

# SECRET LIFE OF TEES

## introduction

Our stuff has a secret life – a life that exists long before it reaches you as a consumer and extends long after you’re done with it. Most people aren’t aware of the life cycle stages our stuff goes through, not to mention how those stages impact the planet and other people’s lives and economic well-being.

Consider the garment industry and a single cotton-polyester t-shirt. Arable land, fossil fuels, and water are consumed to provide its raw materials. The shirt’s production impacts the lives, jobs, and homes of the people who manufacture it. It is responsible for carbon dioxide emissions as it is shipped, sometimes thousands of miles, to the store where it will be sold to consumers. Once it’s in use, the shirt is washed in detergents, often in heated water, and then sheds synthetic microfibers that wreak havoc on local waterways. After the consumer tires of the shirt, it may be exported and sold on a shipping pallet to a **developing country**, where reselling it provides jobs for some but disrupts the market for local craftsmanship. Or, it is simply tossed in the trash – an estimated 10.5 million tons of American clothing ends up in landfills every year.

A **life cycle analysis, or LCA**, is a technique that assesses the impact of a product and can help identify changes that will decrease a product’s eco-impact over the course of its life. As our population grows, it is more important than ever to consider how the clothes we wear are intricately connected to other people’s lives and to our environment.

**Vocabulary:** composted, developing country, greenhouse gas, life cycle analysis (LCA)

## materials

- Paper bag
- T-shirts with legible tags
- 5 personal computers/tablets
- Student Worksheet

## preparation, before class:

1. Arrange the room in five collaborative work stations that can each accommodate 4-6 students. (If you prefer smaller



Studies For Our Global Future

### concept

Every man-made product has a life cycle, each stage of which contributes to its environmental footprint and social impact. Consumers can change these impacts through their purchasing decisions.

### objectives

Students will be able to:

- Analyze the factors that influence a product’s environmental, social, and economic impact.
- Conduct guided research to complete a basic life cycle analysis of a t-shirt.
- Create an action plan, including responsible parties and possible consequences, that would decrease the impact of their t-shirt by altering key parts of its life cycle.

### subjects

Environmental Science (General and AP), AP Human Geography, Geography, Economics

### skills

Guided research, critical thinking, analyzing costs and benefits, creating an evidence based action plan

### method

Students use guided research to perform a five-stage life cycle analysis on a t-shirt and brainstorm ways to reduce the garment’s social and environmental impact.

groups of students, make two of each station so there are 10 total, each accommodating 2-3 students.) Each station should have a computer or tablet with sound and internet access.

2. Ask students to bring in a clean t-shirt from home. It can be any material, design, or size if it has a legible tag and does not display inappropriate images or messages. The t-shirt will not be damaged during the lesson. Bring in 5-10 additional t-shirts, preferably from different countries of origin and made of different fabrics, for students who are unable to provide their own; each student will need one shirt. If you prefer to bring in t-shirts for all students rather than asking them to bring their own, make sure there is a good variety of different fabrics and countries of manufacture.

## procedure

1. Bring a paper bag to class, and ask students to hypothesize what they think it means to conduct a life cycle analysis (LCA) of a product. Then brainstorm the paper bag's LCA as a class. You can display the circle image below if they have trouble determining the five stages. As you go through each stage as a class, ask students to think about what factors influence the environmental impact of that stage.

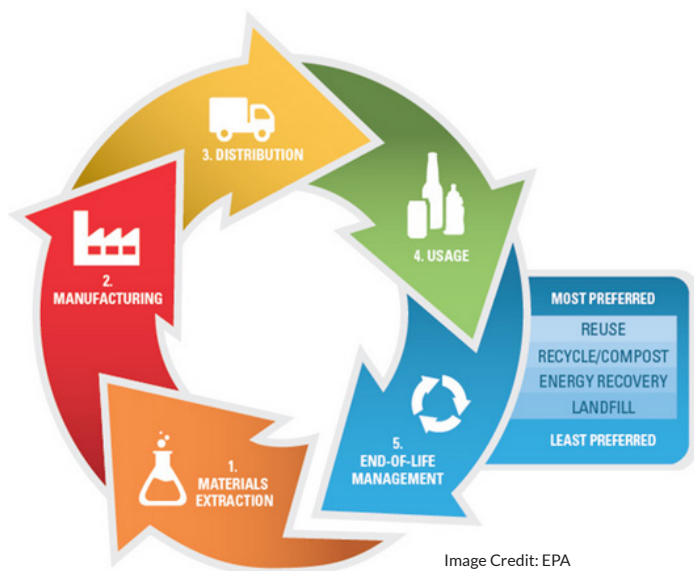


Image Credit: EPA

Here's an overview of potential impacts during each stage:

**Materials** – The materials used to create a product must come from somewhere. Some are extracted from mines, others are grown specifically to be used by humans, while others might be taken from the ocean or a forest. Removing these materials impacts the Earth's natural resource base and gathering them requires labor and energy.

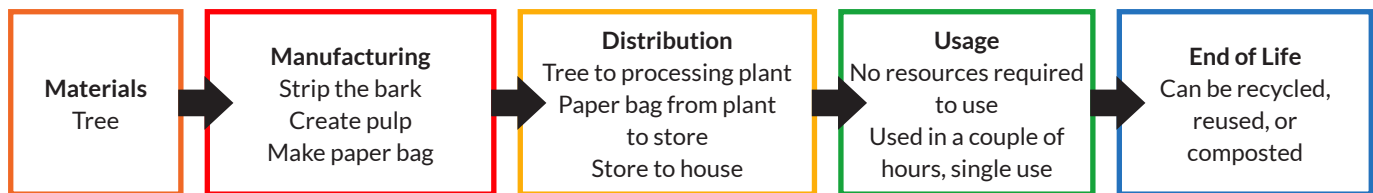
**Manufacturing** – Each piece of a product has to be created separately before being combined with the other parts. The manufacturing of each piece requires energy and water and can produce toxic waste. The processing of metals and plastics is especially resource intensive because they must be melted and refined before use.

**Distribution** – Many things must be transported for a product to exist – the raw materials to the production factory, the product to stores, and finally, the product to consumer homes. All of this transportation emits **greenhouse gas** and contributes to the eco-impact of the product.

**Usage** – Some things require energy to work (appliances, electronics, cars, etc.), and this gets factored into their life cycle analysis. Others may require energy to maintain and reuse them, such as clothing. Length of use also plays a role – items that can be used longer have less of a footprint, since they don't need to be replaced by new versions as often. This often means that buying high-quality or reusable items (such as rechargeable batteries) contributes to a lower impact over time than lower-quality, often less-expensive items.

**Disposal** – Both the product itself and its packaging must be eliminated. Materials that can be recycled or **composted**, like cardboard, have less of an impact than those that cannot, like Styrofoam. Some items are also easier to reuse or donate than others.

### Paper Bag LCA:



2. Divide students into groups of 4-6 and distribute a Student Worksheet to each student. Explain that they will build on their experience of conducting a quick life cycle analysis for the paper bag by doing an in-depth LCA of another everyday consumer product: a t-shirt.
3. Students should follow the directions on the Worksheet to complete LCA of their t-shirt. For each life cycle stage:
  - a. Students conduct guided research, accessing specific articles and/or videos.
  - b. Students then use their own data (from the t-shirt they brought in, or from their own experiences and habits) to describe the social and environmental impact of the t-shirt in that stage.
  - c. They will then describe at least one idea for improvement that could lessen that impact.

Students should work together in their groups to access all of the resources for each life cycle stage and collaborate when discussing answers. However, every student should complete his or her own Worksheet and use the t-shirt brought from home or provided by the teacher. So, some answers will be different within a particular group.

4. Each stage should take approximately 20-30 minutes to complete. Provide students with a time check and let them know when they should switch to the next step.
5. Once all stations are complete, explain the final question on the Student Worksheet, which asks students to write an action plan based on their ideas for improvement. Give students time to write this plan in their groups collaboratively.

## discussion questions

1. Which stage of your t-shirt's life cycle do you believe had the greatest environmental impact overall?

*Answers will vary. Some students may say that the materials stage has the greatest impact because of the amount of arable land and water required to grow natural fibers, or the plastic and energy required to create synthetic ones. Other students may note the growing scientific concern over microplastic fibers during washing and argue that usage is the stage with the largest ecological impact.*

2. Which stage of your t-shirt's life cycle had the greatest social impact overall?

*Answers will vary. Students will likely focus on the manufacturing stage, as most shirts are made in developing countries with low minimum wages and often difficult working conditions. However, some students may note that this provides job opportunities for those who need them – these students may focus more on the disposal stage and the impact of the massive shipments of donated clothes from the U.S. to parts of sub-Saharan Africa, which can disrupt the local economy by flooding the market.*

3. Could we assign a monetary cost to these environmental and social impacts? Explain.

*Right now, most items with lower environmental and social costs tend to have higher monetary costs because they require higher quality materials or more expensive labor. So it would be difficult to flip that paradigm, although regulations (laws, fines) may help discourage products that have an especially high impact on the Earth. When consumers are more aware of the impacts of a product, though, some may be willing to pay more money for a product that has a smaller footprint.*

4. Would you be more likely to buy a product that had a smaller environmental impact over another one? Why or why not?

*Answers will vary.*

5. When and how does a consumer have the most power to change the t-shirt's impact? What are some of these possible changes?

*Answers will vary. Students might argue that usage is the best place to reduce impact, since that is the stage where the consumer is in possession of the item and can decide when and how to launder it, as well as how long to wear it before disposal. Others may note that when you buy a t-shirt, you have the power to affect both materials and manufacturing, since you can select the fabric and the country of origin, as well as purchase from companies with sustainable and socially responsible practices.*

6. Based on your research, what would be the “perfect” t-shirt? How would it be made, shipped, used, and disposed of?

*Answers will vary. You may wish to have each group briefly share its action plan for improvement. Students should combine the ideas shared to come up with an “ideal” t-shirt. It is likely that some groups did the same stage for their action plan and may disagree with each other. You can discuss with students why that is the case and provide them with opportunities to defend their action plan with notes from their research. If no group chose a particular stage to improve upon, briefly come up with some potential suggestions as a class and jot them down on the board.*

7. Why do you think companies don't make the “perfect” t-shirt? What factors are stopping us from creating clothing with the smallest possible impact?

*Cost is a major prohibitive factor. Companies must be profitable, and so they tend to go for the cheapest options. If the company pays more for higher quality materials or for better wages for its workers, then it will pass these additional costs on to the consumer. Many people cannot afford to buy more expensive clothing. There is also an awareness factor – consumers are not always educated about the ways their purchases impact the Earth and other human beings' lives around the world, so they do not see the point of changing their buying habits. Finally, all may not agree on what constitutes the “perfect” t-shirt. For example, some people may say that we should save our valuable crop land for growing food by avoiding cotton clothing, while others would argue that synthetic fibers have a major impact on the world's bodies of water and we should avoid them instead.*

## assessment

Assess students' action plans for clarity and creativity, as well as incorporation of the research findings.

## follow-up activities

1. Have students send their LCA of the t-shirt to their favorite clothing store. They can explain their concerns and interests as consumers, and describe what steps the store should take to improve the footprint (social and environmental) of the clothes for sale.
2. Students create an LCA for products that the school or district uses, such as desks, carpets, or textbooks. They can identify ways to decrease the school's impact and share it with the principal or school board.
3. Students research other everyday items, besides t-shirts, to see if anything is being done to lower their impact. For example, Nike uses a program called Nike Grind (<https://www.nikegrind.com>) to create sports fields out of pieces of old shoes that were otherwise bound for the landfill.

# SECRET LIFE OF TEES | student worksheet

Name: \_\_\_\_\_ Date: \_\_\_\_\_

For each stage of your t-shirt's life cycle, first visit the listed websites and examine the information provided. Then fill in the chart columns for pros and cons beside each fact. Next, answer any additional questions in that life cycle stage. In the "Impacts" portion, provide a detailed analysis of the environmental and social effects of your particular t-shirt, using your answers to the questions that came before it. Finally, identify at least one way to decrease the impact in this life cycle stage as an "Idea for Improvement."

## life cycle stage 1: materials

Article: <https://www.nytimes.com/2017/05/24/climate/eco-friendly-organic-clothing.html>

Video/article: <https://apps.npr.org/tshirt/#/cotton>

Fact	What are some pros of this?	What are some cons of this?
Rayon is a natural fiber harvested from bamboo forests and refined using chemicals in factories.		
Synthetic fibers like polyester and nylon make up over half of the global market for fabric.		
Cotton, which is the most widely used fabric in the world, uses about 2 percent of the Earth's arable land and almost 3 percent of the global water supply.		
About 90 percent of all cotton crops grown in the United States are genetically modified to be pest-resistant or higher yield.		

Look at the tag on your t-shirt to determine what fabric(s) it is made of and record them here, with percentages:

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Impacts of My Shirt: \_\_\_\_\_

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Idea(s) for Improvement: \_\_\_\_\_

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## life cycle stage 2: manufacturing

Video/article: <https://apps.npr.org/tshirt/#/people>

Podcast/article: <http://www.npr.org/sections/money/2013/12/03/247360855/two-sisters-a-small-room-and-the-world-behind-a-t-shirt>

Article: <http://www.nytimes.com/2013/07/15/world/asia/bangladesh-pollution-told-in-colors-and-smells.html>

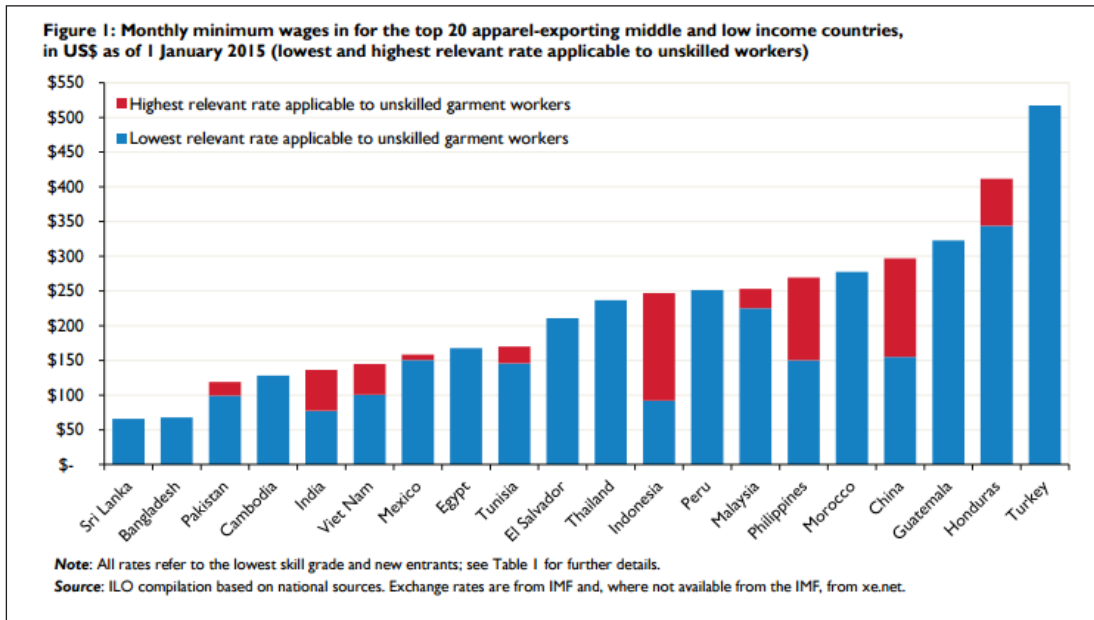
Fact	What are some pros of this?	What are some cons of this?
Compared to other countries that make and export large amounts of clothing, Bangladesh has the lowest minimum wage.		
Many women in Bangladesh are leaving subsistence farming villages and moving to cities to work in garment factories.		
Due to lack of regulation by the government, pollution from factories (such as chemical dyes) often enters the living areas of people in Bangladesh.		

In what country was your t-shirt made? \_\_\_\_\_

Describe any dyes or colorings used in your t-shirt. \_\_\_\_\_

What is the minimum wage in that country\* for garment workers? \_\_\_\_\_

\*If it isn't available in this chart of the top 20 apparel-exporting countries, look it up on the internet.



Impacts of My Shirt: \_\_\_\_\_

Idea(s) for Improvement: \_\_\_\_\_



## life cycle stage 3: distribution

Article: <https://www.theguardian.com/environment/2014/nov/02/environmental-impact-of-shipping-goods>

Article: <https://www.theguardian.com/sustainable-business/2014/aug/01/sustainable-shipping-is-making-waves>

Fact	What are some pros of this?	What are some cons of this?
Over 90 percent of the world's exports are shipped by sea.		
New regulations will require the world's freight ships to invest in better fuel or install scrubbers to remove pollution.		

Impacts of My Shirt: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Idea(s) for Improvement: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## life cycle stage 4: usage

Web page: <http://envormation.org/environmental-footprint-of-clothes-washing/>

Web page: <http://home.howstuffworks.com/laundry-detergent4.htm>

Article: <https://www.theguardian.com/environment/2016/jun/20/microfibers-plastic-pollution-oceans-patagonia-synthetic-clothes-microbeads>

Fact	What are some pros of this?	What are some cons of this?
Newer models of washing machines and dryers tend to be more efficient and use less energy to do laundry.		

How often do you (or someone in your family) wash your clothes? \_\_\_\_\_ machine loads/week

Do you use hot/warm water, cold water, or a mix? \_\_\_\_\_

How do you dry a typical t-shirt after washing it? \_\_\_\_\_

What type of detergent do you use when washing clothes? \_\_\_\_\_

What type of fabric is your shirt made of? \_\_\_\_\_

Impacts of My Shirt: \_\_\_\_\_

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Idea(s) for Improvement: \_\_\_\_\_

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## life cycle stage 5: disposal

Article: <http://www.npr.org/2016/04/08/473513620/what-happens-when-fashion-becomes-fast-disposable-and-cheap>

Article: [http://www.huffingtonpost.com/entry/these-african-countries-dont-want-your-used-clothing-anymore\\_us\\_57cf19bce4b06a74c9f10dd6](http://www.huffingtonpost.com/entry/these-african-countries-dont-want-your-used-clothing-anymore_us_57cf19bce4b06a74c9f10dd6)

Fact	What are some pros of this?	What are some cons of this?
"Fast fashion" is growing rapidly, much more quickly than traditional fashion retailers.		
The United States exports over 1 billion pounds of used clothing every year, shipping it across the ocean to developing countries.		
The East African Community inter-governmental group considered a ban on imported clothing.		

How long do you usually own an article of clothing before getting rid of it? \_\_\_\_\_

What do you usually do with your clothing when you don't want to wear it anymore? \_\_\_\_\_

\_\_\_\_\_

Impacts of My Shirt: \_\_\_\_\_

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\_\_\_\_\_

Idea(s) for Improvement: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



# Suggested Answers to Student Worksheet

## stage 1: materials

Fact	What are some pros of this?	What are some cons of this?
Rayon is a natural fiber harvested from bamboo forests and refined using chemicals in factories.	<i>It's not made from fossil fuels, unlike synthetic fibers. Bamboo is very fast-growing so it takes relatively little space to grow.</i>	<i>Some chemicals are dangerous to the workers who breathe them in. Often, old-growth forests are cut down to make room for bamboo fields to make rayon. Arable land is sometimes dedicated to rayon instead of food.</i>
Synthetic fibers like polyester and nylon make up over half of the global market for fabric.	<i>No arable land is dedicated to growing these materials, and they do not require watering as crops do. Consumers may find synthetic fibers to be lighter-weight and better for athletic activities.</i>	<i>Making these fabrics requires plastic which is fossil-fuel based. Melting the plastic into fibers involves energy and water. Also, these synthetic fabrics shed tiny microplastic fibers that can get into waterways and cause harm to ecosystems.</i>
Cotton, which is the most widely used fabric in the world, uses about 2 percent of the Earth's arable land and almost 3 percent of the global water supply.	<i>Cotton is a natural fiber that isn't made from fossil fuels. Unlike synthetics, it doesn't break down into microplastics in the wash. It's biodegradable too.</i>	<i>This arable land could be used to grow food for those who are malnourished. Growing cotton diverts water from other sources, such as food crops or drinking water.</i>
About 90 percent of all cotton crops grown in the United States are genetically modified to be pest-resistant or higher yield.	<i>This produces more cotton per plant and prevents pests from eating the cotton. It could lower the use of pesticides if plant is genetically pest-resistant. It saves money for farmers and thus saves money for consumers in the long run.</i>	<i>Pest-resistant cotton could harm other non-pest insects. Many consumers don't trust GMOs. Some companies own the rights to certain seeds and charge more money for them.</i>

## stage 2: manufacturing

Fact	What are some pros of this?	What are some cons of this?
Compared to other countries that make and export large amounts of clothing, Bangladesh has the lowest minimum wage.	<i>Bangladesh is a major exporter of garments, which can help its economy. The huge number of factories there can reduce poverty by providing jobs.</i>	<i>It can be difficult for workers to get out of debt or make enough money to save for a future outside of the factory job. It is also energy intensive to ship large quantities of garments for U.S. consumers to and from Bangladesh, increasing the emissions that cause climate change.</i>
Many women in Bangladesh are leaving subsistence farming villages and moving to cities to work in garment factories.	<i>Women are able to earn more money in the new job than they were before. They are also empowered to work outside the home and support their families, and have more choice about when they get married and have kids.</i>	<i>Cities become crowded and living conditions deteriorate. Working prevents some girls from finishing school, limiting their options later in life. In addition, women have to leave their homes and families (including their kids) to move to cities. Factories can also be dangerous places to work.</i>
Due to lack of regulation by the government, pollution from factories (such as chemical dyes) often enters the living areas of people in Bangladesh.	<i>This column should be left blank.</i>	<i>This harms the health of people nearby, as well as of factory workers. It also negatively impacts the economy by ruining crops and destroying ecosystems.</i>

## stage 3: distribution

Fact	What are some pros of this?	What are some cons of this?
Over 90 percent of the world's exports are shipped by sea.	<i>It's more efficient and less polluting than air travel. Thus, it contributes less to climate change than if it were being flown on planes.</i>	<i>This requires significant amounts of fuel. The people who work on the ships often lack safe and healthy working conditions.</i>
New regulations will require the world's freight ships to invest in better fuel or install scrubbers to remove pollution.	<i>These decrease the negative health impacts of shipping on workers. It reduces air pollution that causes illness.</i>	<i>The scrubbers are not addressing major greenhouse gases that cause climate change. These higher costs to the company mean higher consumer costs. If shipping by sea becomes more expensive, it could lead to more air freight, which is a bigger polluter.</i>

## stage 4: usage

Fact	What are some pros of this?	What are some cons of this?
Newer models of washing machines and dryers tend to be more efficient and use less energy to do laundry.	<i>People can contribute less to climate change if they upgrade their appliances. This requires no additional work on your part once you have the newer machines. This saves money on your water and electric bills.</i>	<i>Making and buying these new washers and dryers requires energy and labor. These appliances have their own LCA with social and environmental impacts. It also might encourage people to use the laundry machines more often if they think it's better for the Earth, rather than doing less laundry and/or air-drying their clothes.</i>

## stage 5: distribution

Fact	What are some pros of this?	What are some cons of this?
"Fast fashion" is growing rapidly, much more quickly than traditional fashion retailers.	<i>The clothing is cheaper for consumers. This allows people of all income levels to express themselves according to the latest fashion trends.</i>	<i>Frequent turnover of styles creates lots of excess waste. The clothing doesn't last very long, so consumers have to buy new clothes more often, which may not be as cheap in the end and means a higher footprint from the previous life cycle stages.</i>
The United States exports over 1 billion pounds of used clothing every year, shipping it across the ocean to developing countries.	<i>It is better to keep using the clothes than for them to take up landfill space. Sending these clothes overseas allows secondhand stores to get rid of clothes no one will buy. This provides clothing in places where there aren't as many reliable retailers.</i>	<i>The used clothes are shipped which requires energy, contributing to carbon emissions. Because Americans think they are doing good for the world by donating clothes, they may choose to do that, instead of doing more eco-friendly options, such as keeping their clothes for longer, upcycling them, or swapping with friends/family.</i>
The East African Community inter-governmental group considered a ban on imported clothing.	<i>People who make clothes locally would be able to compete better if imports were banned. This would mean less shipping of clothes from other countries which requires energy and causes carbon emissions. This ban may encourage pride in local fabrics and artisans.</i>	<i>Many people in these East African nations would lose their jobs reselling clothes. It would be difficult for local retailers or artisans to meet the demand for clothes. The U.S. and other developed countries would have a huge excess of used clothes that they would likely sell to countries outside the EAC instead.</i>