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Developing a stepwise approach towards designing a web- based knowledge platform for multidisciplinary communication (research)

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Table of content

Abstract

Multidisciplinary research and communication offers many advantages and has become essential in modern research settings. Still it faces various problems that it must overcome in order to reach its full potential. These problems often lie in the communication between the various disciplines involved in e.g. a project. A web-based knowledge platform could offer a solution to these problems in communication. The question of how such a platform could be created was answered through the analyses of interviews from two different cases that are multidisciplinary in nature. Furthermore a workshop and a focus group were held as an iteration and these results were translated into a seven step approach towards developing a web-based knowledge platform.

Keywords: Multidisciplinary research, multidisciplinary communication, web- based knowledge platform, seven step approach towards developing a web-based knowledge platform

Introduction

As science is continuously progressing and developing, the need for multidisciplinary research increases. This is due to the fact that science, society and management are becoming more dynamic and interdependent than they have ever been(Naiman, 1999).
Multidisciplinarity is defined as a process where scientists and other stakeholders from different disciplines of research, society or management work together, addressing a common goal and/ or problem from their individual viewpoints or expertise (Stokols et al.,2003).

Because of this science can no longer be discipline driven (researched from the perspective of one particular discipline). In order to be more more comprehensive of the complexity of the systems that are being researched, it must move towards multidisciplinarity (Kates et al., 2001). According to literature science in general benefits greatly from multidisciplinary research (Kates et al.,2001). Scientific problems can be viewed from a variety of different perspectives, this is of great importance, because many problems of today's science have become too complex to be resolved by a single discipline (Naiman, 1999).

But multidisciplinary research still faces many challenges and a lot of additional research needs to be conducted on this topic. One of the biggest challenges that it faces is the problem of effective communication. Scientist speak in "dialects that are specialized to their disciplines" and

this can lead to misconceptions and confusion about what is being said (Wear,1999). Wear compares these dialects to constitutive metaphors, which frame the way we see the world around us. He says that the greater the divergence between these worldviews, the more difficult effective communication becomes.This barrier in communication therefore does not only exist between scientists of different disciplines, but also between scientists and other stakeholders involved in the process, which can be e.g. companies, governmental agents etc. Learning the language of a particular discipline (the jargon) is a time consuming process, but it is crucial to effective communication (Naiman,1999).

Wear provides an example of the use of these metaphors and the confusion which it can bring in his paper "Challenges to interdisciplinary discourse". He states that the word "competition" for example has an entirely different meaning to an ecologist, for whom this brings to mind the concept of survival of the fittest species, as to an economist, who links this concept the operational processes of the economy (Wear,1999).

This paper addresses two examples of projects that are faced with the purpose of multidisciplinary communication barriers.

1. A Narrative approach

A solution to the problem in communication is required. Members of multidisciplinary teams that are conducting research together will generally not have the time and resources to master the jargon of the other disciplines involved completely and therefore problems in communication will never cease to exist. A different kind of solution must be found.

A possible solution can be found in narrative psychology. Narrative psychology has proven to be an effective tool in increasing (scientific) knowledge and effective comprehension of this knowledge. Narrative approaches to science communication have been widely used in healthcare, but are applicable to other fields of science (Fix et al.,2012). Narrative psychology addresses how people make sense of their surroundings, the people around them and the information presented to them. It states that human beings live in a storied world, and that through stories they make sense of it (Murray & Sools,2014). This can be used in any context and with any type of content. By linking events or ideas narrative shaping creates a meaningful pattern between chunks of information that would otherwise be random and disconnected and therefore more difficult to understand (Riessman,2008). By using narratives, holistic knowledge is promoted. By putting previous misunderstood or unknown words or actions into a story, these are understood and acknowledged better (Murray & Sools,2014). Research shows that using narratives in science communication also increases the engagement of audiences and allows more effective comprehension of the information at hand (Dahlstrom,2014).

For science communication this means that information is presented to the audiences in a storied form. The representation of information in such a way are called “storylines”. The target audience must make sense of the information presented to them through the stories instead of through complicated and not easily understandable scientific papers and reports (Lundgren & McMakin, 2009). Storylines do not only consist of written text, but can also include visual elements or (in an online setting) interactive elements that aid the story that is being told.

Narrative approaches to multidisciplinary science communication have been used in the communication of e.g. flood risks before. A storyline approach was used by De Bruijn and

colleagues (2016) and this proved to be an effective method for conveying scientific information to scientists from other disciplines and non-scientists involved. However they stated that it is of great importance that not only a static view of the information must be given, but an understanding of the sequence of events must be guaranteed in order for the scientists from other disciplines and the other stakeholders involved to effectively comprehend the relevant information. This must be taken into consideration whilst framing the information in the most effective possible way (De Bruijn et al., 2016).

2. Web based knowledge platforms

The question remains how the target audiences will gain access to the relevant information in the form of storylines. Creating a web based platform could offer fast and easy access to all people involved. This includes researchers from different scientific backgrounds as well as the general population interested in the topic at hand. A knowledge based platform can be understood as a "*combination of persons (or organizations), usually dispersed over a number of geographically separate sites, with appropriate communications technology"* (Creech & Willard, 2001, p. 5).

To secure more effective communication and reduce the general problem of communication in multidisciplinary research a web based knowledge platform which contains narrative elements in the form of storylines could offer a solution. It addresses the problems in communication between researchers of different backgrounds and the general population, with no specific scientific background.

In addition to the fast and easy access that web based platforms provide, the internet is also a convenient platform for supporting multidisciplinary teamwork (Choi & Pak, 2006). It can bring

people together from all kinds of different backgrounds, disciplines and parts of the world (Choi & Pak, 2006). By using an online platform much time can be saved, for there would be less need for face to face meetings, because communication can occur from all geographical locations thinkable.

Creating a web based knowledge platform does not only diminish the need for additional meetings and grant fast and easy access to the relevant information. It also stresses the importance of joint value creation between all members/ users of the network, strengthens the capacity for communication and research, makes individual parts stronger through the participation of others and secures a higher level of engagement (Creech & Willard, 2001).
By adding elements that allow a certain degree of interactivity through e.g. different online navigational options, visual and written aspects of the information can be combined to increase the level of user adherence also known as the "stickiness of the platform" (Bush & Tiwana, 2005) even further (Segel & Heer, 2010; Stephens et al.,2014).
Multidisciplinary cases will benefit from using web- based platforms in practice. The two exemplary cases, that are multidisciplinary in nature, that are addressed in this thesis, River Care and the Zoonoses prevention and control case, aim at creating such a web based knowledge platform. And both theses platforms could benefit from incorporating storyline elements on to these platforms to increase effective communication and comprehension of relevant information.

3. Research Questions

There are certain steps that need to be taken and certain requirements that must be present before narrative elements can be embedded into the online platforms. This thesis focuses on the steps

that need to be taken in order to secure a fitting framework for the narrative presentation of the relevant information on the web-based platform. It takes a close look at the requirements, which the platform must fulfill in order to allow the best possible comprehension of information for all parties (disciplines) involved. It focuses on how the content/ information should be presented and therefore be perceived, the users/ stakeholders that are involved, the interface design of the platform and it's capabilities, the management of the platform and how the platform aids multidisciplinary research and communication. These requirements should all be met, before the narrative part can be included.

Thus, the main research question of this thesis is:

- Which requirements should a web-based knowledge platform meet, in order for the narrative presentation of information to be optimally included?

This main research question consists out of five sub- research questions:

- How should the content/ information be presented on the web-based knowledge platform?
- Which features should the platform contain in order to fit the stakeholder/ user's needs?
- What should the interface of the platform look like and what are its capabilities?
- In which way should the platform be managed?
- How can the aid multidisciplinary research/ communication?

These questions will be answered through the analysis of interviews in both cases, through the analysis of an evaluation workshop for the RiverCare project and through a focus group held for the Infection Prevention and Control case.

4. The two exemplary multidisciplinary cases

These two cases were chosen because they are multidisciplinary in nature and deal with the issues related to multidisciplinarity, like e.g. problems in communication between the several disciplines involved in the projects. Furthermore they both address complex problems and have multiple different stakeholders involved. Because of these characteristics the two chosen cases represent multidisciplinary settings accurately.

4.1. The RiverCare research programme

River research aims at the achievement of a more sustainable and safe future and does this through developing different environmental policies. The development of the human population has a great impact on local, regional and global ecosystems like rivers. Therefore it is of uttermost importance that the effects of these impacts are understood and managed in order for there to be a healthy resource base for future generations (Naiman, 1999). To develop effective policies and work on ideas to increase flood safety and environmental sustainability actors from multiple sectors must come together (Lafferty & Hovden,2003; Eckerberg, 2007; Nowotny,

2004). These sectors include limnology, fisheries and fish research, hydrology and water research and geomorphology (Vugteveen et al., 2014).

Experts have agreed that it is a necessity to bring in actors from all involved disciplines to guarantee effective comprehension and management of the complex environmental issues (Mainstone and Brierly, 2009; Thorp et al., 2007; Wear, 1999; Naiman, 1999; Benda et al., 2002; Palmer and Bernhardt, 2006; McCulloch,2007). By all disciplines they do not only mean the direct contributing fields like ecology, geomorphology and hydrology, but also fields such as social sciences, engineering and economics (Vaughan et al.,2009; Hannah et al., 2004; Bond,2003; Thoms & Parssons, 2002).

The problem however is that river research is not an exception and it is faced with the same problems of multidisciplinary communication that other disciplines face. The integration of the various sectors is still considered uncommon and comes with difficulties in communication, comprehension of information etc. which in turn takes a toll on the effectiveness of working together and creating good results (Hillman,2009). These problems can be attributed to different factors. Some experts claim that there are still extensive boundaries between the disciplines, which can not be overcome so quickly. These boundaries lie in the problems of communication between the actors in the different fields of expertise. Boulton and colleges (2008) refer to mutual misunderstandings between disciplinary cultures and the lack of effective communication. Another aspect of the problems in communication lies within the fact that the actors have different paradigms and approaches to their fields of research, which can lead to even more problems in effective communication (Cullen,1990; Benda et al.,2002; Petts et al.,2006).

The RiverCare research programme is involved with various projects and focuses on the long term effects of certain measures that are taken to e.g. decrease the risk of floods in the Netherlands. Additional examples of projects in which RiverCare is involved are the construction of side channels, the removal of obstacles, the lowering of groynes, the replacement of groynes by longitudinal dams, the lowering of floodplains, the relocation of levees etc. It is a six year programme (2014-2019), which was called to life by the Netherlands Centre for River Studies (NCR) and the University of Twente.

4.2. Infection (zoonoses) prevention and control

Infection prevention and control addresses the distorted ecological balance due to human associated behaviors. The greater part (60.3%) of infectious diseases are zoonotic (Jones et al., 2008). Zoonotic infections are infections that can be transferred from animals to humans (Pappas,2011). Infection prevention and its control can be characterized as a "wicked public health problem". It is called a wicked problem because there is no general unanimity regarding the problem definition and solution, because there are multiple independent stakeholders from different levels (e.g. political, societal and economical agents) involved and because there is no clear goal set in the problem solving process (Van Woezik et al.,2016). A multidisciplinary approach is essential when addressing these "wicked problems", and solutions depend greatly on the collaboration of all parties involved (Van Woezik et al., 2016).

In the zoonoses prevention case stakeholders from three different sectors are involved in the problem solving process. These three sectors are veterinary health, human health and the public health sector. These three sectors offer different views and insights on the problem and

contribute by elaborating on the problem and its solution from their specific, individual point of view.

The World Health Organization (WHO) stresses the importance of a multidisciplinary approach when addressing this problem. A partnership between the different sectors involved is essential in the problem solving problem according to the WHO (Rabozzi et al.,2012). They call this multidisciplinary approach: " One health approach". This one health approach focuses on interdisciplinary communication and collaboration in order to prevent and control zoonoses (Van Woezik et al.,2016). This multidisciplinary approach has many advantages and has proven to be of great value in the problem solving process, but there are still many problems in reality. These problems originate in uncertainties between the stakeholders involved e.g. problems in communication, and also arise due to insufficient knowledge of the general public about zoonoses (Van Woezik et al.,2016).

Van Woezik and colleagues offer a solution to this problem in the form of an online platform designed in co- creation with the different stakeholders involved. They involved the stakeholders not only in the implementation phase, but also in the design phase to increase commitment and ownership of the project (Goodyear-Smith,2015). The goals of the platform are to increase the knowledge about zoonoses in the general public and to aid the communication between the different stakeholders involved.

Method

For the RiverCare project interviews were analysed and an evaluation workshop was held, for the Infection Prevention and Control project there were also interviews analysed and a focus group was held .

For the RiverCare project 20 semi-structured interviews were recorded, transcribed and then analysed. The evaluation workshop took place on the 22.6.2017. The audio of this workshop was recorded, transcribed and then analysed.

For Infection Prevention and Control at first 19 transcripts were coded and analysed and then the transcripts of a focus group that was held on the 14.11.2017 were coded and analysed.

The coding scheme was developed through open coding. This means that the scheme was created through the assessment of the values discussed by the people that were interviewed, that participated in the evaluation workshop for the RiverCare project or that were part of the focus group for Infection Prevention and Control. This information served as basis for answering the main research question as well as the sub- research questions.

1. River Care project

1.1. Interview analysis and coding in RiverCare

In the case of river management 20 semi structured interviews were conducted in May and June of 2016. The participants were all involved in the River Care project, but originated from different disciplines. The participants either worked in government organizations involved with the project (N=4), were members of research/ academic institutions (N=7), worked for consultancies (N=6) or were otherwise involved in the River Care project (N=3).

The interviews that were conducted lasted approximately two hours and consisted of three different parts. Of these three parts only the second part, which addressed the topic of storylines in a knowledge based platform and the potential usefulness of these storylines in this setting, is of interest to this research paper. The other two parts focussed mainly on the context of multidisciplinary work in general and the experiences that the participants have in this domain. One interview was conducted with two participants simultaneously and one recording malfunctioned, so it could not be used for analysis. This means that a total of 19 interviews was analysed.

The interviews were transcribed verbatim and analysed using a coding scheme. The first round of analysis was conducted by a first analyser, who developed a draft coding scheme. The transcripts then were read, reviewed and codes were assigned by a second analyser. The third step of the analysis was to compare the two coding schemes and based on this comparison the original scheme was adapted (Appendix A).

The codes were analysed in both a quantitative and qualitative manner, meaning that the content of the codes, the quotes of the participants, were analysed and the frequency of the codes was measured. High frequency of occurrence of certain codes however does not mean that these codes are of greater importance than codes which do not get named so often. This means that they just may be more obvious to the participants. Therefore the focus of this paper remained on the qualitative analysis of the transcripts.

1.2. Analysis and coding of RiverCare evaluation workshop

After this first round of analysis an example storyline was created using a fast prototyping software called articulate studio 360. This example was presented to a group of participants during an evaluation workshop. These participants stemmed from the multiple disciplines (Government representatives, researchers, consultants and other stakeholders) mentioned above, that are involved in the River Care project. The participants were asked to reflect on the storyline example in anonymous feedback forms and through means of group discussion, which was recorded and then transcribed verbatim for analysis.

2. Infection prevention and control

2.1. Analysis and coding of interviews for Infection Prevention and Control

19 transcripts (n=19) were coded and then analysed according to the following coding scheme (Appendix A), which was developed for both the interviews from the RiverCare project and the interviews from the infection prevention and control interviews, to identify the key elements that added significant information to the development of the stepwise approach of designing a web based knowledge platform with narrative elements.

Because of the multidisciplinary nature of the zoonoses prevention problem, stakeholders from multiple disciplines involved were interviewed.

In sum, 13 women and 11 men were interviewed. One interview was conducted with three people, and two interviews were conducted with two different stakeholders simultaneously. The stakeholders were veterinarians, human medicine practitioners, members of the LTO (Land- en Tuinbouworganisatie Nederland), Faculteit Dierengeneeskunde, Inspectie voor de gezondheidszorg, Economische zaken, GGD Brabant (Gemeentelijke gezondheidsdienst), LCI

(Landelijke Coördinatie Infectieziektenbestrijding), IGZ (Inspectie voor de Gezondheidszorg), Q- Support, RIVM (Rijksinstituut voor volksgezondheid en milieu), CVI (Centraal vet. Instituut), KNMvD (Kon. Nederlandse maatschappij voor dierengeneeskunde) and the LIGC (Landelijke informatiecentrum gezelschapsdieren).

These stakeholders are all involved in the problem of zoonoses prevention and control on federal, provincial and municipal levels.

2.2. Analysis and coding of focus group for Infection Prevention and Control

In addition to the interviews a focus group was held on the 14.11.2017. This focus group consisted out of five expert participants from the human, veterinary and government sectors of health care. Goal of this focus group was to gain input on how the platform for the Infection Prevention and Control project could be improved. These suggestions that the participants made on improvement of the platform could also be used for answering the research questions posed in this thesis.

This focus group was recorded and the recordings were transcribed subsequently. These transcripts were then analysed using coding scheme X (Appendix A).

Results

1.1 Background of the the cases (Rivercare and Infection prevention and control)

The two research papers: "User's perspectives about the potential usefulness of online storylines to communicate river research to a multidisciplinary audience" by Cortez Arevalo (2016, *work in progress*) and "Tackling wicked problems in infection prevention and control: a guideline for co- creation with stakeholders" by Woezik et al. (2016), offer valuable insights into which stakeholders and users will be invested in the platform or will be using the platform and the requirements that they have towards the platform.

Both of these papers used the first two phases of the CeHRes Roadmap developed by Van Gemert- Pijnen et al. (2011): The contextual inquiry and the value specification phase. In both

papers the contextual inquiry and the value specification were aimed at identifying the stakeholders and their requirements towards the platform.

1.2. Contextual inquiry

Through the review of the articles, potential users and stakeholders for the web based knowledge platform were identified. The next step was to generalize these users and stakeholders, so they were not specific to the cases anymore. Five different prospective user groups were identified:

1. Users from research and academic backgrounds (multidisciplinary)
2. Government organizations involved
3. Laypeople interested in the topic
4. Investing companies
5. Consultancies

The prospective users of the platform are all involved one way or another through their line of work, with the exception of the "laypeople", who are users that are not necessarily involved in any way, but only desire to acquire certain knowledge or understanding of the topic.

1.3. Value specification

Next the values of the potential users were assessed in two steps. The articles were analysed to gain insight in the values that were identified through the research done in these papers.
The eight values that were identified in the study of Cortez Arevalo (2016, *work in progress)* for the RiverCare project were:

1. *Users need a clear view on what the benefits of using the storyline component are and on how it is useful for the users (in the form of a concrete/ generalizable example)*
2. *Using visual aids in the form of multimedia interactive elements to aid effective comprehension*
3. *Interface design: Easy to follow navigation and search options, fast access, availability of contact details and related external links to other platforms and they called for a project overview, timeline and overview of the user's involvement*
4. *The need for tailored information*
5. *The presentation of results in a simple and clear context*
6. *The engagement of stakeholders in general*
7. *The possibility to access additional information if required*
8. *The applicability to other research topics (generalizable example)*

The five values that were identified in the study by Woezik and colleges (2016) for Infection Prevention and control were:

1. *Information must come from a trustworthy source.*
2. *Websites must be connected with already existent zoonoses initiatives.*
3. *The website must contain external links to other relevant sites.*
4. *It must provide only relevant information.*
5. *It must provide up to date information. (van Woezik et al.,2016).*

Through analysis of the results of the articles some important values could be assessed. Distinctive similarities in both cases have come to the fore related to the way the information and the content is to be presented on the platform. Like e.g. the presentation of the information (relevance and up to date) and the possibility to access (external) additional information. These values were taken into account in developing the stepwise approach to develop the web based platform.

In addition to these values found in the two respective cases, the analysis of the interviews brought some new insights in what features an effective knowledge based platform should provide its users. Like e.g. providing the users with the possibility of personalization, how interactivity can be ensured, which information should be selected under consideration of the target groups etc.

2. Analysis of the interviews, the RiverCare workshop and the Infection Prevention and Control focus group

The results that were found in the interviews, the evaluation workshop and the focus group answer the main research question: "Which requirements should a web-based knowledge platform meet, in order for the narrative presentation of information to be optimally included?" by answering the five sub research questions related to the content/ information presented on the platform, the features which it should contain in order to fit the users/ stakeholders needs, the

interface design and capabilities of the platform and how the platform aids multidisciplinary research and communication.

These sub questions consist out of multiple facets, of which a short overview will be given.

2.1. Content and Information related categories

Table 1

Overview of content related/ information category

Category	Examples
1. Provide external links to related online sources (other platforms, research papers etc.)	-Additional information -Links to metadata -External sources -easy access
2.Ensure the credibility of the presented information on the platform	- Perceive as credible -Expert involvement (internal and external)

3.Update information regularly	- Usefulness -Management -Central Database
4.Information availability	-Different levels of entrance - External links
5.Presentation of the information on the platform	- User group appropriate -Visualisations - Language - Context
6.Selection of appropriate information under consideration of the target groups	- User appropriate - Levels of entrance - Link to confidentiality, personalization and management
7.Provide procedural knowledge on how the information is gathered	- Link to external links
8.Confidentiality of information/ Possible intellectual property constraints	- Legal policy issues - Link to information availability and selection of information

**Category: Required aspects of the online platform that are content/ information related*

2.1.1. Provide external links to related online sources (other platforms, research papers etc.)

Throughout the interviews it became very clear that the participants valued the availability of external links to **additional information**, external related platforms and actors very high.

"Be able to link to in-depth information." (Focus group Infection Prevention and Control)

"Link the platforms together. As a central thread throughout the platform, there is a lack of this at the moment. OneHealth is everything and OneHealth is nothing. Zoonosis are complex problems. You cannot just rely on the humanitarians or veterinarians. " (Focus Group Infection Prevention and Control)

If there would be any questions that were left unanswered by the information presented on the platform the users could diverge to o**ther sources of information** (through external links on the platform) to look for the answers.

"If you as the GGD want to place something on your website, so you can answer specific questions, then you can refer to other sources. The RIVM for example and then combine it with in-depth information." (Focus group Infection Prevention and Control)

"And maybe it is possible to have some link to questions and answers when you don't know them." (River Care project)

Another interviewee pointed out the importance of having **links to the metadata** of the project that is presented on the platform:

"And it is in a technical way and also in a way of metadata, but on the other hand, you need to put the metadata there, because otherwise no one knows what (example) means." (River Care project)

In other words: Additional data surrounding the topic must be made available (through external links) so that e.g. researchers who want to look deeper into the context of the research can if they desire to do so.

"But it's not the idea that for instance some storylines may connect. I think. So is it also possible to make one together?" (RiverCare Workshop)

The participants also stressed the importance of not having to explicitly look for these links, but that they would be **easy** to find and the **access** to the required information would also be easy. This could be done through adding external links on the platform that connect to e.g. other related platforms. These links could be incorporated through e.g. symbols.

2.1.2.Ensure the credibility of the presented information on the platform

The participants also addressed the topic of credibility of the information on the platform. As already mentioned in the section about the perceived barriers, the participants expressed the concern of who will be able to upload information onto the platform and the type of information that they upload. This concern became even more clear whilst addressing the **credibility of information.**

One participant said:

" Yeah, that is very difficult, because you must also have quality. So if everybody is going to put information on your website. It can be anything, you must look who is putting (more) in your website." (River Care project)

If the user of the platform does not perceive the information that is being given as credible then he or she will not continue to use the platform.

"And also, well let's say, the management of it. And with management I also mean(..) If it is total chaos and if all data, different standards and different metadata (..). Well, if that's all messy, then the people, well then they start to distrust the information and then it will not be useful anyway." (River Care project)

Information becomes credible if the user is under the impression and/ or has proof of the fact that **experts** are involved in giving the information (uploading it to the platform).

"You should put together a group of experts, who are familiar with the problem and that are able to give advice on this problem." (Infection Prevention and Control)

A link between the credibility of information and the provision of external links could be found in the interviews. By providing links to e.g. **external expertise** metadata (scientific based metadata) the research will be conceived as more credible and therefore more useful.

"It would be so great if the platform would be able to find and provide the right expertise. And if it could attract new experts. That would be really great." (Focus Group Infection Prevention and Control)

2.1.3. Update information regularly

Another aspect of the content and information related findings was "up to date information". Throughout the interviews it became clear that the content of the platform would only be perceived as **useful** if the information is kept up to date/ actual.

"I think, yeah, the time barrier of putting all the information, and also keeping it actual. You should update frequently, because I think for all data or all information, keeping it up to date is important." (River Care project)

Participants furthermore suggested that not only one person should be in charge of keeping the platform up to date, but that more people should **watch over this process** in order to keep the information more up to date, faster to access and through this encourage more people to use the platform.

An interviewee of the infection prevention and control case talked about the platform needing to be the only **central database** where the relevant updated information can be found. The need for a single central platform is high and based on updated information presented in this knowledge base decisions can be made.

"Our need for a central place where decisions about communications and further actions can be made, is very high." (Infection Prevention and Control)

2.1.4. Information availability

On the topic of information availability participants had two suggestions. The first one was to incorporate a feature that would **shield of certain information** to certain users. This would mean that not all information would be available to all types of users (link to personalization).

"Meaning that you have some kind of rights management on top of the page that you can shield of certain content for certain users etc." (River care project)

The second suggestion is related to "**external links**". Through the platform users should be able to access even more information and this information should be made available to them.

2.1.5. Presentation of information on the platform

Another important feature that must be guaranteed on the platform according to the interviewees is the understandable presentation of information. To secure this feature they suggest different approaches.

"Yesterday I asked a citizen to join our knowledge platform and give input. In this way we try to bring the knowledge, mails, information and scientific articles closer to the people." (Infection Prevention and Control)

To ensure that "lay people" can understand the information presented to them on the platform, the information must be **presented in an understandable way**. Meaning appropriate **language** and **visualisations** must be used.

" So then I guess that I will have a page like this with one storyline, which is like the threat in my PhD, so let's expect it will be my PhD thesis in common language. Right? And then we have contributors and users, which is my user committee, research programme I did it in and I saw a few other things. And then the resources and publications and everything that I have produced in those four or five weeks." (RiverCare workshop)

One participant stressed the importance of using visual aids to secure a more understandable presentation of the information at hand:

" I think it would be very easy to have a platform, which encloses information in a visual way, without lots of texts. Keep the layout simple." (RiverCare project)

Through the use of visualisation of information on the platform participants expected facilitation of better understanding.

Furthermore the participants were in favour of presenting the information appropriate to the target group of users. By this they meant a presentation in a not too scientific and technical way, so that users not from the explicit scientific research field would be able to understand the information presented to them more effectively. Furthermore the layout was addressed. A clear and well designed, easy to follow layout would also benefit the ease of understanding of the information.

Another important feature that was mentioned by an interviewee of the River Care project was in relation to the use of storylines on the platform. The interviewee expected the use of storylines to facilitate better understanding of the presented information:

"Under the storylines, I like them, so I can really easily share with other people outside of River Care what specific things River Care is about." (RiverCare project)

The use of storylines would improve the ease of understanding by explaining the information in a more simple way, giving users insight into the background and **context** of the project. Participants expressed the need for a balance between complexity and simplicity for researchers and non- researchers. By this they mean that the information must be presented and written appealing enough for the researchers to feel like they gain something by using the platform, but must also be presented in such a way for the non- researchers that they are able to understand and follow the information presented to them.

"Well for me when sharing my information , well, it might not match the level that the scientists are used to." (RiverCare project)

This participant expressed his/ her concern that if information is presented in a too simplistic manner, that researchers might lose interest and turn to other sources of information.

2.1.6. Selection of information under consideration of the target groups

The next content and information related factor that arose from the analysis of the interviews was the "selection of **(appropriate) information**. Participants stated that not all information of certain project would be relevant for all the users of the platform:

" There is less need to access than to share. If you need more kinds of data there is more pressure to get it. Than if you have data, you know. And it is also related to the questions whether your data is useful to others." (River Care project)

The underlying thought of this quote is that some information that might be useful to e.g. researchers will be of less use for other stakeholders, like members of government branches involved in the project. They should have the possibility of selecting the parts of information by clicking on them in an overview on the platform that are useful to them, without having to look through all the other information. Because as one interviewee stated:

" The volume of data, it can be overwhelming." (River Care project)

The selection of information is closely related to other factors found during the analysis of the interviews. The first being the issue of "**confidentiality**". Not all information from certain project can be shared with the general public, because of confidentiality. This must be considered, whilst designing the platform.

One participant suggested the use of different **levels of entrance**, which in turn is closely related to the factor of "**personalization**":

" Perhaps it is possible to make different levels of entrance. (River Care project)

The third factor related to the "selection of information" is "**management** of the platform". The managers of the platform, which consists out of involved stakeholders of the project, must select the appropriate information in relation to the project and guarantee the quality of the information, which in turn is related to the issue of "credibility".

2.1.7. Provide procedural knowledge on how the information is gathered

For a better understanding of the information presented in the storylines, participants suggested to give more insight into the way that the information was gathered.

"It is not only the data, but also the way the data is collected." (River Care project)

This statement can also be linked to the feature of "**external links**". The desire to have access to additional information and to gain insight into the process of how this was gathered appears of great importance to the interviewees.

"Then you wonder, where does the information come from" (Infection prevention and control)

Another interviewee of the River Care project said:

"I hope to have access also to the history of the information. So, then I also know a little bit what was the process that it came through." (River Care project)

2.1.8.Confidentiality of information/ possible intellectual property constraints

This feature, discovered through analysis of the interviews, appears in many ways and is linked to other elements of the content and information related feature of the stepwise approach to developing the platform, like e.g. "**information availability**" and "**selection of information**". The confidentiality issue is mainly perceived as a barrier by the interviewees (see "barriers/ disadvantages"), because of this sometimes it is not possible to share all relevant information. For certain projects it is not always possible to share all data researchers explain in the interviews. One researcher gave an example for this:

"Also if the government gives us subsidy, they ask us to share often the information. Only for very sensitive projects they ask us to keep it confidential." (River Care project)

For such “sensitive” projects the design of a web- based knowledge platform accessible to different kinds of users would not be ideal. Here the issue of “selection of information” becomes apparent again.

Furthermore they speak of other projects where certain information can not be shared for other reasons, such as **legal policy issues**.

“ Going back, sometimes there are security concerns and legal policy issues with sharing data.”

(River Care project)

2.2. User related category

Table 2

Overview of user related category

Category	Examples

1. Interactivity/ contact other actors involved	- Contact other actors involved - Communication - Feedback - Contact details
2. Time and effort to use the platform	- Minimal time and effort - Visualizations -Software -Language -Age issues
3. Personalization of the platform	- Profile - Interactivity - Difference in profiles
4. Notifications provided to the users	- Emails -Newsletters -Small news or stories -Link to personalization
5. Downloading of data	-Using the data - Increase adherence - Link to confidentiality and personalization

**Category: Required aspects of the online platform that are user related*

2.2.1. Interactivity/ contact other actors involved

Throughout the interviews it became apparent that there is a great desire to make the platform interactive. The participants listed several different aspects of what this interactivity should look like. One suggested that the platform should provide the possibility of **contacting other actors involved** in the project or involved in similar projects throughout the country or in other countries even.

"Again, if you will use the platform just to find people which you can find the information with, but you can not share it on the platform itself." (River Care project)

"Who can I contact to get the information I would like to have. Because I am somebody who is going to call somebody or going to send somebody an email." (River Care project)

If the platform was to provide **contact details**, then possible sharing of other data, input or ideas could occur outside of the platform.

They also suggested giving the details of the authors of the data that is presented on the platform, so they can be contacted if any other questions, issues or the desire to co-operate etc. with these authors should arise.

Another aspect of interactivity would provide users with the possibility of giving feedback to and receiving **feedback** from others.

"If you make a nice dataset or collect it. This is a good place to share it. They have the opportunity to get reflexion of people from the field. They are also the people that will be working in companies and universities." (River Care project)

Not only the possibility of giving and receiving feedback would present itself, but also decisions on what to share and which information is deemed useful by the users could be made through **communicating** with each other.

Another statement that was given related to the fact that through using the platform to contact other actors, new alliances could be made and experts from various different fields could more easily get in touch with each other.

"So that's something and I know how to find people to cooperate with or to gain information from or gain experience from." (River Care project)

2.2.2. Time and effort to use the platform

The time and **effort** spent on learning how to use the platform should be **as little as possible** according to the interviewees. This is closely related to all content and information codes presented in the section above. E.g. if the information is presented in an understandable way,

appropriate **visualisations** are used, the right information is selected etc. then the time and effort spent on learning how to use the platform will be minimized.

Furthermore this factor is dependent on how the user interface is designed (see section below). If e.g. the interface design of the platform is easy to follow, easy understandable and usable **software** is used, the platform can be navigated easily, relevant information can be accessed fast and the choice of **language** is appropriate to the target audience then this will also affect the time and effort spent on learning how to use the web based knowledge platform.

Another factor that is pointed out by one of the interviewees for the River Care project is the fact that time and effort are also linked to the age of the users in question. Users of a certain age might have more difficulties getting acquainted with the software. This must be taken into consideration, whilst designing the platform. Concerning the use of software one interviewee stated:

*" You should do it, in this time in the world, you should learn it. Not everybody knows it, not everybody uses it, because it is **related to age**." (River Care project)*

2.2.3.Personalization of the platform

The possibility of being able to install a **profile** on the platform was mentioned many times during the interviews. Regarding these profiles participants suggested several different things.

First of all they saw benefit in setting up personals profiles on the platform in relation to contacting other actors involved and giving and receiving feedback. Personal profiles would improve the level of **interactivity** on the platform.

Profiles would need to be updated regularly. If not this could damage the impression of credibility on the platform.

" I only view profiles that are recently well maintained. I feel the obligation to make sure that at least the vision of a profile that is on the internet should reflect who I am. So that I am at least aware how I am visible in the outside world." (River Care project)

Another interviewee stressed the importance of making the setup of the profile no too complicated, because otherwise people/ potential users might not join at all.

" So, if it is a simple one , then it is ok, but if you ask a lot of things before I can access the the website, i guess that a lot of people don't even start it." (River Care project)

One researcher mentioned the creation of different levels of entrance, meaning a **difference in profiles.** These different levels would allow different things, like restricted access to information or contact details, the ability to upload data, give feedback or receive feedback.

2.2.4. Notifications provided to the users

This code is strongly related to the code "personalization" according to the interviewees.

" So if you get too much information, you need a proper way for me to say what kind of information do I get from this. I need announcements, but not too often. I need to define that for myself." (River Care project)

This means that users want to be updated about changes to the platform or addition of information on e.g. projects, but want to define how much and what type of information they receive. This is closely linked to the code of "**personalization**".

Notifications could be given through **emails, newsletters, small news or stories** related to the information presented.

"You should try to get, if your platform is there and the results are there, then you should have small news, stories, water board related, emails, newsletters." (River Care project)

It is not only of the essence that notifications are given but also that they reach the desired audience as fast as possible.

"It would be ideal if people would receive notifications on their phones or computers if something is up. We have arranged that if some type of signal reaches someone within our organization that this gets to the right people as fast as possible." (Infection Prevention and Control)

2.2.5. Downloading of data

The last user related code found throughout the interviews is being able to download certain data (sets). By allowing users to download certain data(sets) the interviewees expect **higher adherence** to the use of the platform. They repeatedly speak of "**using the data and results**" and voice a clear preference on using the data themselves after downloading it on their own computer to working with the data on the online platform.

"And also I, you have really found the information, for instance if you have found data and you can use the data. Is it for me possible to download the data and work with it in my own system? Or do I have to work with the data on the river care site?" (River Care project)

This code is related to "**confidentiality**" and "**personalization** of the platform". If some information for example is only available to certain users, because of different levels of entrance on the platform then only these users can actually access and download the information.

"And then I can even download the data and do my own stuff that is nice." (River Care project)

2.3. User interface (Capabilities)

Table 3

Overview of user interface related category

Category	Examples
1. Easy to follow interface design	-Visualizations - Understandable navigation
2. Use common and easy to use software	- Familiar software
3. Fast and easy access to information through fast and easy navigation of platform	- Link to overview -Visualizations
4. Choice of language	- Consider user groups - Dutch or English - Personalization
5. Provide an overview of the data and all actors involved	- External links - Contact information
6. Use platform on multiple devices	- Smartphones - Tablets etc.
8. Ensure the generalizability of the platform	- For other projects

**Category: Required aspects of the online platform that are (user) interface related*

This section explains all codes found in relation to the interface design of the platform. The interviewees described how the interface should ideally be designed to satisfy their demands.

2.3.1 Easy to follow interface design

The interface design of the platform should be easy to follow. This could be achieved by using appropriate **visualisations** of the information presented on the platform and by allowing the **navigation design** to be simplistic.

" By all means there should be no manual to use it. It should be so easy that even my grandma could use it" (River Care project)

"Professionals conduct their search through keywords. So let the platform appear through this. Selective keywords are really important." (Focus group Infection Prevention and Control)

They also stress the importance of making the platform easy to find on the web for the general population.

"It should be easy for the general population to find it. " (Focus group Infection Prevention and Control)

2.3.2. Use common and easy to use software

The interface design of the platform should be easy to follow. This could be achieved by using **common and easy to use software**, which provides fast and easy access to the required information and through easy navigation of the platform in general, by using e.g. keyword search. Interviewees suggested the use of common software, that almost everybody already is **familiar** with.

" Yeah, and use common programs like, I should not download first the program, because it will give problems with our IT staff. Use common programs like Microsoft programs." (River Care project)

"You need a platform that is very recognizable." (Infection Prevention and Control)

2.3.3. Fast and easy access to information through fast and easy navigation of platform

Not only should the use platform be easy to understand, but also the navigation to relevant parts of the platform should be designed in such a way that information can be access fast and without any trouble for all **different types of user groups.**

"But just the ease of navigation through the application is important and being able to query and find the data. That is relevant to what is your interest." (River Care project)

2.3.4. Choice of language

Furthermore interviewees stressed the importance of the appropriate choice of **language** of the platform.

"And what I think that a really big choice you have to make is the language of the platform. If you make it, I think from the traditional point of view or scientific point of view, you, the main language should be English. But I think if you want to share also the platform with other people (like e.g.) RWS (Rijkswaterstaat), the waterboards or just local communities, then English will be a disadvantage, or will make it difficult for them to be part of the platform." (River Care project)

Before randomly selecting a language for the platform the **target audience** should be considered first. The advantage of using an online knowledge based platform is that fact that it can be in different languages, which the users can e.g. select on the main/ starter page of the platform. For the two exemplary cases the user could e.g. choose between **Dutch and English.** This code is therefore also related to the code of **"personalization"**.

2.3.5. Overview of all data and actors involved

Further capabilities that the platform should provide to its users according to the interviewees were an **overview of all the data and all the actors involved**, to ensure an even more simplistic navigation of the platform.

" To access, I think would be easier, that you have a quick overview of what data there is and where." (River Care project) and " Now, I do not have an idea about who is involved in the entire River Care project, for instance. Who is dealing with what kind of subject, on what, that would be nice." (River Care project)

"A 'what are their names' would be helpful." (Focus Group Infection Prevention and control)

This overview can e.g. be linked to **external sources** of information about the content or the authors and could provide the possibility of **contacting** these authors.

2.3.6. Use platform on multiple devices

They also discussed the possibility of being able to **use the platform on multiple devices** such as **smartphones and tablets** etc.

" Maybe you can, have an app for example for it. To use it on a smartphone." (River Care project)

2.3.7. Ensure the generalizability of the platform

The last aspect in relation to the capabilities that the platform should provide was the **capability to be generalizable.**

"And suppose that you build your platform using open source technology like the GIS tools open source and the web page is open source, the content management system is open source. Then I have this framework that I can easily deploy for a different project." (River Care project)

The framework of the platform should be easily **applicable to other projects** according to the interviewees. By doing this the use and navigation of the platform will roughly be the same and then can be used in a similar way for other projects or platforms.

"Not to be overwhelmed if you visit the website, the platform as a new user, in a minute you should oversee the structure of the site, the way you can use it. I think it is important not to have a lot of texts, but to make it easily accessible." (River Care project)

2.4. Management of the platform

Table 4

Overview of management of the platform related codes

Category	Examples
1. Issues regarding the maintenance of the platform	- Link to credibility
2. Ensure quality of the information and data provided through monitoring	- Responsibility questions
3.Management by multiple experts	- Link to credibility - Avoid double posting e.g. - Expert in charge
4. Issues regarding the decision making process	- Management team - Timing questions

**Category: Required aspects of the online platform that are management related*

2.4.1. Issues regarding the maintenance of the platform

The interviewees expressed certain concerns related to the management and maintenance of the platform. These concerns related strongly to the issue of how **credibility** could be ensured through management.

"Who is going to tell what the quality of the data is. And who, what are you going to do if somebody is putting a giant amount of terabytes of information on your platform. All kinds of practical problems. We are also looking at sharing the information from users, but then, we can

get information from the provinces. But then we must check the quality of information from the provinces." (River Care project)

2.4.2. Ensure quality of the information and data provided through monitoring

The main concern in relation to credibility is the monitoring of the data that can be uploaded on the platform. The interviewees were mainly concerned with the **responsibility** issues. They asked questions like:

" Who will be able to upload data?" and "who will ensure the quality of the data." (River Care project)

"Talking about communication, sometimes I wonder who is in charge and how." (Infection Prevention and Control)

"Who owns the help-desk. Who is in charge of maintenance and updates on the platform. This is relevant. Who is responsible." (Focus group Infection Prevention and Control)

2.4.3. Management by multiple experts

Interviewees suggested multiple **(expert) actors** involved in the project should manage the sharing of the data to ensure the **credibility** of the information. They should decide what is relevant and what is not and prevent things like e.g. ***"double- posting".***

"If the information is very poor I will not come a second time to get information. It should be fast, actual information, I guess it should be one or two persons who are updating all the time. It is quite a job." (River Care project)

" I think if you get an abundance of information it is difficult to keep track (...) to make a good structure." (River Care project)

2.4.4. Issues regarding the decision making process

This **"management- team"** should also make decisions concerning when certain updates should be made or **when** additional information relevant to the program should be added to the platform.

"But I think the main drawback would be, that there is no pressure, no one is asking for your data. When will you put it there." (River Care project)

2.5. Multidisciplinary related categories

Table 5

Overview of the multidisciplinary related category

Category	Examples
1. Connection of multiple disciplines	- Better relationships - Central database
2. Prohibit misunderstandings in communication	- Tackle previous multidisciplinary related problems - Decision making process
3. Connect various sources from abroad	- Increase knowledge flow
4. Increase effectivity and quality of the platform and information through multidisciplinarity	- Likelihood of gathering more knowledge will increase through connection of disciplines - Platform can offer guidance and support

**Category: Required aspects of the online platform that are related to multidisciplinarity*

2.5.1. Connection of multiple disciplines

The aim of using a web based knowledge platform is to connect multiple disciplines and ensure that information can be exchanged fast and without misunderstandings in communication. This in turn was expected to result in **better relationships** between all parties involved. Regarding this multidisciplinary feature of the platform interviewees suggested that the platform should function as a **central database** of sorts.

"Working together will build a better relation and possible more willingness to help us with our interest." (River Care project)

2.5.2. Prohibit misunderstandings in communication

Through the connection of disciplines and actors involved **previous multidisciplinary problems are tackled.** These were mainly problems in communication. Effective communication is crucial in **decision making processes** and necessary in order for the actors in charge to make good choices.

"We want to be a reliable advisor to the government. In order for them to make good choices and secure that the Netherlands becomes healthier." (Infection Prevention and Control)

2.5.3. Connect various sources from abroad

According to the interviewees all parties/ actors involved in the platform could benefit from it. They speak of scientists, researchers and Universities in general, of consultancies, the

government and lay people interested in the topic presented on the platform not only in the Netherlands, but also abroad. By doing this not only will more people have access to the information on the platform, but the likelihood of gathering information from other sources (e.g. abroad) will increase and the interviewees expect the platform and the **knowledge flow** through the platform to benefit greatly from this.

"Access for research institutes or universities abroad. That will be interesting." (River Care project)

2.5.4. Increase effectivity and quality of the platform and information through multidisciplinarity

Through the connection of the multiple disciplines the **likelihood of gathering additional information** will increase. This could benefit problematic situations as well. For example when certain actors involved feel like they do not have enough information about the topic. In situations like this the **platform can offer guidance and support**.

"The mayor has been assigned with tasks concerning the zoonosis, but does not know much about the topic. They are in need of support." (Focus group Infection Prevention and control)

2.6. Implementation

Throughout the interviews it became apparent that the interviewees also had a lot to contribute concerning the future implementation of the knowledge based platform. The statements made in the interviews gave valuable insights into the expected benefits and barriers of such an implementation and should be taken into consideration in the development process of the platform.

Table 6

Overview of the Implementation related category

Category	Examples
1. Benefits	- Additional knowledge - Better Results - Reduce uncertainties - Acquire new projects - Improve collaborations - One Health - Goal oriented - Generalizable template - Open to public and peers - More and qualitative higher knowledge
2. Barriers	- Amount of data input - Management issues - Relevance and reliability issues - Intellectual property issues - Accessibility of information - Presentation of information (scientific jargon)

**Category: Required aspects of the online platform that are implementation related*

2.6.1. Benefits

Participants mainly talked about the different benefits they expected the web based knowledge platform to have. These anticipated benefits gave insight in what they believe the platform should contain to assure the most effectivity.

"Should this extra knowledge become available. Based under decisions to modify, the landscape becomes richer, and decisions ultimately will be wiser, because (they) will be based on knowledge not only of (e.g.) hydraulic effects, but also on (e.g.) ecological effects. More knowledge." (River Care Project)

Through the participation of various different users and stakeholders of the project, **more knowledge** will become available and the participants expect the platform to benefit from this. They also expected **better results** from this and believe that this assimilation of knowledge will additionally **reduce uncertainties** and increase the possibility of **acquiring new projects**.

"Doing a project better, getting better results out of the project. Reduce uncertainties and acquire more projects." (River Care Project)

Using a platform in such a way, to connect multiple disciplines and to **improve the collaborations** of these disciplines is described by some interviewees of the infection prevention and control case as the "**one- health" approach**.

"We can state in general that the communication between human and veterinary medicine and it's practitioners is not entirely ideal, that is why these platforms are founded so that the thought of "One Health" can prevail." (Infection Prevention and Control)

Uniting multiple disciplines to work towards a **common, general goal** is perceived as a great benefit, which the knowledge based platform provides for its users.

Further benefits that were discussed were related to the template and technology of the platform. By using open source technology and designing the platform in the boundaries of a certain **template** the approach to developing the platform could more easily be deployed **for different types of projects.**

" I think you should also be able to fit the story in the same format. It should be possible for something small, but it should also be possible for something big. And if you want to tell a bigger story you should be able to do." (RiverCare Workshop)

Another benefit they saw was the fact that through the usage of a web based knowledge platform projects would be **open to the public and to peers** (other researchers, government etc.) and this would allow them to give their insights and expert knowledge, which in turn would lead to **more and qualitatively higher knowledge.**

2.6.2 Barriers

The participants also anticipated some barriers that would come along with using an online knowledge based platform. These expected barriers also were of great importance to the development of the approach towards developing the platform.

The issue that was addressed most frequent was the concern of **too much data input**.

"That would be is, that more persons have the availability of data for us to update and manage." (River Care project)

They expressed the concern that if too much data would be made available on the platform, **management** of this data would become a problem. They also addressed the issue of who would be able to upload information and the **relevance and reliability** of this data.

Another factor of this concern that the participants outed was the concern about **intellectual property.**

" Yeah, sometimes well, when you work on projects. It is, you can't share all information because it is confidential. So what you, that makes it difficult, to share information or your question on the whole platform." (River Care project)

To conclude, the perceived barrier that was most eminent to the participants was the barrier of selecting the appropriate information to share on the platform and the management issues that come along with this process.

Aside from these barriers they also talked about they way of communicating on the platform. Some expressed their **doubts about all users being able to understand and access the information**. These doubts originated in the fact that they wondered if e.g. older people, who are not as familiar with using the internet or laypeople, who are not familiar with **scientific jargon** would be able to use the platform in the way that they desired.

Discussion

1.1. Research questions

To answer the main research question, which requirements a web- based platform should meet in order for the narrative presentation to be optimally included, a stepwise approach that considers the five sub- research questions on how the content/ information should be presented, which features the platform should contain, what the interface should look like, how it should be managed and how it generally aids multidisciplinary research and communication, has been developed.

1.2. Stepwise approach towards developing a web based knowledge platform with narrative elements

Step 1. Information and content selection

- Select relevant information
- Ensure credibility of the information through e.g. external links, references, procedural knowledge, contact details of the authors and up to date information
- Ensure that the selected information is available (consider confidentiality issues)
- Draft possible visualisations, like e.g. maps to aid better understanding of the presented information

Step 2. Integration of user related features on platform

- Interactivity
- Time and effort spent on using platform
- Personalization
- Notifications
- Downloading and uploading data

↻ Revise the information and content selected and adapt if necessary & Adapt visualizations

Step 3. Design the user interface

- Select an easy to follow design
- Use common software
- Ensure easy navigation of the platform
- Consider target user group in choice of language (if possible give different options)
- Make sure that an overview of the data and actors involved is given
- Ensure usage on multiple devices

↻ Revise the information and content selected and adapt if necessary & Adapt visualizations

↻ Additional feature prominent during all steps: Management of the platform ↻

- Supervision of the platform and presented data

- In charge of possible uploads of new data
- Management of possible problems, should these arise
- Decision making processes
- Multiple experts

The initial direction of this research was focussed more on how the storylines would look like specifically on an online knowledge platform. After analyzing the data from the four different sources however, the interviews for both RiverCare and Infection Prevention and Control, the workshop for RiverCare and the focus group held for Infection Prevention and Control it became clear that before the storylines could be incorporated on a web- based platform a lot features had to be present and functioning according to the requirements of the prospective user groups.

Taking this into consideration the results that became clear throughout the analysis contributed significantly to the question how a web-based knowledge platform should look like and which important factors should be considered whilst developing such a platform. The results that have been found offer a relevant and significant contribution to the field of multidisciplinary research in the form of the recommendation for a stepwise approach to develop the web-based platform and the features it must contain in order for narrative elements to be incorporated in a web- based environment.

A suggestion for how these narrative elements could be fitted into the web based environment is given in a fourth step of the *stepwise approach* and is based on the model developed by Murray and Sools (2014).

Step 4. Translation of information into a storyline using the model of Murray and Sools (2014)

- Describe the main agents and characters of the story
- Illustrate the main events that take place in the story
- Give an account of the means and helpers in the storyline

- Give a detailed description of the setting/ scene in which the storyline takes place
- Describe the purpose behind the storyline

1.3. The Model of Murray and Sools (2014)

The Model of Murray and Sools (2014) could function as a guideline in creating the content of the platform in the form of storylines.

In this model the creation of storylines and the important elements that they must include are described. It is not yet possible to use this model in an online setting, like on a web- based knowledge platform.

The model is also known as the "five circle model", because it consists out of five important features that every storyline must have in order to aid effective comprehension of information. These five elements are: The agents and characters, the acts and events that take place, the means or the helpers, the setting and the scene and the purpose, intention, desired or feared goal (Murray & Sools,2014).

The first element of the five-circle model the "agent or character" must be described elaborately. It is not only important to state who the main agent is, but also to ascribe certain characteristics to this agent. By doing this it will be easier for the user to identify with the main character of the story (Murray & Sools, 2014). The actor is not necessarily a person or a collective of persons. It can also be the acting entity or the functional element of the storyline. In the case of the RiverCare storyline the main agent could be the narrator of the story or someone the narrator is talking about, e.g. a scientist, a local fisherman, someone who lives near the river or a shipping professional etc. Or it could e.g. be the the river, the water management system etc.

In Infection Prevention and Control the main agent could be a poultry farmer, a veterinarian or a virus e.g.

The second element of the model the “acts and events” that take place have to be described elaborately as well. The user must get a clear view on what exactly is happening in the storyline and a clear distinction between “acts”, which are done by the characters or “events”, which happen to the characters must be made (Murray & Sools,2014). A description of an act by the scientist could be the implementation of the river intervention and an event could be the fact that the river intervention is started and a local fisherman is influenced by this. And for the Infection Prevention and control case this could be the ban on transportation issued by government officials for example.

Furthermore the “means and/or helpers” must be described in the storyline. These can be persons or means that are either helpful in achieving the desired goals or intentions at hand, or hinder them from being achieved (Murray & Sools,2014). An example of a “helper or mean” that assists the main character in achieving their desired goal for RiverCare could be a local fisherman documenting his or her catches to the scientists, in order for them to get a view on how the intervention is changing the fish population in the river and for Infection Prevention and control this could be a farmer, who notices the early signs of a virus outbreak and reports to the veterinarian. An example of hindering the achievement of the goal could be a group of nearby living residents, which start a protest campaign against the River research or the elimination of all infected poultry.

The fourth element of the model is the “setting or scene”. Here not only the physical environment of the agent must be described, but also the emotional and psychological states that

he or she experiences during the storyline (Murray & Sools, 2014). This could mean that the scientists could experience feelings of guilt and doubt, after being confronted by dissatisfied residents or protesters.

The last element of the model is the “purpose, intention, desired or feared goal”. These can be implicit or explicit (Murray & Sools,2014). In the case of the RiverCare project goals could be the decrease of flood risk, the conservation of the natural habitats of river creatures, the securance of the scenery, safer passage for ships etc. and for the Infection Prevention and control case this could be the minimization of harm caused by a virus outbreak e.g.

The additional element of the five-circle model the “breach” can be found between all five elements. A breach is essential to any type of storytelling and consists of an imbalance between two or more elements of the five-circle model. For example there can be a breach between the purpose/ desired goal: “ I want to reduce the flood risk in this river” / “ I want to prevent infection in the Netherlands” and the means: “ I do not have all the support I need in order to conduct an effective intervention”. By explaining these breaches users can get a clearer view on the problems at hand and experience them through the storyline.

As for the question on how a storyline could be visualized or how the content would specifically look like a simplistic example is given in Appendix B. It is important to state that not all factors of the stepwise approach could be considered whilst developing this example, because of the limited resources of the program with which it was developed (The Marvel Application). The example focuses more on how a story could be incorporated in the platform. So it focuses more on the content of the platform. Through this it gives the reader a first impression on how a storyline could look like on an online platform. Narrative visualization in such a form has not

been done before and further research will be necessary on this topic. Theories and models on multimedia visualisations and the recommendation for a stepwise approach can serve as basis for this research.

1.4. Linking and comparing the two cases

The two cases that were analyzed (RiverCare and Infection Prevention and Control) differ from each other significantly. But the results that were found concerning the development of the platform were very similar. This means that researchers, government employees and all the other stakeholders that were involved in both cases had similar views and attitudes on which factors are relevant when developing a web-based platform. Because of this the coding scheme (Appendix A) that was developed fitted both cases. There will be need for further research concerning these factors, because these two cases are not representative for all fields of (multidisciplinary) research, but the fact that these very different cases brought these similar and specific results, speaks for itself.

Furthermore it is important to state that only in the RiverCare cases the interviewees were informed about using storytelling as a way to convey information on the platform. For the Infection Prevention and Control case this was not included in the interviews. Even though this was the case, the results were incredibly similar, which leads to the assumption the the way of presenting the information (through storytelling) is secondary. The approach therefore could also be applicable for other web-based knowledge platforms. The scope of this generalizability could be tested in future research.

The stepwise approach to developing a web-based platform has not yet been tested in this paper, for it would exceed the scope of this research. Therefore this approach should be tested in different multidisciplinary research fields and settings and through this the approach can be improved or an actual theory could be developed.

1.5. Suggestions for future research

The RiverCare project is set in a research environment. The Infection Prevention and Control case focuses on informing, communication and education next to research. Further research could be aimed at finding out if and how the approach works in these different settings. This means that it should be tested if the development of a web- based platform not only aids communication in multidisciplinary research settings, but also in other multidisciplinary settings like e.g. in the government, when actors from different branches need to work together on non-scientific based projects.

- Test the stepwise approach explicitly, with interviews/ questions developed based on the approach.
- Test the approach on how generalizable it is (use on other web- based platforms e.g.).
- Research on how storylines could be visualized on an online platform under consideration of the approach and possible multimedia principles and theories.
- Combination of how the approach towards designing the platform, the storylines and their content and the visualisation of this could look like.
- Research concerning how the approach fits into other multidisciplinary settings and other scientific fields.

This paper has shown, which factors a web- based knowledge platform, aimed at aiding multidisciplinary research in the form of using storylines to present information, should contain in order to be effective. The 29 factors found that can be divided into the steps of the approach were derived from two entirely different cases and became very apparent in both cases, even though the interviews were not explicitly aimed at finding these factors. This speaks to the relevance and importance of the factors.

1.6. Using the findings

This research has shown that it is important to ensure that certain features are present on the platform before narratives can be incorporated. In practice the approach should be used stepwise, with iterative processes after every step. The approach can serve as basis for designing any type of web- based knowledge platform that aims at improving multidisciplinary research and communication and serves as basis for including narratives on such a platform.

Ideally using narratives will benefit multidisciplinary cooperation in an online setting, but further research is necessary on this topic.

Overview of main findings:

- Before integrating narratives into an online knowledge platform the platform must have certain features.
- The general features are: Information and content selection (Step 1), user related features of the platform (Step 2), the user interface (Step 3) and management of the platform (Omnipresent step).

- After taking these features/ steps into account the translation of information into narratives (Step 4) can begin.

The approach is the first step to be taken on the road to the integration of narratives and narrative psychology into online knowledge settings in order for multidisciplinary research and communication to improve over time.

References

1. Benda, L. E., Poff, L. N., Tague, C., Palmer, M. A., Pizzuto, J., Cooper, S., ... & Moglen, G. (2002). How to avoid train wrecks when using science in environmental problem solving. *AIBS Bulletin*, *52*(12), 1127-1136.
2. Bond, B. (2003). Hydrology and ecology meet-and the meeting is good. *Hydrological processes*, *17*(10), 2087-2089.
3. Boulton, A. J., Piégay, H., & Sanders, M. D. (2008). Turbulence and train wrecks: using knowledge strategies to enhance the application of integrative river science in effective river management. *River futures: an integrative scientific approach to river repair*, 28-39.
4. Bruijn, K. M. de, Lips, N., Gersonius, B., & Middelkoop, H. (2016). The storyline approach: a new way to analyse and improve flood event management. *Natural Hazards*, *81*(1), 99-121.
5. Bush, A.A., & Tiwana, A. (2005). Designing sticky knowledge networks. *Communications of the ACM, 48*(5), 66-71.

6. Choi, B. C., & Pak, A. W. (2006). Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research, services, education and policy: 1. Definitions, objectives, and evidence of effectiveness. *Clinical and investigative medicine*, *29*(6), 351.
7. Cortez Arevalo (2017). User's perspectives about the potential usefulness of online storylines to communicate river research to a multidisciplinary audience *(work in progress)*.
8. Creech, H., & Willard, T. (2001). *Strategic intentions: managing knowledge networks for sustainable development*. IISD, Winnipeg, MB, CA.
9. Cullen, P. (1990). The turbulent boundary between water science and water management. *Freshwater Biology*, *24*(1), 201-209.
10. Dahlstrom, M. F. (2014). Using narratives and storytelling to communicate science with nonexpert audiences. *Proceedings of the National Academy of Sciences*, *111*(Supplement 4), 13614-13620.
11. Eckerberg, K. (2009). *Environmental policy integration in practice: Shaping institutions for learning*. Earthscan.
12. Fix, G. M., Houston, T. K., Barker, A. M., Wexler, L., Cook, N., Volkman, J. E., & Bokhour, B. G. (2012). A novel process for integrating patient stories into patient education interventions: incorporating lessons from theater arts. *Patient education and counseling*, *88*(3), 455-459.
13. Gemert-Pijnen J.E. van, Nijland N,Limburg M. van, Ossebaard HC, Kelders SM, Eysenbach G, Seydel ER. A holistic framework to improve the uptake and impact of eHealth technologies.(2011). *J Med Internet Res*, 13-111.

14. Goodyear-Smith F, Jackson C, Greenhalgh T.(2015). Co-design and implementation research: challenges and solutions for ethics committees. *BMC Med Ethics*, 16-78.

15. Hannah, D. M., Wood, P. J., & Sadler, J. P. (2004). Ecohydrology and hydroecology: A 'new paradigm'?. *Hydrological processes*, *18*(17), 3439-3445.

16. Hillman, M. (2009). Integrating knowledge: the key challenge for a new paradigm in river management. *Geography compass*, *3*(6), 1988-2010.

17. Jones KE, Patel NG, Levy MA, Storeygard A, Balk D, Gittleman JL, Daszak P.(2008) Global trends in emerging infectious diseases. *Nature*, *451*-990–3.

18. Kates, R. W., Clark, W. C., Corell, R., Hall, J. M., Jaeger, C. C., Lowe, I., et al. (2001). Environment and development: sustainability science. Science, 292(5517), 641–642.

19. Lafferty, W., & Hovden, E. (2003). Environmental policy integration: towards an analytical framework. *Environmental politics*, *12*(3), 1-22.

20. Limburg M. van, Wentzel J, Sanderman R, Gemert-Pijnen L.E. van.(2015). Business modeling to implement an eHealth portal for infection control: a reflection on co-creation with stakeholders. *JMIR Res Protoc,* 4-104.

21. Lundgren, R. E., & McMakin, A. H. (2013). *Risk communication: A handbook for communicating environmental, safety, and health risks*. John Wiley & Sons.

22. Mainstone, C., & Brierley, K. A. (2009). River Futures: an Integrative Scientific Approach to River Repair. *Environmental Conservation*, *36*(2), 172.

23. McCulloch, C. S. (2007). Integrating research for water management: synergy or dystopia?. *Water resources management*, *21*(12), 2075-2082.

24. Murray, M., & Sools, A. (2014). Narrative research. *Qualitative Research in Clinical and Health Psychology. London: Palgrave*, 133-154.

25. Naiman, R. J. (1999). A perspective on interdisciplinary science. *Ecosystems*, *2*(4), 292-295.

26. Nowotny, H. (2004). The potential of transdisciplinarity. *H. Dunin-Woyseth, H. and M. Nielsen, Discussing Transdisciplinarity: Making Professions and the New Mode of Knowledge Production, the Nordic Reader, Oslo School of Architecture, Oslo, Norway*, 10-19.

27. Palmer, M. A., & Bernhardt, E. S. (2006). Hydroecology and river restoration: Ripe for research and synthesis. *Water Resources Research*, *42*(3).

28. Pappas G. (2011). Of mice and men: defining, categorizing and understanding the significance of zoonotic infections. *Clin Microbiol Infect, 17*-321.

29. Petts, G. E., Nestler, J., & Kennedy, R. (2006). Advancing science for water resources management. *Living Rivers: Trends and Challenges in Science and Management*, 277-288.

30. Rabozzi G, Bonizzi L, Crespi E, Somaruga C, Sokooti M, Tabibi R, Vellere F, Brambilla G, Colosio C. (2012). Emerging zoonoses: the "one health approach". *Saf Health Work, 3*:77–83.

31. Riessman, C. K. (2008). *Narrative methods for the human sciences*. Sage.

32. Segel, E., & Heer, J. (2010). Narrative visualization: Telling stories with data. *IEEE Transactions on Visualization and Computer Graphics, 16*(6), 1139–1148.

33. Stokols, D., Fuqua, J., Gress, J., Harvey, R., Phillips, K., Baezconde- Garbanati, L., Unger, J., Palmer, P., Clark, M. A., Colby, S. M., Morgan, G., & Trochim, W. (2003). *Evaluating transdisciplinary science. Nicotine and Tobacco Research, 5*(Suppl 1), 21–39.

34. Thoms, M. C., & Parsons, M. E. L. I. S. S. A. (2002). Eco-geomorphology: an interdisciplinary approach to river science. *International Association of Hydrological Sciences, Publication*, *276*, 113-119.

35. Thorp, J. H., Stanford, J. A., Thoms, M. C., & Petts, G. E. (2007). Global partnerships and the new international society for river science (ISRS). *River Research and Applications*, *23*(1), 1-5.

36. Vaughan, I. P., Diamond, M., Gurnell, A. M., Hall, K. A., Jenkins, A., Milner, N. J., ... & Ormerod, S. J. (2009). Integrating ecology with hydromorphology: a priority for river science and management. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *19*(1), 113-125.

37. Vugteveen, P., Lenders, R., & Besselaar, P. van den. (2014). The dynamics of interdisciplinary research fields: the case of river research. *Scientometrics*, *100*(1), 73-96.

38. Wear, D. N. (1999). Challenges to interdisciplinary discourse. *Ecosystems*, *2*(4), 299-301.

39. Woezik, A. F.van, Braakman-Jansen, L. M., Kulyk, O., Siemons, L., &Gemert-Pijnen, J. E.van. (2016). Tackling wicked problems in infection prevention and control: a guideline for co-creation with stakeholders. *Antimicrobial Resistance & Infection Control*, *5*(1), 20.

Appendix

Appendix A Coding scheme

1. Content related/ information codes

a. External links

b. Credibility

c. Updated information

d. Information availability

e. Presentation of information

f. Selection of information

g. Procedural knowledge on how information is gathered

h. Confidentiality of information/ intellectual property constraints

2. User related codes (Skills and goals)

a. Interactivity/ contact other actors involved

b. Time and effort to use the platform

c. Personalization

d. Notifications

e. Downloading of data

3. User interface codes (Capabilities)

a. Provide an easy to follow interface

b. Use common and easy to use software

c. Provide fast and easy access to the platform and it's content

d. Ensure an easy navigation of the platform through e.g. keyword search tools

e. Choice of language

f. Provide an overview of all data and actors involved

g. Enable use on multiple devices

h. Make the platform generalizable

4. Management of the platform

a. Issues regarding the maintenance of the platform

b. Ensure quality of the information and data provided (expert in charge)

c. Monitoring of uploads

d. Management of multiple experts

e. Issues regarding the decision making processes

5. Multidisciplinary related codes

a. Connection of multiple disciplines

b. Fast and simple exchange of information/ data/ communication in general

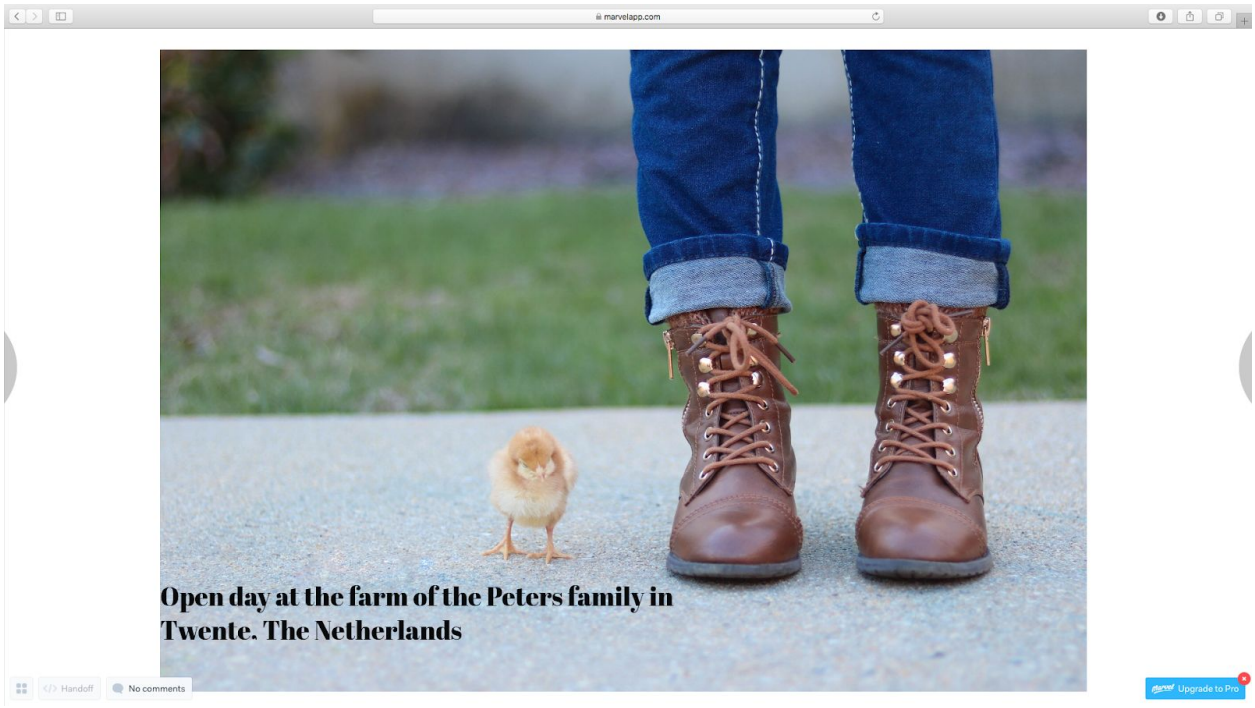
c. Prohibit misunderstandings in communication

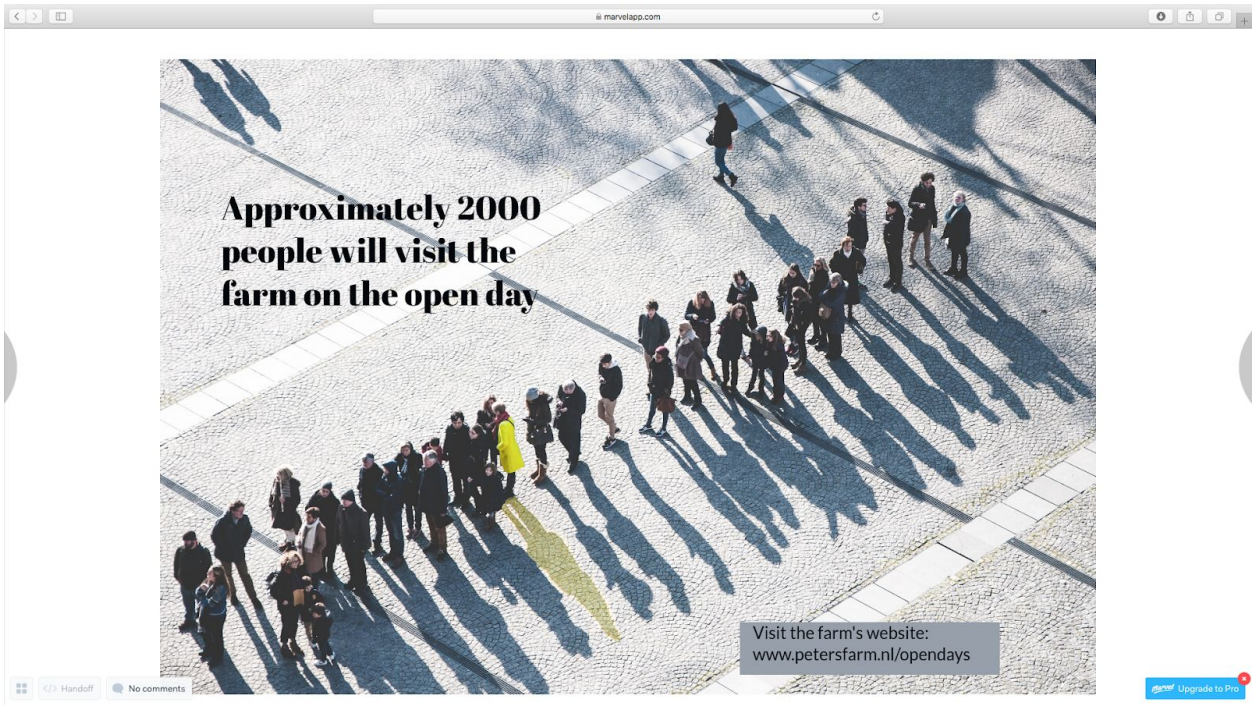
d. Use the platform as a central database

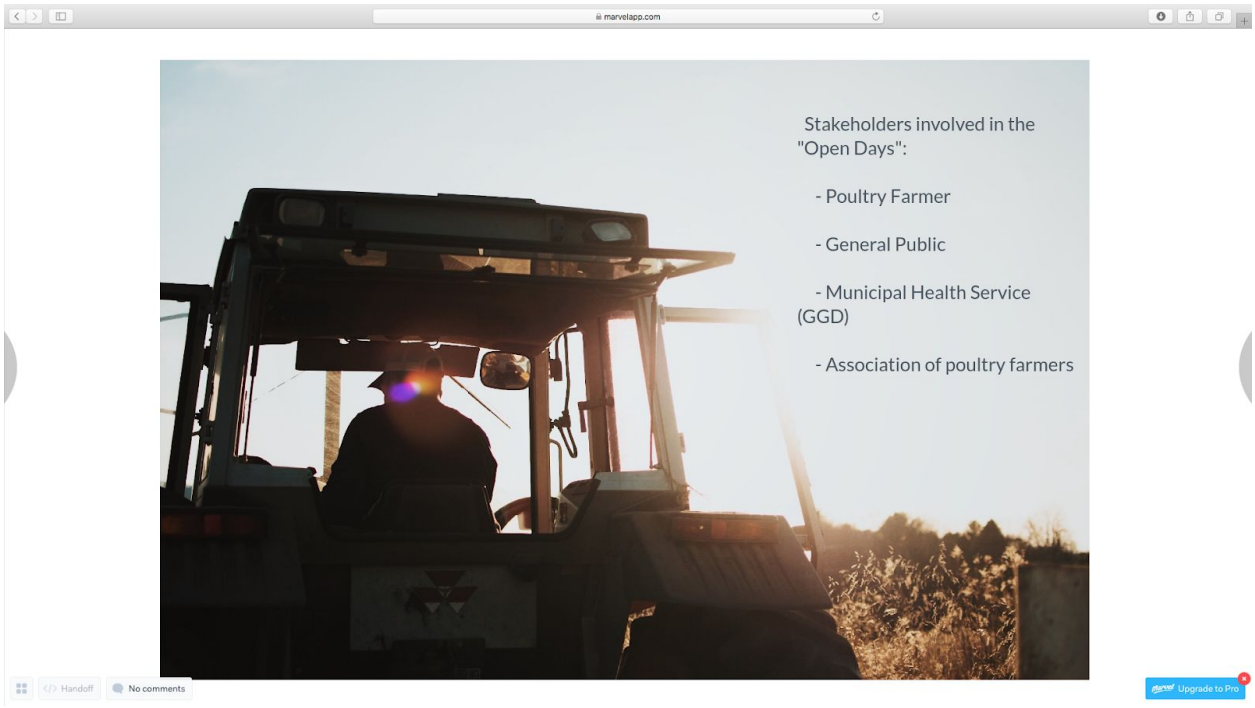
e. Connect various sources from abroad

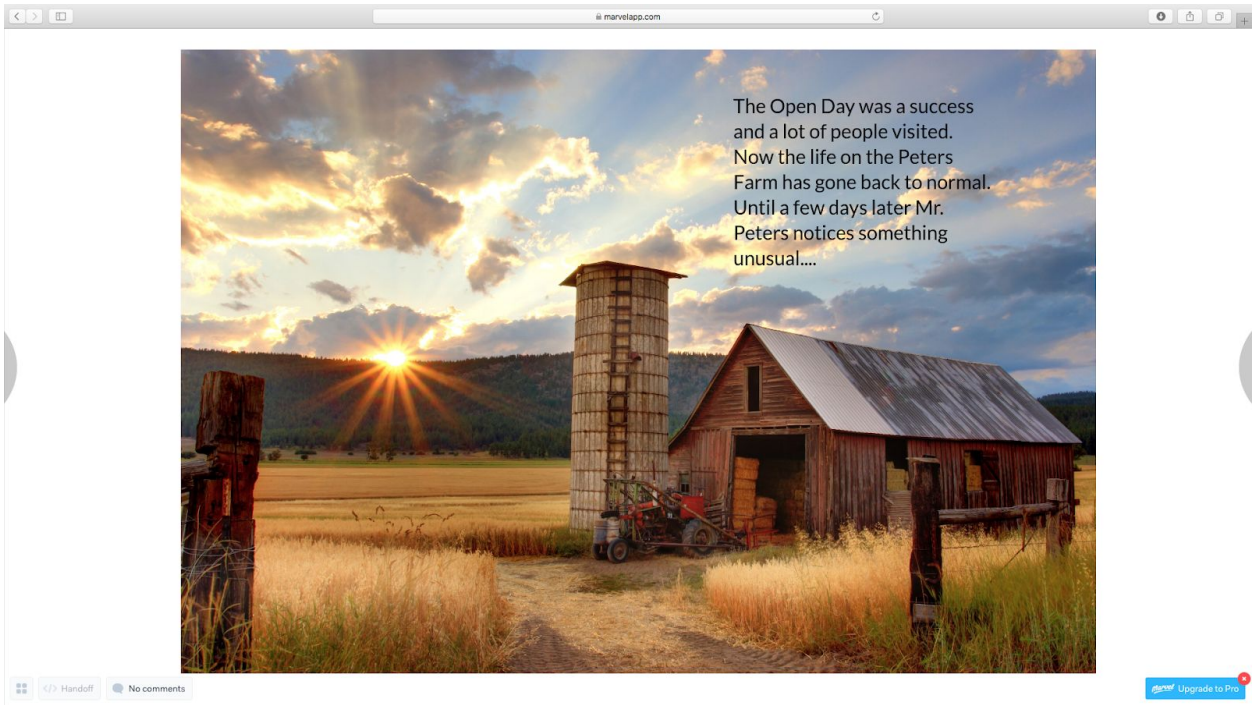
f. Increase effectivity and quality of the platform and information through multidisciplinarity

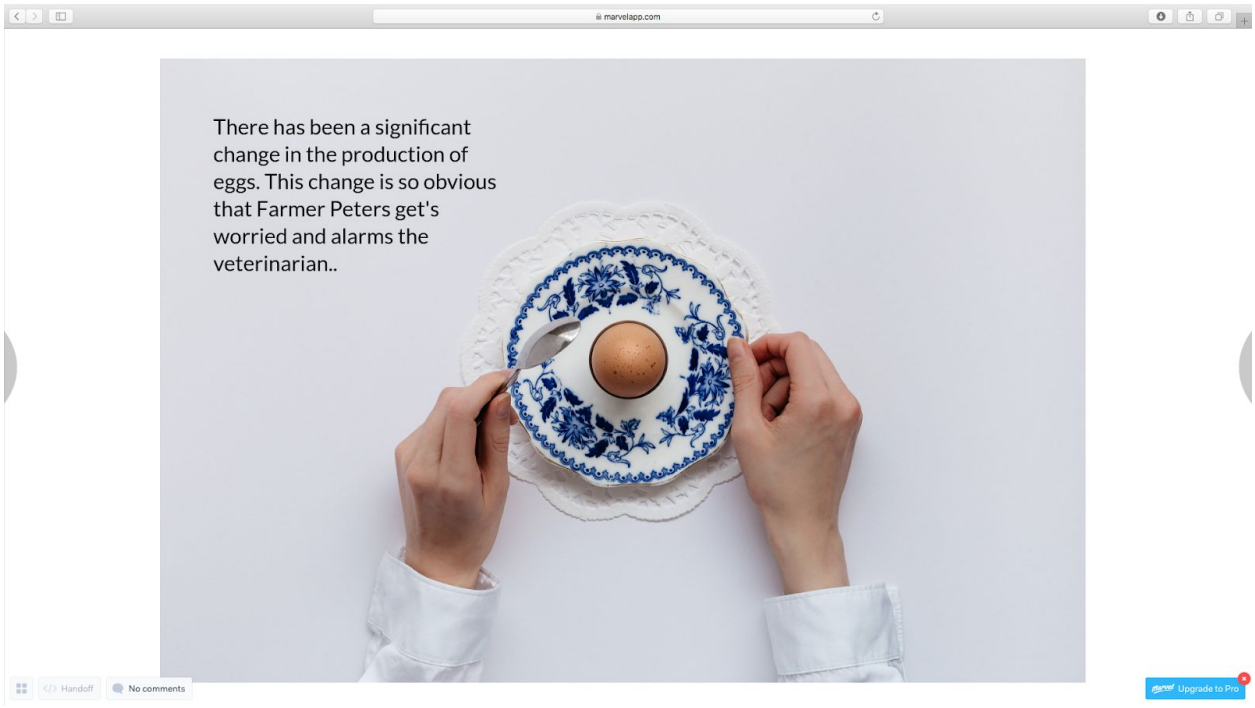
Appendix B Example of storyline visualization


marvelapp.com
Open day at the farm of the Peters family in Twente. The Netherlands
Handoff
No comments
Upgrade to Pro


marvelapp.com
Approximately 2000 people will visit the farm on the open day
Visit the farm's website: www.petersfarm.nl/opendays
Handoff
No comments
Upgrade to Pro


marvelapp.com
Stakeholders involved in the "Open Days":
- Poultry Farmer
- General Public
- Municipal Health Service (GGD)
- Association of poultry farmers
Handoff
No comments
Upgrade to Pro


marvelapp.com
The Open Day was a success and a lot of people visited. Now the life on the Peters Farm has gone back to normal. Until a few days later Mr. Peters notices something unusual....
Handoff
No comments
Upgrade to Pro


marvelapp.com
There has been a significant change in the production of eggs. This change is so obvious that Farmer Peters get's worried and alarms the veterinarian..
Handoff
No comments
Upgrade to Pro


marvelapp.com
The veterinarian informs the Dutch Food Safety Authority (NVWA)
Visit the NVWA's website: www.nvwa.nl
Handoff
No comments
Upgrade to Pro

The veterinarian and the NVWA speculate that there has been an outbreak of the AI Virus (H5N8) also known as the bird flu virus.

The law demands that other instances should be involved.

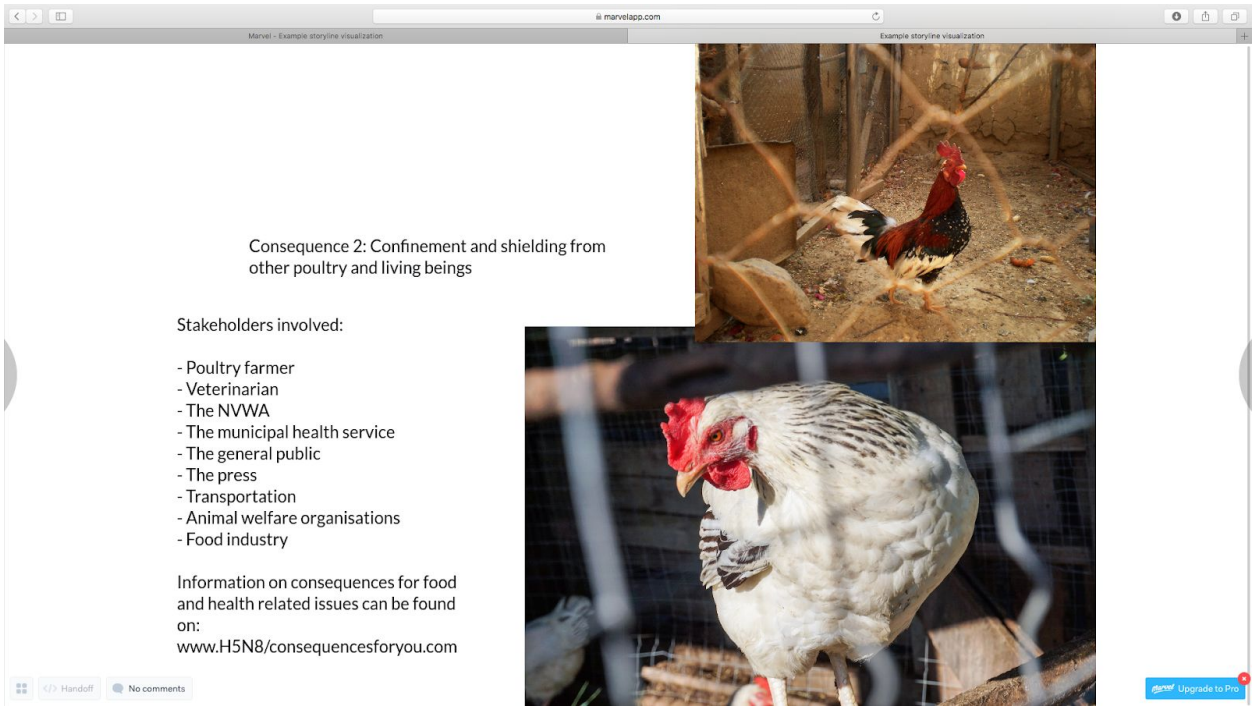
Summary of stakeholders involved at this point:
- Poultry farmer
- Veterinarian
- The NVWA
- The municipal health service (GGD)
- The general public
- The press

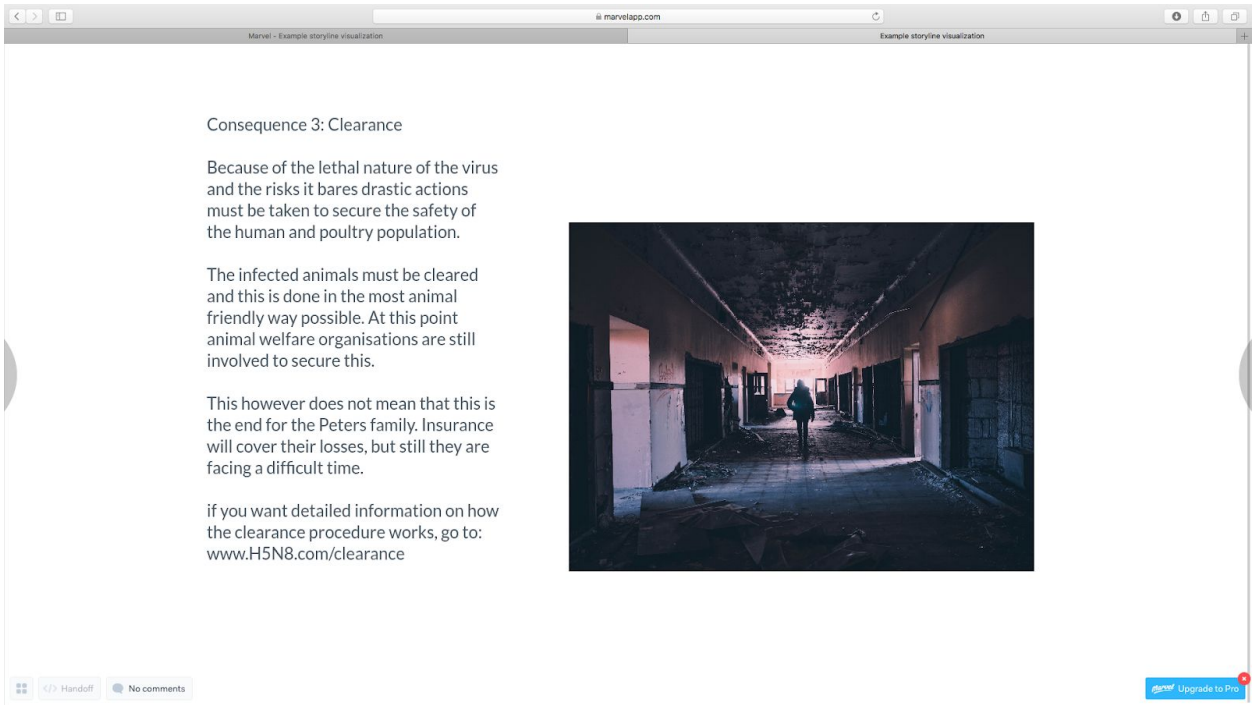
Additional information on thw H5N8 virus can be found here:
www.H5N8.nl/howwhatwhy

In order to avoid false information being leaked to the public by the press this matter must be dealt with cautiously.
False information is printed regularly and can lead to public distress and even panic.
If you have any questions regarding health issues etc. contact the following instances below.

1. Example x1
2. Example x2
3. Example x3
4. Example x4


marvelapp.com
The H5N8 virus has been found on farmer Peters farm.
This has certain consequences:
Consequence No. 1: Transport Ban
ROAD
TRAIN
Handoff
No comments
Upgrade to Pro


marvelapp.com
Marvel - Example storyline visualization
Example storyline visualization
Consequence 2: Confinement and shielding from other poultry and living beings
Stakeholders involved:
- Poultry farmer
- Veterinarian
- The NVWA
- The municipal health service
- The general public
- The press
- Transportation
- Animal welfare organisations
- Food industry
Information on consequences for food and health related issues can be found on:
www.H5N8/consequencesforyou.com
Handoff
No comments
Upgrade to Pro


marvelapp.com
Marvel - Example storyline visualization
Example storyline visualization
Consequence 3: Clearance
Because of the lethal nature of the virus and the risks it bares drastic actions must be taken to secure the safety of the human and poultry population.
The infected animals must be cleared and this is done in the most animal friendly way possible. At this point animal welfare organisations are still involved to secure this.
This however does not mean that this is the end for the Peters family. Insurance will cover their losses, but still they are facing a difficult time.
if you want detailed information on how the clearance procedure works, go to:
www.H5N8.com/clearance
Handoff
No comments
Upgrade to Pro