissa systemaattisesti?
- Minkälaisia projektinhallinnan työkaluja tai lisätietoa toivoisit?
- Onko teillä tarkistuslistoja (Checklist) käytössä projekteja suunniteltaessa?
- Tunnistetaanko informaation ja tiedon ero?
- Huomioidaanko projekteissa informaation ja tiedon ero?

Haasteet Projekteissa

- Millaisia haasteita teillä on ollut projekteissa?
- Onko projekteissa tullut esiin tilanteita jossa informaationkulku ei ole toiminut?
- Mistä haasteet projekteissa ovat johtuneet?
- Onko aikaisempien projektien kulusta tietoa ja käytetäänkö sitä hyväksi

- Onko teillä systemaattista paikkaa tai kirjallista järjestelmää missä tätä tietoa säilytetään?
- Mitä olisit tehnyt toisin näissä projekteissa joissa on ollut haasteita?
- Mitä parannusehdotuksia haluaisit asiakkailta tulevaan tietoon, tai tapaan jolla tieto kulkee asiakkaan ja CompanyXn välillä?

Appendix 5. Questions from a Junior Engineer

Taustakysymykset

1. Mikä on asemasi yrityksessä?
2. kauan olet työskennellyt yrityksessä?
3. Kauanko valmistumisestasi on?
4. Oletko opinnoissasi käynyt projektinhallinnan teoriaa ja ns. parhaita käytäntöjä?
5. Oletko työsi aikana saanut tietoa, tai koulutusta projektin hallintaan?
6. Koetko että sinulla on projektin hallinnasta tarpeeksi tietoa?
7. Kun aloitit ensimmäistä kertaa projekteissa työpaikallasi, tuntuiko sinusta siltä että tiesit mihin työpanoksesi sijoittui isossa kuvassa?
8. Tuntuuko sinusta nyt siltä että tiedät mihin panoksesi sijoittuu isossa kuvassa?
9. Saatko helposti tietoosi missä vaiheessa projekti on?
10. Onko Scrum metodologia tuttu?
11. Onko Sprint projektivaihe tuttu?
12. Onko Kanban metodologia tuttu?
13. Onko teillä Kanban tauluja käytössä virtuaalisesti tai fyysisesti?
14. Onko joku seuraavista projektin laadunvalvonnan keinoista tuttu: Root Cause analysis eli kalanruotomalli, Balanced Scorecard, DMADV eli Define-Measure-Analyze-Design-Verify.
15. Onko teillä mikään seuraavista laadunvalvonnan periaatteista tuttu: Total Quality management TQM, TOC (kapeikkoajattelu), Six Sigma, Lean?
16. Käytetäänkö edellä mainittuja laadunvalvonnan periaatteita projekteissanne?
17. Käytättekö projektinsuunnittelussa hyödyksi ”projekti verkko diagrammeja” (Network Diagram for a project)?
18. Onko teillä MS Project tai vastaavaa työkalua yleisessä käytössä?
19. Onko teillä sharepoint käytössä yhdessä MS Projektin kanssa?
20. Käytätkö itse tarkistuslistoja (Checklist) hyödyksi omassa työssäsi?

21. Käytätkö mitään projektinhallintatyökalua itse työssäsi?
22. Tunnistatko informaation ja tiedon eron?
23. Huomiotaanko projekteissa informaation ja tiedon ero?

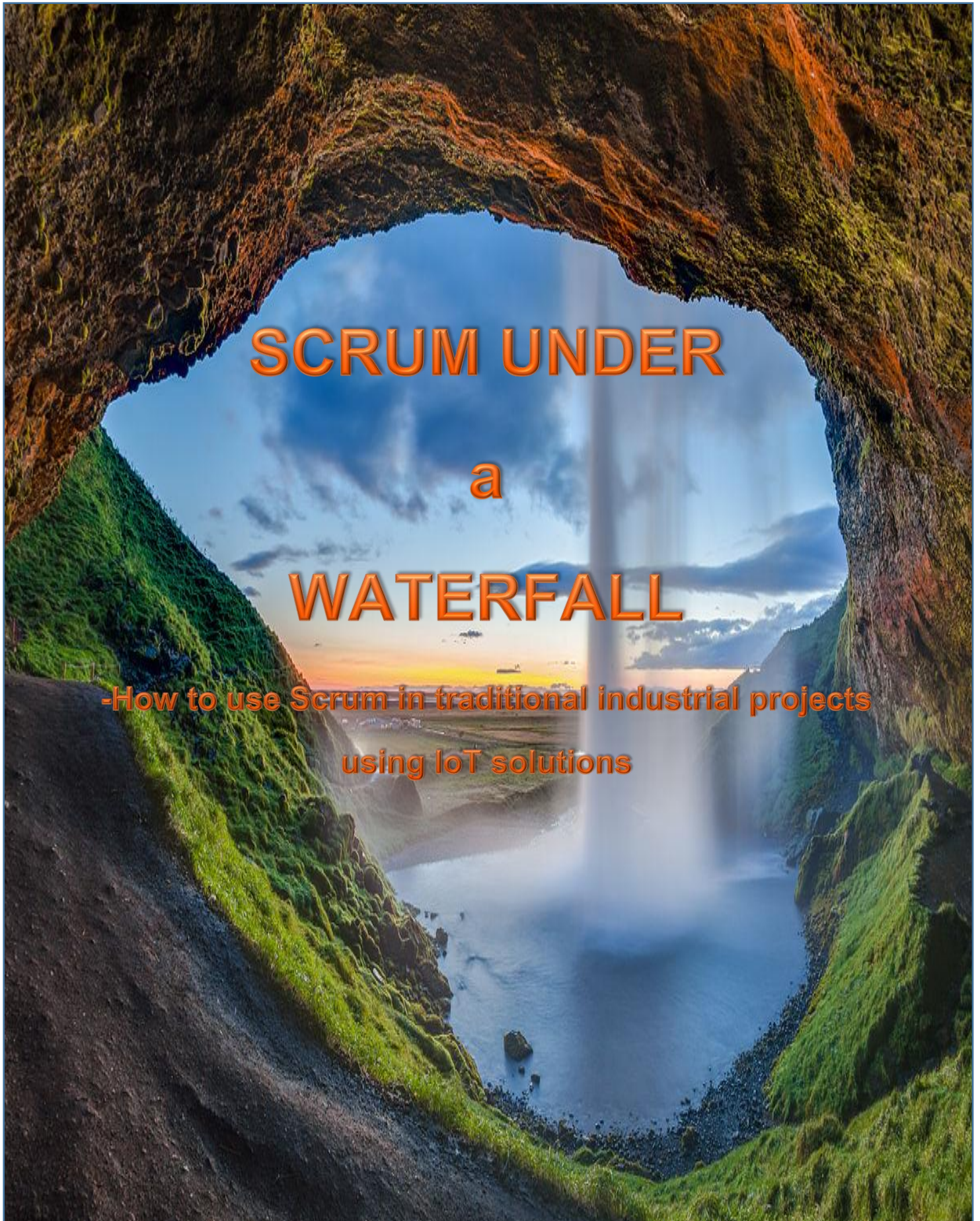
Haasteet projekteissa

24. Millaisia haasteita teillä on ollut projekteissa?
25. Onko projekteissa tullut esiin tilanteita jossa informaationkulku ei ole toiminut?
26. Mistä haasteet projekteissa ovat johtuneet?
27. Onko aikaisempien projektien kulusta tietoa ja käytetäänkö sitä hyväksi?
28. Onko teillä systemaattista paikkaa tai kirjallista järjestelmää missä tätä tietoa säilytetään?
29. Mitä olisit tehnyt toisin näissä projekteissa joissa on ollut haasteita?
30. Mitä parannusehdotuksia haluaisit asiakkailta tulevaan tietoon, tai tapaan jolla tieto kulkee asiakkaan ja CompanyXn välillä?

Big Data ja teollinen internet

31. Oletteko huomioineet Big Datan käyttöönoton erityistarpeet projektin suunnitteluvaiheessa?
32. Onko IoT'n (internet of things) käyttöönoton erityistarpeet otettu huomioon projektin suunnittelussa?
33. Millä tavalla on teollisen intranetin/ internetin turvallisuustekijät otettu huomioon projektin suunnitteluvaiheessa?

Onko sinulta kysytty millaisia Big Data, IoT ja/tai industrial internetin palveluja CompanyX voisi tarjota?



SCRUM UNDER a WATERFALL

-How to use Scrum in traditional industrial projects
using IoT solutions

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Introduction

This manual gives simple and visual solutions and tools to create a vision for internet of things solutions. Emphasis is on Scrum methods, for most traditional industrial companies work in the traditional project management methodology, and IoT needs an agile mindset in projects.

Internet of things is a new concept that will revolutionize different areas of business and industries. The possibilities on this ground-breaking technology are endless and by such companies at large are very interested in it. McKinsey & Company projects that the IoT business will have a potential value up to 11 trillion dollars

SCRUM

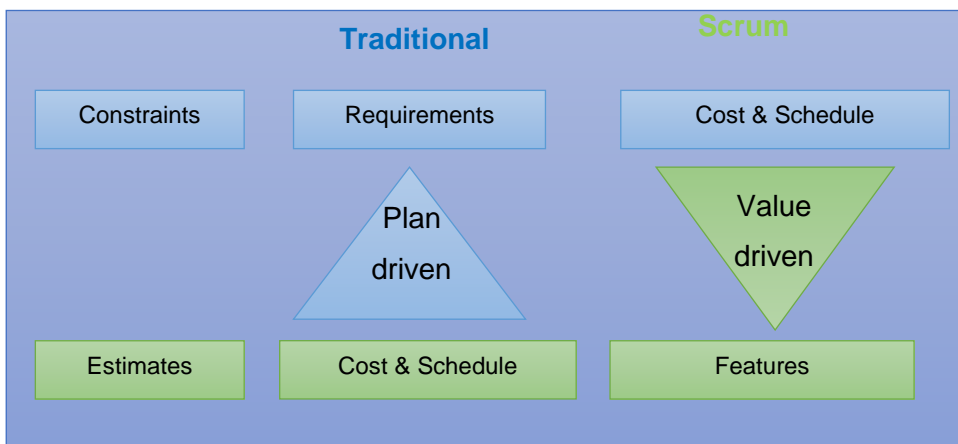
Scrum project management was created by Jeff Sutherland and Ken Schwaber in 1993. The founders were frustrated that projects were late and did not meet the quality requirements predefined in the project planning phase of traditional project management methods. Scrum was first used in software and product development, but as it is a lightweight framework for solving complex problems, it is used in many other projects also. Scrum is generally lightweight and easy to understand, but it is difficult to master.

SCRUM VALUES

- ❖ Courage
- ❖ Focus
- ❖ Openness
- ❖ Respect
- ❖ Commitment

A project has generally three constraints and three possible estimates. These constraints and estimates are requirements, cost, and schedule. In traditional project management the constraints are requirements, and costs and schedule are estimates. In Scrum the constraints are cost and schedule, and the estimate is features/requirements.

Differences between traditional project management and Scrum



The rules of Scrum consist of roles, events, and basic artefacts, and the requirement of each of them is clearly defined. The Scrum team consists of the Developing team, Product Owner and Scrum Master. The events in Scrum are the Sprint, Sprint Planning, Daily Scrum, Sprint Review, and Sprint Retrospective. The artefacts of Scrum are: the Product Backlog, Sprint Backlog, and Increment. All other tools and methods are optional and can be added on top of the basic structure as needed.

Scrum Rules

Scrum Roles	Scrum Events	Scrum Artefacts
Development team	The Sprint	Product Backlog
Scrum Master	Sprint Planning	Sprint Backlog
Product Owner	Daily Scrum	Increment
	Sprint Review	
	Sprint Retrospective	

Scrum roles

The Product Owner

Product Owner is responsible of getting the maximum return on investment of the product. The Product owner is in a way the driver of a car, if the project is a car. The product owner has the vision of the product, and ensures that the product is the one that the end user needs. The Product owner is responsible on the “**What**” is produced. The product owners main responsibilities are the following.

- Product Vision
- Product Backlog
- What are the features and requirements of the product
- What features and requirements should be done first
- What is the most valuable product and return on interest
- Informing & managing stakeholders ensuring that the right product is produced

The Development team

Creates the Product Owners vision. The development team is a cross functional team that contains professionals of their own fields of expertise needed to produce a product defined by the Product Owner. The ideal size of a Development team is 7, plus or minus 2 people, and the team manages its own work, responsibilities, and execution of the project. Basically in the simplest way the development team is responsible on “**How**” the vision of the product owner is achieved. A list can be created to describe the responsibilities of the Development team.

- How the tasks are performed
- How many tasks are performed each sprint
- Tracking the work progress
- Ensuring quality
- Communicating with the product owner
- Working with the product backlog items together with the Product owner, so that each item is clearly understood.
- Sprint Backlog

The Scrum Master

Not the project manager of the Scrum team, but the coach of the whole team. Scrum master is a “servant leader”. Scrum masters responsibilities are to facilitate the work of the team, make sure that the scrum rules are followed, and basically do his best that the team can improve its effectivity incrementally, and solves impediments and issues of the whole team. The Scrum Master leads by influence not authority, and this might be difficult to understand in traditional organisational cultures. Responsibilities are the following

- Coaching the team
- Protecting the Development team from impediments
- Manages the Scrum process and rules
- Helps the team improve its work process
- Helps solve arguments and challenges
- Facilitating Scrum Events
- Presenting Scrum to the organization, Stakeholders, and Customers Etc.

Scrum Events

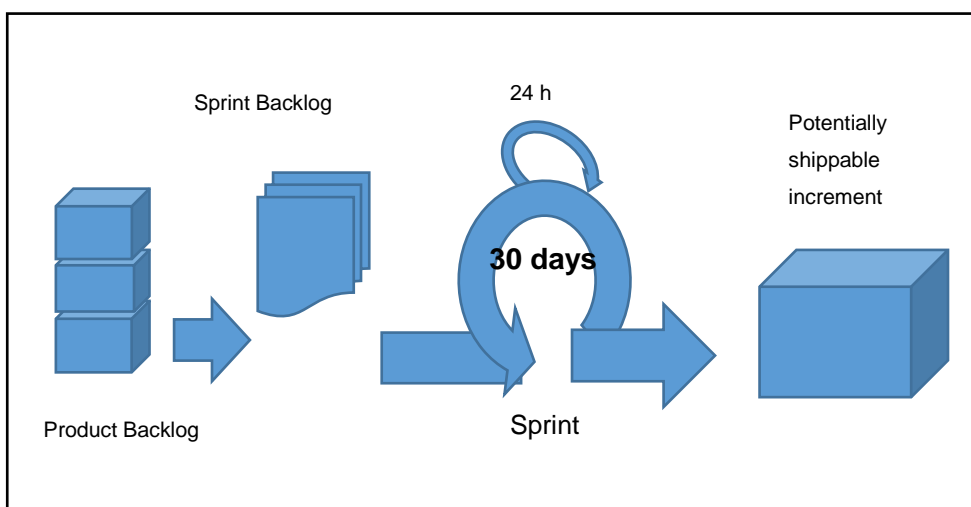
Sprint Planning is the first step in the Scrum cycle. Sprint Planning is done before every Sprint.

Sprint Planning is often held in two parts.

1. Development Team pulls tasks from the top of the Product Backlog to the Sprint Backlog. Team asks questions from the Product Owner to understand better these pulled stories. The team decides what is achievable, taking into account absences and vacations etc.
2. The Development team discusses how they can achieve the tasks and stories elected. Definition of Done.

A Sprint last normally from one week to a maximum of one month. Sprint is an event where the work itself is performed and in the end a product increment is created.

Sprint cycle



The Daily Scrum is a ritual that is held every work day by the Scrum Master and the Development team. Lasts 15 minutes and answers only three questions.

4. *What have you accomplished since the last meeting?*
5. *What will you accomplish today?*
6. *What impediments or obstacles are in your way?*

Plus optional fourth question with Scrum masters discretion. *“What is my confidence, on a scale of one to ten, that the team will accomplish the goal of this Sprint?”*

The Sprint Review one hour per the week length of the Sprint, the produced “product” is examined. Stake-holders and the whole Scrum team participate in the meeting. During the meeting the Development Team shows the work they have done.

The Sprint Retrospective is the last event in a Sprint that also lasts exactly one hour per a week of Sprint. The whole Scrum team participates in the retrospective. The whole Scrum team tries to find out how they could work better in the future, and the things that need to be removed or tackled.

Scrum Artefacts

Product Backlog is an ordered list of user Stories or tasks. The stories and task are ordered by the business value and risk. The most valuable items that create true value as soon as possible are ordered first. Also tasks and stories that have risks associated in late completion are ordered in the top. The **Sprint Backlog** is visualized list of tasks and stories that are pulled from the Product Backlog by the Development team. User stories are the tasks and features that need to be done during the Sprint.

Sprint Backlog

	Sprint Backlog (Tasks)	To Do	In Progress	In Review	Done
User Story 1					
User Story 2					
User Story 3					
User Story 4					

Increment is the objective or goal of each Sprint. An increment is all the added Stories and tasks done during a sprint. Each Increment should be able to be sold or shipped to the customer if the

Product owner so decides. An increment can be anything from a concrete product, to a detailed plan how to build a part of a factory

User Story is a specific feature or requirement that brings real value to the product. Normally task lists only answer the question what need to be done? But user stories are deeper. Each story needs also acceptance criteria. The criteria can be anything from the color of a wall, to more detailed acceptance criteria that answers also three questions.

EPIC is a User story that contains many user stories. In industrial projects it might mean the whole factory, or bigger pieces of the factory. As an example **Epic 1**-Warehouse, **Epic 2**-production etc. Epics and stories both answer the same questions, and follow the Scrum rules.

Story

- As a (who)
- I want (what)
- So that (Why)

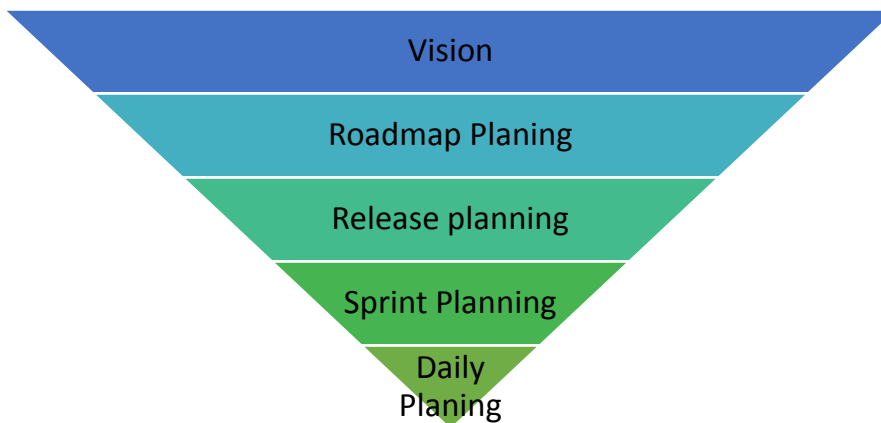
Acceptance Criteria

- Given (some precondition)
- When (a certain action/event happens)
- Then (result should be)

How to use Scum under traditional project management

Project Management is the art of creating a working environment where a product, service etc. is created. Projects are seldom business as usual, and have a clear starting and ending point. Further on, projects might have significant impacts on the future of the company, as they may make or break the company. A project might have cross functional teams, and a person working on a project often answers to managers from different areas of the project. As every project is somehow different from the other, predicting the exact costs and end results is difficult.

When starting to modify traditional methods a certain planning process needs to be done. **The most important thing to do is to create a vision.** After this come other steps.



The following table shows different planning steps and what the outcomes from each level are.

Planning level and outcomes

Level of planning	Outcome
Vision Planning	Vision, Success criteria, ROI
Roadmap Planing	Lean Canvas & Story map
Release Planning	Minimum viable product
Sprint planning	Stories and velocity
Daily Planning	Self-organization

Create a Vision

Vision is paramount when creating anything valuable the simplest tool to create a simple vision is the elevator pitch. This pitch can be used not only for product development but also for creating the epics and bigger more important stories. The vision projects the intellectual as well as the emotional idea of the project, product or service

CREATING A VISION -THE ELEVATOR PITCH

- ❖ For (*target customer/ user*)
- ❖ Who (*statement of need*)
- ❖ The (*product name*)
- ❖ Is a (*product category*)
- ❖ That (*key benefit*)
- ❖ Unlike (*primary competitor*)
- ❖ Our Product (*further differentiation*)

To create something of value, one needs to know what valuable things that can be measured. This measuring helps the team and all the stakeholders to know how successful the project has been in achieving the vision.

Success Criteria table

SUCCESS CRITERIA	
1	
2	
3	
4	
5	
6	

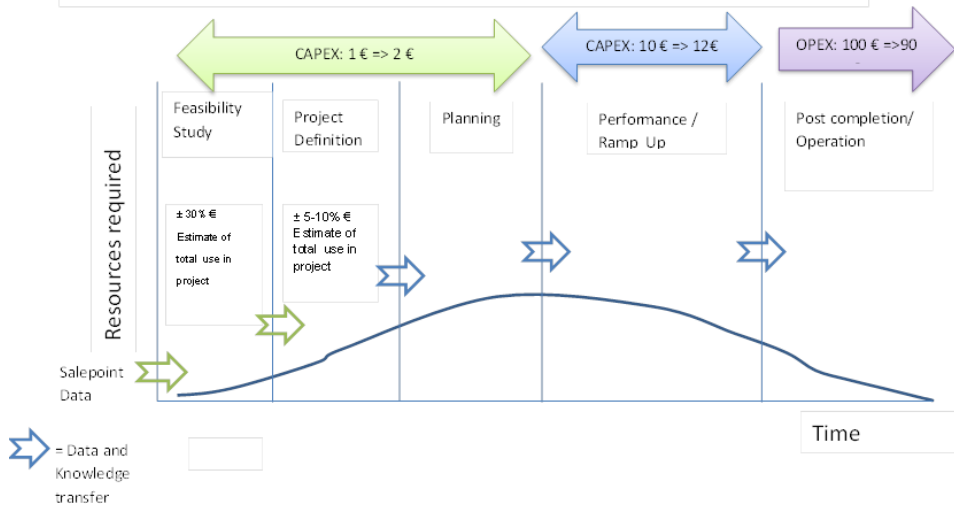
When creating products, services, and epics it is useful to use the Lean Canvas to get a bigger picture of the project, its values and challenges. This document should be visible to the entire stakeholders in the project. The product owner or project manager is responsible of this canvas.

LEAN CANVAS			
Problem	Customer segments	Key metrics	Possible solutions
top 3 problems 1 2 3		key activities you measure	
Alternative solutions 1 2 3	Channels		Business Readiness
Business Value	Cost of delay	Costs	
user& business value Cost of delay		People, training, capital, marketing etc.	

Modifying Traditional project management artefacts

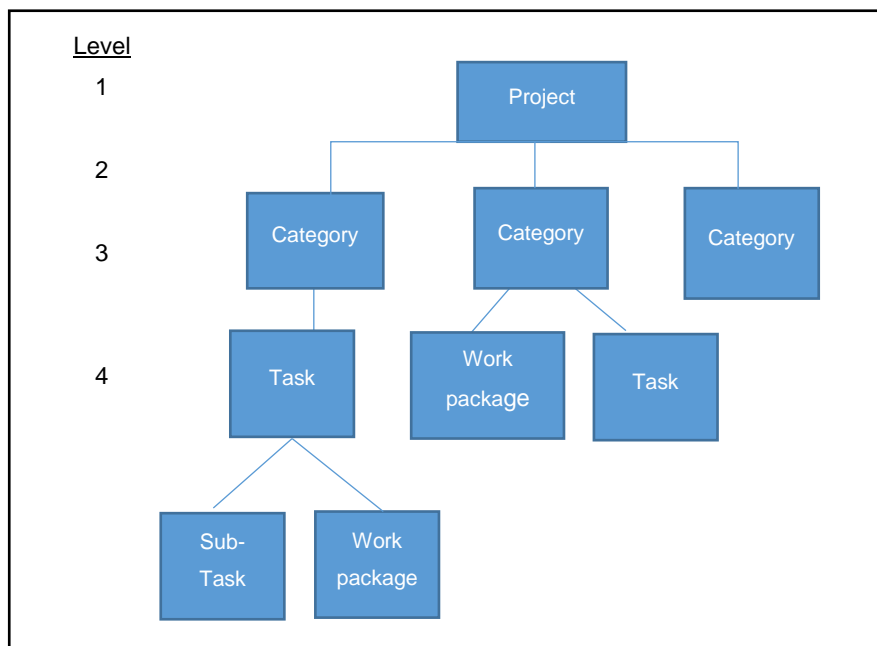
A project can be divided in five phases, Concept/Feasibility study, Project definition, Planning, Performance/Ramp up, and Post completion/Operation. In the following graph one can see the resources required by the project marked with the blue line. Many times a projects resource need is presented by a bell curve. The big arrows on top of the graph symbolize the sales argumentation most consulting companies have to the end customer according to the. Spending more money in the beginning and thus increasing the Capital Costs (CAPEX) will bring savings in the post completion/Operation phase of the project, thus decreasing the Operating Costs (OPEX).

FIVE PHASES OF A GENERIC PROJECT, MODIFIED WITH INPUT FROM COMMISSIONING PARTY



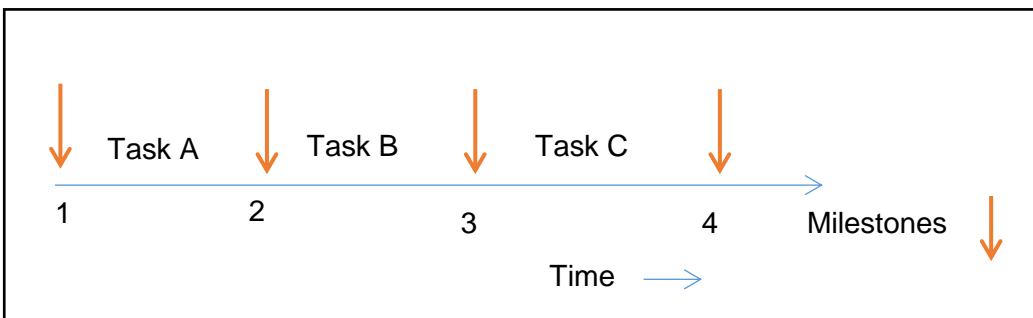
The most common three tools for traditional project management are Work breakdown structure, Road Map and Gantt Diagram. These three tools can be modified to fit the Scrum framework, and in a way modifying them makes them more agile. Work breakdown structure contains normally four levels as shown in the following figure. Level 1 the project level, level 2 Sub-project, level 3 activity, and level 4 work packages and tasks. Each higher level explains and divides the tasks and requirements into smaller pieces. These levels can be created into **Epics** and **Stories**. Levels 1 and 2 can be considered Epic stories, and level 3 and 4 are common stories. To change these work packages into stories, the Product owner needs to answer the three questions to create a story, as well as create acceptance criteria. The product owner should concentrate on one epic at a time, for projects change.

Work Breakdown Structure



A traditional project has also milestones that normally tell when something needs to be released. To Change this to compatible with Scrum, the product owner need to think about the project triangle. A project can have three kinds of constraints and estimates. The constraints and estimates are requirements, cost, and schedule. So that a project is not a death march, a project can have only 1-2 requirements. And the roadmap of the traditional project should take this into account. A good project has either requirements of time and or resources, and the features and end product is an estimate. Or as in many industrial projects the requirement can be a working factory, and the cost and/or schedule should be an estimate.

Milestones of a Project



Whatever is decided on, it should be seen in the milestone map. This milestone map can be further re-created into a story map. First a Simple Story Map, and then together with the whole Scrum team, into a Divided Story Map.

Simple Story Map

Feature 1	Feature 2	Feature 3
User story 1	User story 6	User story 11
User story 2	User story 7	User story 12
User story 3	User story 8	User story 13
User story 4	User story 9	User story 14
User story 5	User story 10	User story 15

Divided Story Map.

	feature 1	feature 2	feature 3
Release 1	User story 1	User story 6	
	User story 2	User story 7	
Release 2	User story 3		User story 11
	User story 4		User story 12
	User story 5		
Release 3		User story 8	User story 13
		User story 9	User story 14
		User story 10	User story 15

Gantt Diagram can be forgotten and thrown into the bin. It is not a useful tool and creates false expectations that the project will go exactly as planned

	Week number									
Work Package	1	2	3	4	5	6	7	8	9	10
A1	█									
A2		█								
A3		█	█							
B1				█	█	█				
B2					█	█	█			
C1							█	█		
C2									█	
C3									█	█

Internet of Things

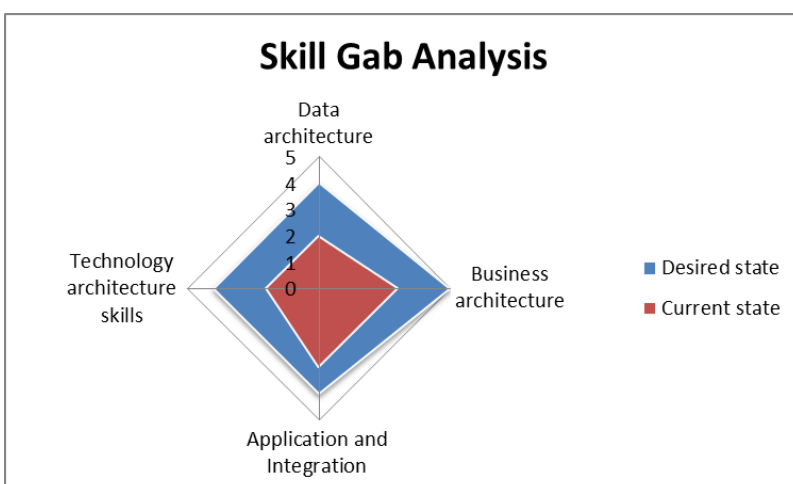
Internet of things is built upon the industrial internet. In the heart of internet of things is the machine-to-machine communication, first introduced in industrial internet. Another essential part of internet of things is data and data transfer. The essence of the Internet of things is data and creating value from this data. To create value from raw data computer algorithms are used to make sense of the terabits of information that can be created in mere hours. To create value models need to be created and tested. In the best situation these models and algorithms can forecast future actions, like when a customer is changing to another bank or when a person is beginning to look for a new car.

Current state analysis

Before creating any solutions, the company needs to know its own situation. A current state analysis on the information architecture, data points, and the business information need, should be done. A skill gap analysis on the needed project should be done. There is many tools to create this, but the easiest is to list the needed skills in excel and give a value for each team member, and calculate the average of the whole team. If there is a gap in the needed skills a decision should be done to train the team members, get a new team member with the needed knowledge, or outsource. A Skill gap table that fits every situation is not viable to do, and the tool should be reviewed periodically due to the speed of change.

1. Business architecture skills
2. Data architecture skills
3. Application and Integration skills
4. Technology architecture skills

Skill Gap Analysis



IoT Solutions

The internet of things solutions are based on generated data and knowledge and business value generated from this data. The data is generated by input points connected to computer systems. These data points are diverse and include things like geolocation, GPS, barcode scanners, various sensors, cameras, audio and video monitors, radars, sonars, and light detection ranging devices etc. The data gathered from these data points is analyzed with computers so that sense can be made from the gathered data, and that the connected devices can be managed.

Most of the solutions in IoT fall in the categories described in the following table. When creating IoT solutions, the designing team should know the business that the solutions are created for. The solutions generally fall in to five categories: Location awareness, Enhanced situational awareness, Sensor Based Decision analytics, Automation and controls, and “Big Data” analytics.

Data points for these solutions come from the following sources. And when designing a solution the data sources should be thought of. Data sources affect the needs for security and investment and planning.

- ❖ Sensors etc.
- ❖ GPS
- ❖ ERP system
- ❖ CRM system
- ❖ 3rd party data

The benefits of IoT come generally either from streamlining processes or from Business Intelligence. To create a solution, the Key Performance Indicators need to be known. The IoT solution will improve these Key Performance Indicators, or give valuable business information to create new business models and improve marketing and sales.

Solutions table

	Streamline Processes						Business Intelligence			
	Quality	Speed	Cost	Performance	Availability	Cycle time	Sales	Marketing	logistics	Opportunities etc.
Location awareness										
Enhanced situational awareness										
Sensor Based Decision Analytics										
Automation and Controls										
Big Data Analytics										

True value comes from testing solutions in practice. That's why it is good practice to think what the true needs of the users are. A minimum viable product should be the first aim of all IoT projects. This MVP can be expanded later on, with feedback from the customer, and the end users.

Who are the users	Minimum User Interface needs	Possible solutions	Minimum Viable Product

Conclusion

It is not a question why companies should invest in internet of things solutions, but when. Internet of things has a possibility to change whole business models, and can bring a cumulative saving in processes. Those companies that are early adopter will have a significant competitive edge to those who don't. The telephone and internet spread to all business, so will internet of things. And companies should think how and when to get IoT solutions to their business, and better adopt the capabilities early than late.

Companies offering internet of things solution use agile project management methods, and as the speed of change has increased, traditional project management methods are too slow for software and information technology. It has been clear in the study that the biggest obstacle to companies adopting internet of things is not technological, but cultural. Traditional companies need to adopt a more agile way of working, which means also transparency and vision. Many companies are not ready to admit that there is something in their company culture that could be improved.

Scrum as a simple and light framework for agile project management is at the right tool to offer companies that feel that they are ready to the transition. No transition is painless or free. This is why investing in agile know how and a change of mindset is imperative to companies using traditional project management.