Reflection [1]Report for Investigation based project Assignment.

Natural detergent from chestnut as an alternative to washing powder

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Group Number: 12

[1] Reflection is “the practice of periodically stepping back to ponder the meaning to self and to others in one's immediate environment about what has recently transpired” Raelin, J. A. (2001). "Public Reflection as the Basis of Learning." Management Learning **32**(1): 11–30. A reflective practitioner is a person capable of learning, acting and adapting to environments, someone who is constantly seeking to widen their experience and knowledge by adapting their manner of work in the profession. Someone who always learns through what they do, and who continually combines action with reflection on what has been done.

1. Introduction (1 page)

Short description of your project assignment and its intended purpose. In your introduction, give the reader adequate background information about the investigation or the review you were aiming to deliver.

This investigation aims to decide whether chestnut can be an effective alternative to commercial detergents for washing clothes. The chestnut species are trees, from quite small to very large. They have valuable wood and bark is used in tanning . In Norway, horse chestnuts are found and they can be seen as ornamental and park trees. Horse chestnuts, which are otherwise inedible, contain the substance called saponin. As per literature, saponin is a mild detergent that is used for washing clothes. Many commercial detergents contain microplastics that end up in the wastewater and pose a threat to ocean or water bodies as they are difficult to remove by conventional water treatment. Ultimately it can also be a danger to humans since our diet is composed of marine species or plants. Hence it is worth investigating to see if naturally occurring chestnuts can replace the commercial available detergents.

Chestnut harvesting season is typically August – October in Norway. Hence it was a good time to conduct this investigation. The saponin is found in the nut under the shell, so the chestnut must be split and needs to be soaked in water. The strained liquid is then used as detergent. Three different types of fabric material (polyester, twill, denim -all in white color) were dirtied with a salad dressing and divided into two groups. The first group of clothes was washed with commercial detergent and second with the chestnut using the washing machine. The method and the time in the washing machine is kept identical for both the kind of detergents. These clothes were then put for display to the reference group without revealing the nature of detergent used for washing the clothes. The group were then asked to rate each piece of fabric on a scale of 1-10 based on the cleanliness, feel, freshness and smell. This survey was conducted in the NTNU premises. This survey is intended to give an unbiased overview of which detergent performed better in terms of the above mentioned factors. At the end of survey, group were also asked if they are aware of and are open to buy an chestnut based detergent

1. Evaluation of Project management effort (2-3 pages)

The group should make an overall evaluation of their own efforts during the project. The evaluation should include:

a) *Evaluation of the organization of the project group, distribution of the tasks, roles and responsibilities? What went well and what did not went so well.*

   All the team members were instrumental in setting up the project aim. The idea of using chestnut as a detergent was bought out by two members and was later refined as an investigation project by group discussion. There was a brainstorming session within the team and everyone asked the right questions to shape up the project aim.

   The role of project manager was to ensure the deliverables are completed on time and were of quality. She had arranged a weekly online meeting to discuss the status of the project. Most of the project members attended and had discussed how the past work was executed and how the future works are planned.

   Most of the members executed their task in time. One of the team member had an unexpected personal emergency to manage and couldn't actively take part in some stages of the project. However his absence was not felt as the remaining resources managed well to cope up with the project load.

b) *Evaluate the effectiveness of the risk management plan of your project? What went well and what did not went so well.*

   Student unwillingness to take the survey was anticipated as the major risk of this investigation. To some extent this risk actually occurred during the survey. The risk remedy of sweet gifts to participants was overlooked, as the project members were busy with preparation of chestnut powder and soiling and washing of the clothes. A poster was prepared to invite more participants, this only solved the problem to some extent as there were multiple big companies who had set up their booths to discuss the possibility of internship with the prospective students. Naturally more students were interested in attending their booth compared to our survey. This risk was partly mitigated in time with the project members bringing their friends and known acquaintances to complete the survey.

c) *Evaluate the effectiveness of the communication plan? What went well and what did not went so well.*

During the initial phase, the communication went very well. However during the final phase, since all the members were busy in executing their own sub task, communication between project members was lacking. For instance there was little communication between the members who prepared the survey and the members who washed the clothes. This resulted in the survey getting changed at the last minute. Survey questions had to be changed last minute to account for the no-visible difference between some of the fabrics washed by both the detergents. Initially the survey was structured as a two multiple choice question, as to whether cloth A or cloth B were clean . However for some types of fabric such as denim, both cloth A and cloth B were clean. In that case it was decided to change the type from multiple choice question to rating based question since it was hard to choose between which cloth is best.

It was planned to complete the survey during the lunch break so that we can benefit from more students who are either existing from the lecture during the start of the lunch break or who are joining the class lecture during the end of the lunch break. However we couldn't start the survey as planned, as we had to change the survey questions at the last minute. Hence the survey was not ready in time, so we had to lose some of the participants. In the end, however, we managed to get the minimum number of participants needed for the survey.

d) *Did the group manage to deliver the project results according to the originally stated success criteria (according to your original plan)? If not, why? Is there any deviations between the stated success criteria and your final evaluation of the project? Reflect on the causes or reasons of this deviation.*

Yes we managed to deliver the project according to the original criteria.

The following success criteria was met in terms of most of the aspects:

Proper planning – weekly project meeting ensured there was good planning

People involvement – Most of the team members were active in taking up additional responsibilities.

Good working environment – full independence was given to all the team members and the project manager was not authoritative and was keen to get everyone's views and opinions .

Sticking to the schedule – we stuck to the schedule in spite of obstacles.

Completing the goal – The ultimate goal of the project, which is to conduct an investigation on performance of chestnut detergent was completed.

Fast problem solving – Each team member displayed good problem solving skills and they knew what they were doing.

There were some minor deviations in the project success criteria such as communication, right risk verification. The main cause for this was the project load, however at the end we managed to complete the project goal.

Please evaluate the degree of your support to the following statement (group-based evaluation):

We evaluate our project management effort as successful

Scale	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
Your response			We managed to complete the project in time, with minor deviation from some of the success criteria		

2. Evaluation of the impact (Project success) (1 page)

The group should make an overall evaluation of the impact or the significance of their final results (the investigation or the literature review).

A) *Who is the target audience of your project results (target audience could be individuals, groups or organizations that could benefit from the results of your work)*

The target audience for this project is the society. The investigation result will tell if the clean natural detergent can be a replacement for a commercial detergent. It will tell if the chest nut based detergent is effective enough to clean the fabric dirtied in a harsh environment.

B) *How do you evaluate the quality of your final results? What evidence do you have to support your evaluation?*

Only one project member was responsible for soiling the fabrics and washing the soiled fabric using both chestnut detergent and commercial detergent. Another project member was involved in editing the survey based on the washed quality of the fabric. Other than these two project members, no other project members knew the chestnut washing ability result. These two project members were barred from attending the survey, so as to avoid any bias.

The quality of the fabric after washing is evaluated in terms of cleanliness, touch (or feel), smell. This was clearly communicated to all the survey participants during the beginning. Since none of the survey participants know which fabric was washed using which detergent, the survey result was unbiased.

There were two parts of the survey question. First part of the survey had fabrics washed by both the detergent. Second part of the survey had fabrics washed by only one detergent. But the survey participant is not aware of this. They were only asked to rate each piece of fabric on a scale of 1-10 where 1 meant poor and 10 was outstanding.

Please evaluate the degree of your support to the following statement (group-based evaluation):

We evaluate the quality of our final results as outstanding

Scale	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
Your response				Final results are were of good quality (unbiased)	

3. Factors that have contributed to failure / success. (1-2 pages)

In this section students should reflect and elaborate on all the factors that they believe have contributed to the success or (failure) of their project assignment. These factors could be related to project management, process or project success.

Which factors were the most significant and why? Compare your identified factors with the factors listed in (Hussein 2018) pp-92.

Project Management success:

1. Project was completed within the set deadline. There were multiple work packages / deliverables and each was executed by individual project team members.
2. Project goal was achieved. The intention of this investigation was to decide if chestnut detergent can be a worthy replacement for commercial detergent for washing clothes. By the survey it is clear that chestnuts cannot be a replacement for commercial detergents.
3. Project was completed within a minimal budget. Chestnut was taken from the nearby tree and the detergent was made at home. Hence no cost was incurred in this detergent making process. There were some minimal costs associated with purchase of white fabrics, but that was the main requirement of this project. The equipment required for conducting the survey such as table and chairs were taken from the college premises / classroom. So no money was spent on this either.

Process success:

The main stakeholders who were project group members and survey participants were satisfied. At the end of the survey, project members were happy that there were 8 participants. At the same time, survey participants were also happy that they took part in something different and interesting. This falls under the process of success as this is the experience they perceived during the implementation phase.

Project success:

Project in itself is a success because we were able to meet the objectives we set in the beginning. However, at the end of the project, there was no change or big transformation achieved. If the investigation result turned in favor of chestnut, then it would have been transformational. First our own group members would have started using it in their home

and then by word of mouth, others would have started following. Though chestnut in itself is not an alternative for all commercial detergents, it could pave the way for further research, like addition of other agents with chestnut powder to make it work universal for all types of fabric and all types of dirt.

4. Most important lessons from your project (1 page)

A- Based on your collective experience as a group and if you were to give unambiguous advice to other students on how they should work on similar projects what would you advise them to do? Formulate your lessons like the following:

1) If you are not sure whether your product would be useful for the target audience, then you can formulate it in the form of an investigation report.
2) Our advice is to keep the communication going between the team members. Most of the time all of us are so focused with our deliverables and we were waiting for the weekly meeting to convey our concerns. Continuous communication also creates trust between the team members.
3) We learned that it is important to identify the workflow of the project early. Arrange each segment of work sequentially so that before starting the work, examine whom you are dependent on or which activity is an input to your activity. Not following a proper sequence will result in changing your work last minute.
4) Our experience suggests that every member must be aware of all the other activities. So if anyone falls sick or has to take emergency leave, other team members can quickly take up their place. We suggest that the start date of the project has to be early, so then it will be easy to make changes in plan if there are contingencies like this. Also it will create a sense of ownership among each team member.

5. Reflection on learning and unlearning (1-2 pages)

Look back on the entire process of your project assignment and answer the following questions:

1) ***What did you need to learn*** *(acquire or gain knowledge, insights or ideas) so that you can handle the emergent needs and challenges of your project? Compose a short list of knowledge, practices or attitudes that you have gained during working on your project.*

Can you describe or reflect on situations where learning was critical to the success of your project?

a) Creating a positive and open working environment so that everyone is ready to take additional responsibility when needed. This is important also to avoid any complexity since multi cultural members were involved.
b) To plan and analyze the interdependence of each deliverable well in advance.
c) To discuss the risk in advance and also keep the mitigation plan ready.
d) To keep the communication between project members going all the time.
e) In case of Investigation report, good skills in Microsoft excel is needed for analysis of result.
f) In particular to this project, some of the project members learnt how to prepare laundry detergent from chestnuts.

2) *What did* ***you need to unlearn*** *(discard beliefs, practices or knowledge that no longer was helpful or outdated or wrong) in order to handle the emergent issues/problems/challenges during the project? Compose a short list of attitudes, practices or knowledge that you have discarded or found obsolete during working on your project.*

Can you describe or reflect on situations where unlearning was critical for the success of your project?

Project manager was the most senior member for the project with some years of industrial experience. Being senior or more experienced does not mean you are an expert at all . Throughout the project, instead of an authoritative environment, she created an healthy and open environment where everybody can freely express their opinions. The project members were the brains behind this investigation idea and the role of project manager was to monitor the execution and jump in

with implementing additional tasks when needed. In the end we felt there is no need to have strict project structure and an informal environment helped the project.
In particular to this project topic, we were under the impression that horse chest nut does not have use. However we found chestnut to some extent can be used as a laundry detergent to remove mild dirt, though not as a complete replacement for commercial detergents.

6. Acknowledgments

We would like to thank Professor Bassam for his initial guidance for shaping up the project aim and also for answering our queries throughout our project.

7. References

Please use (Author-date) style when you writing your references as follows:

Hussein, B. (2018). The Road to Success: Narratives and Insights from Real-Life Projects, Fagbokforlaget.
Raelin, J. A. (2001). "Public Reflection as the Basis of Learning." Management Learning **32**(1): 11–30.

1. https://snl.no/kastanje
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8. Appendix

Appendix 1: Your pre-report

Appendix 2: The investigation report

Appendix 3: Link to your video presentation.

Applied Project Management

Project assignment
pre-report

Natural detergent from chestnut as an alternative to washing powder

Group 12:

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22 September 2022

CONTENTS:

1. Focus of the investigation

Chestnuts are an effective washing agent as the chemicals known to us, and at the same time harmless to the environment, allergy sufferers and all fabrics, and they can also be obtained for free. Thanks to the foaming properties, chestnuts reduce the surface tension of the water, which allows dirt particles to combine more easily with water and, as a result, cleans fabrics well. Saponins are responsible for this action. Referring to the information above, it was decided to base the project on this topic.
The goal of the investigation is checking the possibility of replacing the usual washing detergent (washing powder) with a natural detergent made from chestnuts. The research will primarily focus on 'producing' an alternative detergent. Then, two pieces of material (research sample) will be washed with it. Two consecutive pieces of cloth, washed in ordinary detergent (in the same proportions possible), will be used simultaneously as a control sample. Such washed items will be presented to the reference group (university students), whose purpose will be to assess the effectiveness of washing on a given sample. This opinion will be 'collected' from students in the form of a questionnaire in which they will be asked about the effectiveness of the detergent expressed in:

- cleanliness,
- freshness,
- smell,
- fabric touch feeling,
- color protection

In addition, respondents will be asked for their opinion on an alternative powder , have they heard about something like this before, would they like the idea, would they buy such a product, would they replace the usual powder with an alternative one, or would they be afraid of something related to its use (e.g. an allergic reaction).

2. Value and impact

This study aims to show that a natural chestnut powder is also effective with traditional laundry detergents. Thus, the main value of the project is to act to reduce the consumption of chemicals. Potentially, this may have an impact on reducing the amount of plastic packaging in which detergent is sold, obtaining a powder alternative that is cheaper to buy (which you can make yourself at home), managing chestnuts (which are not particularly used) and reducing costs generated by traditional Detergents. It is evident from recent research that microplastics are released into the environment (including water) in an increasing amount, including from washing when using the commercial detergent. This becomes a problem that even scientists are starting to worry about, because it also affects our health (in an unknown so far).

3. Potential stakeholders

Due to the fact that the project is based on research, the potential stakeholders could be basically just a group of students willing to assess the quality of the clothes (reference group). The involvement of these stakeholders during the project will be based on drawing the student's attention through e.g. stoist at a strategic point at the university.

However, if this idea was implemented on a larger scale (product implementation), potential project stakeholders could be:

- Eco stores where our products will be sold initially,
- Customers,
- Company producing washing tablets (e.g. by advertising our product itself),
- Organizations supporting environmental protection,
- Group of willing people (potential employees) whose goal is to collect chestnuts needed for the year-round stock of our products (chestnuts collection),
- Investors who are interested in eco-topics and believe in the success of the project

And their involvement in the project would also focus their attention to innovation and potential benefits based on previously carried out research results.

4. Risk

A project risk assessment plan, indicating the main risks and how are you going to address these risks

A project risk is an uncertain event that may or may not occur during a project and could have either a negative or a positive effect on progress towards project objectives. The main risks were presented in the table below.

Tab 1. Project risk assessment plan.

Identified risk	**Analyze**		
	Probability of occuring	**Monitoring**	**Plan to deal with**
Student unwillingness	Possible	Difficult to implement - observation of students' behavior/ willingness only during the survey	Increasing the interest of students (relaxed atmosphere, sweet gifts)

Detergent ineffectiveness	Unlikely	Difficult to implement - observation only during realization	Adding auxiliary agents to the created detergents (e.g. soda)
Lack of team's collaboration	Unlikely	Observing the commitment and contribution of team members (mainly by PM and PM assistant)	Just avoid the risk by resolving some misunderstandings from the very beginning

5. Acquire skills

Below are the competences and / or qualities necessary to effectively coordinate a project in order to conduct the investigation correctly.

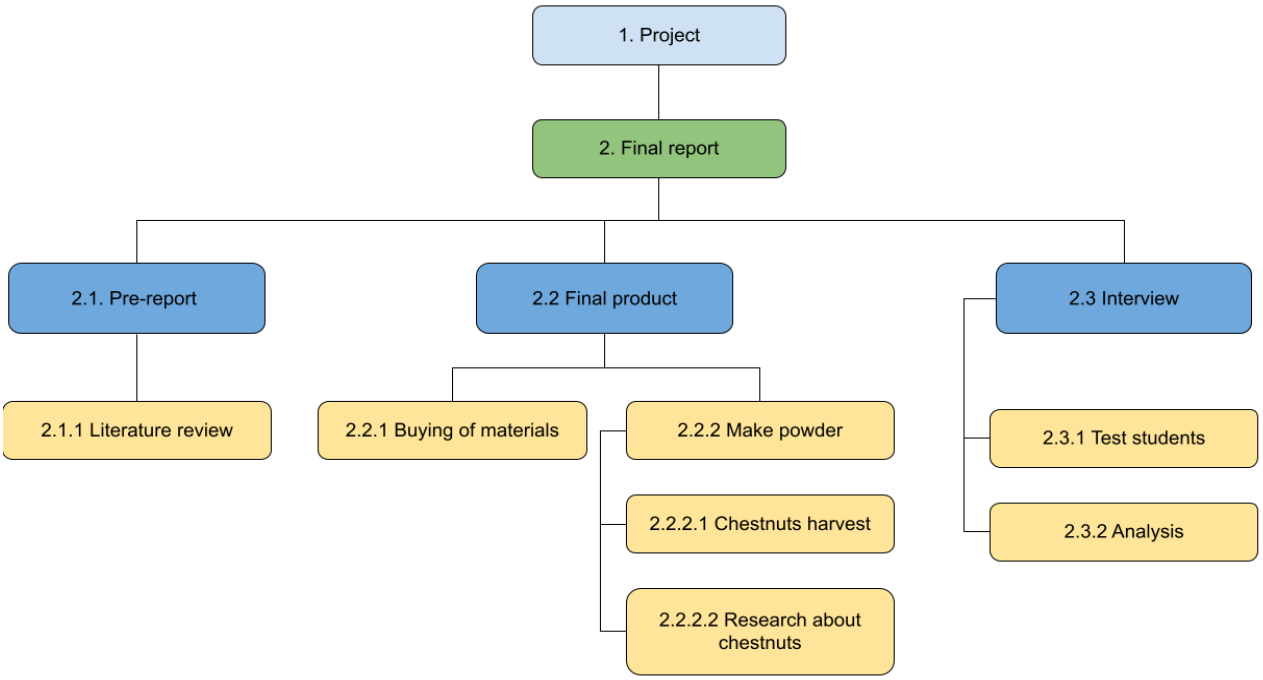
- The ability to present and speak in public,
- Interpersonal skills,
- Collaboration. Proper coordination of tasks and ensuring effective cooperation of all.
- Time management,
- Organization management,
- Fast problem solving,
- Work under pressure (may occur)

Acquiring these skills will mainly be based on reading and studying from books, internet etc. on our own to get some basic knowledge. Also, surely we will learn some of these just in practice (during accomplishing this task).
In other circumstances also, it would be possible to participate in workshops or courses on project management or other related.

6. Breakdown structure

Project breakdown structure indicating the major deliverables, subdeliverables and work is shown in the diagram below

Diagram 1. Project breakdown structure indicating the major deliverables, subdeliverables and work



7. Schedule

Below, in the form of a table, the estimated time of performing individual tasks in the project has been prepared.

Tab 2. Project schedule.

TASK	Task owner	WEEK						
		I 15-22.09	II 22-29.09	III 29-06.10	IV 6-13.10	V 13-20.10	VI 20-27.10	VII 27-3.11
Pre-report	Kasia Mateusz							
Chestnuts harvest	Kasia Mateusz							
Make a chestnut detergent	Ingrid, Rajalakshmi							
Purchase of materials to washing	Ingrid, Md Shahabuddin							
Preparation of the survey	Ghazi, Md Shahabuddin							
Idea for a position at the university	Ghazi, Rajalakshmi							
Research and survey	All members							
Analysis of results	Team members							
Making a report	Ghazi, Rajalakshmi							
Final report preparation and submission	All members							

8. Success factors

The main success factors that need to be adhered to in order to succeed in the project are:

- Proper planning,
- Effective communication,
- People involvement,
- Good working environment
- Sticking to the schedule,
- Good measurement,
- Completing the goal
- Right risk verification,
- Fast problem solving,

9. Roles and responsibilities

The following table shows the roles and responsibilities in this project.

Tab 3. Roles and responsibilities

Roles in the project	Responsibilities	Members
Project manager	Main planning, realization of established tasks, motivation, monitoring of the project closure phase,	Rajalakshmi
Project manager assistant[1]	Support for PM, monitoring the effectiveness of the fulfillment of tasks by team members, realization of established tasks	Ghazi
Team member	Realization of established tasks	Ingrid, Md Shahabuddin, Kasia, Mateusz

[1] In the likeness of the team leader in large projects. Generally, in small projects this role 'takes over' the project manager. However, in our project, due to little experience in project management, it was decided to appoint this role mainly to support the project manager.

10. Communication plan

This plan identifies how communication will look throughout the project. Such a plan helps to stay on track and meet project assumptions.

Tab 4. Communication plan.

Who	Ways	Frequency
Team[2]	Personal or online meetings	Weekly
	Other online communication channels like facebook, whatsapp	As needed
Lecturer	Personal meeting or e-mail	As needed

[2] Due to the nature of the project, basically the only contact will be inter-team.

Appendix 2. The investigation report

Natural detergent from chestnut as an alternative to washing powder

Group 12:

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3 November 2022

Abstract

Based on knowledge that naturally occurring chestnuts contain chemical compounds, show the ability to reduce the surface tension of aqueous solutions because of foaming in water, it was decided to investigate the possibility of using chestnut detergent as an alternative to the ordinary detergents.

The research was primarily focused on 'producing' an alternative detergent and based on the developed study design, carried out the washing tests. At the end, in order to assess the effectiveness, the washed materials were presented to the reference group (university students) in unknown order for them and then a survey was conducted in which the respondents were asked to evaluate the materials. In the survey, the group also was asked for an opinion on an alternative powder. After that, an analysis of the results was carried out and an evaluation of the feasibility of using chestnut detergent as equal to ordinary detergents was made. Finally, the opinion of the project's success could be formed.

Table of contents:

1. Introduction

Chestnuts are an effective washing agent as the chemicals known to us, and at the same time harmless to the environment, allergy sufferers and all fabrics, and they can also be obtained for free. Thanks to the foaming properties, chestnuts reduce the surface tension of the water, which allows dirt particles to combine more easily with water and, as a result, cleans fabrics well. For this action, so-called saponins are responsible. Hence, the objective of the investigation was to check the possibility of using the natural chestnut detergent in addition to the usual washing detergent. Due to the lack of professional literature on this type of powder, as well as other sources that would describe the conduct of similar studies, the first step was to properly plan the study design (which was described in section 3 - method). Then the scope overall was to:

- harvest the chestnut to make the natural detergent,
- wash in an appropriate manner, previously purchased materials,
- conduct the survey on a reference group to have the ability to analyze the results and draw conclusions. In the survey, the students were asked about their assessment, on a scale of 1 to 10, how they rate a given piece of material in terms of cleanliness, freshness, smell and color. Also respondents were asked for their opinion on an alternative powder - have they heard about something like this before, would they like the idea, buy such a product or replace the usual powder with an alternative one,
- measure the success of the project and evaluate whether it has succeeded.

One of the values of this project, seen on a larger scale, could be to reduce the use of chemicals. This has the potential to reduce the amount of plastic packaging the detergent is sold in, obtain a cheaper powdered alternative (you can make yourself at home), manage chestnuts (which are not particularly used) and reduce costs generated by traditional detergents. Recent research clearly shows that microplastics are released into the environment (including water) in increasing amounts, including when washed with a commercial detergent. This becomes a problem that even scientists are starting to worry about, because it also affects our health (to an unknown extent).

2. Literature review

In general, about the chestnut laundry detergent, there is no specific literature or similar research that would similarly assess the feasibility of a chestnut alternative, as in our investigation. We found several sources on the internet that wrote about the use of chestnuts, but these were not scientific articles but DIYs (Do It Yourself) forums/articles. They described why chestnuts could be used as a natural detergent and gave some ways in which they could be prepared for later use in laundry. Bator (2020) suggests in his article that chestnuts should be rinsed and broken into small pieces and such chestnut pieces, pour water over them and set aside for about three hours. Then strain it through a fine mesh strainer and pour the cooled chestnut liquid into the washing machine's compartment intended for washing liquid. In another article by the author Adamska (2018), she writes that for one wash (in the washing machine) only a few chestnuts are needed, which should be peeled of their brown skin, and the chestnuts thus peeled should simply be cut into quarters and placed in a special washing bag or, for example, in a knotted sock and placed in the drum of the washing machine. As you can see, there are many ways to make a laundry detergent from chestnuts.

However, during the review, literature was found in which the use of other natural sources as a substitute, for not only washing detergent, but also as a hair cleaner or soap was found. Similarly, opinions were found that indicate the harmfulness of ordinary detergents, which at the same time increases the value of the investigation carried out in this project. Khan (2022) in his work points out that *"Chemically detergent is composed of surfactants, builders, bleaching agents, enzymes, and other small ingredients [...]. The detergents have a negative effect on aquatic life both on flora and fauna of water bodies, microorganisms, soil, and plants. The harmful effects of detergents can be enlisted as eutrophication, oxygen depletion, decrease light transmission, change in pH and salinity."*. So, you can see how important it is to find an alternative to such remedies. As already mentioned, research is being carried out on the use of naturally derived compounds as an additive or substitute in cleanliness. Yang et al. (2021) proposes to use halloysite nanotubes (HNT) to make green detergent. In his work, he examines them as *a green, non-toxic, multifunctional, and cheap detergents". [...] HNT has high adsorption ability, which provides the possibility for removing various stains from different substrates. [...] The cleaning capacity of HNT on cotton fabric for dyes is almost twice that of laundry powder, indicating that highly efficient cleaning capability of HNT. HNT detergent is also effective to remove ink, tea, and chili oil from textiles with clean efficacy higher than 88%. [...] Overall, HNT has great potential as an alternative detergent in the future because of its excellent cleaning efficacy and ecological friendliness."* Correspondingly, Kora (2022) in her research, proposes the use of plant saponin biosurfactants, she stated that *"The biosurfactants derived from plants are bestowed with many characteristic features such as natural abundance, sustainability, lower cost, superior stability, biocompatibility, biodegradability, low environmental and human toxicity when compared with synthetic surfactants. [...] The superior emulsifying action of natural saponins makes them ideal, ecofriendly, commercial, economical laundry detergents. Further studies are envisaged on bulk raw material production, isolation and purification of saponins, and toxicological evaluation."* In the presented literature, it can be noticed that the authors in their research show the importance of searching for such detergent alternatives, guided primarily by limiting the negative impact on the environment caused by the compounds contained in it. Moreover, it can be concluded that in the near future this topic will gain strength and its importance will increase.

3. Method

3.1 Materials

A list of the materials and equipment involved in the study is given as follows:

- fresh horse chestnuts
- kitchen oven
- bamix® hand blender with food processor
- 400 ml glass jar
- water boiler
- cloth sieve
- refrigerator
- thin, white 100% polyester fabric about 1 m x 1.4 m in size
- white 100% cotton twill fabric about 1 m x 1.4 m in size
- white 97% cotton 3% elastane denim fabric about 1 m x 1.4 m in size
- Idun hamburger dressing
- Whirlpool 6th sense AWO/D 6126 washing machine
- Neutral® Farget & hvitt tøyvaskemiddel (liquid)

3.2 Preparation of the chestnut-based detergent

Horse chestnuts were collected in two rounds from the chestnut trees surrounding the NTNU campus at Gløshaugen. A total of more than 50 chestnuts of different sizes were collected and initially dried in the sun for 5 days. After drying, the chestnuts were peeled to reach the flesh inside the shell. The chestnuts were then placed on a tray and dried in the oven for 5 h at 100°C. After drying in the oven, the chestnuts were left to cool. 56 g of peeled and dried horse chestnuts were shredded using a bamix® hand blender for about 2 minutes and transferred to a glass jar. The dried powder is shown in Figure 1.

Figure 1: Dried horse chestnut powder for making the chestnut-based laundry detergent.

Subsequently, 300 ml of freshly boiled water was poured over the chestnut powder. The mixture was stirred vigorously and left to steep for two days in a refrigerator. The mixture was then strained using a cloth sieve. 150 ml of viscous liquid was collected in total.

3.3 Preparation of the fabric samples

The three fabrics were cut into eight pieces each. All denim pieces were of the same size and shape, and so were the twill pieces and the polyester pieces. Using a sewing machine, a mark was sewn onto each piece of fabric in a light gray thread. Together with the fabric type, the mark gave each piece of fabric a unique ID. The IDs are shown in Table 1 in the format "mark" "fabric type". The purpose of the ID system was to enable a controlled, doubly blind study while preventing one sample from being confused with another. The samples bearing an underlined mark were soiled with mud, whereas the remaining half were saturated with salad dressing.
Each sample was soiled directly before it was washed (i.e., all samples were not soiled at the same time). The marking system partitioned the samples into four identical groups. Groups 1, 2, and 4 were washed using the chestnut-based detergent, whereas group 3 was washed with the reference detergent. The partitioning of the fabric pieces is illustrated in Table 1.

Table 1: Scheme for partitioning fabric pieces into four groups. The left column describes the type of stain.

	Group 1 (Chestnut)	Group 2 (Chestnut)	Group 3 (Reference)	Group 14 (Chestnut)
Salad dressing	I Polyester	II Polyester	III Polyester	IIII Polyester
	I Twill	II Twill	III Twill	IIII Twill
	I Denim	II Denim	III Denim	IIII Denim
Mud	I Polyester	II Polyester	III Polyester	IIII Polyester
	I Twill	II Twill	III Twill	IIII Twill
	I Denim	II Denim	III Denim	IIII Denim

One person ("the washing person") was assigned with marking and washing the fabric samples. The information about what detergent each group had been washed with was intended to be withheld by the washing person from both the rest of the group conducting the study and the participants until after the data were collected so as to make the study doubly blind. However, due to some practical challenges, this information was shared with another

group member who was assigned with guiding participants through the survey. The study was thus only singly blind.

All samples were washed using the 30-minute program of a Whirlpool 6th sense AWO/D 6126 washing machine. The details of the washing program are listed in Table 2. The program was run four times. First, the halves of groups 1, 2, and 4 soiled with salad dressing were washed with 75 ml of liquid chestnut-based detergent. Then the remaining halves of the same groups (soiled with mud) were washed with the same amount of the same detergent. Then the part of group 3 soiled with salad dressing was washed with 40 ml of liquid Neutral® Farget & hvitt tøyvaskemiddel. Finally, the remaining half of group 3 was washed with the same amount of the same laundry detergent (Neutral®).

The fabric pieces were hung up to dry directly after the end of the program. Those washed with the reference detergent were kept separate from those which were washed with the chestnut detergent to prevent transfer of smell. After drying, the samples were transferred to eight separate bags according to group number and type of stain.

Table 2: Details of washing program used to wash the test fabrics.

Duration [minutes]	30
Temperature [°C]	30
Maximum rotation speed [rpm]	1600

3.4 Survey design

The samples were laid out on a long table as shown in Table 3. Only half of all the samples were used in the survey. The decision to use only the samples that were soiled with salad dressing was made because the number of samples to assess for each participant was thought to be too high. To reduce the risk of participants leaving before finishing the survey or becoming indifferent in response to a large number of repeats of the same question, the volume of samples to assess was reduced by half. Since even the washing person was unable to tell the difference between any of the samples that were soiled with mud, these samples were not used in the study.

Table 3: Schematic of the setup of the samples on the table for assessment by the participants in the study. The rightmost half of the table constituted the control group since samples marked I and samples marked II were both washed with the chestnut-based detergent, something which was not known to the participants.

Polyester III	Twill III	Denim III	Polyester I	Twill I	Denim I
Polyester IIII	Twill IIII	Denim IIII	Polyester II	Twill II	Denim II

The participants moved down the table from the left to the right, submitting their assessment of each sample in an online survey as they went. A representation of the survey is shown in Table 4. Apart from the information provided in the survey, the participants that asked for more information were told that the samples in the upper row were washed with a different laundry detergent than those in the lower row. That is, the participants were not told that the samples marked II were washed with the same laundry detergent as those marked I.

Table 4: A somewhat compressed representation of the online survey which was presented to the voluntary participants along with the samples.

Title	Laundry detergent survey
Info	This part of the survey consists of six questions, all of which concern pieces of fabric which have been soaked in salad dressing (or, strictly speaking, burger dressing) and then washed with one of two different laundry detergents. We want to compare the detergents in terms of washing performance, for instance smell, cleanliness, freshness, and feeling to the touch.
Q1	On a scale from 1 to 10, where 1 is very poor and 10 is excellent, how would you grade the performance of the laundry detergent used to wash this piece of polyester fabric marked III?
Q2	Now, how would you grade the performance of the laundry detergent used to wash this other piece of polyester fabric labeled IIII? This fabric was washed with a different detergent ("detergent 2") after the salad dressing marinade.
Q3	Twill III.
Q4	Twill IIII.
Q5	Denim III.
Q6	Denim IIII.
Info	Part 2
Q7	Polyester I.
…	
Q12	Denim II.
Info	Part 3
Q13	Have you ever heard about laundry detergent made from chestnuts? (Yes/No)
Q14	Do you like the concept? (Yes/No)
Q15	Would you buy such a product? (Yes/No/Maybe)
Q16	Would you replace the usual powder with an alternative one? (Yes/No/Maybe)

Strengths of the design:

- Subject three different materials to the test and wash them in three rounds (like it is shown at table 1.) simultaneously with the reference group - the structure.
- Understandable and concise. Due to the fact that the whole methodology was described in a simple way and did not require any sophisticated skills, e.g. programming, it was easy to understand and implement.
- Low risk of failure. Referring to the above, i.e. the lack of the need to have special skills, education, and also due to the lack of the need to involve many external entities/ factors, there was a low risk of undesirable factors in a specific study design.

Weaknesses of the design:

- Too fresh/young chestnuts. Due to the limited time, it was necessary to harvest the chestnuts at the end of September. However, it turned out that Norway's fully ripe chestnut season began a month later.
- Generally, the seasonality of chestnuts. As a result, the possibility of carrying out an investigation is possible in principle only during the period of their occurrence
- Due to the lack of professional literature sources, the detergent recipe was taken from internet forums or DIYs,
- Due to the lack of literature sources, the drying times of the chestnuts were selected at the discretion

4. Findings

There were eight participants, of which six answered the entire survey. A summary of the results is shown in Figures 2 and 3. A complete account of all the answers given in part 1 and 2 of the survey is given in Appendix A.

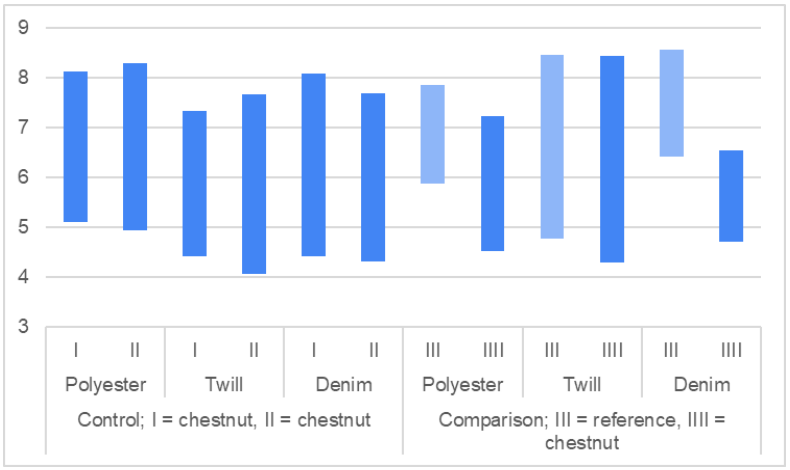

Figure 2: A summary of the survey results. Each bar is centered on the average grade given to the sample and extends one standard deviation above and one standard deviation below the average value. The bars representing samples washed with the reference commercial detergent are coloured a lighter shade of blue.

The average grade given to all nine samples washed with chestnut-based detergent was 6.125 with a standard deviation of 1.565. In comparison, the average grade given to all three reference samples was 7.000 with a standard deviation of 1.351. Figure 3 is a rendition of Figure 2 in which groups 1, 2, and 4 are shown collectively as one group to compare chestnut samples with reference samples.

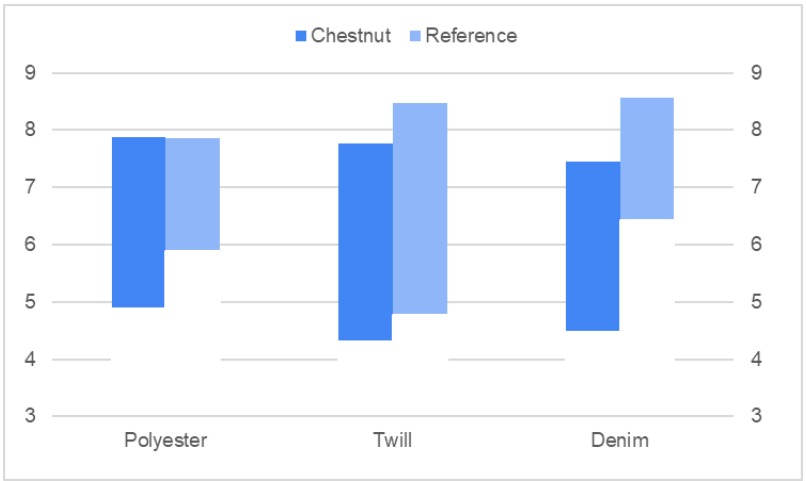

Figure 3: A slightly different summary of the survey results. Each bar extends one standard deviation above and one standard deviation below the average grade given in the assessment. Note that the number of samples in the chestnut and reference groups is 9 and 3, respectively.

The answers to the questions in the third part of the survey are presented as pie charts in Figure 4. The questions are included for clarity.

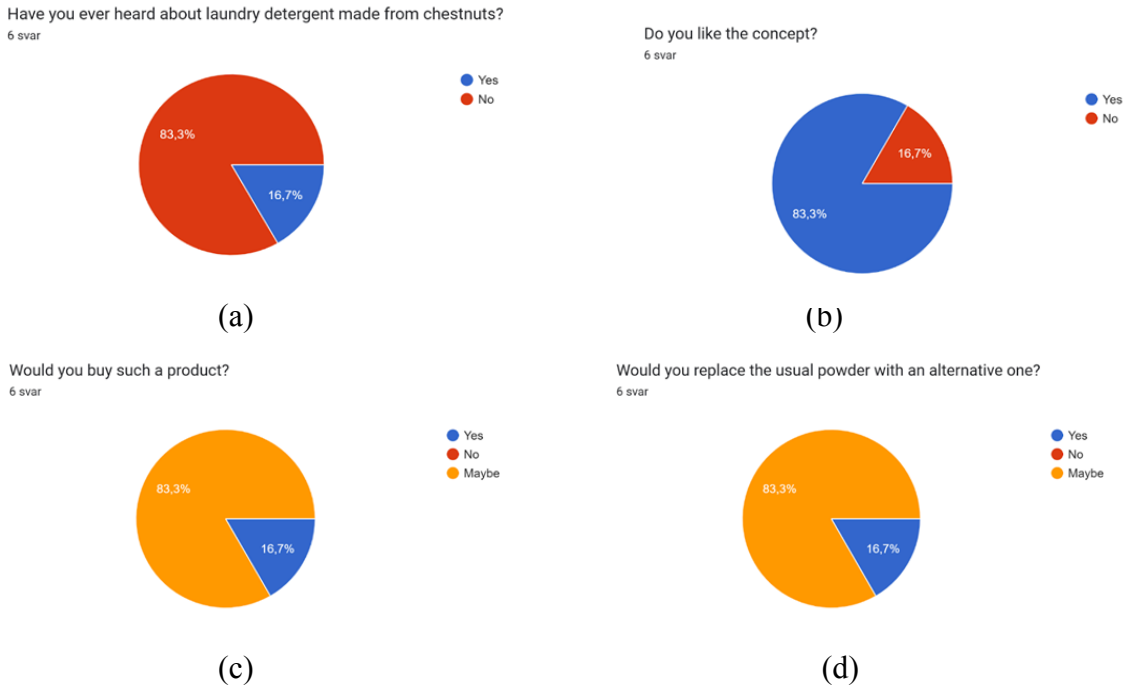

Figure 4: Questions and answers from the third part of the survey. (a) question 13, (b) question 14, (c) question 15, and (d) question 16.

As it can be seen most of the respondents are interested in the idea of an alternative washing powder made of chestnuts. They liked the idea and would be willing to buy and use such a product.

5. Discussions and conclusions

The method described above was used to evaluate the use of chestnut detergent as a replacement for a commercial laundry detergent.

The reference samples performed better than the chestnut ones in the assessment. The control group (comparison of I with II, both washed with the chestnut-based detergent) revealed that the difference was significant. Therefore, the investigation concluded that in fact, chestnuts contain compounds that have a detergent effect but that a regular detergent cannot be completely replaced by an alternative detergent. However, it opens up the way to use chestnut powder not as a complete replacement for standard detergent but to promote the refreshment of fabrics that are not very dirty, which will to some extent reduce the use of commercial detergents and this will in turn reduce the use of chemicals that can get into the natural environment.

Unfortunately, due to insufficient time, it was not possible to test the effects of chestnut powder with additives such as soda (as described in the deal with potential occurred risk plan). In addition, the difficulties that occurred while completing the questionnaire, i.e. the lack of adequate encouragement of students or simply their lack of interest, may make the results unreliable. It can be concluded that conducting the survey on a larger number of people or on people who were more implemented in the topic would give a different result. It

was due to the fact that the questionnaire was quite complex and took time to understand, which automatically discouraged people from completing it.

From our investigation we could learn that in this type of project (relatively not a very extensive investigation), it is important to collaborate, work together on the entire project. During this project, assigning individual tasks to people (such as creating a powder or carrying out washing) ultimately resulted in other team members "lacking knowledge" about these specific tasks and further causing problems in working on subsequent tasks. So it can be concluded that the ability to work in a group was a strategic issue in this project. On the other hand, I think the project showed how important organizational skills and case-by-effect thinking are. Compared to the previously prepared pre-report, there are specific changes in the structure of the task related to the purchase of materials and the method of washing them. Thus, despite the previously established plan, its reorganization was necessary in a relatively short time. So it turned out that organizational skills are related to fast solving problems and ability to work under pressure.

6. References

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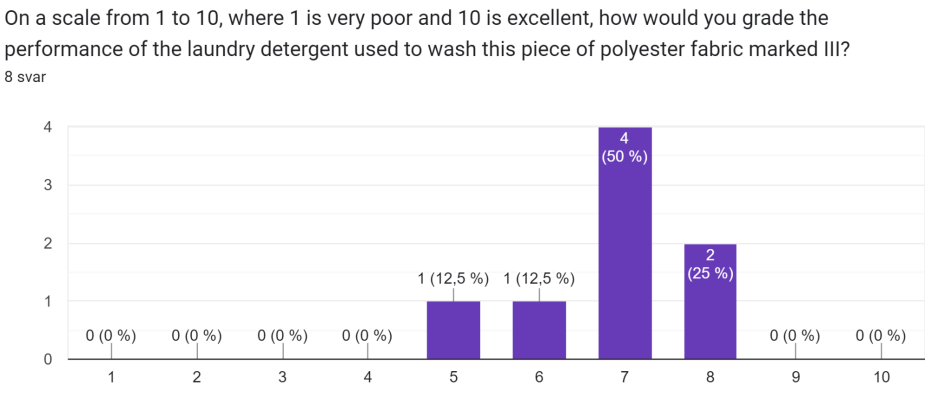
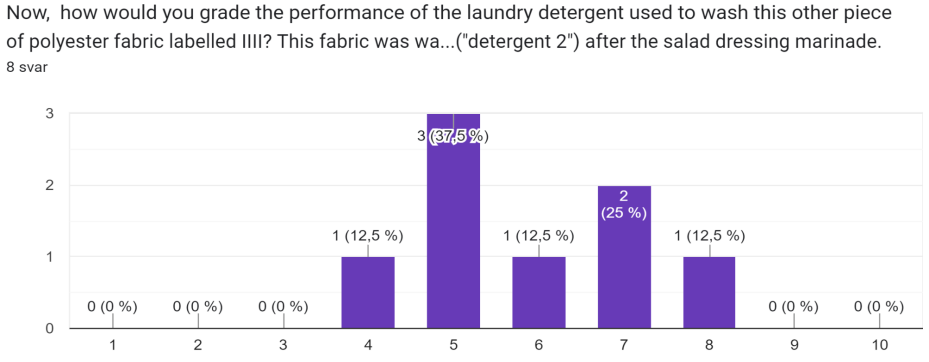
7. Appendix A

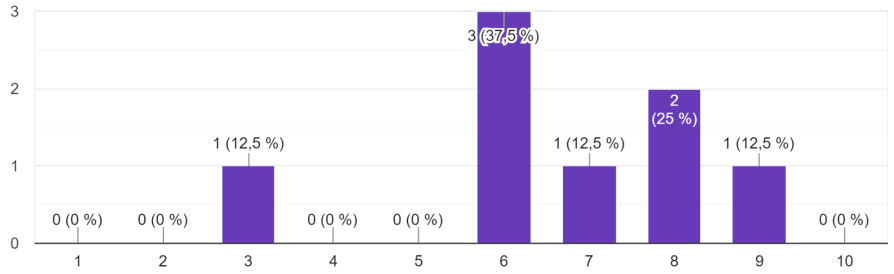
Diagrams





Twill III.

8 svar



Twill IIII.

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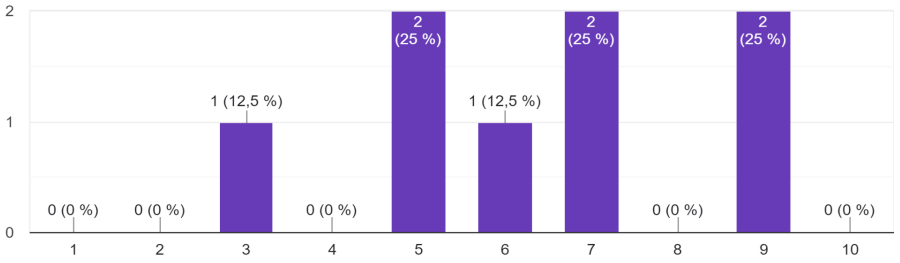

Denim III.

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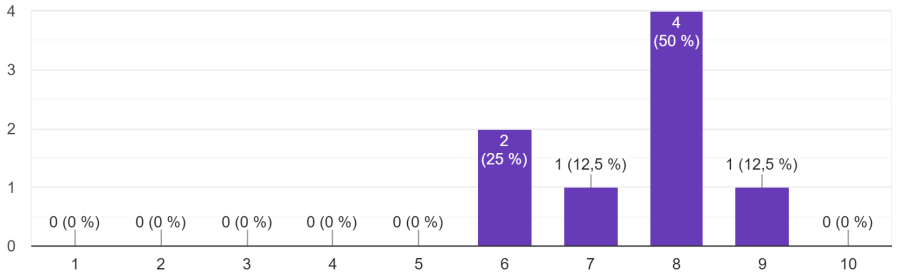
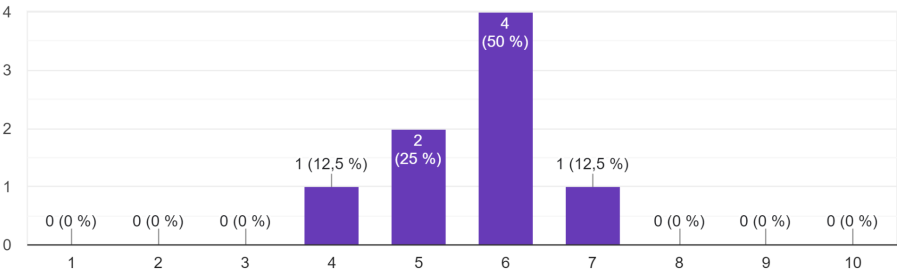


Denim IIII.

8 svar



Polyester I.

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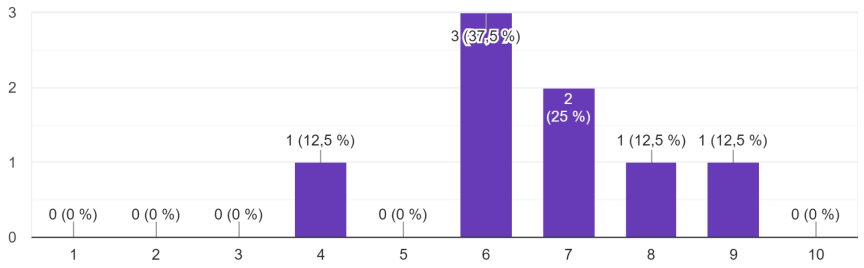
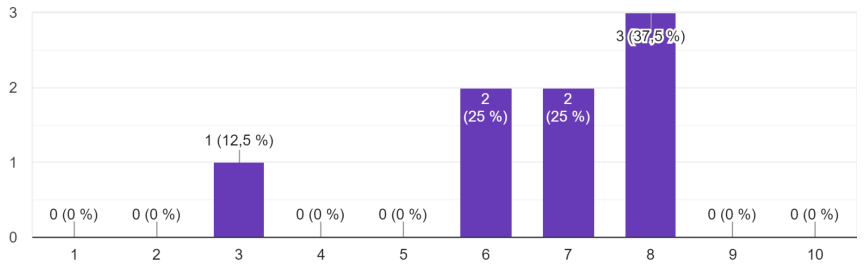


Polyester II.

8 svar



Twill I.

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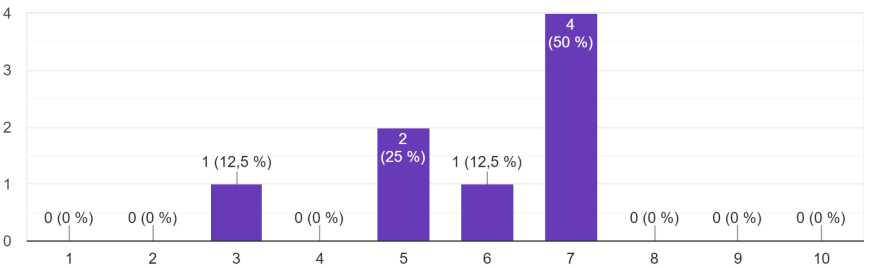
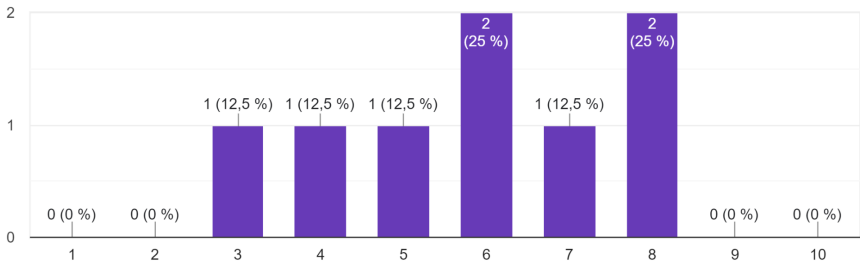


Twill II.

8 svar



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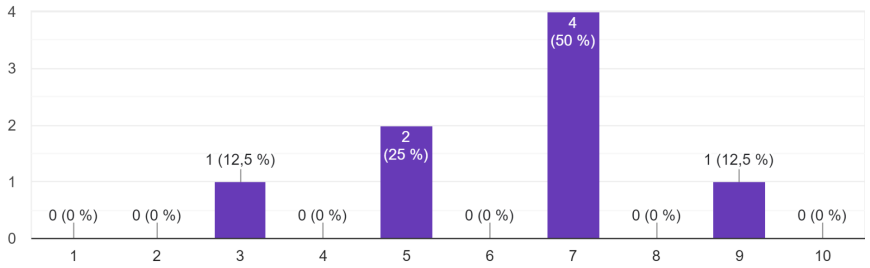

Denim II.

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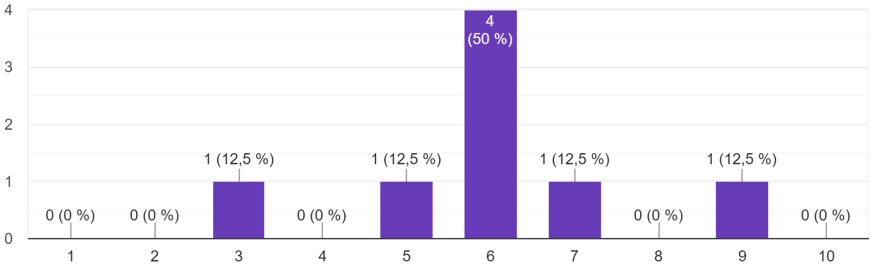

APPENDIX 3

Below is the link to our video presentation:

https://ntnu.blackboard.com/courses/1/194_TPK5100_1_2022_H_1/groups/_341405_1//_4756142_1/Video%20presentation%20Grupe%2012.mkv