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DEVELOPING EMPOWER'S DNA NETWORK CONSTRUCTION PROCESS AT LOHJA

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Bachelor's Thesis | Abstract

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Developing Empower's DNA network construction process at Lohja

The objective of this thesis is to develop Empower's DNA network construction process at Lohja. The aim of this study is, for its part, to merge Empower's network construction operation model to one common process. The key issues are excavation work productivity, how to overcome the unfamiliar factors underground, and what steps are necessary in producing value for the customer.

The study covers process theory and management practices such as Business Process Reengineering and Lean Management. The process concept is then used as a perspective to describe and develop the current situation. In addition the personal knowledge gained as an installer, designer, and team leader is applied.

The results present the proportional adaption of Lean Management and three distinct network construction models each of which is suitable for different company visions. The team-based network construction application allows a customer-oriented approach in every step when the Lohja DNA construction unit is combined to a greater entity.

INDEX TERMS:

Earthwork, Cable network, Process management

OPINNÄYTETYÖ (AMK) | TIIVISTELMÄ

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Maria Smit

Empower Oy:n DNA verkonrakennusprosessin kehittäminen Lohjalla

Tämän opinnäytetyön tavoite on kehittää Empowerin DNA rakentamisen prosessia Lohjalla nykyisen prosessin tutkimisen kautta. Työn lähtökohtana on olla osa Empowerin verkonrakentamisen toimintamallien yhdentämistä. Ydinkysymyksiä ovat kaivutyön tuottavuus ja miten selviytyä maan alta paljastuvista yllätyksistä sekä mitkä vaiheet ovat välttämättömiä lisäarvon tuottamiseksi asiakkaalle.

Tässä työssä käydään lyhyesti läpi prosessiteoria ja hallinnointikäytäntö Liiketoiminnan uudelleen suunnittelun sekä Joustavan ja kevyen toimintatavan kautta. Näitä prosessien periaatteita käytetään näkökulmana kuvaamaan ja kehittämään nykyistä toimintaa. Lisäksi sovelletaan henkilökohtaisesti saatua tietoa asentajana, suunnittelijana ja tiiminvetäjänä.

Tulokset esittelevät Kevyen ja joustavan johtamistavan osittaista adoptointia sekä kolme erilaista verkonrakennusmallia joista jokainen sopii tietynlaiseen yritysvisioon. Tiimiperusteinen rakennusmalli varmistaa jokaisessa vaiheessa asiakaslähtöisen lähestymistavan kun Lohjan DNA rakentamisen yksikkö on osa isompaa kokonaisuutta.

ASIASANAT:

Maarakennus, Kaapeliverkot, Prosessijohtaminen

ACKNOWLEDGEMENTS

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1 Introduction

Empower Ltd. offer infrastructural network construction services for different internet service providers. The starting point of this thesis is the integration of Empower's network construction operation model. Process descriptions help to understand the relations between distinct functions, ease the creation of new processes, and supports the process of creating procedures. The goal is to develop the Lohja DNA network construction process through the investigation of the current process and management practices, and reflect on the experience as an installer, designer, and team leader. An extremely problematic aspect of construction is the excavation work which is often more than half of the project revenue. Even though the installation phase is discussed, the focus is more on excavation work. Fault correction is part of the Lohja DNA construction unit. However it is excluded from the scope of this thesis. In the beginning process theory is explained shortly followed by two management practices. Then, the present construction process is presented and finally the development ideas are introduced.

2 Process Theory

Business process is defined as a sequence of interdependent procedures which at every stage consume one or more resources to convert inputs into outputs. These outputs, then, serve as inputs for the next stage until a known goal or end result is reached. Business processes are important for the understanding of how we work and how we should develop, and how should we administer our work activities. Process defines what (product), how, and to whom (customer) chain of actions. How answers questions such as what the process phases are, what directing factors there are such as laws, who is responsible for the process, and where the process takes place. [1][2]

Core business processes can be divided into primary and support processes. Primary processes bring direct value for the customer and support processes are mainly administrative activities. To better detail the flow in different levels core processes can be partitioned into multiple sub-processes. Process maps graphically present the process work flow in different levels. Empower uses process maps at five different levels which are core processes, sub-processes, segment of process, operation layer, and work layer. The purpose of the maps is to adduce dependency of matters, critical facts affecting the process, and to advance cooperation between parties. Additionally, the maps standardize work for future improvement. Enhancing business processes implicates improving cooperation over the department borders and the supply chain producing value for the customer. Transparency of the department borders is required even if departments are retained for clarity. It entails a process team working toward a common goal, where every team member can see the big picture and their part in it. [2][3][4]

For business process management there are plenty of different management methods attempting to make companies flexible, adaptive, and capable for rapid changes. The general aim for all the policies and tools is to improve business processes and to operate according to demands. Next, two business management practices, Business Process Reengineering (BPR) and Lean Management, will be covered. [3][4]

2.1 Business Process Reengineering

The idea behind Business Process Reengineering is to notice business functions as core processes linked together and recreate them. Michael Hammer states in his book, “Reengineering the corporation”, that reengineering is fundamental rethinking of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed. Reengineering seeks for dramatic improvement, for example in reducing costs into one third, not just enhancement of the existing business process. It challenges the old, takes nothing for granted and asks what we must do and how we should do it. Often, processes are unidentified or processes are fragmented and a company has a necessity to

reengineer. Reengineering is especially important for the old functional, or industrial, organizations which are limited to their departmental boundaries and are thus bureaucratic and stiff. But it is also important for companies that want to maintain their compatibility or avoid adversity. [5]

Process recreation is started from a clean slate directed by the company's vision and strategy. The current process is investigated including its state and performance limitations. Then, designing the new process is started backwards from the process vision by defining what the results of the process are, what activities are obligatory, and what the order of performance is. Also new technology plays an enabling role through the consideration of its benefits and utilization. Next the new process is described in detail through process maps and written procedures. Training and pilot projects are an essential stage before the comprehensive adaption. Once the new process is adopted into practice it is evaluated and improved continually. [6]

Reengineering processes affect the whole company. The Business diamond in Figure 1 illustrates the circle of influence. The process determines the jobs which in turn defines how people perform the work and how they are grouped. Now when the process is remade it changes the tasks and how people are organized. Usually, a team that crosses department borders is assigned to handle a process. The people in the team are aligned to think from the customer perspective, either the internal next phase customer or the final customer. The team has the responsibility of completing the entire process and, therefore, decision making is also on the ground level. As a consequence of the new jobs and structures, the management measure the performance based on the value created and compensation is set accordingly. The leaders have the responsibility to build encouraging support systems that enhance the motivation of employees. They encourage and guide their subordinates to perform well. The management system affects how employees think and what they appreciate. For this reason, management systems must support the process by reflecting the values and beliefs in practice. To successfully reengineer an enterprise's process all the four points of business diamond has to be affiliated, otherwise failure is a risk. [7]

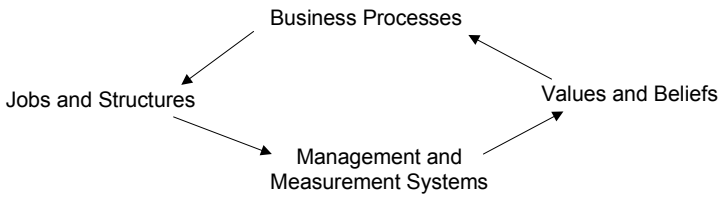

Figure 1. The Business Diamond. [8]

2.2 Toyota Production System and Lean Management

Toyota Production System, TPS, has 14 basic principles which are not just tools or techniques but values that constitute the foundation of operation. These principles can be divided into four categories: Philosophy, Process, People and Partners, and Problem Solving. Often the second section, Process, is viewed as Lean Management and the values are considered unsuitable for western culture, thus only the tools are put into practice. Yet, the values are a significant part in management and in how employees, subcontractors, and suppliers play. Employee motivation, innovation, and problem solving skills are the result of challenging work task, sense of safety, and encouraging management. The Toyota Way is dependence on people with a mission greater than making money; it is about contributing to the society where a necessity for a company's survival is to be competitive and profitable. Figure 2 enumerates the 14 principles of TPS.

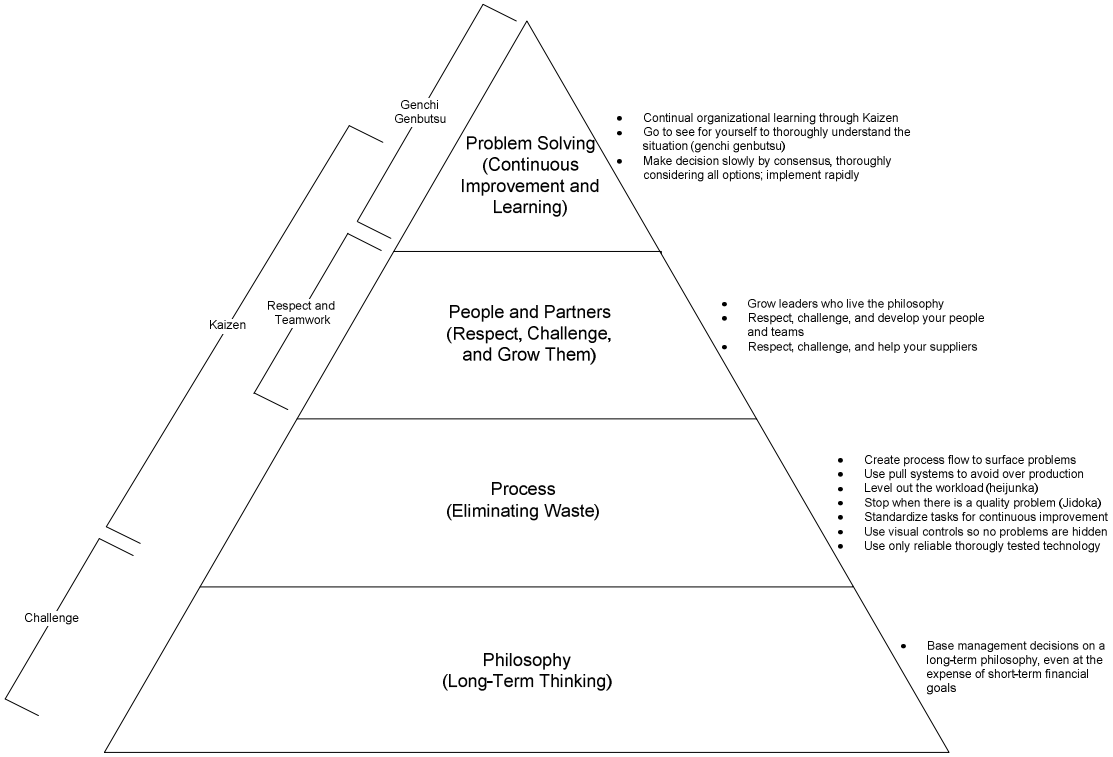

Figure 2. The “4P” model. [9]

2.2.1 Philosophy

The principle, *base your management decisions on long-term philosophy, even at the expense of short-term financial goals* basically means doing the right thing for the customer, society, employees, and the company. First of all, a company’s management has to have a prolonged mission and vision of the company’s future, live accordingly and align the people on behalf of it. This, however, is a hard and demanding job in today’s world where respect and trust has been perishing. Therefore it requires from management responsibility and trustworthiness toward their employees that has to be practiced even during economic crises. Toyota is an example proving that the mutual respect and trust do not have to be sacrificed in any situation. When employees know that there is a defined purpose and mission greater than earning a paycheck and they have a safe environment, better results can be achieved. Second, appreciating the customer denotes considering their needs and producing products with built in quality. This can be accomplished with the tools explained later. Another viewpoint is to take

customer complaints seriously. As Jim Press explains in the Toyota Way book, to satisfy the customers and to gain their long-term trust, it is important to show dignity by treating customers appropriately even though you do not owe them anything. In brief, the values of management will reflect on the whole company and its operation. Basing management decisions on long-term mission is the foundation for all the other principles in TPS and Lean Management. [10]

2.2.2 Process

The process section is about the tools a company uses for improving its processes. In the core is *creating continuous process flow to bring problems to the surface*. The goal is that every work project flows smoothly through the process where all unnecessary waste is eliminated. [11] Some examples of waste are machines or people idling and waiting, transportation, over processing, defects, unused employee creativity, unnecessary movement, and inventory. The waste should be removed or reduced to minimum and fundamental in defeating waste is to create continuous flow and link operations together. Flow reduces lead time and helps to adopt the other lean tools as well. The previously mentioned waste types are all together just one third of all the waste in lean production. The two third is elimination overburden of people and equipment, and unevenness. The overburdening people lead to burnouts and worse quality, whereas the overburden of equipment and machines leads to breakdowns. Unevenness is caused by fluctuation in orders and irregularities in the production system such as downtime and defects. Moreover, unevenness results in the other two types of waste. *Leveling out the work load* and expunging unevenness stabilizes the production system which is one of the cornerstones in creating stable flow and in deleting the two other types of waste.

The third principle urges to use the “pull” system. Pull systems are replenishment systems that target to zero inventory in supplies and customer products. In other words, a warehouse inventory will be replenished based on usage rather than guessing the exploitation. A good illustration is SLO-DNA contract shop which is owned by the

supplier SLO. Empower installers use a handheld device to “pull” out a product they need and it will replenish when a threshold value signals back to the supplier for a refill.

A culture of stopping to fix problems is eligible *to get quality right at the first time*. An operative is responsible for stopping and fixing the problem when noticing a deviance from standard so it will not continue further in the process. Toyota has implemented simple quality methods for every employee to practice: go and see, analyze the situation, use flow and andon, and ask “why” five times. The five why method, which will be explained in more detail later, helps to figure out the root cause of the defects and andon is a light system which notifies the problem to get help. Similarly, standardized coherent tasks build in quality and support problem-solving. *Standardized tasks are the foundation for continuous improvement and employee empowerment*. The standards are written to support corporation wide learning and to enable people to improve themselves.

Fujio Cho, President of Toyota Motor Corporation stated “Clean it up so you can see problems”. In Lean Management *visual controls are used so no problems are hidden*. Visual controls support value-added flow and employees so that they are able to work well. One of the most known tools is 5S, which improves the work environment, decreases injuries and simply helps to find equipment quicker. 5S is as follows:

1. Sort: Sort items that are used often and rarely, and dispose what is not needed
2. Straighten: Arrange a place for everything
3. Shine: Everyday cleanliness
4. Standardize: create rules to help sustain the previous 3S
5. Sustain: Use regular management to stay disciplined

The last principle of section two stimulates to *use only reliable, thoroughly tested technology that serve the company’s people and processes.* When considering adaption of new technology, strong internal processes help in evaluation and ultimately

in implementation. Evaluation includes analyzing the impact on the existing process and reflecting with the people who utilize the new technology. After comprehensive evaluation, a pilot project among small group tests and debugs the mistakes. Eventually the implementation is extensively faster and easier. [12]

2.2.3 People and Partners

Building a company on enduring values sustains it through tribulations. The leaders are in a key position when developing the company and creating its future. The challenge is to have vision, how to execute it, and how to get people participating and to do their best. Deep understanding of the work has substantial part in decision making and in guiding people. The leaders exist to create the best possible environment for employees to succeed in their work and certainly it supports the idea of putting customer first. At Toyota the principle is to *grow leaders who thoroughly understand the work, live the philosophy, and teach it to others*. Here are some common qualities of TPS leaders:

- Focus on long-term purpose
- Never deviate from the TPS principles, and live and model them for all to see
- Work the way up in company and continue to go to the place where value added work is done
- See problems as opportunities to train and coach their people

Jeffrey K. Liker states briefly the concept: “A company growing its own leaders and defining the ultimate role of leadership as ‘building a learning organization’ lays the groundwork for genuine long-term success”.

In TPS the work is done in teams that coordinate the work, motivate, and learn from each other. The teams always have a direct supervisor ready to support the ongoing work. To *develop exceptional people and teams that follow the company’s philosophy,* TPS uses combination of various management theories that are summarized in table 1.

Table 1. Motivation theories and TPS. [13]

Internal Motivation Theories	Concept	TPS
Maslow's Hierarchy of Needs	Satisfy lower level needs and move employees up the hierarchy toward self actualization.	Job security, good pay, safe working conditions satisfy lower level needs. Culture of continuous improvement supports growth toward self actualization.
Herzberg's Job Enrichment Theory	Eliminate "dissatisfiers" (hygiene factors) and design work to create positive satisfiers (motivators)	5S, ergonomics programs, visual management, human resources policies address hygiene factors. Continuous improvement, job rotation, and built-in feedback support motivators.
External Motivation Theories		
Taylor's Scientific Management	Scientifically select, design standardized jobs, train, and reward with money performance relative to standards.	All scientific management principles followed but at the group level rather than individual level and based on employee involvement.
Behavior Modification	Reinforce behavior on the spot when the behavior naturally occurs.	Continuous flow and andon creates short-lead times for rapid feedback. Leaders constantly on the floor and providing reinforcement.
Goal Setting	Set specific, measurable, achievable challenging goals and measure progress.	Sets goals that meet these criteria through policy deployment. Continuous measurements relative to targets.

Another aspect for *people and partners* is *respect for your extended network of partners and suppliers by challenging them and helping them improve*. The aim is to grow together to mutually benefit in long-term. Respectful relationship has no room for bullying the contractor but instead stand out through demanding work and fair treatment. Demanding high standards of performance and teaching the lean management to partners brings respect and shows leadership. In addition, a possibility in TPS exists to enhance cooperation and learning in development meetings, projects, and activities.

Growing together as a company requires exceptional people, individuals, who share the same values. It requires reliable partners who are ready to evolve. Perceiving cooperation and the capability in people can lead to an extended learning enterprise. [14]

2.2.4 Problem Solving

The principle *go and see for yourself to thoroughly understand the situation (genchi genbutsu)* differentiates Lean Management from other management methods. To truly understand the situation and any business problem, genchi genbutsu has to be practiced. Data, for instance is always one step away from the actual situation. It is a result indicator and when it is put back to its context by going and seeing, and deeply observing the situation, then it can be truly understood. The following lists the Toyota technical center manager's management methods related to genchi genbutsu.

- Think and speak based on verified, proven information and data
    - Go and confirm the facts for yourself
    - You are responsible for the information you are reporting to others
- Take full advantage of the wisdom and experience of others to send, gather or discuss information

Admittedly the above applies in network construction in a case of a problem. It can be difficult to understand circumstances and report to the customer of the changes unless going and seeing the situation first.

Going and seeing the situation is also the first step in problem solving and specifying the problem. Defining the point of cause on the spot will lead to the five why analysis and towards the root cause of the problem. The five why analysis is needed to look back at the symptom of a problem and prepare countermeasures to prevent the same situation from happening in the future. If countermeasures are effective, they will become part of the standard.

A real life situation demonstrates the power of the why questions. A network constructor has two different jobs for a location close to each other. The distance to the site is long so he decides to build the networks consecutively to lower the costs. A commencement inspection is required with a road administrator and a meeting is agreed for the next day. On the site, it turns out that the other construction cannot be started because permission has not been applied for. The network constructor does a five why analysis, see the table 2 below.

Table 2. Five why analysis example.

What is the Problem?	We cannot start the construction.
Why?	Because we lack a permission to work on a road area.
Why?	Because the designer did not apply for it.
Why?	Because the designer was uncertain if the permission was needed because we pull cables into existing pipes.
Why?	Because rules are unclear, hard to interpret and find out.
Why?	Because of lack of training and communication.

In Lean decision making 80 percent is planning and 20 percent is implementing. *Making decisions slowly by consensus and implementing them rapidly* includes five parts:

1. Finding out what is really going on including genchi genbutsu
2. Understanding root causes that explain the surface appearances- five “why” analysis
3. Broadly considering alternative solutions and presenting detailed arguments for the preferred solution
4. Building consensus with the team, including company’s employees and outside partners
5. Using visual aids to express the previous four in one A3

As with the adaption of new technology, matters are considered thoroughly and all the possible alternatives are pondered. Also, people affected by the decision are brought in to the process to give input and new alternatives. Finally, after careful analyzing, the best solution is chosen and presented for the decision makers in one piece of A3 paper. The proposal includes title, information about the background and the current situation, recommendations, implementation, and follow-up.

The extensive process of analyzing accomplishes three main points. First, all the facts are noticed which if undetected could lead later to retrieving. Second, implementation is often straightforward because of the support from different parties. Three, learning of new matters is achieved beforehand.

The final principle of TPS is to *become a learning organization through relentless reflection and continuous improvement*. To be able to continually improve and learn, processes must be stable and standardized. Once the processes are stable, waste and inefficiencies are made visible providing a chance to learn from the improvements. For a company to sustain the learned abilities, it is essential to have stability of personnel, slow promotion and a success system. Then, the learning is built up on past and grows the professional capital without discovering everything again.

Both the problem solving and the decision making principles mentioned above strive for organization-wide learning. Problem solving and the five why analysis are an essential part of constant improvement which is an attitude of life-long learning combined with reflection. To conclude on what could be done better, reflection is performed at individual level and at reflection group meetings. Reflection improves processes and methods by finding flaws which then, in turn can be solved through kaizen.

A policy deployment stretches objectives from executives to work group level directing and motivating company-wide learning. In Figure 3 the objectives start from the executive level and move downstream to work group level. The goal statements are very specific and pursue massive improvement where every team member has few detailed objectives. The progress is measured daily and reported upstream until the executives. [15]

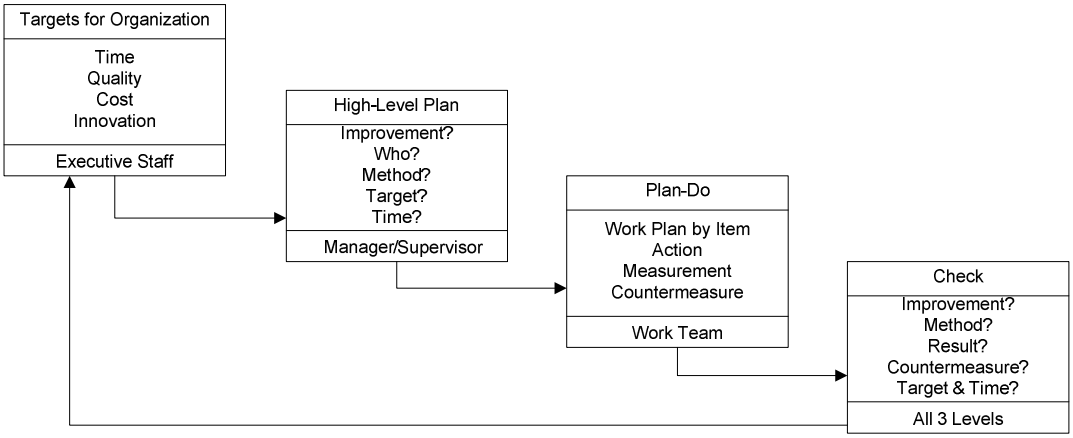

Figure 3. Policy deployment process. [16]

3 CONCURRENT PROCESS

The Empower's DNA network construction process applies when constructing network for Internet Service Provider (ISP) DNA at Lohja. The process starts when an order is received and ends when the work is completed according to the objectives. The main goal is to produce additional value for the customer through a cost-efficient process. During the process different interest groups impact the process either directly or indirectly. The interest groups involved are employees, subcontractors, suppliers, DNA, municipality, and government, all influencing the processes. The network construction process can be divided into five sub processes according to the phase of operation. As illustrated in Figure 4, order management, preparations, construction, technically completed and invoicing are the main internal processes conducted in each project.

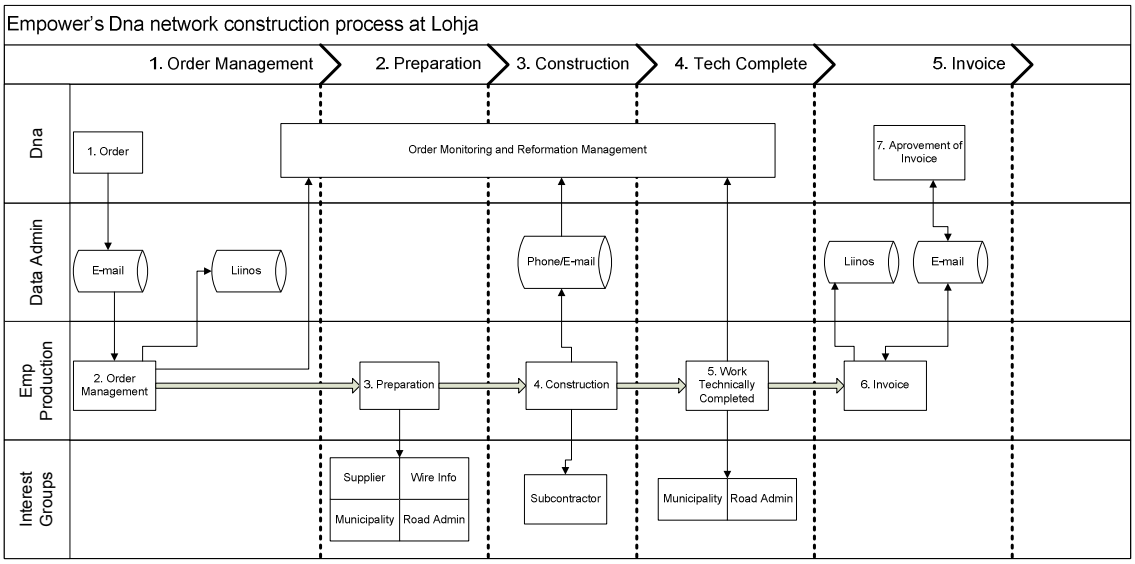

Figure 4. Empower's DNA network construction process at Lohja.

3.1 Order Management Process

Order processing begins when a DNA Designer is placing an order by email or phone and defines the billing method which affects the establishment of a process number in

the IT system Liinos. The creation of a Liinos number is fast because a billing clerk creates the features and the team leader adds the necessary extensions. The DNA Designer is also informed about the created process number for later recognition of the project. At this point, blueprints are received via email or as a paper version. However, in some cases the blueprints are received while the project is running, thus slowing down the operation. Figure 5 illustrates the order management process.

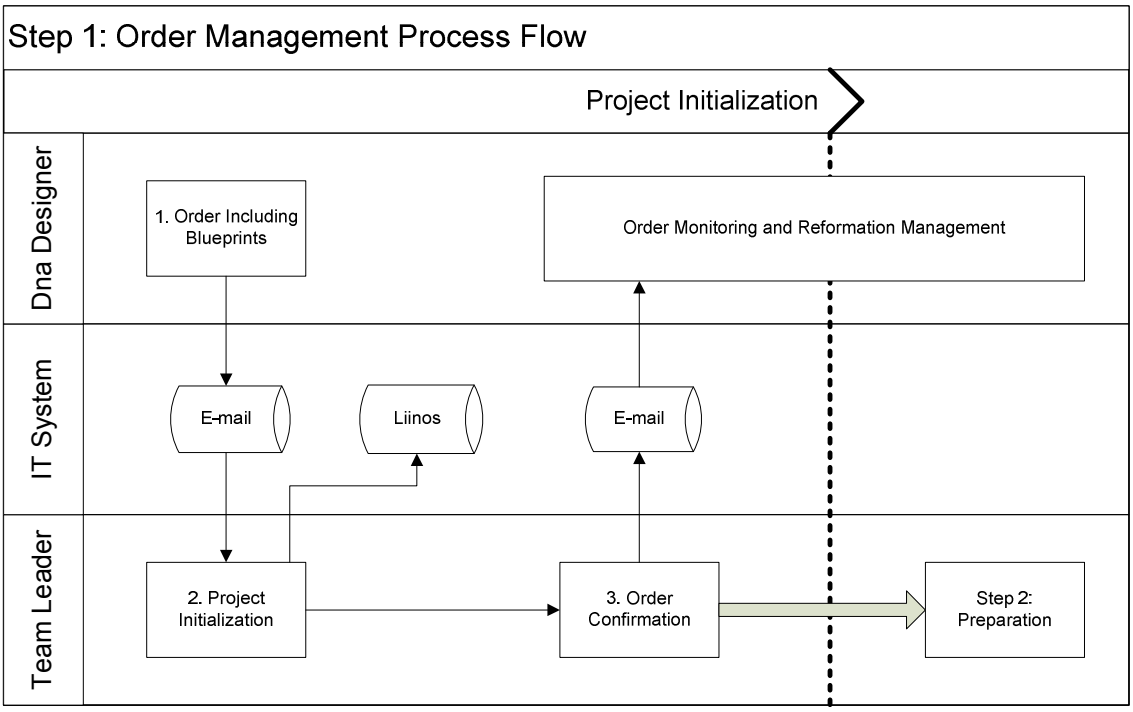

Figure 5. Order management process.

3.2 Preparation Process

The Preparation process starts when order management process ends. First, a team leader performs site survey to become familiar with the project. Occasionally the DNA Designer is attending on the first visit to the construction site to clarify the blueprints, later only if major changes occur. Second, the necessary material is ordered online via the SLO's and DNA's contract shop. The products utilized on the DNA network are classified based on aerial or ground copper or fiber network. Behind the network types, the items are described with electric number, product name, and assortment label,

therefore requiring detailed knowledge of the purchased product. Usually, if the order is placed before 3pm, the goods will arrive the following morning. However, exceptions exist. The third phase is contingent on whether working on Finnish Road Administration area, municipality region or private land. When working at Road Administration area, a traffic arrangement plan is typically rendered by the DNA Designer while applying for the permissions. At times, the responsibility lies on team leader despite the Road administrator's definition that the contracting party has to introduce the traffic arrangement plan [17] [18]. This is a consequence of unclear instructions and lack of knowledge of one's duties. The Designer applies the permissions regardless of whose land is in question. The municipality of Lohja is also expecting essential traffic arrangements and a notification of at least one day in advance before starting the construction. Moreover, the Municipality Maintenance Administrator as well as the Road Administrator typically stipulates a commencement inspection where the operation methods and current structures are agreed on [19]. In case of private land, a site survey is performed together with the landowner to confirm and approve of the Designer's blueprints. Finally, a cable display to paint the underground cables on the land surface can be ordered immediately after the site survey by calling the Wire Information Center. Nonetheless, the subcontractor may also order it himself later during the process to get first hand information. On the contrary, an urgent proceeding presumes the display as soon as possible. The cable display waiting period vary from a couple days to weeks and sometimes Wire Info telephone lines are overloaded with incoming calls. Thus, each project is evaluated separately to proceed according to suitable measures. Figure 6 shows the phases of preparation.

3.3 Construction Process

The construction process is a key phase in the production system where the work concretizes. The process initiates after preparations are finished and terminates when the construction site is in its original shape. The successful completion of the project is highly dependent on the participators' professionalism and experience. The construction begins by ordering undershoots, jacking or directional drilling that has to be used when asphalt is not allowed to be broken. This requires an additional visit to the construction site for marking the undershoot spot and amount of pipes. Also, a

cable display is needed. The excavation work can be started immediately if it is maverick from undershoots, or undershoots are unnecessary. The subcontractor's preparations include cable display, traffic signs deployment, fetching of materials, and transporting the excavation equipment to the construction site. Traffic signs can be borrowed without a fee from the municipality of Lohja by calling the Maintenance Administrator and stating the constructions site name and approximate utilization time. The material is transported to the site from Empower's warehouse at Lohja during preparations and the excavation work. The excavation work and material placement are important to install according to the municipality's instructions and in consideration of the installer's work. Generally, the installer's work starts after the excavation work is finished and cables are pulled. Rarely is the construction site large enough for gradual and simultaneous completion of excavation and installer's work. After the termination and junction of the cables, the subcontractor can finalize the construction site by filling the excavation, replanting grass, and replacing possible tiles. Asphalt, however, is repaired by an asphalt company. Multiple paving of asphalt is conducted consecutively around the same region because the areas demanding asphalt are often small. Therefore, if asphalt is needed, it delays the termination inspection with the Municipality or Road Administrator. On the other hand, an invoice of the conducted work can be sent and an announcement can be made to the DNA Designer of the nearly completed site. The asphalt will only postpone the termination inspection because a separate asphalt invoice can be sent afterwards. The construction process is visualized in Figure 7.

3.4 Technically Completed Process

A constructions site can be considered technically completed when the cables are terminated and covered. As mentioned earlier, an announcement of the finished site is made to the DNA Designer and also to the inspector. Together with the inspector, either from the municipality or the road administration, the site is viewed to examine that everything is flawless. Figure 8 present the technically complete process.

3.5 Invoicing Process

Invoicing is a consuming process because of the inadequate information and rigid IT system, Liinos. Before the actual billing starts, information is gathered from the subcontractors and installers and sometimes a visit to the site is necessary to measure distances. When gathering information for invoicing at this point there is a possibility that the information is flawed or inaccurate and not everything is charged. Eventually after the information is collected and it is accurate, the invoice is made in Liinos and an email is sent to the billing clerk to forward it to the customer. See Figure 9.

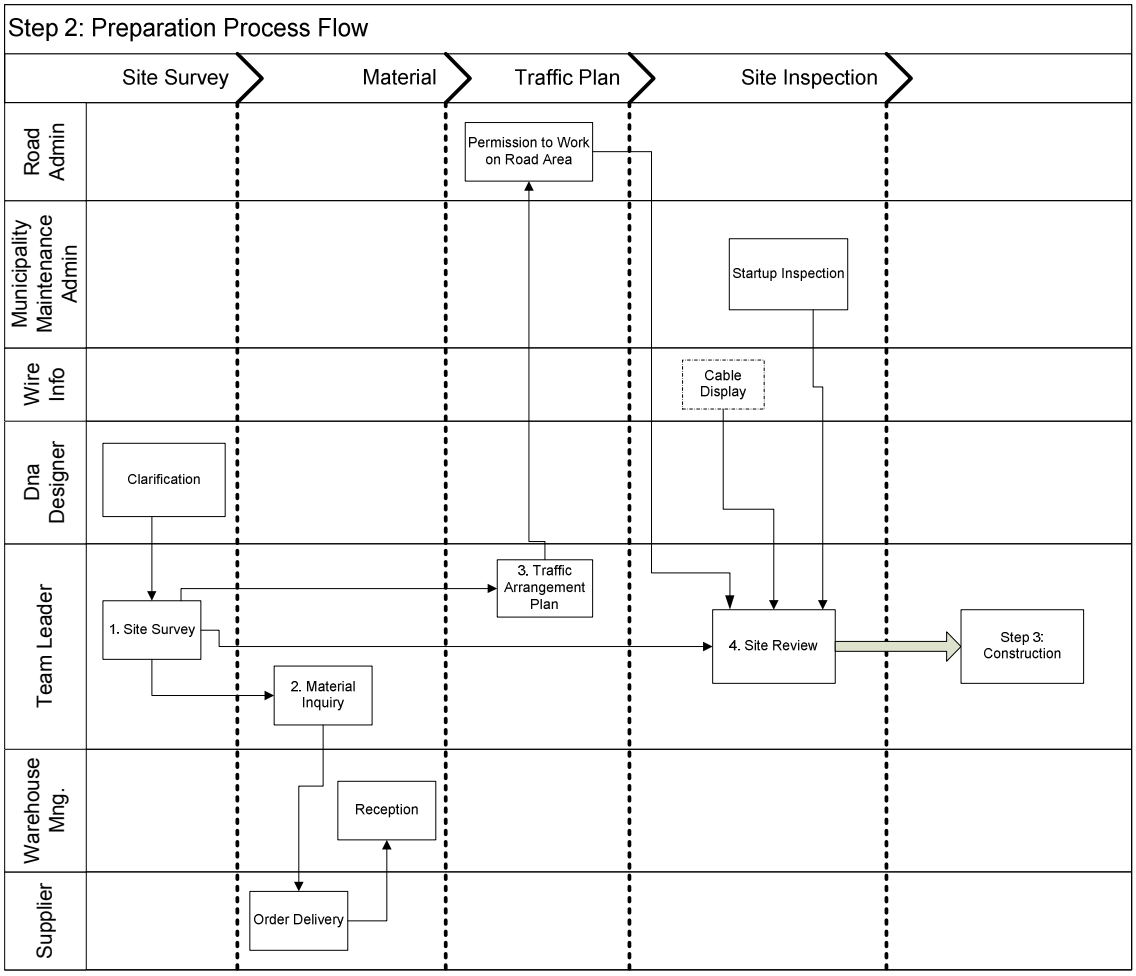

Figure 6. Preparation process.

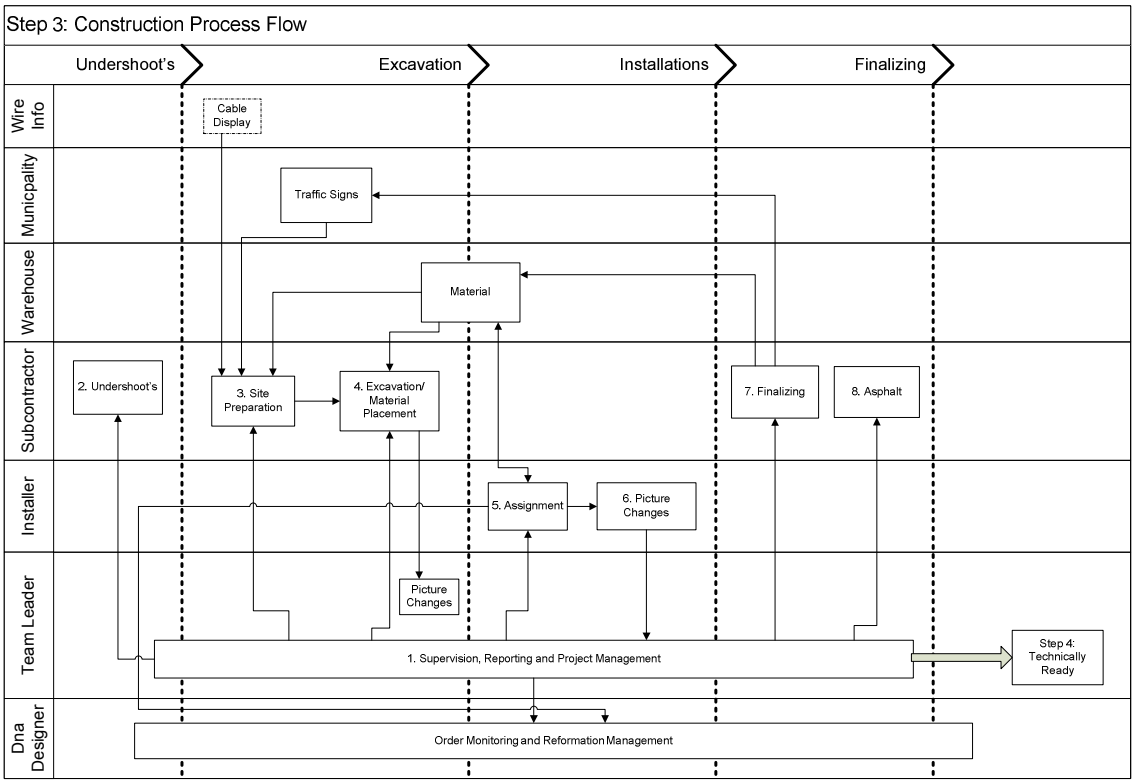

Figure 7. Construction process.

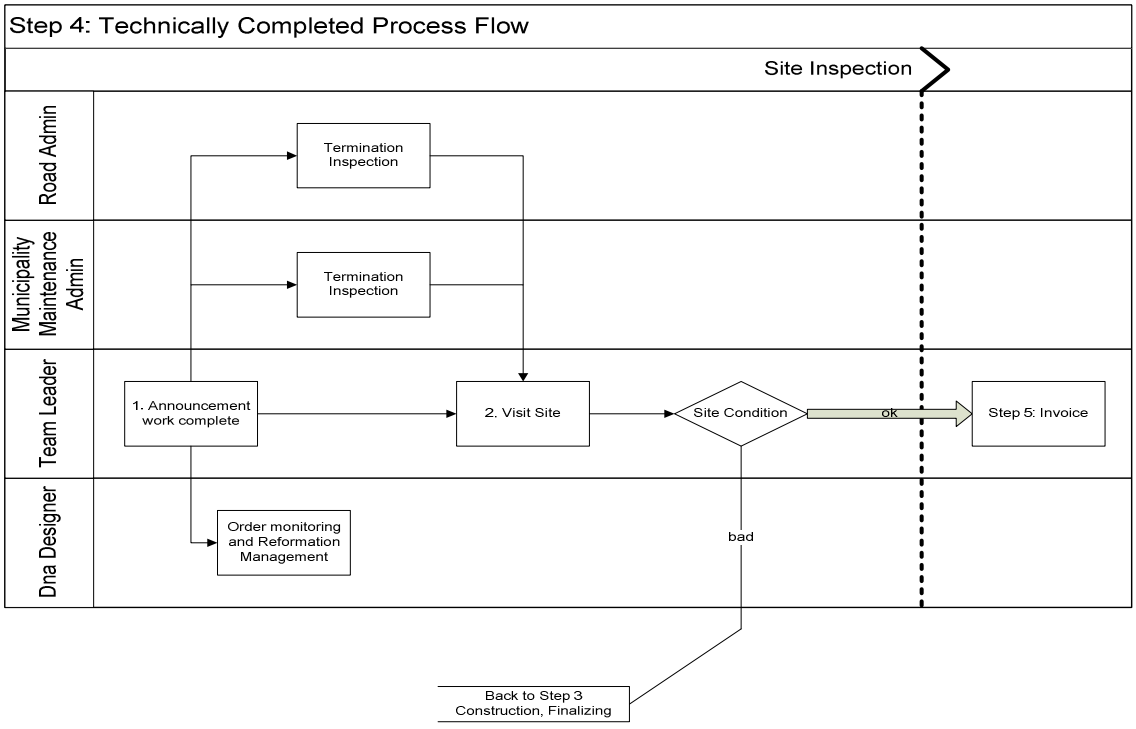

Figure 8. Technically completed process.

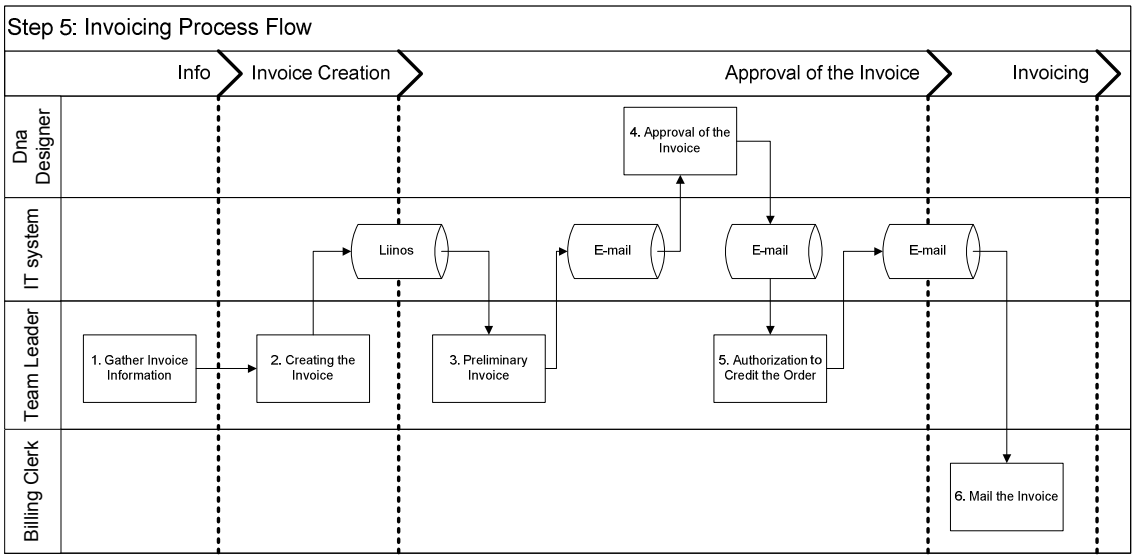

Figure 9. Invoicing process.

4 DEVELOPMENT CONCEPT

Empower has an enormous amount of potential to obtain a strong foothold in the business of network construction through influential leadership and brilliant labor. Seeing the network construction production as a process and applying management methods modified for Empower's environment helps to establish a flexible and efficient operation.

Adaptation of Lean Management should be company-wide but we will look at the TPS through the process of the Lohja unit. Excavation work which produces approximately half of the net revenue of the Lohja unit but with low sales margin demand standardization. In some instances the profit gained by installation is gobbled up by the excavation work. Certainly due to the nature of excavation work and the unknown factors underground, surprises are unavoidable, thereby, when balanced against for this reason, the salience of standardization comes forth more evidently. When the norm clarifies the sequence of operation, and what the expectations and objectives are, then

surprises can be taken into account, reversed and work can be continued as before. Standardization is the rule of how the team works today and acts as a basis for improvement and independent problem solving.

The Lean tool “5S” would be particularly practical in warehouse environment. At the moment, the Lohja warehouse is in disarray because it is not anyone’s responsibility and the materials and equipment are organized poorly. Empty cable coils are lying around, shelves are in disorder, and material deliveries are left outside the door. Even if the “5S” would be for everyone to conduct, a single person needs to be accountable for the inventory. Cable coils should be arranged according to their owner and usage. Hence, the SLO-DNA contract shop and Empower’s material has to be separated and a manager assigned to handle unloading of the material deliveries to their correct places. When everything is in order the material and equipment can be found easily and wasting time for searching ends.

Two principles of Lean Management are to grow leaders and to be a learning organization which is suitable for infrastructural network construction. People graduating from schools have knowledge either from civil engineering or telecommunication and the generation that possesses the skills is aging. Employment education is inevitable to guarantee the skills and professionalism of Empower where standards can be used for orientation. People with diverse abilities and ages maintain the knowledge capital and teach each other. A consequence of investing in people creates sustainable development and enduring foundation for the company values. Without the value base as the BPR business diamond describes the company is lost. Respect and trust that Lean Management proclaims are earned and are built in long-term. In large companies, such as Empower, changes are time-consuming but worthy of pursuing.

4.1 Empower's model of four spheres

The model of four spheres is developed based on Empower's IT system Liinos to support the economy of a construction process and timely reporting. The economic situation requires observation over a specified time period in order to obtain a realistic image of the current business finances. Therefore, Empower applies actualization monthly to achieve the most truthful results of a company's or a unit's condition. Figure 10 illustrates the factors of actualization. The partial income recognition involves two actualization methods, covered actualization and uncovered actualization. The covered actualization includes profit produced by hourly or budgeted projects. The uncovered actualization has no added profit because of piece-rated projects, thus only the expenses are matched. Both actualization actions are automatic in Liinos if entries are recorded, but they can also be performed manually. Actualization is the result of the produced value subtracted from the already invoiced work. Produced value appears on accrual basis or timework; yet in both cases, it is substantial to track the work done. Equally important as partial income recognition is the cost increase provisioning which allows the concentration of expenses on the exact month of purchase. All the involved expenses have to be known whether the invoices are received or not before the calculation of cost reserve. A tally of expenditures avoids surprises and verifies that everything is taken into account. Ultimately, the four spheres provide an up-to-date tool to analyze the financial state of a company.

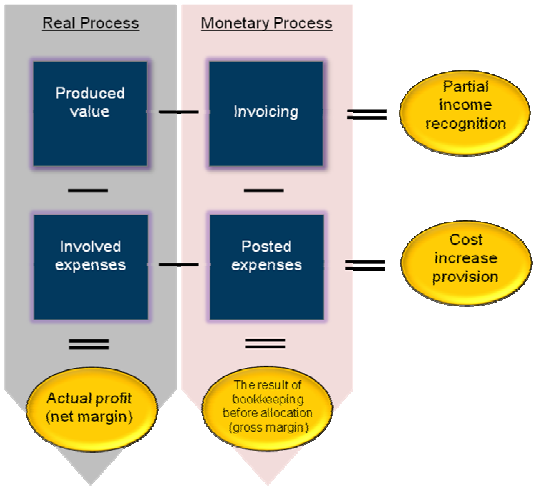

Figure 10. The basic factors of allocation. [20]

4.2 Laws, rules, and agreements affecting the process

Different laws, rules, and agreements shape a process and work flow. The law defines that before starting construction work various permissions have to be applied for from the designated officials. Neither cables, wiring closet, poles etc can be placed, nor can excavation work be performed without authorization. According to the law, municipalities and Road Administration have the right to give instructions for the contractor to follow. The instructions can include, for example, operations methods or allowed working hours. Further, to guarantee safety of workers and fluent flow of traffic, temporary traffic arrangements are often necessary. To familiarize people with the risks, the Finnish Road Administration expects everyone working on road area to participate a course of road safety. In addition, construction managers and designers follow a secondary course to effectively conduct their responsibilities.

The following laws and rules affect the network construction at Lohja.

- Road Traffic Act 3.4.1981/267
- Road Traffic Decree 5.3.1982/182
- Decision of Ministry of Transport and Communications on traffic control devices 16.3.1982/203
- Road Act 23.6.2005/503 Road Act
- Land use and Construction Act 5.2.1999/132
- Act of maintenance and public sanitation on streets and certain public areas 31.8.1978/669
- Decision of the Council of State on construction work safety 26.3.2009/205
- Occupational Safety and Health Act 23.8.2002/738
- Decree on Driving Licenses 7.9.1990/845
- Decree on the Use of Vehicles on the Road 4.12.1992/1257
- Vehicles Act 11.12.2002/1090
- Road Administration instructions
- Municipality's instructions
- DNA's and Empower's service agreement

4.3 Process Models

Lohja's three installers and excavation pair should be part of another team for better resource management and lower cost level. In a larger team resource planning and weekly tasks are easier to determine in advance for the coming week and mobilizing people to other units becomes more convenient in case of an inadequate work load. Jobs divided on Monday for the installers reduce the unnecessary sitting at the office since four days a week the work can be started at the construction site at 7.30 am which results in at least two hours a week of value added work. The success of work should be measured per project, for example, with a simple form filled with the work done and how much financial value it produced. The form if in electronic format would be easy to store and calculate the economic result. Similar information gathering should be arranged for subcontractors although the information could be handed in pre-filled forms. Furthermore, the sheet could record whether any additional accessories are rented or extra materials used to keep track of the expenses. Moreover, the invoicing process is facilitated and accuracy is guaranteed because the information is attained from its source. Tracking the expenses and value produced are two of the four spheres explained earlier to perceive the current state of the project.

The excavation work can be implemented in multiple ways, usually deploying Empower's equipment or renting accessories defrayed by Empower, and the excavator either hourly or piece-rated. When utilizing hourly machines, the character of the contractor should play an even more major role than when a piece-rated digger is hired because the personality affects work motivation and problem solving skills. In timework the emphasis is on the efficient completion of a job particularly if Empower invoices the customer on accrual basis. Contractors performing excavation on hourly rate do not have any risks themselves instead the onus is on Empower to yield a possibility for greater loss or profit. In contrast to the piece price which has a somewhat fixed profit margin, the hourly excavation is more demanding in every aspect. Piece price excavation work puts the risk on the subcontractor's shoulders and generally requires less supervision from the team leader and visits on the site. Regardless of which method of excavation is used, Empower needs collective rules for subcontracting.

Later three distinct network construction processes all possessing the same order, design, and invoicing phase will be introduced and compared. Figure 11 illustrates the order and design steps.

An old saying goes that well planned is half done. So it is crucial for the Lohja network construction process that DNA Designers would be Empower's own as part of the network construction team. Once an order of a new construction project is received from DNA including start up details the Designer goes to observe the site and looks for the best possible route for the cables. The Designer applies for permissions for wiring closets, wells, and the cables from the municipality or road administration and inspects locations with the necessary parties. Photographs from the inspected places are beneficial for excavation workers and installers later for better perception. After the authorization from various parties is acquired, the graphs and maps can be drawn into DNA IT systems, and the main materials and work units are listed. When the design package is ready, the proposal is submitted for DNA approval. After the design is accepted, a time period is defined for the construction project in cooperation with the customer, team leader, and designer. Then the designer applies for the excavation permission and plans the necessary traffic arrangements to save the team leader hopping at the construction site. At this stage, the designer also orders the main materials. The design phase allows the next stage internal customer to receive a complete design package. It is more the rule than the exception that pictures will be changed, even so a well designed and documented plan prepares each person attending the process to do their share efficiently. In each process model introduced, the designer plays a key role because of the first-hand knowledge thus close cooperation between the team leader and the designer is essential.

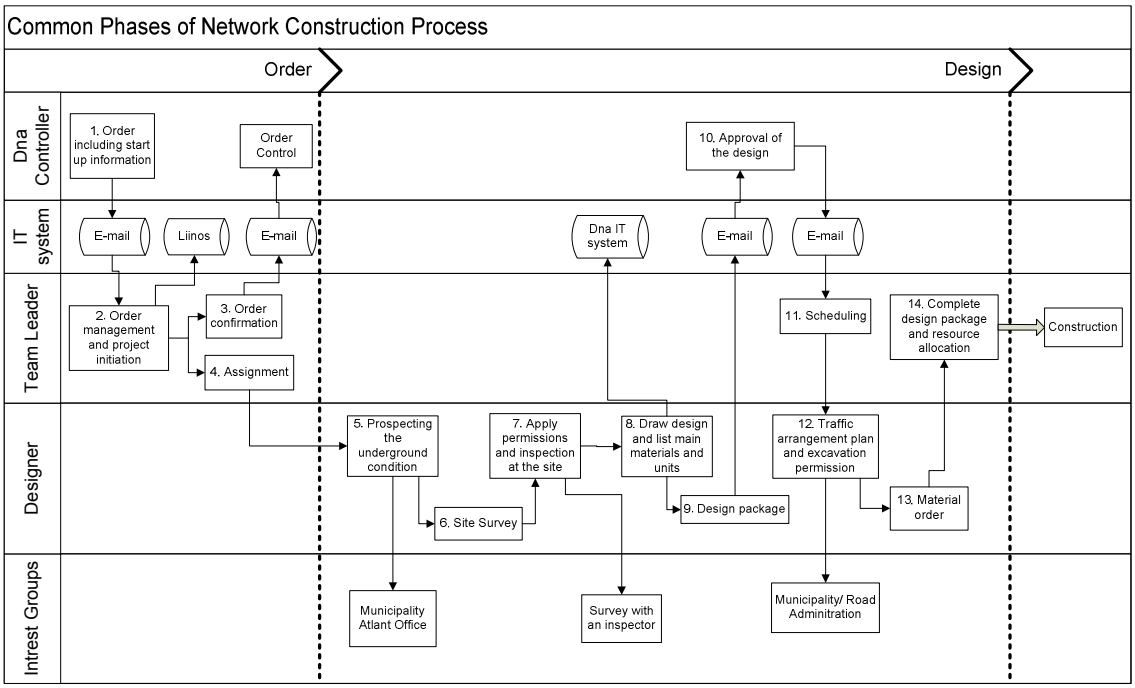

Figure 11. Common phases of the network construction processes.

Next, we will look at the three diverse construction models. In all of them unnecessary hopping at the site has been reduced to a minimum through efficient planning and designated duties.

4.3.1 Simple network construction process

In the simple network construction process, Figure 12, the team leader hands out the ready design package with all the permission covered to the subcontractor. The subcontractor handles the excavation work and the start and end inspections while the team leader and the designer ensures that DNA standards are followed. In case of a problem the subcontractor consults and confirms the reformations with the team leader or the designer because the end customer DNA often has to be informed. This type of excavation model demands plenty of resources from the subcontractor and, therefore, the costs for Empower can be higher. On the other hand, Empower employees do not have to hop at the site and the team leader's professional knowledge is unnecessary.

The lack of supervision and control on Empower's side requires a piece-rated subcontractor. Piece-rated work force will at maximum reach up to 15% sales margin but allots Empower to focus on cable heads and design, and maybe in the future for higher levels of the OSI model.

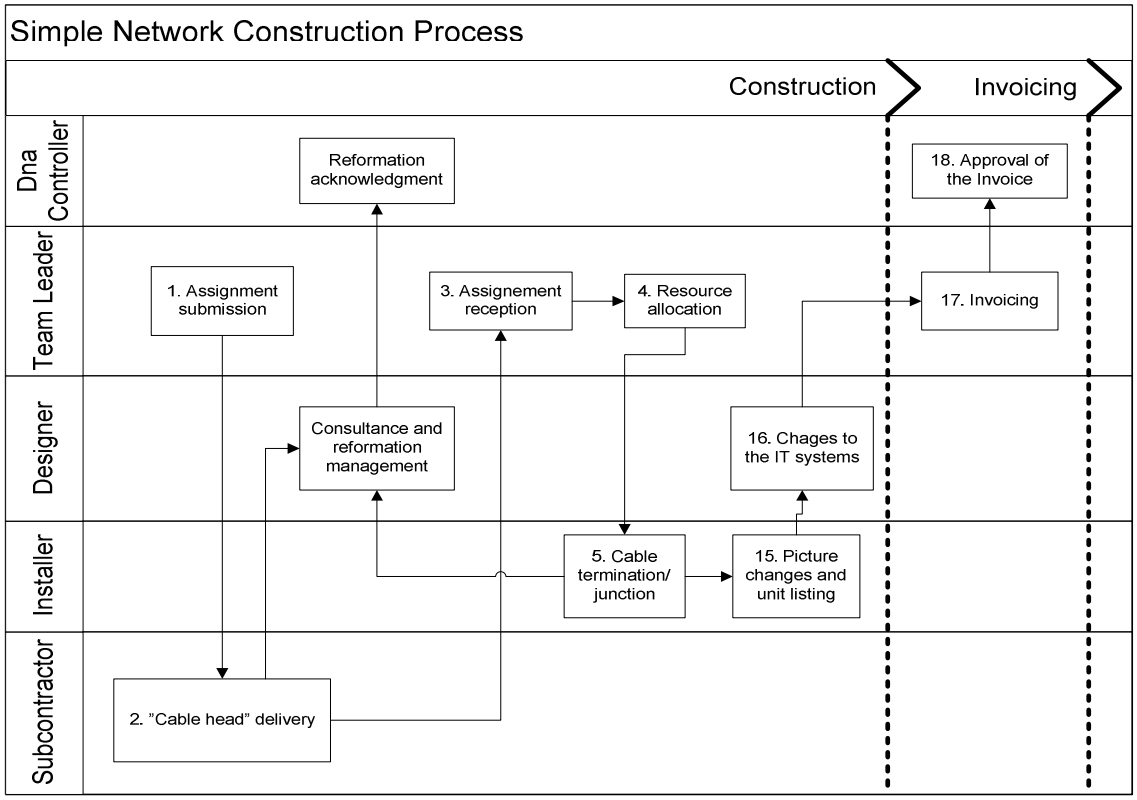

Figure 12. Simple network construction.

4.3.2 Team leader-based network construction process

The team leader-based network construction process is very similar to the current process with some enhancements. The design phase which is now part of Empower's production provides potentiality for better pictures and consultancy from the designer. Cable display is reserved by the subcontractor and more attention is on the listing of the performed work according to the model of four spheres. The network designer

provides support for the constructors and acts as a right hand for the team leader. The idea is that the team leader and the designer work in concise cooperation. Alternatively, if the Lohja DNA construction team is kept as small as in the past, this model can be used by combining the work of the team leader and the designer. It results in much less hopping at the site because of familiarization in the early stage of the project. One person handling design and team management has a positive effect on guiding for installers and excavation workers. However, the volume of workload one person can deal with is limited.

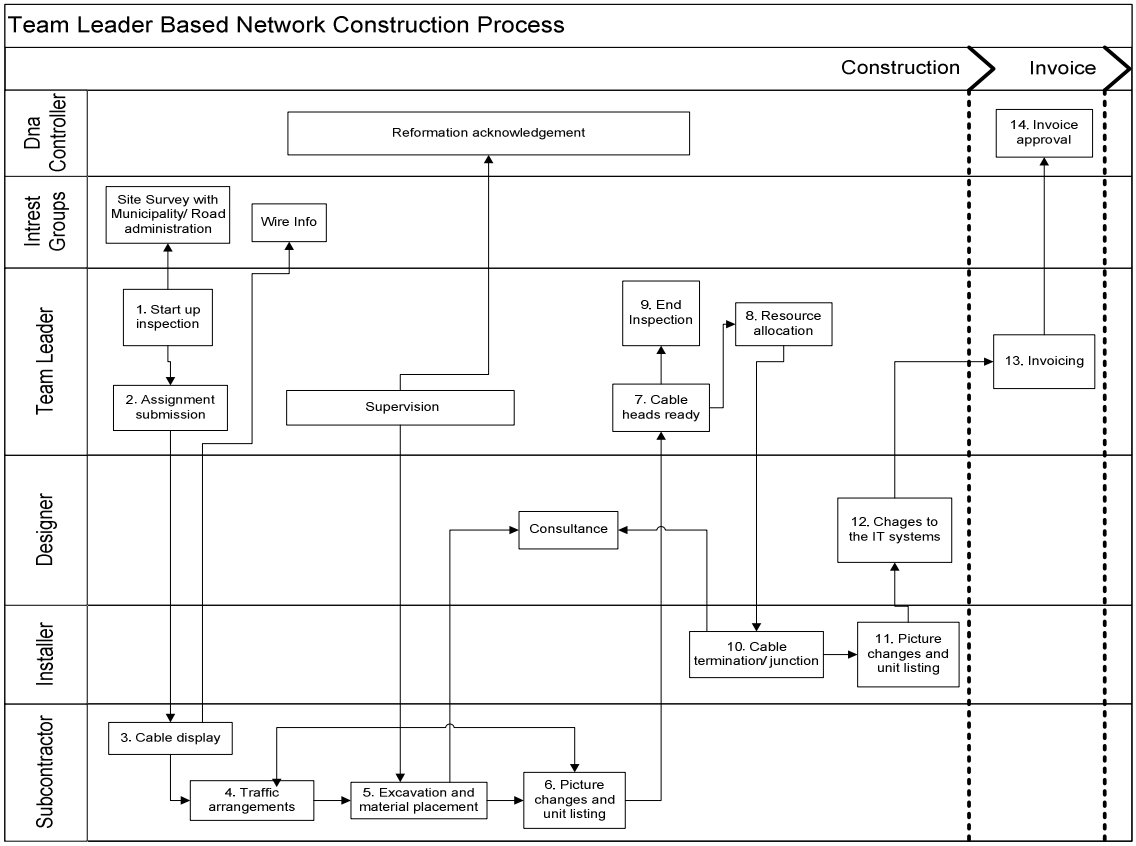

Figure 13. Team leader-based network construction.

4.3.3 Team-based network construction process

In the team-based network construction, the team leader is an administrative group manager working in a profound cooperation with the designer and the excavation director. The advantage of having a separate excavation director enables a person to supervise multiple construction sites simultaneously. The control stays in Empower's hands and hourly-rated excavators can be used to gain better sales margin. In addition, a separate director for excavation work saves extra time for the team leader for financial management and administration, hence integrating the work of an installation chief and team leader. Contrary to the previous two models, team-based construction is suitable exclusively for a large input of workload of various sizes. The team can have few excavation directors and designers to serve other customers along with DNA.

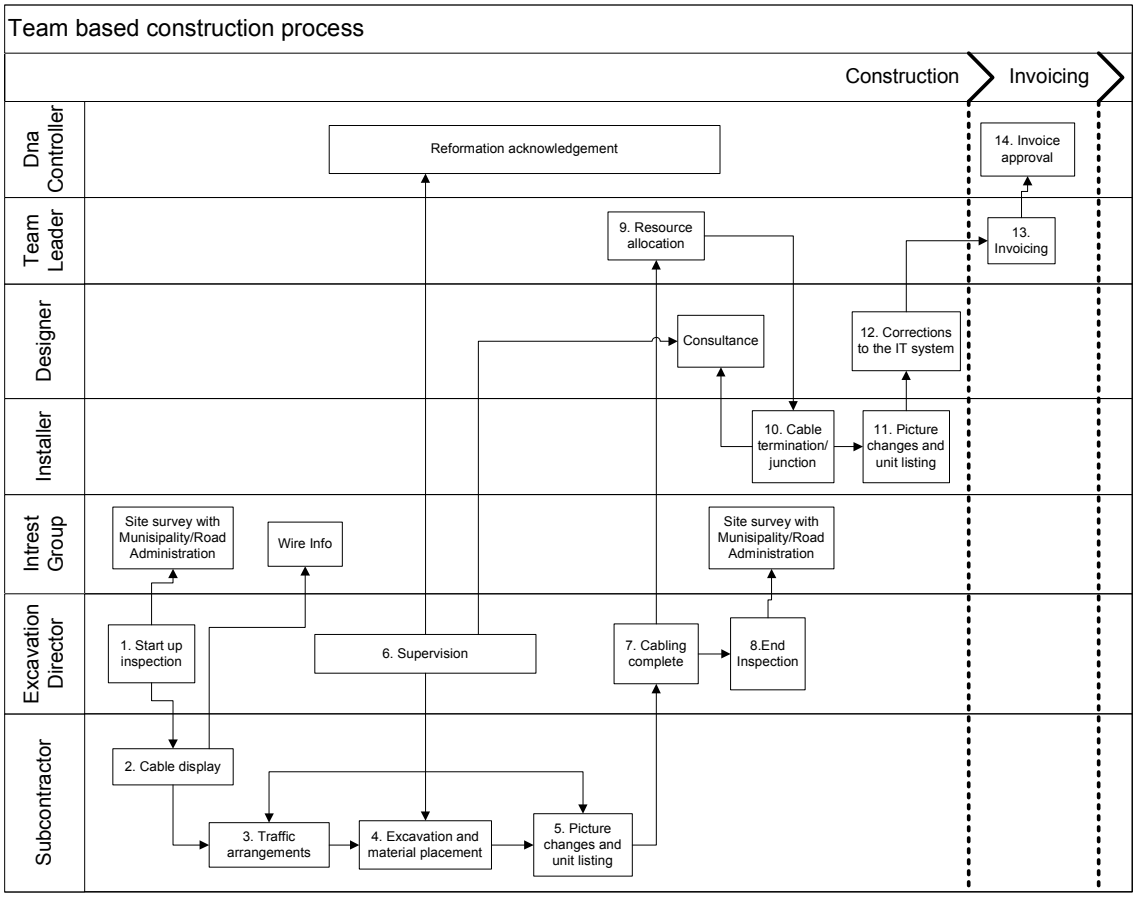

Figure 14. Team-based network construction.

5 CONCLUSION

Examining how to develop the Lohja DNA network construction process has granted multiple applications, each one of them suitable for diverse arrangements. The sales margin that Empower desires is achieved if excavators are mainly hourly-rated or if piece rates are renegotiated. On the other hand, tiny construction sites can result a great profit loss when the excavator operates on an hourly wage, but as long as the construction has more than one or two unit functions to perform simultaneously, timework can be profitable with correct supervision and guidance. Team-based network construction gives the best results when viewed from the value added perspective. The excavation director adds value by having the professional knowledge about the DNA standards and supervision of the correct working methods. The designer adds value by planning the network and applying for permissions on behalf of DNA, and in turn the installer by terminating the cables. When responsibility is shared in a team, the administrative work usually handled by two separate people is combined into one and the importance of serving the customer in different phases becomes the core. Smooth flow of work is created when everyone has designated duties and standardized work tasks. Standardization is the key for innovation and constant improvement in a work environment where trust and respect are the foundation. The applications and concepts of network construction can be applied at Lohja but also in other units of Empower although the implementation would require more pondering. The work could be continued by further research about how, for instance, drawing tablets or mobility could be used for enhancing the process and additionally standardizing DNA network construction.

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