YRKESHÖGSKOLAN
NOVIA

Development of Production Line

Quality Check Scale

Robin Paro

Bachelors´s Thesis

Degree Programme for Electrical Engineering and Automation

Vasa 2022

DEGREE THESIS

Author: Robin Paro
Degree Programme and place of study: Electrical Engineering Vasa
Specialisation: Automation Technology
Supervisor(s): Lars Backlund

Title: Development of Production Line

Date: 4.10.2022 Number of pages: 20 Appendices: 1

Abstract

This thesis is commissioned by Edupower Oy for their client. The assignment in this degree project is to improve an already existing industrial line with a quality control at the end of the industrial line to check the quality of the products as well as thickness and shape. To accomplish this, a scale is planned to weigh the products as well as a sorting mechanism to sort out defective products. This means that the customer gets a more profitable production with higher quality.

This thesis contains how everything started, with finding information and how a day could be like in the factory.

The thesis contains how I began the work of finding out information, how a day could be in the factory and how I have figured out to cope with all the criteria´s that the company needs to introduce a scale to their production. The result shows what type of scale can be used and how it should work to get the most efficient production possible. The work also shows different solutions for how to make the sorting work.

Language: English
Key Words: Scale, Woodcast, Lean

EXAMENSARBETE

Författare: Robin Paro
Utbildning och ort: El- och automationsingenjör Vasa
Inriktning: Automationsteknik
Handledare: Lars Backlund

Titel: Development of Production Line

Datum 4.10.2022 Sidantal 20 Bilagor

Abstrakt

Detta examensarbete är på uppdrag av Edupower Oy till deras kund. Uppdraget i detta examensarbete är att förbättra en redan existerande industrilinje med en kvalitetskontroll i slutet av industrilinjen för att kontrollera produkternas kvalitet samt tjocklek och form. För att utföra detta planeras det in en våg för att väga produkterna samt en sorteringsmekanism för att sortera bort dåliga produkter. Detta innebär att kunden får en mer lönsam produktion med högre kvalitet.

Examensarbetet innehåller hur jag började arbetet med att ta reda på information samt hur det kunde se ut då jag var på plats för att se hur linjen fungerade och hur jag har kommit fram till vilka alla kriterier som behövs för att kunna införa en våg som klarar av alla kriterier som kunden behöver. I resultatet framkommer vilken typ av våg som kan användas och hur denna ska fungera för att få en så effektiv produktion som möjligt. I arbetet framkommer också olika lösningar för hur man kan få en sortering att fungera.

Detta projekt är endast teoretisk planering för kunden så att de kan avgöra om det är ekonomiskt lönsamt att införskaffa denna modul.

Språk: Svenska
Nyckelord: Våg, Woodcast, Lean

Table of Contents

1 Introduction

This thesis is an assignment from Edupower Oy. Many workplaces and industrial settings today have workers working on things that can be automated using various machines and robots. This means less labor, more efficient production, and more profitability for the workplace in the long term. Factors that must be considered are whether it is profitable to invest in more automated labor, how much more efficiently the work will be done, and a timetable for when this has paid off.

The purpose of the work is to develop an industrial chain for one of edupower's customers. The industrial chain manufactures a finished product, but it has no quality control, so this means that the finished product cannot 100% guarantee that it is completely error-free. My task in this work is therefore to introduce a quality control at the end of the industrial chain.

My plan is to add a scale that makes sure the product being made is the exact weight the product is allowed to have. A camera will also be planned to check all the dimensions of the product and any different shapes. My task in this work will mainly be to focus on the scale and to figure out a plan so that it also works for future products that can be put into use. This work is only theoretical planning with the ability to perform if the customer is willing to do so.

My goal with this project is to automate the control of the quality of the products, which then means less labor and a faster manufacturing process. This will also mean less waste production and that the company in question will not send the wrong goods to its customers.

2 Edupower

EduPower Oy Ab is a company founded in 2012 that focuses on consulting, education and training in Lean leadership. (Edupower, n.d.)

Edupower Oy Ab coaches and trains its customers in Lean leadership methods and tools. The goal is to achieve lasting progress in the productivity of companies and organizations, and to unite the entire staff around common goals. (Edupower, n.d.)

Edupower Oy Ab operates both in the home country and on selected foreign markets. The head office is in the center of the energy industry, on the Vaasa University campus. The company also has offices in Turku and Espoo. (Edupower, n.d.)

Figure 1 Edupower (Edupower, n.d.)

3 Background

The production line on which the work is carried out is a line that has been in use since 2009 and which produces a product called Woodcast. Woodcast can be used for all sorts of different things, but one big thing is that it is used in hospitals for support if you have a broken hand, for example.

Figure 2 Woodcast (Primo, 2018)

Made from wood chips and biodegradable plastic. Woodcast is both stronger, lighter and much easier to use than other plastic materials. (Primo, 2018)

3.1 Pros with Woodcast

- No toxins, Woodcast is only made of wood and biodegradable plastic
- No isocyanates or latex
- Completely biodegradable
- Always a perfect fit.

Woodcast takes shape in 2 minutes after it has been heated and can be heated again if you want to change the shape. When you have the right shape, you cool it down with a cooling spray. (Primo, 2018)

- 96% of hospitals that have tested Woodcast have continued to use it.

Woodcast is mostly used by emergency departments, hand therapists, podiatrists, orthopedic departments and veterinarians. According to several studies, Woodcast has worked just as well as traditional plaster. Woodcast is also easier and faster to use than a

plaster. Woodcast can be used in x-rays because x-rays see through the Woodcast. (Primo, 2018)

Woodcast is a very environmentally friendly option because the product is recyclable. You can also heat the product for 1-2 minutes and then it is soft and can be reshaped, this means that you can use the same product for several different purposes. (Primo, 2018)

4 Customer

The client for this work is a large company. The company works with all kinds of profiles made of plastic, rubber and composite materials. In the beginning, the company manufactured plastic profiles for windows and doors, but today has expanded to almost all business areas where different profiles can be applied. Today, the company's products are used in the medical industry, for transport, construction, offshore, energy, white goods, power and lighting and for a wide range of other industries.

The company´s products can be found in e.g. packaging material, in furniture, in fishing nets and in technologically advanced greenhouses.

5 Criteria

The weight

The weight is the biggest criteria because the material the profile is made of must contain the perfect mixture of wood and plastic to be as durable as possible and still easily bend to a good fit.

Shape

There are up to 100 different profiles that are manufactured today and there will be more in the future. All profiles have different lengths, widths and can have different shapes.

With a camera at the end, it will be able to read that all profiles also have the correct shape.

The mixture of the material

The mixture of the material is a key point to achieve the right durability of the product. The biodegradable plastic and the wood chips are in different containers and from there these are mixed together and heated.

The holes

During the manufacture of the profiles, holes are made in these, this to make the profiles more bendable and so that there is airing if the profiles are used in, for example, healthcare as support for a broken leg

6 The line today

The line that was added in 2009 has been renewed over time and today has 5 to 6 different machines that work one after the other. The problem with the line is that it has to be closely monitored by workers because small errors in production means that there will be defect products and since the product is used in healthcare it is very important that everything is done perfectly. Even though the line has existed for a long time, it is not used too often, largely because that it can be difficult to obtain basic materials for the product.

7 Approach

For several weeks we have been out and checked on the customer when the production line has been running and got to see how it works. We have taken part when the production line has been started and also when it has been shut down. In this way, we have gained an

insight into what would need to be done in order for it to go faster and more efficiently. We have also had meetings with the management about the line as well as short meetings with the mechanics about the line to ask what they think are the biggest problems with the line and what they think would improve it. We have been equipped with Go-pro cameras that filmed everything and used the phone camera to take photos on the production line to be able to remember more easily how everything has worked. We have also participated in the customer's internal weekly meetings and gained an insight into how they work and think.

8 Problems

The problems with the line in today's situation is that far too much of the material is wasted. For example, in the beginning when the line is started, it takes anywhere from 30 minutes to 2 hours before an approved product is manufactured. As I have previously written, the product is of course recyclable, but since it is used in healthcare there are laws that say that an already recycled product may not be used on humans but only on animals, this means that the price the product is sold for also drops drastically.

The product's quality control is also done by the worker who is at the line. This means that it is only random samples where the quality is measured, which means that a lot of products that are not approved for sale can be sold.

The human factor is also a big problem because a small error in the line can cause a lot of material to be wasted.

9 Waste products

Defective products are today a big problem at the production line, this because that it takes a long time before the machine has obtained the right width and thickness, and that it takes a while before you see that the mixture and the temperature of the mixture have become correct so that the product is approved. This means that it can take up to 1–2 hours before you have the machine fully set up and this results in a large amount of waste production.

Because this process takes so long, they instead try to run the machine for long stretches at a time. During a longer run there is usually about 25% spillage, but during a shorter run the spillage percentage can go up to 40%. This is often because the machine has only been run for a short time and half the time the machine was running it needed to be adjusted to get the product right.

10 The module

What I strive for in this work is to get a module with a scale and possibly a camera that should be easy to install, move around and easy to use for all workers at the customer. The module must be easy to use by all workers and not too large to fit in with the line currently in use. The module must also have a conveyor belt that will take the product from the previous process up to the scale and after that on to some kind of sorting that sorts the defective products from the approved products. In the future, the customer also wants the module to be able to be connected to someone with an advanced machine that will be able to pack the finished product, so this will also be considered when choosing a scale. In today's situation, compressed air is used in several different places along the line, so one of the options is to use compressed air to sort out the bad products. The problem with this is that the product is very thin and can therefore be difficult to blow away. Another option is to use a pusher which is an arm that comes out and buffs the product off the conveyor belt into some box for bad products.

11 Future development

In our planning for the scale and the camera, we also try to take in information from the management what is planned for the future of the line and adapt our module accordingly so that it does not become obsolete after just a little while. An important thing is that in the future they have planned to start manufacturing a lot of larger products and this means that the scale must be able to weigh products that amount to 1500mm in length.

Another future thought is also to have the line sort and pack the finished products in boxes that will be ready for delivery. At the moment, the finished product only falls into a box and

from there a worker ends up going and picking and sorting into boxes and this takes an unnecessarily long time compared to if a sorting machine were to be developed.

12 Placement of camera and scale

There have been many considerations as to how the construction would be the smartest to put together. Should the camera be before the scale or after at the production line? We have spoken with people both from our own company and from the customer's side and tried to put together the most efficient and most profitable set.

It would be best if both the camera and the scale were to work at the same time and be on the same module. This would make the module smaller and easier to move when needed. The sorting would then also be able to take information from both the camera and the scale so that a completely problem-free product is manufactured.

13 Standards

ISO 9001

ISO 9001 is an international management system standard whose purpose is to act as support for continuously improving and developing companies and their management systems. (Wikipedia, 2021)

ISO 14001

ISO 14001 provides a clear framework to reduce your environmental impact, ensure you meet statutory requirements and build trust with stakeholders. The standard provides your organization with a systematic approach to planning, implementing and managing an environmental management system. (Wikipedia, 2022)

ISO 50001

ISO 50001 is a voluntary international standard. It applies to organizations of all sizes and contains requirements to determine, manage and improve their energy consumption and energy efficiency. (Wikipedia, 2022)

14 Lean

Lean is a method for business development where the focus is on creating maximum customer value based on the resources available. There are many reasons to invest in Lean: it simplifies, increases quality for the customer and increases profitability. (Leanway, n.d.)

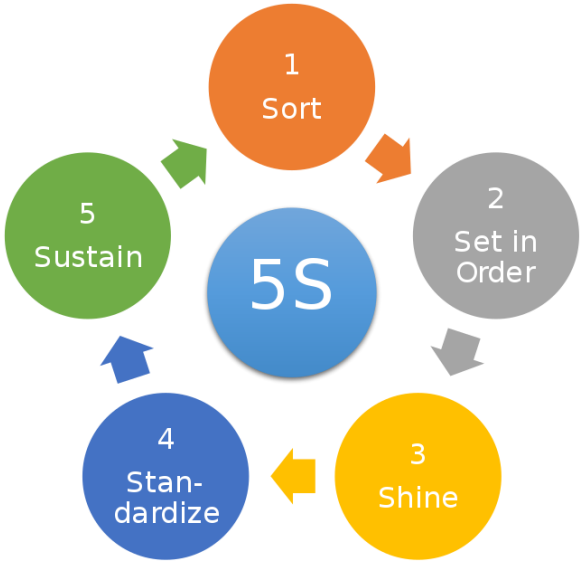

Figure 3 5S (Wikipedia, 2022)

Lean values

- The belief that everything can always be better. Instead of looking for who is slowing down the business, highlight problems that can be fixed.
- The principle that you should start by changing yourself. You know best yourself where "the shoe pinches". Everyone is responsible for their own improvement.
- The principle of always focusing on customer value.
- Respect your employees and help them develop.

(Leanway, n.d.)

Lean way of working

The second part of Lean is a common and visual way of working. By mapping work processes and highlighting improvement measures, everyone becomes involved and the work progresses faster. (Leanway, n.d.)

- The flows
- Mindset, communication, collaboration, information
- Getting it right from the start

(Leanway, n.d.)

Lean tools

Finally, Lean consists of practical and concrete tools to gradually take the improvement work further. Central tools are:

- 5S: Sort, Set in order, Shine, Standardize and Sustain
- The 8 Wastes: Eliminate waste and unnecessary work.
- Time and energy management to focus on what adds value and leads to the goals.

(Leanway, n.d.)

What is efficiency?

Efficiency is about:

- to use their time and energy wisely.
- to achieve goals with the least possible effort.

(Leanway, n.d.)

Lean is not:

Lean is about maximizing value creation and efficiency, not about cutting costs or getting rid of staff. (Leanway, n.d.)

The Lean principle was actually started already in the 1930s when Toyota started manufacturing cars. The son of the owner of Toyota traveled to the United States to study, among other things, Henry Ford's business. When he looked at how Ford made cars, he noticed that sometimes too many parts were made for some things and sometimes no parts at all for other things. The focus therefore became that each process in the assembly would receive only the quantity of parts that was needed and only when they were needed. Each process produced only the amount of parts that the next process in production needed when it was needed. Production and transport took place simultaneously and synchronized throughout production. (Leanway, n.d.)

The Toyota Production System, also abbreviated TPS, is largely built by Toyota Motor Corporation's production engineer Taiichi Ohno. He was tasked by management to raise the company's productivity. Ohno's mission was to figure out how to produce more with fewer resources. (Kanckos, 2015)

Toyota's production system is Toyota's own unique way of working in production. Compared to companies around the world, Toyota is far ahead in using TPS. Toyota has applied TPS throughout its organization. (Kanckos, 2015)

Figure 4 Improvements (Olofsson, n.d.)

15 Example of a scale

Figure 5 Scale (Teltek, n.d.)

Max tape speed	75 m/min
Max product length	150mm
Max product weight	15g to 3000g
Conveyor dimensions	L: 250-600mm
	W: 200mm or 300mm
Conveyor height	800-950 mm
Max capacity	250 pcs / min at 250 mm long wave conveyor
	or 115 ppm at 600 mm long wave conveyor
Sorting	A pusher or blow draft included (max 300 g product weight for blow draft)

(Teltek, n.d.)

Standardmodeller

Checkvågar

	C80-S3	C80-H6	C80-H12	C80-B20	C80-B40
Max bandhastighet	75 m/min	35 m/min	25 m/min	25 m/min	15 m/min
Max produktlängd	Vågtransportören minus 150 mm.	Vågtransportören minus 150 mm.	Vågtransportören minus 150 mm.	Vågtransportören minus 150 mm.	Vågtransportören minus 150 mm.
Max produktvikt	15 g till 3000 g (viktområdet anpassas till aktuell produktvikt).	600 g till 6000 g (viktområdet anpassas till aktuell produktvikt).	1500 g till 12 000 g (viktområdet anpassas till aktuell produktvikt).	3000 g till 20 000 g (viktområdet anpassas till aktuell produktvikt).	3000 g till 30 000 g (viktområdet anpassas till aktuell produktvikt).
Transportörsdimensioner	L: 250-600 mm / B: 200 eller 300 mm (bandbredd 160 eller 250 mm).	L: 400-600 mm / B: 400 mm (bandbredd 350 mm).	L: 500-1000 mm / B: 400 (bandbredd 350 mm).	L: 750 eller 1000 mm / B: 500 mm (bandbredd 450 mm).	L: 750 eller 1000 mm / B: 600 mm (bandbredd 550 mm).
Transportörshöjd	800-950 mm	800-950 mm	800-950 mm		
Maxkapacitet	250 st/min vid 250 mm lång vågtransportör eller 115 st/min vid 600 mm lång vågtransportör.	77 st/min vid 400 mm lång vågtransportör eller 53 st/min vid 600 mm lång vågtransportör.	45 st/min vid 500 mm lång vågtransportör eller 22 st/min vid 1 000 mm lång vågtransportör.	30 st/min vid 750 mm lång vågtransportör eller 23 st/min vid 1 000 mm lång vågtransportör.	18 st/min vid 750 mm lång vågtransportör eller 14 st/min vid 1 000 mm lång vågtransportör.
Utsortering	En pusher eller blåsutkast ingår (max 300g produktvikt för blåsutkast).	En pusher ingår.	En pusher ingår.	Inget utkast ingår (utkastsignal tillgänglig).	Inget utkast ingår (utkastsignal tillgänglig). AC motor med frekvensomriktare.
MID, Verifiering av RISE	Verifiering möjligt som tillval.	Verifiering möjligt som tillval.	Verifiering möjligt som tillval.	Ingen verifiering, Inga tillval tillgängliga!	Ingen verifiering, Inga tillval tillgängliga!

Figure 6 Standard models (Teltek, n.d.)

16 Spare parts

Spare parts are an important thing to keep in mind when choosing a scale. If something breaks when the machine is in operation, it is important that parts are quickly available so that the production line is not left standing still for longer periods of time. Servicemen should also be close at hand in case there is a major problem on the scales.

The scale manufacturer Teltek has service points in Tampere and Helsinki and they also drive out to customers and repair on site if necessary.

17 Problem

The biggest problem with choosing a scale is to get a scale that can handle large products that have a low weight. Since accuracy is one of the biggest criteria, this becomes difficult given the length of the products. Sorting can also become a bigger problem because the product is only a few mm high, so it can be difficult to get hold of the product with, for example, air or with a so-called "pusher".

18 Finding a scale

When choosing the scale, I have been in contact with several different companies to find a solution that would suit the customer's wishes. The problem with this was finding a scale that could handle products with a very low weight, even if the product is long and narrow, and still have an accuracy on the scale of +- 1 gram.

19 My goal with the thesis

Since the production line (L27) today requires a lot of maintenance and that a worker is always on site, my goal is to make the line more independent. This will then mean lower costs for workers and a better result. Much of what is produced today at the line is products that are not approved for sale and this means a lot of material and money that goes to waste.

With a camera and a scale installed at the line, this would mean that no one would have to stand and take random samples of the finished products. This means that the production line needs less monitoring and that all products are tested

Reducing labor, better products, no defective products sold, costs, less waste material.

20 Teltek

Teltek offers a wide range of solutions for weighing, checking and quality assurance of products, mainly for the food and pharmaceutical industries. Since its inception in 1984, Teltek has had steady growth and today there are 30 employees who deliver products of the highest quality to over 20 countries around the world. (Teltek, n.d.)

21 Costs

The cost at stake is a key issue because the customer is only allowed to use a certain amount without involving other parties in the matter. If the module is too expensive, it means that the company must be consulted with higher management and this means a much larger process. If the cost is kept at a reasonable level, the company can decide for itself whether they want to buy the module or not. You also have to think about how long it will take for the module to pay for itself considering that fewer people will have to work on the line after the module is installed. The company has an installment plan of 2 years, then the module must pay for itself. Since the line is not always active and can be down for several weeks, this is not easy to calculate.

22 Own reflection

This has been a very rewarding project for me, partly because I have ended up finding out all the information myself and partly because I have had direct dialogue with the customer and the supplier of the scales. I started the project without really knowing anything, but after a few weeks had passed and we had visited the customer a number of times, an interest arose in being able to make a difference for the company. What I have learned is that it is a long process to introduce something new in an industrial company and that there are many factors that must agree with each other. There have been a great many calls and emails sent between both parties in order to put together a solution that should be possible in practice.

Thanks to Edupower, I have also learned how important it is to maintain good communication within the work group. Reports have been written on all visits, filmed and photos taken of everything we have done. This in turn has led to it being much easier to remember everything that has been done during the past six months.

We got to experience what it's like to work in management in a company like this, but we also got to experience what it's like to work as a fitter and machine maintenance. It is very interesting how these work in different ways but still have a very close dialogue on how things should be managed and are constantly thinking about how things can be improved.

Our work here is finished for this time and now that there is a plan how everything should work and everything is down on paper, in the end it is the customer himself who chooses if they consider it profitable to realize this idea.

23 Results

I have searched around in several different places and finally found a company, Teltek, which is based in Sweden in Örebro, which is one of Scandinavia's largest companies that adapts automatic wave solutions to industrial companies. I contacted Teltek and began to think about how we could get the customer's wishes fulfilled. We came to the conclusion quite quickly that the customer has a requirement that cannot really be met, so we ended up thinking about something else. The biggest problem was finding a scale capable of weighing modules as large as up to 1500mm with an accuracy of only +- 1 gram. We had different ideas but finally came to the conclusion that we will need a scale that functions as a "stair step scale"

We would use a shorter wave path that would handle products up to 400mm which would have an accuracy of +/- 1 gram and a longer wave path that would handle products up to 1000mm which would have an accuracy of +/- 2 grams at best.

This solution is based on the fact that the plastic pieces are rigid so that they do not bend down, this because we need to lay the wavebands at a little "stair step height" in such a way that the first wave is a few mm above the second, which in turn must lie a few mm over subsequent path. This is so that we can complete the weighing while the leading edge of the piece passes out of the wave path. If that doesn't work, the straps must be longer.

After this, another conveyor belt with a trapdoor would be used as sorting for approved and non-approved products.

However, this also comes with several prerequisites:

Then some form of separation and acceleration system needs to be arranged before the wave so that the pieces arrive with a front edge-to-front edge distance of at least 550 mm for the shorter

the wave and 1150 mm for the longer wave. This is needed so that you get a small gap between all the pieces so that the scale does not take and weigh 2 pieces at the same time.

23.1 Reflection on results

With this degree project, I want to see the possibilities of developing the warranty on the manufactured products in order to have the least possible waste production. The goal of the development is to have a growing customer base, and for the individual customer to be satisfied. Thanks to the development of the scale, there will now be more opportunities to see this development in the future. My own vision is to be able to see this proposal on the market and be used by healthcare. In today's society and in the world, sustainability and environmental issues are more relevant than ever, which means that the development of Woodcast is an ultimate alternative instead of other materials that are worse for the environment. Using the scale allows one to see differences in waste production, and that it makes positive developments for sustainability, the environment and economic aspects.

In order for this scale to work in practice, it will still be necessary to review the conveyor belt up to the scale. This is because there is currently no conveyor belt there. Another problem is when the products are cut into different types the saw becomes very hot and when the next product is cut and pushes the product in front of them there is a risk of them to melt together. In order for this problem to be solved, a conveyor belt will be needed immediately after the saw or a cooling device of some kind to cool the products down, which means that the product that comes after does not get stuck in the one in front.

Overall, the product is fully developed to function in practice, however, there are still development opportunities such as, for example, the problems mentioned earlier in the chapter. Overall, I am satisfied with the result and the thesis has given me more knowledge and a clear picture of how to go about developing new products. I also hope that my thesis will provide knowledge to others in the industry.

Figure 7 Example of scale (Teltek, n.d.)

24 References

Edupower. (n.d.). *Edupower lean management*. Retrieved from Edupower: https://edupower.fi/sv/

Kanckos, T. (2015). *Theseus.* Hämtat från Introduktion till Lean: https://www.theseus.fi/bitstream/handle/10024/96861/kanckos_tina.pdf?sequence=1

Leanway. (n.d.). *Vad är Lean?* Retrieved from Leanway: https://www.leanway.se/om/vad-ar-lean/

Olofsson, O. (n.d.). *Skapa en robust och effektiv produktion med Lean*. Retrieved from World Class Manufacturing: https://world-class-manufacturing.com/svenska/Lean/

Primo. (2018). *Treating fractures with a biodegradable material: Primo manufactures revolutionary new materials for otrhopaedic casts*. Retrieved from Primo : https://www.primo.com/news-articles/article/treating-fractures-with-a-biodegradable-material-primo-manufactures-revolutionary-new-materials-for-orthopaedic-casts?PID=10882&M=NewsV2&Action=1

Teltek. (n.d.). *Checkvågar*. Retrieved from Teltek: https://teltek.se/alla-produkter/checkvagar/?https://teltek.se/alla-produkter/checkvagar/&gclid=Cj0KCQiA-qGNBhD3ARIsAO_o7ymcCKgBDzFx2--UD7pZnXNMvkljpN6by2Npl5G2eLjzg7CYr4c0K0gaAskQEALw_wcB

Wikipedia. (2021). *ISO 9001*. Retrieved from Wikipedia: https://sv.wikipedia.org/wiki/ISO_9001

Wikipedia. (2022). *5S (methodology)*. Hämtat från Wikipedia: https://en.wikipedia.org/wiki/5S_(methodology)

Wikipedia. (2022). *ISO 14001*. Retrieved from Wikipedia: https://sv.wikipedia.org/wiki/ISO_14001

Wikipedia. (2022). *ISO 50001*. Retrieved from Wikipedia: https://en.wikipedia.org/wiki/ISO_50001