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IMPROVING TRANSPARENCY IN CABLE PRODUCTION

– Helkama Bica Oy

TURKU AMK
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Bachelor’s Thesis | Abstract

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Improving transparency in cable production

The purpose of this thesis was to improve transparency in cable production in the production facility in Kaarina of Helkama Bica. The main areas of concern were evaluating the current state of production, mapping the process, and making the production more transparent and easier to monitor.

Improvement in transparency was achieved with three separate factors:

Intricate process charts of different activities taking place in the production, such as MTO and MTS processes and events in the ERP system related to them.

Tailored Business Intelligence tool made to monitor material consumption in real-time in different phases and machines of production. The tool is provided with instructions.

Implementation, effects, and requirements of material management software into Helkama Bica’s operations are considered. It would be added to their ERP system and improve in-house logistics.

In the theoretical part, Lean principles, warehousing, and process transparency are presented. Then observations of the production, material flow, and events in ERP are listed with found challenges and improvement suggestions.

Keywords:

Transparency, Lean, Business Intelligence, Cable Production

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Läpinäkyvyyden kehittäminen kaapelituotannossa

Tämän opinnäytetyön tarkoituksena oli kehittää läpinäkyvyyttä kaapelituotannossa Helkama Bican Kaarinassa sijaitsevassa tuotantolaitoksessa. Tärkeimpiä osa-alueita olivat tuotannon nykytilan arviointi, prosessien kartoittaminen sekä läpinäkyvyyden kehittäminen seurannan helpottamiseksi.

Läpinäkyvyyden kehitys saavutettiin kolmella erillisellä tekijällä:

Tuotannossa tapahtuvien eri toimintojen, kuten MTO- ja MTS-prosessien ja niihin liittyvien ERP-järjestelmän tapahtumien kuvaaminen tarkoilla prosessikaavioilla.

Räätälöity Business Intelligence -työkalu, jolla seurataan materiaalinkulutusta reaaliajassa tuotannon eri vaiheissa ja koneissa. Työkalun mukana toimitetaan ohjeet.

Materiaalinhallintatyökalun käyttöönottoa, vaikutuksia ja vaatimuksia Helkama Bican toiminnassa tarkastellaan. Se lisättäisiin yrityksen toiminnanohjausjärjestelmään ja parantaisi yrityksen sisäistä logistiikkaa.

Teoriaosuudessa käydään läpi Lean-periaatteita, varastointa ja prosessiläpinäkyvyyttä. Sen jälkeen esitellään havaintoja tuotannosta, materiaalivirroista ja tapahtumista ERP-järjestelmässä sekä löydetyt haasteet ja kehitysehdotukset.

Asiasanat:

Läpinäkyvyys, Lean, Business Intelligence, kaapelituotanto

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1 Introduction

1.1 Introduction to cable production

Cable production in essence is a unique manufacturing process. In contrast to many other industrial productions, there is no assembling involved in the process. In addition, the output is not measured by produced units but by produced length. Multiple distinct steps take place in the production, adding layers of catalyst, plastic, protective materials, and different sorts of conductors such as copper. The end product can vary a lot depending on the required properties of the cable. (Personal service of information through interview)

As mentioned, there is a wide range of different production configurations due to the different properties of cable. However, generic steps can be mapped to describe the steps in cable production:

1. Wire drawing

   The first step is to feed single wire copper wire into the drawing machine which pulls the cable to the wanted thickness. This is the basic component of the cable and is used for different purposes throughout production.

2. Stranding

   After drawing, single copper conductors are stranded together. Stranded conductors can consist of two or more single conductors and by doing so, flexibility and conductivity are improved due to greater surface area.

3. Mica-taping

   Mica tape is added when fire resistance is required. It is applied on top of a stranded conductor to keep the cable functional during an emergency.

4. Insulation

   Insulation is the first plastic layer of the cable. It is added either on top of Mica taped or bare conductor. It serves the purpose of keeping the electric current stable. This is done by melting plastic pellets and extruding on top of the conductor.

5. Pair twinning

   Pair twinning is an optional process of joining insulated conductor together to further improve the flexibility and conductivity of the cable. This is done to communication cables.

6. Cabling

   Cabling is the process of twisting insulated or twinned conductors together. The number of conductors used can vary a lot depending on the requirements.

7. Braiding

   Braiding is the process of adding protective layer of copper braided together to act as armor around the cable. This protects the cable from pressure, pests, and any other possible damage.

8. Sheating

   Sheating is the last step in the process, in which another plastic layer is added on top of the cable by extrusion for protection. After the sheating cable is inspected, marked accordingly and stored to be shipped to customers.

In addition to the above-mentioned steps, ground cable, different protective tapes, and fillings to obtain symmetrical and round construction can be applied to the cable. Also, ripping cord is added to enable easier cutting of the sheath while installing the cable. (Personal service of information through the interview)

1.2 Examples of cable configurations

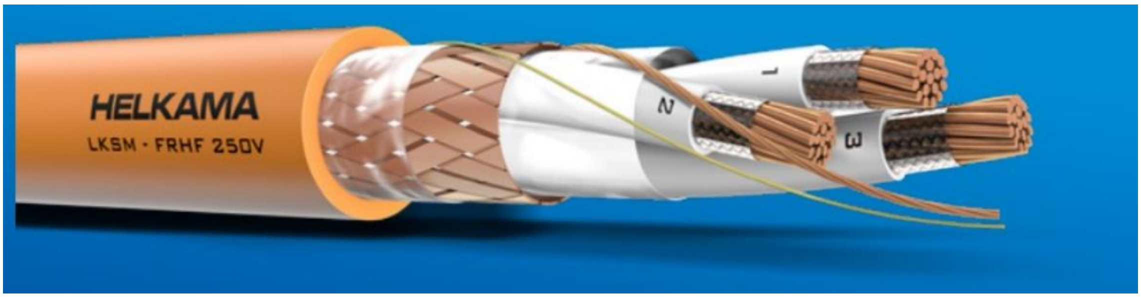

Figure 1: Configuration 1 (Helkama Bica product catalog)

In configuration 1 there are three insulated and Mica taped conductors, each containing multiple stranded wires together, with foil tape, braiding, and plastic tape before sheating. Yellow single wire represents ripping cord and single copper wire ground conductor. This cable is used as a control and instrumentation cable. (Helkama Bica product catalog)

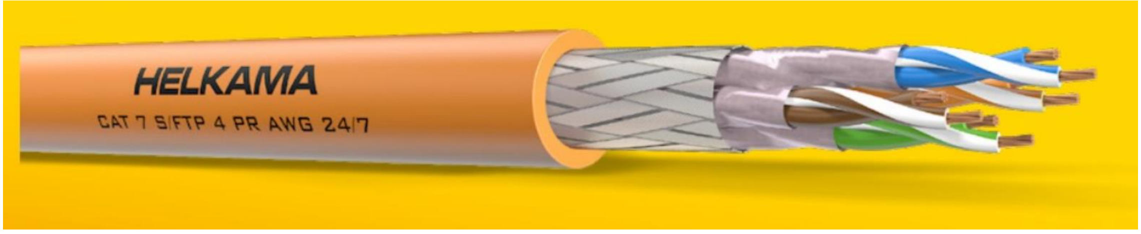

Figure 2: Configuration 2 (Helkama Bica product catalog)

In configuration 2 there are four twinned and aluminum foil protected conductors cabled together. Each pair contains multiple wires stranded together. The cabled product has tinned braiding and sheating. This cable is used as a data cable. (Helkama Bica product catalog)

1.3 Introduction to Helkama Bica Oy

Helkama Bica Oy is one of three subsidiaries of the Finnish family enterprise Helkama Emotor, which focuses on producing and developing electric, data, and hybrid cables for marine and telecom industries. The other two subsidiaries work in the water-cooling industry and bicycle manufacturing. (Helkama Bica Oy)

Helkama Bica has experience in the cable industry for over 55 years and has 1000 customers intercontinental in over 60 countries. They have two production plants in Finland located in Hanko and Kaarina and one in Shanghai, China. (Helkama Bica Oy)

Among the important customers of Helkama Bica are different shipyard companies. For example, Meyer Turku has been using Helkama Bica cables in numerous of their projects throughout the years. Another significant customer segment is telecom network builders and to this date, over 199 000 cell towers have been built using Helkama Bica cables. (Helkama Bica Oy)

1.4 Study of the production

The main objective of this thesis was to improve transparency of the cable production in the facility of Kaarina. To reach this goal, a study was conducted. The study consisted of interviews with the production planners, procurement managers, production operators, in-house logistics operators and warehouse managers. Each interview was conducted verbally and anonymously. Interviews didn’t include any personal questions e.g., name, age, or work history in the company. The presented results in this thesis can’t be traced to any individual.

Each interview was conducted individually among the personnel and each production machine in the process was covered. Interviews with production planners focused on the general view of the material flow in production and how production is managed through the use of the ERP-system. Interviews with procurement managers focused on how materials are ordered, and stock levels are managed. Interviews with machine operators focused on the practical actions on the machines related to materials. Interviews with in-house logistic operators focused on their work and functionality of the material and information flow in production. Interviews with the warehouse manager focused on how the warehouse is managed, what type of equipment is used and how they communicate with other departments.

The goal of the interviews was to gain a general view of the internal material flow in the factory. Essential was to find out where and how each workstation receives its materials, how the information flow is created, how many and what type of smaller unofficial buffer storages are used and what kind of problems or possibilities of development there might be. Other important subjects under review were to define MTS and MTO processes in the production and find out ways to improve the work of in-house logistics operators by implementing ERP addon for material managing.

With conducted interviews process mapping was made from MTS and MTO processes to show how material is moving inside the facility between different entities.

In addition to the interviews, the company’s ERP system was used to gather information from the production and materials.

Due to the business-sensitive nature of this survey, some of the information is not published.

2 Lean, warehousing and transparency

2.1 History of Lean

Originally a textile loom manufacturer Toyoda Automatic Loom Works, founded automotive division called Toyota Motor Company in 1937. First, they mainly produced vehicles for military use and during the war all auto production and development came to an end. After the war Toyota wanted to re-establish commercial manufacturing, but Japan’s economy was obliterated. In addition, in 1949, due to management issues, Toyota faced severe financial problems and had to lay off people. To that date Toyota had only produced 2685 cars. In comparison, Ford made 7000 a day. (Womack, Jones, Roos 2007, p.49)

To address problems engineer Eiji Toyoda travelled to Ford’s production plant to observe and learn about their methods. Ford was known for forming the world first mass production line. This method was developed to pour out as many as possible vehicles to meet the needs of the soaring auto industry with large batch sizes and slight variation. This did not quite fit to Toyotas capabilities as they lacked the capital and equipment to compete with sole production output. (Womack etc. 2007, p.50)

Eiji returned to Japan and together with other engineer Taiichi Ohno, they went through Eiji’s notes from the visit. They realized that a huge amount of time was used to change the dies that pressed the sheet metal into the wanted shape. Dedicated specialists were used to perform the change and it would stop production for a day. As Toyota only had limited equipment and couldn’t purchase a machine for every step, they had to change the die multiple times to complete production of one car. For this reason, they developed the technique to change it faster, and eventually were able to perform it in only three minutes. They also discovered that it was more cost efficient to produce smaller batches instead of big ones. It lowered the inventory carrying cost and by making only the required number of parts for assembling, mistakes in the pressing were noticed immediately and quality started being the number one concern. (Womack etc. 2007, p.52-53)

Other significant observations made by the engineers were that in Fords factory, the culture was extremely strict and inorganic. Assembly line workers performed only a few tasks, they were led by one foreman, and they didn't have any possibility or interest to suggest improvements. This was changed in Toyotas approach so that workers were performing more tasks, they were divided into smaller groups led by team leader, and they were encouraged to bring their ideas to the table. This made a huge impact as workers became more motivated, production didn't stop in case of absence and a more open atmosphere was established. (Womack etc. 2007, p. 55)

2.2 Muda

In the center of Lean thinking is waste, or in Japanese *muda*. In Lean, waste is defined as activity which does not add value. By eliminating waste from production, the process can output more with less inputs while keeping the quality required by the customer, which is the ultimate goal of Lean. Ohno defined seven types of waste as:

(Womack & Jones 2003, p. 15)

- Defects
- Overproduction
- Transportation
- Motion
- Inventory
- Waiting
- Overprocessing

Defects are items that can't be used in production or delivered to the customer, meaning that extra work is required to compensate for the mistake. *Overproduction* is making items that are not required, which absorbs resources in unnecessary action and prevents the process from reaching its full potential. *Transportation* is moving goods outside one facility, which creates waiting times, jeopardizes the goods being transported and adds no value. *Motion* is the movement of items inside the facility, which creates extra work and waiting. *Inventory* ties up value, adds costs and takes physical space inside the facility. *Waiting* creates underuse of resources and time spent without adding value. *Overprocessing* means steps in production that are not actually required by any internal or external customer. (Womack & Jones 2003, p. 15)

2.3 Toyota Production System and principles of lean

There are multiple different ways to describe and explain Lean and one of the most used one is Toyota Production System or House of Lean. It sets the foundation and defines the basic lean tools that are required in a company emphasizing lean thinking. It is a house diagram with a roof, pillars and a foundation symbolizing the importance of each piece. If one is weak, the whole house might fall down. In addition, each part reinforces each other. (K. Liker 2003, p. 48)

The roof represents the goal of lean thinking: to provide the best quality at low costs and in the shortest possible time for the customer. The two pillars holding the roof are Just-In-Time and *Jidoka.* The foundation of the house consists of *Heijunka*, Standardized work and *Kaizen.* In the centre of the house are the people. Different versions of the house diagram exist adding and removing certain elements, but this is the most used. (K. Liker 2003, p. 48)

JIT or Just-In-Time, second pillar of the house is a material management method to deliver goods in short time to right place and just when required. It enables lower inventories and better overall flow while increasing productivity and ability to respond fast. JIT thinking can be applied from single production machine to the whole supply chain, thus improving the entire inter-enterprise operation. JIT defines every step in the process as a customer which creates demand for the previous step upstream. (K. Liker 2003, p.39)

Kaizen is Japanese word for “good change” and in lean context it is a method of small continuous improvements. It emphasizes involving everybody from factory floor level to top executives in the process of making the company more Lean. (Monden 2011, p.197)

2.4 Layout

Layout means how physical objects that are relevant to the process are positioned inside the factory and how steps are divided between the objects. It sets the foundation for the whole process and is one of the most important decisions made when planning flows. If the layout is not giving the best output, it causes problems with slowed production, extra work, and eventually lower customer satisfaction. In addition, rearrangement of layout can be expensive, as it might cause production interruption. (Slack, Brandon-Jones, Johnston 2013, p191-193)

In a production environment, layout serves the purpose of creating flow through the factory from initial receiving of materials to loading the ready products on a transportation vehicle. A good layout creates logical and balanced flow, minimizes nonvalue adding actions e.g., unnecessary movement of material or people, provides a safe working environment and achieves sufficient use of space. It is also good to design the layout in a way that later modifications or expansion in the process can be made without major disruption. (Slack etc. 2013, p193)

When choosing the layout, there are many factors that need to be considered. The most important is the end product, as for example cruise ship and cable are very different from each other. A ship requires thousands of steps, needs to be assembled in a fixed location and is very low on output volume. Cable is the opposite in every aspect. Another important matter is that much product variation is in the process. In general, there are four different basic layout types which are used to compound each individual solution. **Fixed-position layout** is opposite of every other layout. Rather than the product flowing through different processing steps, the product itself stays in a fixed location and everything else is brought and moved around it. **Functional layout** groups together similar activities, such as machines, enabling numerous and complex routings. A good example of functional layout is hospital. Patients can have numerous different routings and processing through “production”. Functionalities, such as x-rays and surgery halls, are equipped and located so that they can perform a large variety of tasks inside the one functionality and move to the next one without extra movements. **Cell layout** combines functionalities required by the product into single cells. It is like a smaller version of fixed-position layout and usually part of larger system for products that require specific attention. **Product layout** is used in mass production where variation is minimal, every item uses similar routing, and the most important objective is to output as many products as possible without stoppage. (Slack etc. 2013, p194-195)

2.5 Warehousing

Traditionally warehouses have been seen simply as entities to store goods for future use. They have functioned as a buffer for downstream demand to ensure continuous flow of product. In the past, stock levels were higher due to lack of transparency and slow flow of information. Supply chains and the whole economy have worked with *push* method, in which product is delivered to the market with high volumes for customers to consume. (Richards 2021, p.5)

Modern supply chains aim to react continuously faster to changes in customer demand. Philosophy has been to move towards *pull* methodology in which downstream customers create demand. Companies also look for ways to minimize storage as it decreases the inventory carrying costs, labor costs, energy costs and enables faster delivery. (Richards 2021, p.6)

Every warehousing implementation is a unique solution. Although some standard procedures can be spotted in each of them. These actions include pre-advice, receiving, put-away, storage, picking, replenishment, value-adding processes, and dispatch. Some warehouses practice cross docking which is the process of moving received items straight to outbound storage without any other activities e.g., using item in production. (Richards 2021, p.60)

The warehousing process starts with *pre-advice* which means deciding internally and informing the supplier about quantities, packaging, labelling of the product and other important matters that might have an effect in streamlined warehousing of the items. The buyer has to also take into account suppliers' restrictions e.g., quantity that is in terms of transportation and economically reasonable to deliver at once and what type of packaging supplier has to offer. Pre-advice includes also deciding on a delivery schedule with supplier. In ideal situation items arrive ready-to-storage packaging and quantities. This prevents extra labor with sorting and labeling items to be storaged and overall reduces *waste* in the warehousing process. (Richards 2021, p61-63)

Next step is the *receiving* of the items. This can vary a lot depending on the item type, quantity, package and transportation method. Receiving includes guiding transportation vehicle to correct place, offloading, checking, and recording of the items. Offloading is usually done with forklift or other similar in-house logistics apparatus. Items are checked that they have arrived in the right quantity and condition and then recorded using, for example barcode scanner. In ideal situation the barcode automatically records the information about the received goods into ERP/WMS and directs it to the right place in the storage which is also called as process of *put away.* (Richards 2021, p64)

For put away to work seamlessly, many aspects of the warehouse need to be considered. Dimensions of the items and storage shelves, where item is needed later in production, how to maximize usage of storage space and how item is easiest to pick up from the shelf. This planning enables labor efficient warehouse operation as unnecessary movements are minimized and in-house logistic operators can instantly find items and even tell storage levels. (Richards 2021, p64)

Storage is the main procedure of warehouse processes. It includes internal movements, regular inventories and keeping the storage area in order. (Richards 2021, p64)

When items are required from the storage *picking* takes place. It is the activity of gathering requested items from storage and delivering them to the production machine or to delivery preparation station. It is labor intensive, is directly related to customer satisfaction (internal or external) and human effort is hard to replace with an automated solution. (Richards 2021, p64)

Value-adding services can be almost anything that is performed to the final product to increase value for the customer. Examples:

- Packaging of items
- Labelling items
- Customization of items
- Specialized services

The best practice of value-adding services is having it customized for each significant customer where they can affect the provided service. With two-ways communication, maximum value can be attained for the customer. (Richards 2021, p170)

2.6 WMS

According to Frazelle (2016, p5677) in the world of constantly more difficult competition and more requiring customers, companies need adapt and introduce technology in their processes. In terms of warehousing three topics stand out:

- Zero printed paper
- Real time inventory
- Tracking of productivity

Answer to these is WMS (Warehouse management system). It can be addon to a company's ERP-system or standalone software integrated to fit the purposes of warehousing. (Frazelle 2016, p577)

There are many benefits in implementing a WMS system to operations as it will significantly improve the in-house logistics. Having real-time, visual, and automated management of warehouse, less time is spent on non-value adding activities. These kinds of actions are, e.g. wrong or late picking, unnecessary movements of items inside the storage and unwanted waiting between work orders. (Roima. 2023)

2.7 Process transparency

Lean philosophy emphasizes constant and immediate changes for the better. To achieve this one of the most important aspects is overall transparency. As Womack describes "Perhaps the most important spur to perfection is transparency", the ability to oversee the entire process is crucial to get the most out of it. (Womack & Jones p.26)

Many of the Lean methodologies obtain close relation to increase transparency in process. E.g., *5S* (Sort, set-in-order, shine, standardize, sustain), *Kanban* (card-based production control system) and *andon* (visual status of the process monitoring). (Brady, Tzortzopoulos, Rooke, Formoso, Tezel 2017, p.2)

Important to the process transparency is to make it visual so that errors and actions can be easily detected. This concept cascades from overseeing the floor level to managing the whole supply chain. The same principles remain despite the scale of the operation. (Monden 2011, p.146)

3 Current state in production

As part of this thesis production was evaluated and different activities were mapped to gain understanding of what is happening. This chapter consists of specifying production activities with their material and information flow, item structure and events in ERP-system related to the production and specification of MTS and MTO processes. Also, semi-finished and finished products are defined. Information was gathered through interviews with operators and ERP-system research.

3.1 Production activities

3.1.1 Drawing

Drawing has one allocated machine in the facility of Kaarina. In this process only one type of copper wire is used to create all the different girths of wires and conductors required in production. Copper wire used in drawing is brought near the machine by in-house logistic operators and machine operators move it to the machine. After drawing, wires move to small braiding, big braiding or stranding which all have specific storage areas near drawing. The process of drawing is almost non-stop and works with MTS principle. Operators have the responsibility to monitor the inventory levels of drawed wire and always maintain sufficient amount for the rest of the production to use. Drawing works are done as semi-finished works in the ERP.

3.1.2 Stranding

Stranding has two machines. It uses different numbers and kinds of drawn or bought copper wires to twist together. Copper wires used in stranding are moved to the machines by operators either from storage or drawing machine. Stranding is also MTS process as stranded conductor is used in every product.

Operators must follow inventory levels and keep up the production to provide buffer. Stranding works are done as semi-finished works in the ERP.

3.1.3 Insulation

There are three different insulation machines in production. Each machine serves a different purpose in production as they are used for different types of work. One machine is allocated to MTS works constantly to keep the basic wires stocks on proficient level. The other two to MTO machines are allocated to smaller and greater amounts. Insulation is the first step in finished product production and last in semi-finished production. In finished production it uses semi-finished products made either in Kaarina or sent from Hanko and plastic fetched by in-house logistics operator.

3.1.4 Pair-twinning

There is one pair-twinning machine in Kaarina facility. Pair-twinning is located right next to the MTS insulation machine, and they use small coils between each other to execute production. In this process PEST-tape is also added to the product. There is a dedicated small materials shelf for pair-twinning which consists of different tapes. Operators are responsible for overseeing and replenishing the tapes.

3.1.5 Cabling

There are four different cabling machines in Kaarina facility. Two are dedicated to smaller, one larger and one for hybrid cables. There is a lot of variation in different cabling works as the number of used twinned pairs can vary substantially. Especially small braiding is causing a bottleneck for some cabling works, as it is slow step. Operators reported that there is unnecessary moving of coils as storage area is rather small and they spent time searching for right coils. Problems with empty coils also occur as they are used between cabling, insulation, and pair twinning and sometimes operators must search for them. Braiding

There are two different braiding machines in Kaarina facility. Small and big braiding. Braiding receives its wire from drawing or from storage if it is bought, and it is processed on site to be used in production.

3.1.6 Sheating

There are three different sheating machines used in production. Sheating machines execute all similar work and are the greatest consumer of plastic and colorants in production. Sheating has many different inputs as all the end-products are sheated and the previous step can be whichever excluding drawing, stranding, and pair-twinning. Operators ask for in-house logistics operators to fetch their required materials and finished products. In-house logistics operators have the responsibility to supervise colorant and plastic consumption and keep stocks replenished.

3.2 ERP

3.2.1 Item structure

Items are divided into categories depending on their qualities and purpose. **Coils and package materials** consist of empty coils to store the cable during production or used as final carrier for the finished product, and different package materials used to protect finished products during transportation. **Coppers** are the different pure copper items used in production, which can be raw copper wire used in drawing, processed e.g., stranded conductor or bought copper material. **Semi-finished** products are materials made inside the factory to be used in the production to create end products. Properties of semi-finished products can vary a lot from insulated conductor to taped conductor and are made both with MTS and MTO principle. **Brokerage products** are bought from the supplier and delivered to the customer without any processing. **Materials** are unprocessed items that are bought to be used in production. E.g., plastics, MICA-tapes and colorants. **End products** are the final output of the production and sold to customers.

Item categories in the ERP-system vary depending on whether it is bought or manufactured. Copper changes to semi-finished product after drawing or stranding but remains in copper subcategory. All bought copper is considered as copper even if it shares same qualities with self-manufactured semi-finished copper item.

Semi-finished products, brokerage products and end products are also classified with ABC-rating. Brokerage and end products rated with A are creating 80% of the total value, B rated 15% and C 5%. With semi-finished products rating is based on usage in production.

3.2.2 Material flow and events in ERP

The production process starts by opening planned works. Each work is either semi-finished work or end product work. These are distinguished from each other by a code in front of the actual work ID. Each work contains the item ID of the item being manufactured, corresponding routing and BOM for each step in the process. When work is opened, the ERP-system automatically checks out the material and semi-finished product inventory levels and if required, creates replenishment or production proposal. Proposal is after this turned into an order and scheduled accordingly.

Each workstation has its own ERP terminal with access to the software. Operators have the responsibility of making sure that the right materials arrive at the station at the right time. This is done either by the operator fetching the materials by themself or sending a request for the in-house logistics operator via email or verbally asking to bring required materials. Operators must also plan their material needs in advance to prevent production stoppages. This requires an intricate understanding of the process.

Materials are used from stock levels of the ERP incrementally as production moves forward. At the start of each step, materials listed to it get flushed instantly. This does not correspond to the reality, as material picking is not recorded for materials nor most semi-finished products. Only semi-finished product fiber-optic cables and wide copper conductors with width over 16mm have their own tracking number in the ERP-system and their picking is always accurate.

3.3 Storage of items

In ERP-system materials and semi-finished products have only one allocated location called M2. In reality, they are spread across the factory in multiple locations.

Southern inside storage and outside storage contains most of the materials and semi-finished products. It has specific storage places written for each product, semi-finished product, or material. There also is a specific shelf reserved for cables inbound and outbound with other factories. For colorants and plastics, there is FIFO storage.

Recently a Kanban storage solution has been introduced to improve managing of the tape materials e.g., PEST-tapes and polypropene tapes. Each storage place has two pallets of certain items, which consumption is tracked on a whiteboard with corresponding color code. Green card is placed on the whiteboard when there are two pallets of items. When one runs out, the card is switched to yellow and replenishment order made. If both pallets run out, a red card is placed. According to the interviews with operators, this new Kanban self-service storage has made a positive impact on their work.

3.4 Semi-finished products

Semi-finished products are made to be later used as material in a end-product. They are made both with MTS and MTO principle depending on the ABC-rating. Semi-finished products can take many different routings depending on the required properties of the item. Semi-finished products with an A rating are manufactured using MTS principle. Every A-rated semi-finished product has a minimum stock level, and the ERP-system automatically creates a production suggestion when inventory goes below it.

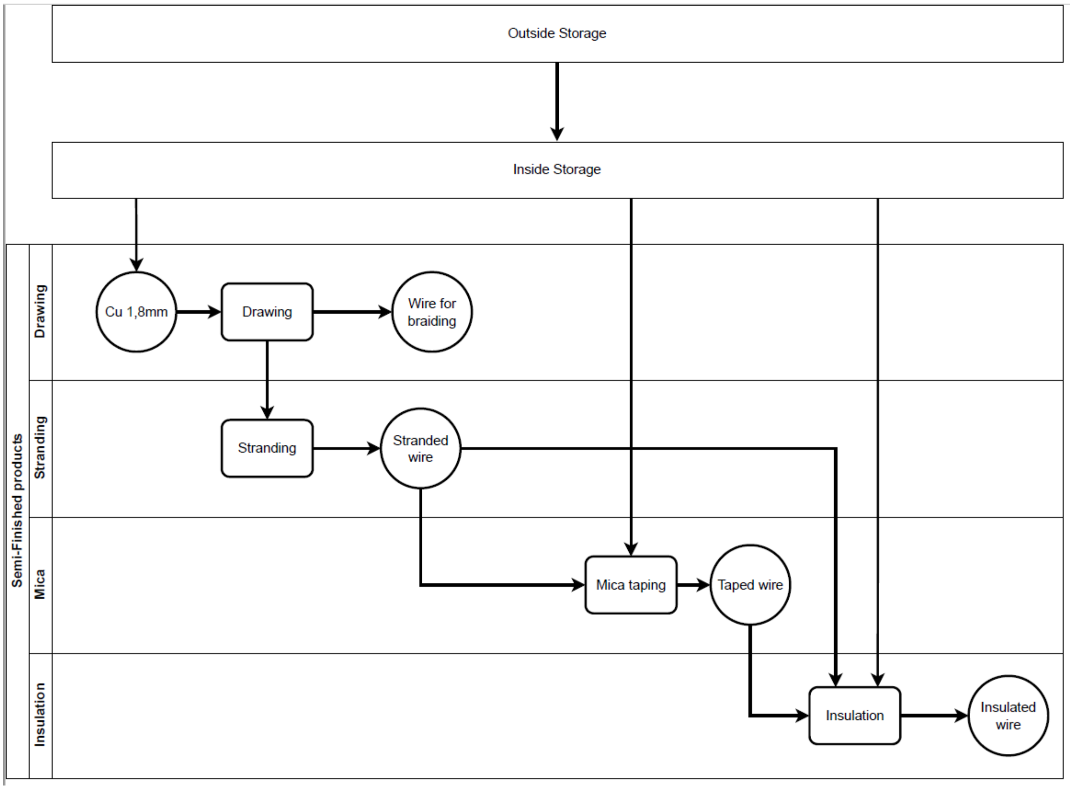

Figure 3 Semi-finished production material chart

Figure 3 describes the material flow in semi-finished production by dividing it into separate steps. The chart shows every possible source and target in semi-finished production. Notable is, that insulated wire is not the ultimate output of the process, as semi-finished products have only one step in ERP.

3.5 Finished products

Finished products are the final output of the manufacturing process and after final inspection shipped to customers. They are made only with MTO principle meaning that safety stock does not exist for any finished product regardless of the ABC-rating. Finished products have two main segments which are marine and telecom cables. Marine cables are voltage cables that are refined to meet requirements of harsh conditions of constant exposure to water. Telecom cables are either voltage, data or hybrid which focus on maximizing conductivity to set foundation for superior data transfer.

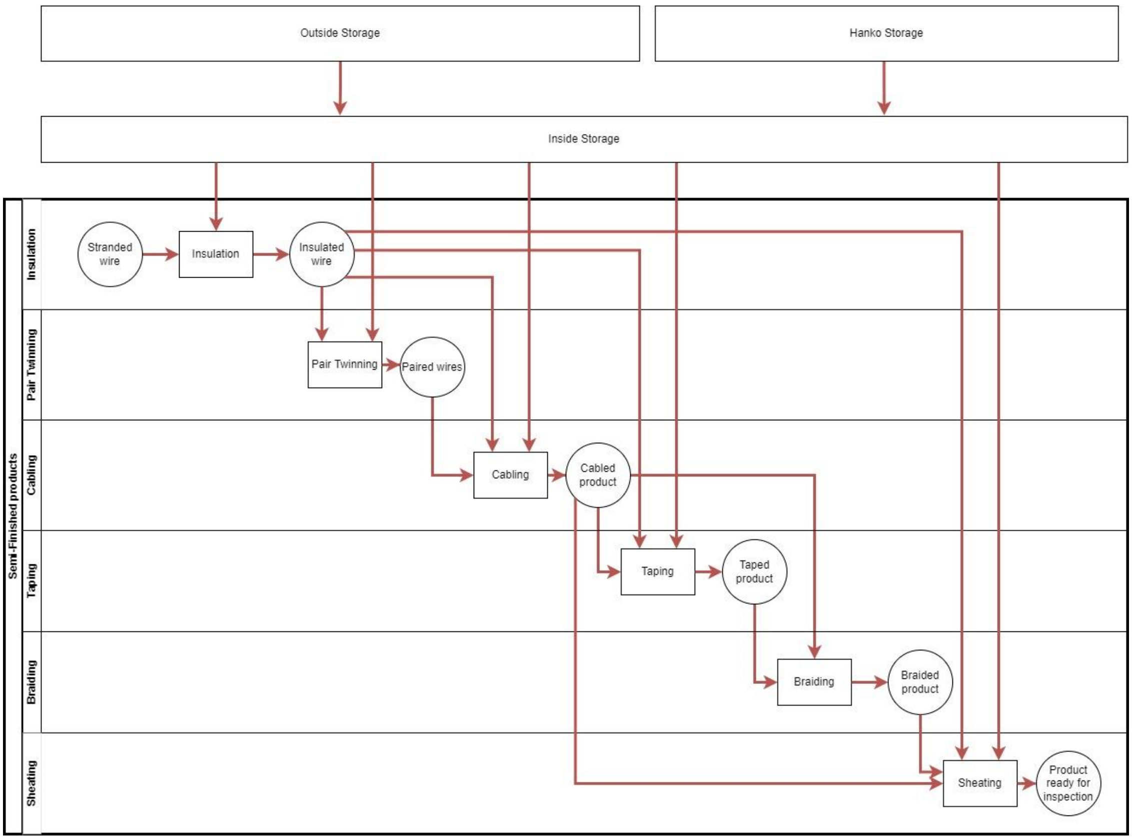

Figure 4 Finished production material chart.

4 Challenges and improvement suggestions

Based on the interviews, observations from the production site and study of the ERP-system, challenges can be identified, and possible improvements suggested.

Operators have enormous responsibility for the whole process. They must ensure that the right materials and semi-finished products are in the right place and at the right time. They need to run the machines in a way that uses materials accordingly and maintain high quality in the production and they must communicate with each other to keep up the sufficient flow of materials and finished product.

Work planning and material allocations are done by work planners, but single machine operators have the responsibility to fetch or order materials to the machine. This also means that the operator has the responsibility to plan the ordering so that the required materials are delivered by logistic operator on time.

ERP system provides the information of required materials for each step and item, but the quantities and specific items does not always correspond to reality Three most occurred cases:

1. Actual plastic required for sheating, or insulation can differ from the amount indicated in ERP. This is due to the plastic or colour change and operators having different methods of running the machines. Differences in methods of operating the machine are small, but in cable production it adds up. Waste occurring with the change is noted in ERP, but it can vary.
2. Different tapes e.g., MICA-tape, and foil tape have multiple sizes allocated to specific products. However, tapes can be used interchangeably with each other if the required size is out of stock. This creates bias in the inventory and must be manually fixed.

Almost every production machine uses materials stored on a coil and require empty one(s) to store the finished or semi-finished product. One recurring challenge from interviews with operators especially was the problem with small empty coils. Due to the variating nature in usage of materials and production lengths sometimes situations occur that there are not enough empty coils to start production. This leads to unnecessary waiting, which lowers the overall productivity. Also, no specific system is established to manage the empty small coils and at times operators must go look for them around the factory or ask from other machines.

Generally, there is a recurring problem with storage space for unfinished cables. As cable moves from machine to another, it must be temporarily stored on the factory floor. Some dedicated areas exist, but according to interviews with operators, these areas are not accurate. The reason for this is that for example, braiding produces big coils, which require a lot of space and dedicated spots simply can’t hold sufficient number of coils to maintain standardized storage places.

4.1 In-house logistics

As mentioned, in-house logistic operators are handling material movements inside the facility using emails and verbal communication. No clear standardized e.g., work queue is implemented in their work and execution of material orders is done based on what is interpreted as priority by each logistic operator. Usually, orders are filled based on email in chronological order, but when an exception takes place, it is up to the machine operator and logistic operator to come up with priority. Work management and planning does not get informed about the material orders nor changes in prioritization of orders.

One major responsibility of in-house logistics is to make sure that insulation and sheating has sufficient amount of plastic and colorants. This causes time to time issues as wrong materials are delivered and materials run out.

Work planning and material allocations are done by work planners but single machine operators have the responsibility to fetch or order materials to the machine. This also means that the operator has the responsibility to plan the ordering so that the required materials are delivered by logistic operator on time.

4.2 BI tool

As part of the thesis, BI tool is provided for Helkama Bica to improve transparency of the production.

4.2.1 Business Intelligence

Business intelligence (BI) is a set of processes, tools and technologies used to collect, integrate, analyze, and present data in a way that helps companies make more informed decisions. It includes using different sources, both internal and external, to generate insight into, for example, business operations, customers, production, and supply chain. (Techtarget 2023)

The amount of data generated by companies is growing exponentially every year as new data driven technologies are implemented into operations. The main goal of business intelligence is to transform this raw data into actionable information that can be used in an effective way. This involves using tools such as data warehousing, data mining, dashboards, and reports to analyze data and present it in a way that is easy to understand and use. (Techtarget 2023)

Well established business intelligence is a comprehensive and integrated approach to data analysis that provides valuable insights into a company’s operations. It should meet the following criteria:

1. Relevant: Good business intelligence should focus on the most relevant data for the company’s objectives and goals. This means that data should be linked to the business questions that need to be answered.

2. Accurate: Business intelligence should be accurate and reliable. Data should be collected with reliable methods. In addition, data and the collection process should be reviewed regularly.

3. Timely: The provided insights should be provided in a timely manner so that they can be used to make informed decisions. This means that the data collection process should be set up in a way that allows quick access and reporting.

4. Actionable: Good business intelligence should provide actionable information. This means that the insights should be presented in a way that allows decision-makers to take action based on the findings.

5. User friendly: Dashboards, graphs and reports should be easy to read and understand. This also means that insights should be easily accessible. (Techtraget 2023)

4.2.2 Tableau

Tableau is a data visualization and business intelligence software that allows users to analyze and visualize data in an intuitive and interactive way. It can connect to a wide range of different data sources, including spreadsheets, databases and cloud services. (Tableau 2023)

One of the main advantages of Tableau is its ease of use. It does not require advanced programming or a deep understanding of data analytics to begin with. There is also a large community of users sharing their best practices and providing support to others. (Tableau 2023)

4.2.3 BI-Tool for Helkama

BI-Tool made for Helkama views material consumption in different steps and machines of the production.

4.3 Other

4.3.1 Empty coils

There are two types of coils used to store cable through production. Small steel coils (referred to as small coils) which are used to store semi-finished products during production. Machines use small coils to feed semi-finished product and to output refined cable. Input of small coils can vary a lot depending on the machine and type of work. Especially cabling can take up to 20 small coils as input.

Another type of coils used in production are wooden coils which have a variety of sizes. Wooden coils are used to store larger semi-finished products during production, for example cables that are worked in big braiding and heavy cabling. Every finished end product is also stored on a wooden coil to be shipped to the end customer.

4.3.2 Empty coils in ERP

If inspection detects quality deviation in finished product, cable is fixed and spooled again to a different wooden reel. This process is recorded into the ERP system using a specific module which relocates the processes coils into different storage location from M2 to VP2. ERP uses the defective finished product as a material which includes both the cable and wooden reel and requires another wooden reel to spool the cable on. This leaves one empty wooden reel in the balance of VP2 and it is not automatically moved back to the balance of M2, and manual inventory is required. This is not usually done immediately and leads to incorrect storage levels in ERP.

4.3.3 Half used materials

As almost in every step of the production cable of some sort is processed through a machine from one coil to another, it is expected that materials stored on coils are not used entirely every time. Coils with materials under 10 meters are automatically discarded from stock and scrapped, but there is no standardized method of handling this process. Near empty coils with unused material lie around the facility and take up space from and cause non-value adding activities e.g., moving and checking of the coils.

To solve this problem, these coils should be clearly marked, and an area dedicated to store them. This type of action serves the purpose of making the production Leaner as operators can focus on value-adding processes with less interruptions. Having standardized methods is the foundation of Lean working and processes will be easier to manage.

5 Conclusions

In essence, cable production is a complex process which requires good planning and flexibility to adjust quickly. There are many factors that need to be considered to keep production flowing. In addition, recent events in the world have caused problems which are hard to control e.g., long delivery times, component shortage and difficulties with global transportation.

In this thesis objective was to improve transparency of the cable production. The objective was reached through three key elements. Firstly, mapping of the processes, finding how material flows through the production and defining MTO and MTS activities. Secondly contemplating implementation of warehouse management software into in-house logistics operators work to enable standardized work queues. Thirdly provide Business Intelligence tool to help overseeing the material consumption and improving decision-making.

No prior mapping of the processes existed, and it was required so that all the necessary stakeholders would gain a better understanding of the production. Also important was to analyze different steps of the production and define how materials move between them and find out possible opportunities for improvement. Implementation of warehouse management software has been in consideration as it would improve in-house logistics and they are already using it in the company's warehouse. It would be great value and should be rather easy to implement. Helkama Bica has recently implemented Business Intelligence to improve transparency and the tool provided with this thesis will serve that purpose. Tool is easy to use and maintain.

Overall due to the nature of the production being so complex and considering the physical limitations of the facility it is hard to implement new entities and changes to the production. And the objective of this thesis was to focus on giving insight into the processes and pointing out possible improvements rather than ready solutions. Changes would require the replacement of machines or expansion of the facility which both are expensive and time consuming.

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