Stakeholder Analysis

Aafke van Aalst, Maxim Allaart, Sergio Babel and Kimberly Barentsen

Design description

Antibiotic resistance is one of the biggest threats to global health, food security and development today, according to the World Health Organization. This resistance occurs naturally, but misuse of antibiotics in humans and animals is accelerating the process. A growing number of infections – such as pneumonia, tuberculosis, and gonorrhoea – are becoming harder to treat as the antibiotics used to treat them become less effective. Antibiotic resistance leads to longer hospital stays, higher medical costs and increased mortality [1]. The iGEM TU Delft Dreamteam 2017 aims to create a diagnostic tool that is able to detect antibiotic resistance, even outside specialized hospital environments. In order to achieve this, *E. coli* needs to be engineered to produce a highly sensitive detector, which can be stored and maintained on a piece of paper. In this way, general practitioners can specifically prescribe antibiotics for each infection, as beforehand it can be checked easily whether or not the antibiotics will be resisted by the microbe. Above that, farmers can check whether or not some of the antibiotics added in the food are non-essential. This can greatly reduce the misuse of antibiotics used for both medical purposes and in the food industry.

Stakeholder Analysis

During the actor analysis an overview of potential stakeholders was made. Our analysis is based on the distinguishment of three different kinds of actors: the direct and indirect customers and potential influencers that can stimulate and inhibit the process. We assumed two different markets could be interesting for our device; medical market for human health and medical market for cattle. These actors are of importance for the development of the new antibiotic resistance detection tool. Considering environmental safety, sustainability, health, security, economic benefit, accountability, meaningfulness, public opinion, efficiency and beneficence, we took into account several stakeholders in an actor map. It is speculated how the actors might influence each other. These actors should be involved and engaged in the design of our tool to make our project relevant and impactful. Taking into account their opinion and their needs will help us to implement our device into society. In Figure 1, an overview of potential stakeholders is presented schematically. Note the arrows indicate which stakeholders *might* influence each other. During the process the map will change when gaining more insights after talking to different actors. In the next section, the most important representatives are interviewed. These interviews helped us in the identification of more potential stakeholders to get a complete overview of the niche we implement our technology in in the future.

During the stakeholders analysis we gained more insights into which stakeholders and which actors are important in this phase of the project. Other actors might be interesting in a later phase.

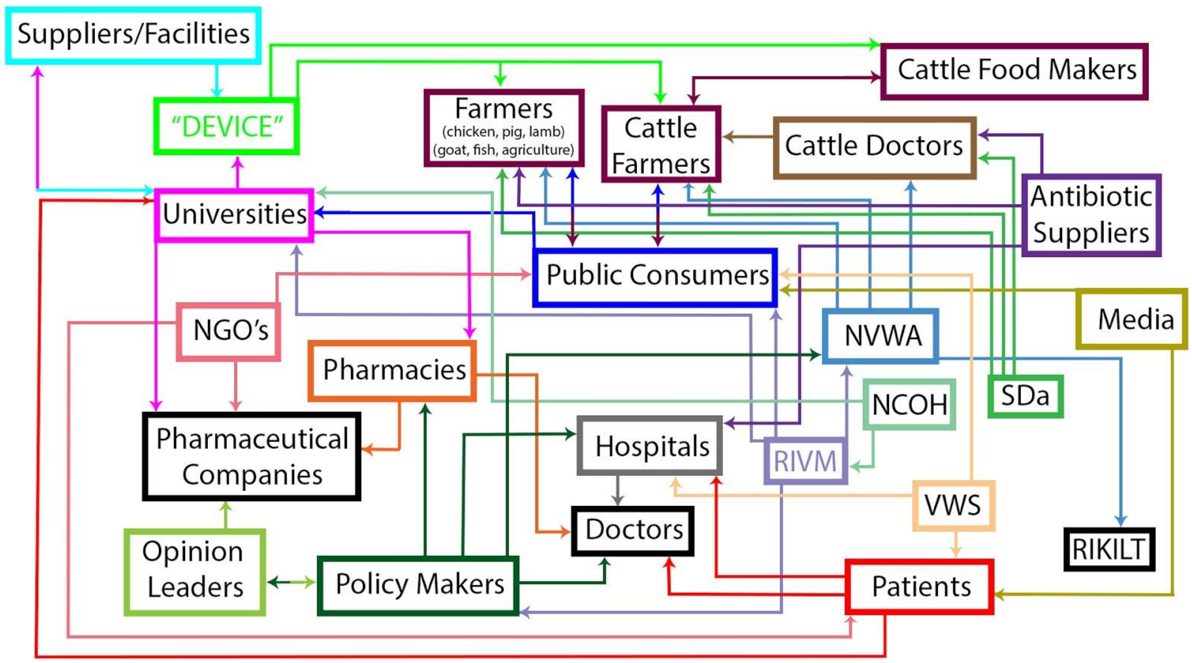

Figure 1. Actor map. This map shows a set of important stakeholders and how they are related to each other. The arrows indicate actors that might influence each other.

First phase engagement of stakeholders

Mapping of stakeholders gave us an overview of the potential impact our device could have on them and their complete field of work. For making our device we are dependent on the University of Delft that helps to facilitate the first prototype. This makes the University Delft an important facilitator. This prototype can be our way into the niche market. A working prototype should attract investors for scaling up the product, and other suppliers. However, as we are still in the first phase of our project, focussing on stakeholders needed for scaling up is not our main goal in this stage. The focus is rather on the stakeholders who can inhibit or stimulate the process to make a prototype.

This is why we should first consider the direct customers, which could be the farmers, general practitioners and diagnostic centres, or veterinarians. What are their concerns and what pain could the device help to overcome? Above that, we should consider the public authorities which can either inhibit or stimulate the process. The feedback of these actors are most important for the design and the actual function of our device. This way, we can identify the need of our device in the society. As these actors are most important for the design of our device, we looked into these actors during this first phase actor analysis.

Public authorities

To have an idea whether or not our design would be resisted by the public authorities, we contacted RIVM (The Institute for Safety and Environment). The first interview was with the **Risk Assessor of GMOs**. We learned about the different movements based on three specific applications for the GMOs; industrial applications, use for improvement of vegetation, and medical applications. The resistance towards GMOs was great during the early stages of GMO development. However, quickly the resistance towards GMOs used for medical purposes ceased as the benefits outweighed the risks. For industrial purposes, this same trend is progressing at a slower pace, mainly due to the fact that the GMOs are in a contained environment.

As long as the consumers do not have to be in contact with the GMOs, people are fine with it. In industries, GMOs are used as little cell factories that are the workhorses that drive the process. Only the products leave the contained environment, making it appealing for the general public. The resistance towards genetically modified vegetation does not seem to decrease. When having modified organisms out in the open the safety of the environment cannot be ensured.

After explaining our idea in detail, the Risk Assessor predicted that our design would not lead to a lot of resistance, as it can be compared to the trend shown for industries. Making compounds with GMOs in industry for medicines and non-food related products are currently not a problem for the broader public. Considering the risks, she has no concerns about our design and she thought that especially for farmers and diagnostic centres our design could be interesting.

Next, the **Policy Advisor of the RIVM** was contacted. First of all, considering our device, she recommended us to contact different authorities that regulate the addition of antibiotics to cattle food in The Netherlands. Besides that, it might provide extra insight to contact the Netherlands Centre for One Health (NCOH), which has a close collaboration with RIVM. Tackling antimicrobial resistance (AMR) is one of their research themes, while focussing on human health, livestock health and healthy wildlife and ecosystems. [2] Secondly, her concern was that this application might not be a 'pain reliever' in The Netherlands as the regulation of antibiotics is strict. That is why she advised to talk to the customs (border control) as the international differences between regulation of antibiotics affects the dutch farm industries. "How to keep "the bug" outside the borders?" seems to be the main issue. The potential of the device would be that it is quick and easy to use.Lastly, she told us to look into the competing tools that are already on the market and compare our device. In this way we can determine whether or not our device is really needed.

Judging from this interview, we might want to consider to look at international policy about antibiotics and possible implementation of the tool in other countries.

Direct customers: cattle farmer and general practitioner

Now that the attitude of the public authorities was rather positive towards our design, we decided to contact our direct customers. An interview with a **cattle farmer in the milk industry** gave us a little more insight in the issues of one of our most important stakeholders. This is one of the most important stakeholders because our technology might influence the health of their animals, which in fact is their income. The farmer told us that in the milk industry antibiotics are generally not used in the food, but only if animals get sick. Beside this, different types of antibiotics are used for the animals than those that are used for humans, to prevent risks. This is due to Dutch legislation that prohibits the use of antibiotics in the cattle industry. The Dutch Food Authorities regularly check the urine of the cows to make sure that no antibiotics are used. This farmer therefore was positive about the technology that we are designing, despite the fact that he did not know exactly how the authorities are currently conducting their controls. In his opinion, it would be practical to make the tests the authorities are doing more easy and less expensive, also if genetically modified organisms or proteins produced by them are used to do this. Beside this, it is clearly important for the cattle industry to minimize the risk of developing resistance for antibiotics that are used for animals.
The farmer thinks that our technology would be the most applicable if quick action is required when animals get sick. He would be very happy with a tool that enables a fast detection of the type of antibiotic that will be suitable to use.

The most important thing that the farmer stresses during the interview is the fact that the free world market is an actual threat for our Dutch cattle. Legislation in other countries is less strict and he is worried about diseases that do strike in other countries and are brought to The Netherlands through international trade. If bacteria become resistant in other countries, this could also affect us. When introducing our technology, it is therefore important not to focus solely on our own country. It would be for example very desirable to be able to influence the European policy with this technology, as it might enable the reduction of antibiotic use in other countries. It is important to note that in countries in which food security is not the standard, our tool might have even more impact than here in The Netherlands.

This interview further substantiates the advice that we should broaden our scope and pay more attention to foreign policy on antibiotics use.

As the other potential application of our device is to make it easier to prescribe antibiotics in a more personalised way, we spoke to a **general practitioner** to find out his opinion about the tool we are able to design. The main message that we got from him, is that the most important thing about the technology is that it has to be safe when genetically engineered organisms are involved. His fear was that these organisms will end up in our environment, which will have consequences we might not even be aware of. We clearly see the importance of this message, as it is likely that a big part of the general public will agree on this with him. When we told him that the GMO will actually not leave the lab, but only some of the proteins it produces, he was still not convinced that this ensures environmental safety. In general, this means that we have to set up a clear communication plan for implementing this tool into society, to prevent that people get scared of it rather than glad that it exists.

We came to talk about the actual application of the device a bit later on during the interview. In this part of the interview, it became clear that a tool such as ours is actually very desirable for general practitioners, as they often prescribe an antibiotic and at the same time a cell culture is started which can be used to indicate the correct antibiotic for the particular case. However, cell culture takes five to six days, which is inefficient. This procedure can lead to the prescription of the wrong type of antibiotic which might facilitate the development of bacterial resistance. Our tool could offer a partial solution for this problem. Also, when local microbiologists are consulted about which antibiotic to prescribe or about current resistances, they often give different answers as the resistance spectra are dependent on the region you are in. If our device could provide unambiguous insight on which antibiotic can certainly not be prescribed, this would help doctors a lot.

However, the practitioner is still concerned about the accuracy of the tool: it must be completely accurate before it can actually be implemented in society. He points out that specific devices for frequently occurring infections would be nice, because he does not believe that all the possible different resistances can be measured with only one kit.

Even though he expressed that our tool could be very desirable for medical purposes, he had a lot of concerns about it. For the first phase of our project development, the medical environment poses too many challenges on the implementation.

Risk management

To get a complete overview of the opinion of important stakeholders and the possible risks for introducing our technology to the market, it would be beneficial to take the opinion of the indirect customers into account as well. The public opinion about reducing antibiotics is important to strengthen our project and to foresee problems. The public opinion is an important forge to change behavior of the antibiotic resistance-related stakeholders. This is why, the public should be engaged in the project in order to stimulate the project for eventual implementation of the device in society. The public opinion regarding the combination of genetic modification and antibiotic reduction is explored with a survey.

With our survey we reached 100 people with quite different fields of expertise, as the figure below shows. Most of our participants are between 18 and 30 years old, with which we are content as this group of people represents the group that will probably benefit from our technology the most. It is, however, important to note that 92% of our participants are highly educated, which might cause a bias in our projection of the general public.

The set of questions was based on two possible applications of the tool: reducing the amount of antibiotics in cattle food and making human antibiotic prescriptions more personal. The responses regarding both applications will be discussed below. In both cases it is important to know that about 80% of the participants are aware of the fact that excessive antibiotic use can lead to bacterial resistance and of the impact that this has on human health.

As for the reduction of antibiotics in cattle food, 93% of our participants agree that this is important and only 11% of the whole group would not be willing to pay a slightly higher price for it. This indicates the societal relevance of the issue. About 60% of the participants would find it important for the antibiotic resistance indicating tool to be used in the cattle and fish industry, even if it contained GMO's. 31,3% is not specifically for or against it when the technology involves genetically engineered organisms, and about 10% would not want it to be used in this case. Of this small group of 10%, 38,8% would change their mind if only proteins produced by a GMO are used in this technology, which is of course the case in our design.

In conclusion, we can state that the excessive use of antibiotics in the cattle and fish industry is an issue for the participants we tested. The technology that will be developed in this iGEM project is, judging from the generated responses, likely to be accepted by the general public when used to reduce the use of antibiotics in cattle food. Only a really small group of around 6% of the participants would oppose our design, due to the fact that it involves GMOs. This is in contrast to the prediction of the general practitioner, as he expected a lot of resistance. This might be because our survey participant group was biased considering education level.

Future prospects

Based on our stakeholder analysis and the interviews, we decided to scope our target group to the cattle farming industry. This includes the veterinary, cattle farmers and their food suppliers, food and consumer products safety authorities and other specialised animal health centres. This way, our niche market and the actors involved becomes clearer. Scoping makes engagement of the different stakeholders in the development of our device achievable. In this way, we can better suit their needs with our device.

When bringing such a technology to the market, it is also important to take into account the parties that might be negatively affected by it. In our case, pharmaceutical companies that produce antibiotics might lose revenues when a tool that reduces antibiotic use is implemented. It is important to also be aware of the hopes and concerns of these companies. In this study, however, we have focussed more on the stakeholders that are likely to see the positive aspects of our technology rather than the negative ones. This technology is designed to make the world a better place and it was not our first concern that some companies might lose some of their profit. However, in a later stage they are important to take into account, as these stakeholders might interfere with progress.

According to our interviews, the national scope seems less interesting than the international scope. Considering the international scope, other actors become more important such as customs and internal authorities and policymakers. However, other types of farmers in The Netherlands, like those who breed for the meat industry should also be contacted, as the regulations for different types of farms might differ. For example, in cattle that is butchered, no antibiotics may be active, but that does not mean that antibiotics are not administered through food during its life. [3] Besides that, these farmers might face different challenges our device can contribute positively to.

Above that, based on our survey, the representation of the general public was quite biased. For a later stage, it is important to engage a more general group in our decision making.

All in all, based on the interviews and the stakeholder analysis the development of the device seems feasible for a specific niche market, when taking into account values, hopes and concerns of the potential stakeholders in this niche. Values are safety considering the use of GMOs, and competitiveness with already existing applications. These values will be taken into account when completing our value sensitive design.

References

[1] Antibiotic Resistance Fact Sheet, World Health Organization, October 2016, http://www.who.int/mediacentre/factsheets/antibiotic-resistance/en/ accessed May 2017.

[2] Complementary Research Themes, Netherlands Centre for One Health. http://ncoh.nl/themes accessed May 2017

[3] Antibiotica, Vlees.nl. https://www.vlees.nl/vlees/themas/vlees-gezondheid/antibiotica accessed May 2017

Appendix 1: Survey Questions indirect customers

What is your age?

What is your gender?

What is your level of education?

Which field are you studying in? / your expertise?

Are you aware of the amount of antibiotics used in the farm industry?

Does it bother you that a lot of animals in the farm industry are fed with antibiotics as a precaution?

Do you want the amount of antibiotics in food to be reduced?

Would you be willing to pay (slightly) more for products produced using less antibiotics?

Did you know that the excessive use of antibiotics could lead to bacterial resistance in your body?

Are you aware of the impact of bacterial resistance on human health?

(If you chose yes on the previous question) Are you afraid of bacterial resistance?

Do you want doctors to be able to prescribe antibiotics specifically for the patient, so that the efficacy is guaranteed?

Do you want farmers to be able to use antibiotics more specifically, so that the chance for development of bacterial resistance is reduced?

What is your opinion on genetically modifying organisms (GMOs) to alter its properties so that it can be used for scientific research or the production of any goods like personalised medicine or industrial products?

If we were able to design a tool for detecting antibiotic resistance, which showed which antibiotic would be effective and which not, would you find the use of this tool in meat/fish industry important?

Would you still have the same opinion if genetically modified organisms (GMOs) were used in the production of this detecting tool?

(If your answer on the previous question was above 3) Would the fact that only proteins produced by the GMO (so not the whole organism) are used in this technology change your opinion?