MF2088 | Innovation and Product Development

A ROADMAP TO A CIRCULAR FLOW OF GLOVES

Business Plan & Prototype
2022

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The Challenge

The use of plastics is essential in large parts of society as of today. Plastics have many important areas of use and their mechanical properties make them non-exchangeable in many applications. In the health care sector for instance, plastics are used in applications such as aprons, gloves and medical devices, and in other sectors they have many other areas of use. However, a great amount of emissions of greenhouse gases come from the extraction, production and disposal of plastics, which make them huge contributors to the global environmental crisis. In general, raw material extraction contributes the most to a plastic carbon footprint (Prevented ocean plastic, 2020) and by decreasing the need for virgin plastics, the environmental impact can be decreased. Since only 10 percent of plastics are recycled (Naturvårdsverket, n.d.-a), most plastics are incinerated after disposal. In order to meet the Paris climate agreement and to limit global warming, the emissions of greenhouse gases need to be decreased in all sectors. The EU also has an action plan for increasing municipal waste recycling to 55 %, 60 % and 65 % in 2025, 2030 and 2035 respectively (European Commission, 2022). To meet these goals, many different courses of action need to be taken.

Plastic and rubber gloves are used in many occupations in the public sector of the City of Stockholm to minimise the spread of disease and bacteria. As of today, recycling of medical equipment, including gloves, is limited as a consequence of strict requirements and policies regarding traceability and patient safety (Naturvårdsverket, n.d.-b). Therefore, single-use gloves are thrown in the regular trash bin after use, which means they ultimately all go to incineration. Furthermore, materials used in rubber gloves are nitrile and latex, which are non-recyclable. These materials are however possible to downcycle and use in other applications (Kimtech, n.d.).

When the user is in contact with bodily fluids, gloves should be used for protection (Stockholm stad, 2021). Currently gloves are being overused in many other applications where they are not needed. Therefore, two main challenges have been identified: finding ways to create a circular flow of single-use gloves in the public sector of the City of Stockholm, and reducing the overconsumption of the gloves in applications where they are not needed. This will involve creating a network of stakeholders which all collaborate toward a common goal which in itself presents many minor challenges, logistically and economically, when creating a circular system for the whole product life cycle. Creating a circular flow of single-use gloves and minimising their overconsumption will lead to less emissions and decreased extraction of finite raw materials.

Vision

The vision of the Environment and Health Department is to reduce the environmental impact of disposable gloves in the public sector of the City of Stockholm. In order to reach that vision, we have provided the Environment and Health Department with our insights and proposals that can be applied in their work towards sustainability. Our vision is to approach behavioural aspects to lower the overconsumption of plastic gloves and manifest a circular product flow to meet upcoming laws and regulations regarding plastics. Since the Environment and Health Department is not driven by profit, this business plan takes a systems perspective rather than an organisational perspective and shows how stakeholders will be changed by the proposal in terms of value losses and value gains.

Current Business Model

The current value proposition involves the creation, delivery, use and waste management of disposable plastic gloves to the public facilities in the City of Stockholm. The current product journey follows a linear flow and is presented in *Figure 1* below.

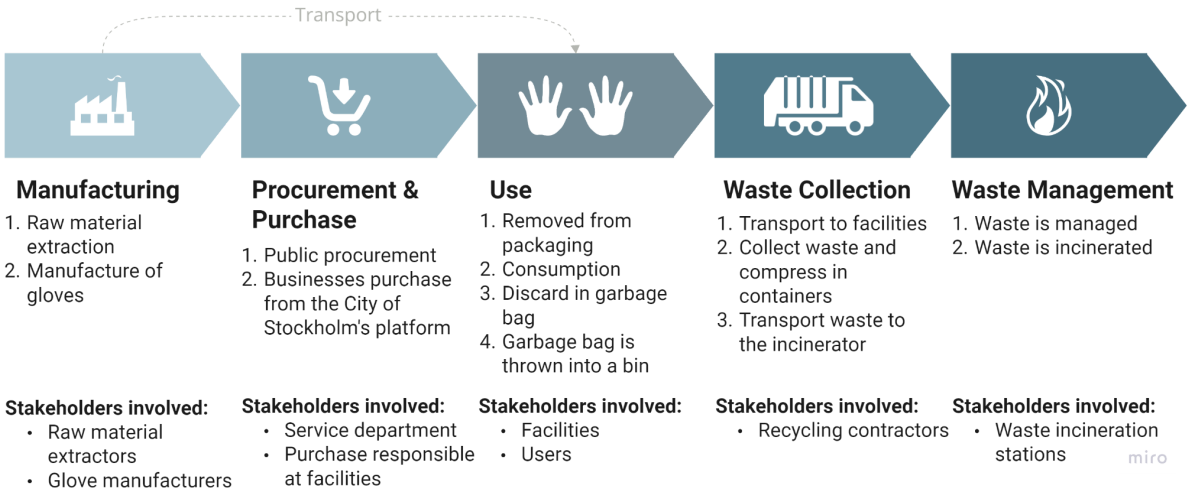

Figure 1. Current product journey

The gloves provide customer value by protecting the users from bodily fluids and bacteria. However, values are being both missed and destroyed for the different stakeholders in the current linear flow, creating opportunities for new value propositions. The current value proposition is presented in *Figure 2* below.

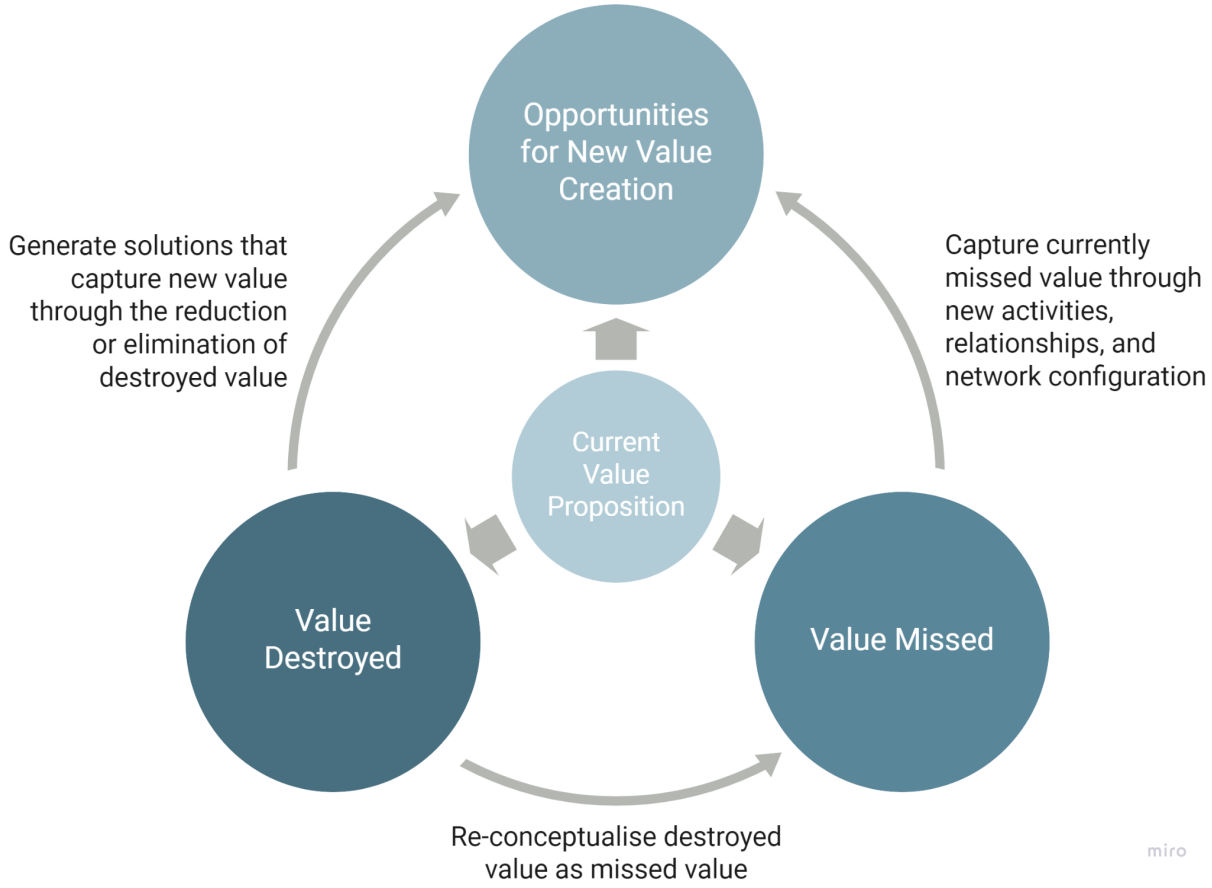

Figure 2. Value proposition (Bocken et al., 2013)

Current Value Proposition

The current value proposition is based on how the flows and operations are run as of today. A list of what value is currently created is presented below:

- Gloves to protect people from bodily fluids and bacteria
- Each facility responsible for purchasing gloves from ordering platform
- Easy for the users to dispose after use
- Properties that users appreciate, for example feel and elasticity
- Gloves with good material properties
- No "strict" limitations on the amount of gloves to use
- Gloves are sorted as combustible waste
- All gloves are being incinerated after disposal (easy process that provides energy)

Opportunities for New Value Creation

Opportunities for new value creation involve chances to develop a new or additional value for the current stakeholders in the network. Also, opportunities for new stakeholders arise as the business model changes. Opportunities for new value creation is presented in a list below:

- Reduced use of gloves in the process
- Recyclable gloves
- Reduce CO2 emissions
- Reduce extraction of virgin plastic is needed
- New stakeholders: research institutes that can investigate future environmentally friendly gloves
- Creates engagement for environmental work

Value Missed

Value missed include under-utilised assets, resources and capabilities, failure to capture value and waste streams. A list of what value is currently missed is presented below:

- Insufficient use of information and guidelines regarding overconsumption/basic hygiene routines
- Access to pages with statistics (Miljöbarometern) that could highlight and monitor waste at the different units
- The material from the used gloves are not being recycled or downcycled

Value Destroyed

Value destroyed are the negative impacts of the business model, this includes negative social impacts, depletion of non-renewables and environmental damage. A list of what value is currently destroyed is presented below:

- Extraction of raw material for one time use corresponding to 140 tonnes of plastics and rubber materials annually (see Appendix B)
- Approximately 50 percent of gloves used are made of a non-recyclable material (see Appendix A)
- Overconsumption of gloves
- High emissions of carbon dioxide
- Restrict opportunities to reach climate targets

A Roadmap to a Circular Flow of Gloves

Moving from the linear flow of gloves that is in use today to a circular flow requires that several measures are taken. For example, gloves must be made from a material that is recyclable, technologies for recycling of the gloves must be developed and infrastructure that supports a circular flow has to be established. As seen in the product journey (*Figure 1*), there are many different stakeholders involved during the lifecycle of the gloves. If changes are to be made in one phase, stakeholders involved during other phases will most likely be affected. These aspects make the transition from current processes to a circular flow complex, which is why a stepwise approach is useful. To achieve a circular flow of gloves in the City of Stockholm, we propose a roadmap with activities arranged in three steps, as shown in *Figure 3.*

The first step focuses on efforts to reduce the overconsumption of gloves, as it includes actions that are feasible with today's knowledge and technology. The work with overconsumption is continued throughout all steps of the roadmap. The second step aims to improve the process by utilising the waste through downcycling and to develop structures that form the basis for implementing a closed-loop system by enabling recycling. In this context recycling refers to closed-loop recycling in which the material maintains its properties after reprocessing, whereas downcycled material receives inferior properties after reprocessing (Bocken et al., 2016). Once a basis for recycling gloves has been established, the third step of the roadmap is feasible. In this step, all stakeholders and activities required to achieve a circular flow are integrated and the system is implemented.

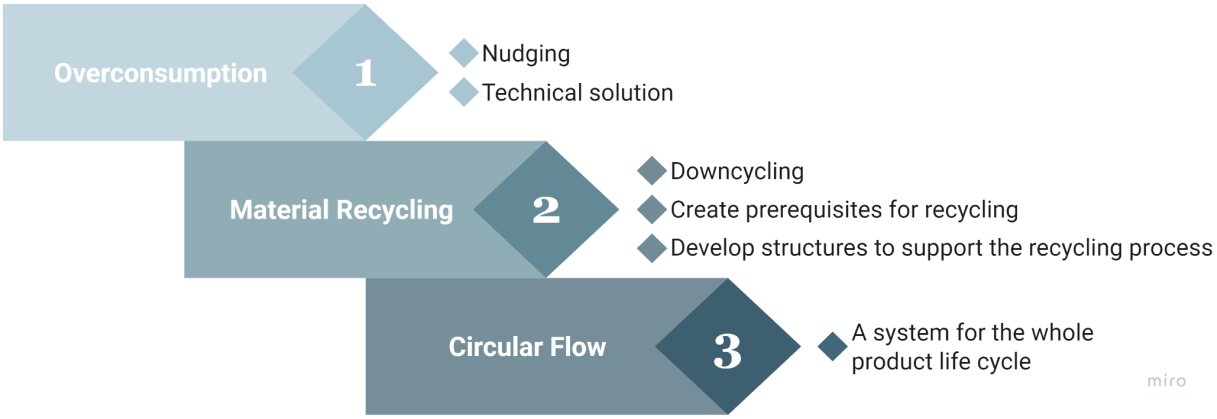

Figure 3. Roadmap

Overconsumption

Two main areas were identified, one focusing on nudging which is a tool for behavioural change and the other focusing on technical solutions regarding gloves. These are presented in *Figure 4*.

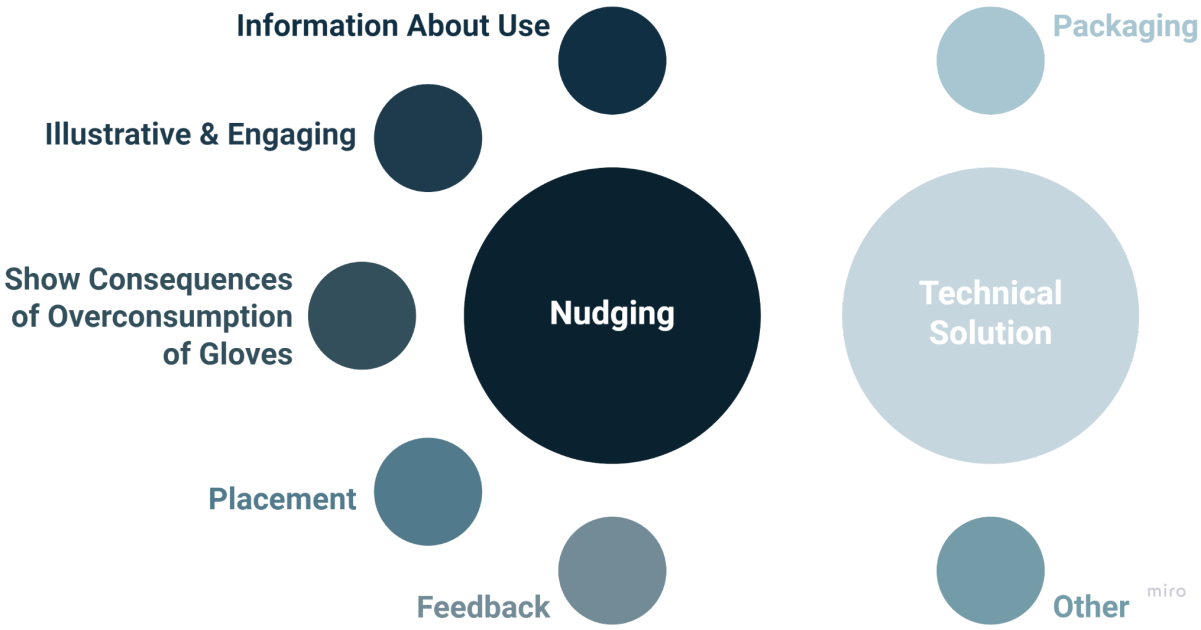

Figure 4. Overconsumption

Nudging

Nudging is a tool for changing people's behaviours by making it easier to make certain decisions (Gunnarsson, n.d.). This is done by designing the decision scope in a way that guides people to make certain choices (ibid.). There are many different ways of applying the tool and what will be most effective is highly dependent on the situation. How it will be applied in this report will be described below.

Information About Use

Information about when and when not to use the gloves should be presented to the users. The purpose of this is to illustrate when their use is unnecessary, hence minimising their overconsumption. For instance, this can be done with information sheets about basic hygiene routines and with illustrations regarding the areas of application for plastic gloves. Their protection can be illustrated by a glove pyramid (Folkhälsomyndigheten, 2020) shown in Appendix C, or other visualisations of their areas of use.

Illustrative & Engaging

One aspect of nudging is to use visual aids to psychologically guide people's behaviours in a preferred direction. There are many ways to do this, and two examples of different applications are shown in *Figure 5* , where the left example is a way to encourage people to make use of basic hygiene routines and protection equipment, and the right illustration is a way to nudge people into using hand disinfectants. Similar visualisations can be used to guide the user's behaviours to reduce the overconsumption of single-use gloves.

Figure 5. Examples of nudging

Show Consequences of Overconsumption of Gloves

For users to realise the importance of reducing the overconsumption of single-use gloves, their environmental effects should be illustrated in a pedagogical way. This can be done by illustrating relatable examples of their detrimental environmental impact. Finding examples that are easy for users to relate to will make it more likely for them to change their behaviour, for example: "Decreasing overconsumption of gloves saves x amount of flights to new york..."

Placement

By placing hand sanitizers and washing stations around the locations where gloves are most commonly overused, users will be more enticed to make use of basic hygiene routines instead of using gloves when they are not needed.

Feedback

Goal-directed feedback is a formative feedback that provides users with information about their progress toward a specific goal (Shute, 2008). To create encouragement to minimise the overconsumption of single-use gloves, the facilities can receive goal-directed feedback on how they are doing in their progress. This can be communicated by staff with environmental responsibility at every facility or representative from the environment & health department. Further, due to

uncertainties regarding the specific level of overconsumption, changing the goal orientation from a performance objective to a learning objective can help gain positive outcomes (Shute, 2008). The feedback can be communicated via email or other means of communication. Communicating through email simplifies the delivery of feedback, but is not as personal as with verbal communication. Verbal communication would be difficult and time consuming due to the large number of facilities.

Technical Solution

The following segment is related to finding technical solutions to minimise the overconsumption of single-use gloves. It will mainly be focused on the excess gloves that come out of the package when they are tugged out.

Packaging

From speaking with users, some have expressed that more gloves than needed often come out of the package when they are taken. Therefore there is a need to package the gloves in a way that prevents that more gloves than necessary are being provided.

Other

Another solution could be an object that captures the excess gloves that fall out of the package and save them for later use. This solution would however require the excess gloves to not become contaminated from airborne bacteria during the time they have been out of the package.

Material Recycling

The second step of the process considers material recycling at an early stage where technology for recycling nitrile and latex is still lacking. The steps for material recycling is presented in *Figure 6* below.

Figure 6. Material recycling steps

Downcycling

Materials that cannot be recycled into the same product can be recycled into other products. For example, nitrile gloves can be recycled into rubber floor coverings or floor coverings for sports fields and running tracks (Shannon Nortz, n.d). Instead of throwing away the material, downcycling creates a second life for the recycled material with a new application.

Create Prerequisites for Recycling

Since most of the materials used for gloves today are not recyclable, producing gloves from a material that can be recycled is a step toward a circular process. To increase the likelihood that preschools and elderly care facilities purchase the best gloves from an environmental perspective, gloves on the ordering platform can have a label indicating whether they are recyclable/environmentally friendly. To increase the use of recyclable gloves, a policy can be developed and communicated to all facilities. The disposed gloves need to be taken care of and recycled which requires cooperation with recycling contractors. The start of pilot projects in companies can show the potential of introducing the process for recyclable gloves.

Develop Structures to Support the Recycling Process

Guidelines can be created explaining which gloves can be recycled and which should be discarded depending on the degree of contamination. This facilitates the disposal of gloves and ensures that the recycling process works as intended. To facilitate waste collection, the plastic can be compressed before or during transportation to minimise space occupied by the waste.

Circular Flow

The third step of the roadmap is to create a circular flow for the entire process, covering all steps from the production of the gloves to the recycling of the discarded gloves. The circular model is presented in *Figure 7*, and the proposed actions for each step of the circular model is presented below.

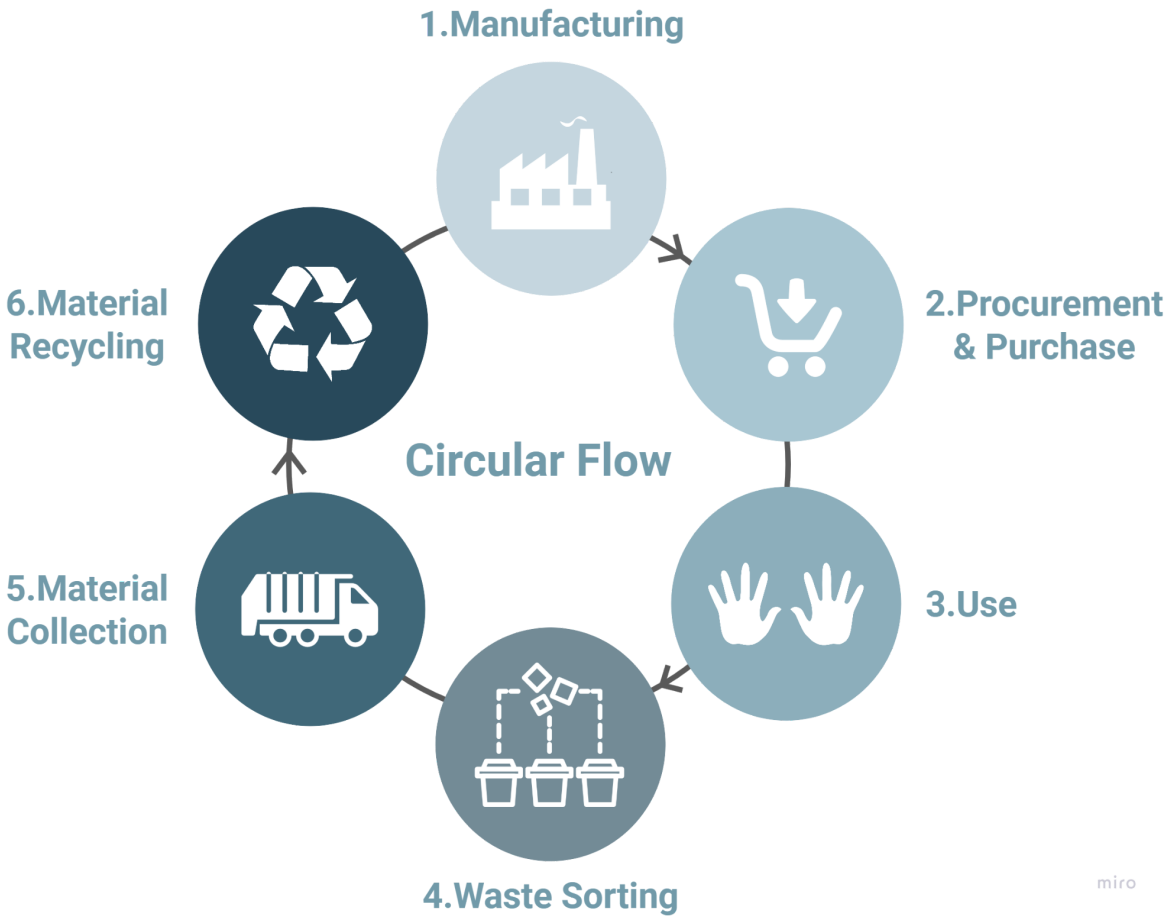

Figure 7. Model for the circular flow process

Manufacturing

When manufacturing plastic gloves, the same type of material can be used to simplify the recycling process. What material that can be used varies depending on the application, but the goal is to find a material that can be used for most gloves. The material will have to have the required mechanical properties from a user perspective, as well as fulfilling the standards needed for use in the area of health and social care. To create incentives for manufacturers to produce gloves from recycled plastic, rules and regulations regarding emissions from production would need to become stricter. Renewable energy can also be used for the manufacturing process.

Procurement & Purchase

Regarding procurement of gloves, environmental aspects should be included in the procurement description/documents to encourage manufacturers to strive for environmentally friendly gloves and to make them aware of what is expected. As mentioned before, the gloves that can be recycled/are most environmentally friendly can have an indication on the ordering platform and these gloves can be added on top of the search list.

Use

As for the use of gloves, it is necessary to work constantly with overconsumption. There should be clear information about which gloves can be recycled and which should be incinerated depending on the degree of contamination. In order to share this information with all employees, along with information about consumption and overconsumption, there can be an elected person at each facility who is responsible for sharing information.

Waste Sorting

To maximise the number of gloves that are recycled while minimising the workload for the staff, users need to be encouraged to sort gloves corresponding to the correct requirements. Depending on the needs for each facility, a ring carrying plastic bags for gloves only can be installed on walls or on the floor to increase the number of places where used gloves can be thrown. By installing a ring where different sizes of bags can be hung, rather than a traditional bin, space is saved, economical and environmental costs for the facilities are decreased, and further investigations of the required space for each station is avoided. Also, by manufacturing the plastic bags in the same material as the gloves, further separation of gloves from the bags is avoided as they can be recycled simultaneously.

A prerequisite for establishing a circular flow of gloves is to separate gloves before being collected by recyclable contractors. Therefore, an investigation into whether there is space in environmental rooms for more vessels is necessary. Further, the required size of the vessels need to be based on the consumption of each facility, minimising the risk of using more or less space than necessary . When established, colour coding the vessels according to colour of the bags and gloves will clarify where the plastic gloves should be placed in the environmental room, for users and recyclable contractors both.

Material Collection

Maximising the amount of material when transporting and optimising the transportation routes are necessary to minimise the environmental costs for the recycling contractors. By compressing the gloves in the bins of the transportation vehicles, and thereby freeing more space in the bins, each vehicle gains an opportunity to transport material from more facilities. By thereafter optimising the routes when collecting recyclable material and using renewable fuels for the transportation vehicles, the environmental and economical costs for the recycle contractors are minimised.

Material Recycling

The plastic collected at the facilities is shredded and melted down at recycling stations. From this, a plastic granulate is produced that can be reused for further purpose. It is important that the material remains in the flow, regardless of what is made of it. The granules can be used to make new plastic gloves as well as plastic bags that can be used in the facilities.

Our Business Model

When establishing the prototype demonstrated above, value proposition, value creation, and value capture changes for all stakeholders in the network. Further, the business model for a circular flow of plastic gloves involves different stakeholders than the current linear flow of disposable plastic gloves. To visualise the value gains and value losses for all stakeholders in the process, a model has been created (*Figure 8*). This business model involves actors within Sweden, neglecting the ways other nationalities' economies and how other societies are affected. However, due to difficulties in limiting the environmental crisis within the borders of Sweden, this business model includes the environmental aspects globally.

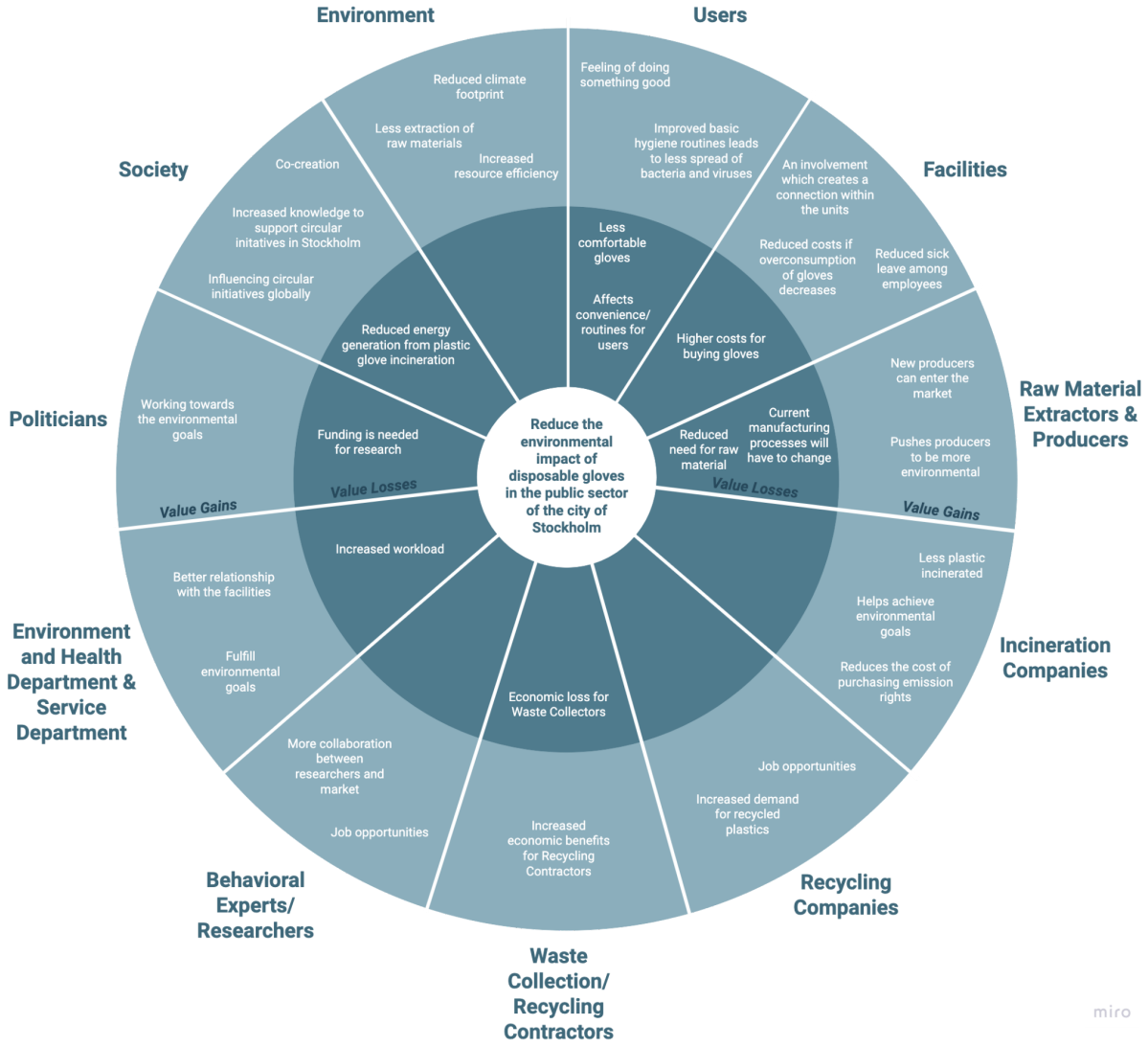

Figure 8. Stakeholder value mapping

Users

By informing users of when gloves are needed and when they are not, the overall basic hygiene routines on facilities improve. Additionally there is the feeling of doing something good for the environment. Since plastic gloves will need to be separated from other waste, a greater responsibility is placed on the end-user. This affects the convenience and routines that users already have and current practices will need to be adapted. Plastic gloves that are recyclable may also lack some material properties that non-recyclable gloves have, this may affect the feel or comfort of the glove.

Facilities

Facilities within the City of Stockholm will gain social, economic, and environmental value with the proposed business model. Recycling plastic gloves can create a unity within the facilities. Moreover, by decreasing the overconsumption of plastic gloves, facilities will reduce costs by purchasing less items. Lastly, by sharing information regarding basic hygiene routines within units, sick leaves among employees will decrease as the staff gain more knowledge.

Long term, the costs for the facilities will be reduced. However, in the short term, the costs might increase before the added value starts paying off in terms of costs. Manufacturing gloves of a recyclable material with renewable material and energy will increase the cost of gloves. Further costs will be added since further services from recycling contractors are needed. However, recycled gloves can reduce the costs for a facility over time as iterations of recycling increases.

Producers & Raw Material Extractors

The possibility to develop plastic gloves that are recyclable can enable the entrance of new producers on the market. Market competition and the increasing trend of environmental consciousness have the ability to push other producers on the current market to implement environmental practices. This will however lead to a decrease in the need for virgin material and present producers will need to rethink current manufacturing processes.

Recycling Companies

Including recycled plastics in an additional market will help recycling companies gain value as the demand for recycled material increases. Recycling plastic gloves in the public sector will create job opportunities as the workload in the sector increases. Additionally, successful operations within the public sector becomes great marketing, increasing the demand for recycled material in the private sector as recycled material has been proven viable.

Incineration

Incinerators see value gains from burning less plastic, as it helps them achieve environmental goals and reduces the cost of purchasing emission rights.

Waste Collection/Recycling Contractors

More types of recycled items need to be managed when considering plastic gloves as recycled goods. Recycling contractors will receive a value gain as more material needs to be transported in different bins to different locations, increasing their workload. As a result, recycling contractors gain economical value as more job opportunities arise. Moreover, since more material is being recycled, the amount of waste is decreased. As a result, waste collectors who do not manage recycling material will lose economical value.

Behavioural Experts/Researchers

When including the concept of nudging to change the behaviour of users, behavioural experts receive an opportunity to interact in the public sector. Furthermore, for the best possible practise to be implemented, behavioural researchers gain value as an extended collaboration between research and market is required.

Environment and Health Department/Service Department

The Environment and Health Department and the Service Department will build a stronger relationship with facilities as communication and knowledge flows are improved. Facilities will gain trust in the departments and they can be a source of information for when they have questions or need assistance. Resources will however be needed from the Environment and Health Department and the Service Department in order to maintain the contact between them and facilities. The implementation of environmental requirements as well as supporting communication will lead to an increased workload.

Politicians

When more projects towards sustainability are considered successful, politicians receive more evidence of the benefits of sustainable alternatives when considering new laws and regulations. If plastic gloves are recycled and accepted by all parties in the value network, politicians that favours sustainable outcomes gain value. On the other hand, all projects in the public sector need to be funded by the government, including this project of establishing a circular flow of plastic gloves. This results in less budget for other needs in society, which can be considered a value loss. However, if more projects towards sustainability have positive results, politicians can receive positive feedback from funding projects and distribute their budgets accordingly.

Society

Initiatives that support circularity can have major power influence, both in the City of Stockholm and globally. By investing in technology and circularity, Sweden has the possibility to gain a leading position in sustainable solutions. This creates opportunities to teach others through leading by example and generating job opportunities at the same time. A leading position in sustainable solutions enables co-creating and producing solutions that benefit society as a whole. In terms of value losses, incineration of plastics is a source of energy that will decrease as a result of introducing gloves that are recyclable. Therefore, alternate sources of energy need to be improved or discovered.

Environment

The essential benefits of circulating plastic gloves is the improved effect on the environment. By avoiding a linear flow of disposable gloves and instead creating a circular flow, the number of incinerated gloves and newly produced gloves are reduced. Since greenhouse gases are emitted when incinerating plastics, the circulatory system reduces emissions of greenhouse gases in the City of Stockholm. Further, circularity decreases the demand for extraction of raw material, resulting in less emissions of greenhouse gases. Since raw plastics are extracted with fossil fuels, decreasing the demand for raw material will benefit the environment (Ciel, n.d.).

Risk Analysis

The roadmap to a circular flow of gloves needs to account for possible risks that the implementation might face. These risks are producer expectations, limitations of laws and regulations and nudging risks.

Producer Expectations

A key assumption is that the plastic used to make gloves is going to be recyclable and that recycling is profitable. It is difficult to predict the evolution of plastics and there are risks for manufacturers entering this unexplored market. At this stage, it is not possible to know how the market will react to this type of solution, whether it is feasible and whether plastic gloves are going to be recyclable.

Limitations of Laws and Regulations

The solution is based on initiatives from the Environment and Health Department. However, there is a lack of sufficient initiatives regarding the subject from other actors, and without laws and regulations from authorities, there is a risk that this will not be pursued further. In the future, stricter rules and regulations will be required, forcing manufacturers and buyers to make more environmentally friendly choices.

Nudging Risks

There are risks that our efforts against overconsumption will have the opposite effect, that gloves are not used when they should actually be used. This must be countered with clear information and continuous communication and feedback to reduce the risk of this happening.

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Appendix

In this section complementary material is provided to give additional understanding of the business plan.

Appendix A. Purchase Statistics from 2019 to 2021

År	Inköpt från	Radetiketter	Summa av Vikt/ köpt totalt KG	Summa av Mottaget antal
2019	Beställningssystem	Nitril	38 849	7 354 650
2019	Beställningssystem	PVC	151 723	22 699 500
2019	Beställningssystem	PE	1 145	472 600
			191 716	30 526 750
2020	Beställningssystem	Nitril	44 392	9 452 212
2020	Beställningssystem	PVC	60 004	9 012 401
2020	Beställningssystem	PE	1 044	431 800
2020	Materialförsörjning	Vinyl= PVC	8 680	1 301 129
2020	Materialförsörjning	Nitril	74 655	14 962 982
			188 776	35 160 524
2021	Beställningssystem	Nitril	53 571	11 924 463
2021	Beställningssystem	PE	899	377 600
2021	Beställningssystem	PVC	58 773	9 365 900
2021	Beställningssystem	TPE	723	298 000
2021	Materialförsörjning	Vinyl= PVC	6 579	986 230
2021	Materialförsörjning	Nitril	56 587	11 341 640
			177 131	34 293 833

Appendix B. Plastic consumables that facilities bought the most of in 2019

Artikelgrupp	Antal unika artiklar	Total mottaget antal enheter (miljoner, avrundat)	Total uppskattad mängd plast (ton)	Huvudsakliga plasttyper
Handskar	23	23	140	Vinyl, gummi (nitril), PE
Blöjor	24	5,2	130	Plastmix
Avfallspåsar, bärkassar och olika säckar	139	11	114	PE, återvunnen plast, biobaserad plast
Inkontinensskydd	112	2,1	105	Plastmix
Engångsförkläden	14	1,7	52	PE
Tvättlappar, svampar, dukar, trasor	75	4,4	44	Övriga plasttyper (t.ex. skum-plast, nylon) eller plastmix
Plastfickor och aktmappar-kontor	33	1,3	13	PE, PP eller plastmix
Engångshaklappar	2	1,2	12	PE, PP
Skoskydd	6	3	7	PE
Portionsform matservering	32	0,3	6	PE, PP
Olika bägare	24	1,8	5	PP, PS, biobaserad plast
Pennor	179	0,7	5	Plastmix
Sanitetspåsar	20	0,5	5	PE
Bestick	14	0,9	3	PS, biobaserad plast
TOTAL	957	57	640	

Appendix C. Glove pyramid