Engineering Challenges Written Coursework Checklist

This cover sheet does not count towards the page limit, but anything on here will not be marked as part of the report.

**Referencing**

The questions below will help you check if you have correctly referenced any external sources you may have used when creating your report. External sources includes the teaching material provided to you. If you do not follow these referencing guidelines then you may commit academic misconduct and you may be penalized.

* What referencing style have you used?

IEEE format

* Have you included references for any external sources (including the teaching material provided to you) that you have used?
  + Yes/No (Please delete as appropriate)
* Where have you specifically referred to an external source (including the teaching material provided to you) in your report have you included in an in-text citation?
  + Yes/No (Please delete as appropriate)
* Where you have directly quoted material from an external source (including the teaching material provided to you), have you used quotation marks (“…”) and provided an in-text citation?
  + Yes/No (Please delete as appropriate)

If you have answered no to any of the questions above please consider reviewing your work and checking that you have not commit academic misconduct.

**AI Tools**

AI Tools are more widespread that you might have realized. They can be useful and help to make our writing clearer and more understandable. However as with all tools, they are only useful when we know how to use them. Part of this process is understanding where we are using them and being transparent about how and when we are using them.

* Which AI tools have you used when writing? This includes spelling and grammar checkers as well as text predictors.

Chat-GPT

* How have you used them? For example, was it throughout the document? Or in a specific paragraph or section?

For suggesting ideas of risks at the PESTEL part of the document.

* If you had to add settings or a prompt, please add that below?

“Potential risks when building a bioreactor”.

* How useful do you think it was? How might you use it in the future?

Chat-GPT was very useful in suggesting ideas for the risks and I took some of them and expanded on them in my document. In the future, will still only use it to give me suggestions.

**Risk and Security Report Template**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Political | Environmental | Social | Technological | Economic | Legal |
| There can be civil unrest.  There can be corruption in the government when handling money for the bioreactor. | Needs to be a plan to deal with potential leaks.  Waste products can worsen the air quality.  Soil health can be affects by the new bioreactor. | The land used can displace local people in that area.  The resources used can be taking away from the locals.  With less community participation, there can be distrust. | Need to secure the data being passed through IoT devices.  Need infrastructure to build the bioreactor.  The bioreactor parts need to withstand the conditions of the area. | The money used to build the bioreactor can run out.  Changes to the tax regulation of imported money can cause a reduction to the total budget | There can be different policies and trade regulations.  There can be different labour laws in Uganda. |

One of the risks I have identified is that we can displace lots of people from the area used. When building a bioreactor, the entire factory can take up hundreds of thousands of feet. There can also be a further amount of space taken up by places where there might be contamination. There might even be multiple of these factories across Uganda, so it takes up much more space. This can cause issues for the local Populus since there has been more immigration to Uganda. Uganda “has received an average of 1800 South Sudanese refugees daily since July 2016.” [1]. This means that the government might refuse for the bioreactors to be built if it interferes with the people living in that area. To mitigate this, we can reduce size of bioreactors through pre-production of materials. Some of the parts can be made in another country, and then we can put all the materials and use them in the bioreactor in Uganda. This means that the factory will be smaller since there are less things to produce in Uganda. Another risk is that there can be potential leaks that injure/kill the local people. From the years 2011 to 2016, “hazards of fire, explosion, and loss of containment of biologically active substances and toxic chemicals” accounted for “the largest fraction (~17%) of the bioprocessing industries” fatalities [2]. So, leaks seem to be one of the more dangerous risks in our list. There are multiple ways to mitigate this risk and one of them is to use a leak detection system that can warn the workers that there is a leak and so can evacuate anyone that is nearby. Another way to mitigate the risk is to have regular checks of the bioreactor system. We can even hire scientists or engineers out of local universities to do these checks on the system so that it can also allow for more community involvement in the bioreactor project.

|  |  |
| --- | --- |
| Issues that may arise | How to mitigate them |
| One of the risks that can arise is the lack of data security between IoT devices. It is said that “every week 54% of organisations suffer from cyber-attacks on IoT devices” [3]. Recently, “Uganda experienced the first terrorist incidents in home soil since 2021…by al-Shabaab” [4] With these terrorist attacks, there could be potential cyber-attacks that happen to disrupt the production of vaccines. Terrorists can exploit the fact that some IoT devices do not encrypt the data that is sent from one device to another.  Another risk is that the waste products can affect the soil life around the factory. It is estimated “that about 68% of Uganda are employed in agriculture” [5]. So just dumping out the waste products to the land can have serious effects on the plant life and so affect the local populous. This may even turn the government against the project as their people are being negatively affected by a project that should be helping them. Dumping liquid such as acid in the soil can “decrease the availability of plant nutrients…and increase the availability of some elements to toxic levels” [6].  Another risk is that there might be a lack of employment in the local area. As mentioned, “68% of Uganda are employed in agriculture” [5] and so taking up land that can be used for agriculture might cause backlash to the project.  One more risk in this project is that we might not be able to get all the resources such as metals from outside of Uganda inside of the country. This means that we would have to make less bioreactors and hence could slow down the production of the vaccines.  A risk for the scientists that are coming in is getting infected with diseases in the area. Examples include malaria, tuberculosis, meningitis, and Covid-19 [11]. This could cause potentially fatal symptoms if the scientists don’t get treated. | To mitigate the chance of being hacked by a bad actor, we can encrypt the data that is sent from the IoT devices in the bioreactor. One example is the ECC encryption algorithm which “makes it possible to generate smaller, faster and more reliable cryptography keys”. [7] Using ECC means that encryption can run on lower spec systems like IoT and still be fast. This can help keep details about bioreactor and factory private.  A way to mitigate waste products polluting the local population is by using bioreactor landfills. This takes the biological waste products of the bioreactor and putting them into a landfill. Then, “liquids are added to help bacteria break down the waste” [8]. For the non-biological waste such as acid, they can be put into safe containers so to be buried away from the locals, leaving no chance for the soil to be affected.  To mitigate the unemployment due to the use of the land, the factory could employ the local people in the factory doing certain jobs such as clearing the land to prepare for the bioreactor factory coming in. Also, the local population can be employed to package the vaccines as this does not require much training. The average wage in Uganda is only 110.534 US dollars per month [9]. So, paying the locals higher wages than this can also mean that the government sees this bioreactor project as beneficial for the economy on top of the fact that they are producing vaccines for a deadly disease in their country.  A good way to mitigate this risk and make it beneficial for the country is to mine metals from Uganda itself. A good place to mine is “mayuge iron ores…the iron content is quite high, about 70% Fe” [10]. This could provide better job opportunities for the locals and so increase support for the project.  A way to mitigate the risk for scientists catching diseases in Uganda is to vaccinate them before they leave. Such boosters include the MenACWY that protects against meningitis. |

**References**

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[8] US environmental protection agency. “Bioreactor Landfills”. [*https://www.epa.gov/landfills/bioreactor-landfills*](https://www.epa.gov/landfills/bioreactor-landfills). [November 29, 2023].

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[11] CDC. “CDC in Uganda”. [*https://www.cdc.gov/globalhealth/countries/uganda/default.htm*](https://www.cdc.gov/globalhealth/countries/uganda/default.htm)*.* [November 29 2023].