

How Software Transparency Can Mitigate Conflicts Among Different Stakeholders in the Animal Experimentation Domain

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Abstract

The arguments of whether animals should be used in the experiments have existed for decades. Stakeholders such as animal advocates, scientists, and mediators have been calling for more transparency to tackle the conflicts. They all claim that being transparent is a way to understand each other and to know the whole picture of the animal experiments. It is believed that laboratories' software should provide aspects of transparency to help mitigate the conflicts among different stakeholders' points of view. In this thesis, a Systematic Literature Review was conducted to collect requirements and potential solutions from the literature from the perspectives of different stakeholders and put them together in a set of softgoal interdependency graphs (SIGs) that illustrating the possible solutions to achieve transparency. The resulted SIGs may help the laboratories to adopt software that provides a level of transparency for the research process, and it will also help to mitigate current problems involving researchers, mediators, and groups contrary to the use of animals.

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1. Introduction

Animal Experimentation has always been a controversial issue. There have been debates between either animals should be used in the laboratories, and the welfare and rights of the animals in the laboratories. Disputes in animal research mainly involve three different stakeholder groups: the researchers who use animals in their studies, the animal advocates who are against the use of animals in any experimentations, and the mediators, who usually are the lawmakers. These groups are trying to gain support from the public opinion as a recourse in the debate to emphasise the righteousness of their statements [1]. Although it might seem harsh to find a perfect solution to appease all sides of the debaters [2], the three stakeholders are trying to seek a balance between the two extremes [3]. All three groups of stakeholders are in favour of transparency in the animal research domain despite the differences they have regarding the best solution to the issue at hand [2] [4].

1.1. Motivation

There are regulations such as Animals (Scientific Procedures) Act 1986, in the United Kingdom (UK) and European Union Directive 2010/63/EU in the EU, which regulate what kinds of researches can be approved regarding using animals, what

kinds of animals could be used, and how animals should be handled in the laboratories. Despite that, most people still assume that animal researches can be commenced without any restrictions. The call for being transparent for scientists has been increasing [5], and it seems like a strong feature that will be able to mitigate the conflicts and bring together these three different group of stakeholders. At the same time, laboratories are increasingly adopting software systems to control their workflow. One of them, Tick@Lab [6], a software for laboratory animal research facilities, already pointed out to transparency as a critical feature of the system. Unfortunately, it only offers transparency in a minimal way, mostly related to the availability of some specific information. It does not cover important aspects such as auditability, informativeness and easy retrieval of information.

Furthermore, a survey [7] demonstrated that many types of research involving animal research failed to provide relevant information about how the experiment was designed, conducted and analysed. The information stated in the publications is not sufficient, nor it can be found inside the laboratories.

In addition to insufficient information in publications, the understandings of transparency are not the same among different groups. For instance, animal advocates are interested in how the decisions are made and how the animals are

handled in the research. However, researchers believe that to achieve transparency, it is sufficient to provide the processes, purposes and values of their studies. Such differences also lead to misunderstandings and lessen conversations among different parties.

Such proposals for transparency and openness have been deployed in the UK and Spain. In the UK, an organisation named Understanding Animal Research proposed “Concordat on Openness on Animal Research [8]” to give guidelines to research institutes for disclosing their research to the public in 2014 [9]. In Spain, a similar agreement was also proposed in 2016 [10]. By April 2018, 119 institutes and 121 institutions have signed the agreement on transparency in the UK and Spain respectively, and have included the institutional declarations on animal research to disclose information on their webpages [5]. Belgium also proposed a similar approach in 2016 as well, with 24 signatories of research organisations[11]. Researches have shown that such information disclosures in animal experimentation can improve public perceptions, which also benefit the workers and the research institutions by adopting policies to open to the public [12] [13] [14] [15]. Thus, the need for transparency in the laboratory regarding animal experiments has risen to both researchers and the public, and this study is aimed to find out the solutions that

software used in laboratories conducting experiments that use animals need to consider for achieving transparency in animal experimentation.

1.2. Thesis Contributions

Laboratories are becoming more and more automated using software systems to support their researches and the manipulation of animals, On the other hand, there is the emerging scenario that transparency dealing with animals can be a solution to mitigate conflicts among different actors who have different perspectives about the use of animals in experimentation. This thesis provides a set of solutions that would support transparency in the laboratory. This set of solutions, some of them policy related others implemented via software, can be used to guide stakeholders to evaluate different scenarios where transparency can help different actors to agree on the use of a set of transparency solutions that will promote a minimal level of trust among parts. Having a set of alternative solutions allows different laboratories to adapt to different solutions based on their scenario and also permits to provide configurable solutions that can be used throughout the software lifecycle accordingly to changes in policies, politics, and procedures.

1.3. Thesis Structure

The rest of the thesis is structured as follows. Section 2 demonstrates related works and the essential knowledge of the thesis. Section 3 states the research goal and the objectives of this thesis. Section 4 discusses the methodology of how the thesis is conducted. Section 5 shows the catalogues of transparency in different perspectives respectively. Section 6 combines all the catalogues altogether and presents the overall SIGs for achieving Transparency. Section 7 demonstrates how catalogues can be reused. Section 8 concludes the thesis and explains how this thesis might help the transparency requirements of animal experimentations in the future.

2. Related Works

Transparency is deemed to be a Non-Functional Requirement (NFR), and as such, it is difficult to elicit and model. Moreover, Leite and Cappelli [16] have shown that achieving software transparency will demand several other NFRs be taken into consideration. In this chapter will present the fundamental concepts of non-functional requirements and transparency.

2.1. Non-Functional Requirements

Functional requirements are mainly discussed in two aspects. One focus on the functions and the other emphasise on the behaviour Functions describe what the system should do. That can also be seen as an action that the system should perform. Behavioural aspects relate the requirements that specify the inputs to the system, the outputs from the system, and behaviour between the inputs and outputs [19]. Both aspects describe the requirements of what the system must be able to perform and operate [20].

Non-functional requirements (NFRs), on the other hand, describe how the system should operate [21]. Contrary to functional requirements, which represent the functional aspects of the system, NFRs are often vague, not quantified, and not

systematic [22] [23]. NFRs are considered as quality requirements [24][25] refers to the requirements of quality characteristics such as privacy, security and accountability [26]. Even though NFRs are not simple to elicit and are very complicated to understand, they nonetheless play a vital role in the system development process.

There are many approaches to deal with NFRs. Boehm et al. [27] developed the Quality Attribute Risk and Conflict Consultant tool to analyse quality attributes trade-offs involved in software architecture and process strategies. The International Standardization Organization [28] launched the ISO/IEC 25010 quality model in 2011. The quality model determines which quality characteristics will be taken into consideration when evaluating the properties of software. Cysneiros et al. [29] presented a strategy based on the use of Language Extended Lexicon to tackle the problem of NFRs elicitation and integrate the NFRs into UML and functional models. Chung et al. [24] proposed the NFR framework to represent NFRs using softgoals and the relationships among them by using the softgoal interdependency graphs (SIGs). This framework is used to elicit and model NFRs and helps to manage NFRs systematically and is a way of treating NFRs. Sancho et al. [30] further designed the SIG ontology framework and purposefully to make it machine-readable. They

introduced NFR type ontology and SIG Ontology, both of which were written in OWL. The SIG ontology, on the other hand, was developed to describe the exact diagrams of SIGs, including the structure and relationships among them.

This thesis builds upon the use of the NFR framework by Chung et al. [24] as the approach to handle NFRs and demonstrate NFRs in softgoal interdependency graphs(SIGs) because it is an intuitive way to present NFRs and the interrelationships with SIGs. Chung's works is explained below in section 2.1.1.





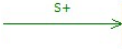


2.1.1. Catalogues and Softgoals Interdependency Graphs (SIGs)

The NFR framework has been proposed by Chung et al. [24] to represent NFRs as softgoals and the interrelationships among them by using the softgoal interdependency graphs (SIGs). This framework is used to elicit and model NFRs and helps to manage NFRs systematically and is a way of treating NFRs. In the SIGs, softgoals are defined as goals to be "satisficed" instead of "satisfied". Comparing to hardgoals, which have well-defined criteria of satisfaction, softgoals are more flexible. The term "satisficed" is a combination of the word satisfy and sacrifice, which indicates the idea that an NFR can hardly be completely satisfied [22][23][31]. It is satisfied within acceptable sacrifices and limits. An NFR softgoal can be decomposed

into other more detailed sub-softgoals, which describe how the parent softgoals can be “satisficed” by one or more decomposed sub-softgoals.

The bottom of the SIGs will present operationalisations which are possible solutions for the softgoals or sub-softgoals. Quite often, operationalisations will translate into new functional requirements. The linkage and relationships of each softgoals and operationalisation are defined to describe their positive contributions, negative contributions or and/or decomposition to its parent softgoal [32]. A positive relationship can be Make, Help, and Some+; on the other hand, Break, Hurt, and Some- represent a negative relationship on a softgoal. A Make relationship indicates that this decomposition on its own is enough to satisfice the parent softgoal. A Help relationship means that the decomposition has a positive impact to satisfice the parent softgoal. A Some+ relationship shows that we are aware that the decomposition will have a positive impact on its parent softgoal, however, we are not clear to what extent it will satisfice. It is possible to be either a Help contribution or Make contribution. Instead, a Break relationship indicates that this decomposition will prevent the satisficing of the parent softgoal. A Hurt relationship shows that the decomposition will damage the satisficing of the parent softgoal. A Some- relationship is like a Some+ relationship but in a negative way. It indicates that the

decomposition will damage the satisficing of the parent softgoal, but we are not sure to what extent. AND decomposition shows that the decompositions are all required to satisfy the parent softgoal. OR decomposition, on the other hand, denotes that either of the decompositions can satisfy the parent softgoal. TABLE 1 shows the elements and description of the SIGs. Cysneiros [33] shows that the reuse of SIGs helps the NFR elicitation, and minimising conflicts between NFRs, and introduced an NFR Tool which uses an ontology-based approach to support the collection of knowledge on possible solutions to implement NFRs and connecting related NFRs [34].

Element	Description
	Non-functional requirement softgoal
	Operationalization softgoal
	AND Decomposition
	OR Decomposition
	Some+ contribution
	Make contribution
	Help contribution

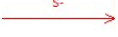



	Some- contribution
	Break contribution
	Hurt contribution
	Correlation Relationship

Table 1 - Legends of the Elements and Description of the SIGs.

2.1.2. Transparency

Transparency has become a crucial part of modern society. Both the public and private sectors have been required to be transparent. More transparency in the public sector is demanded on how the government make decisions and where the expenses are spent at [35]. Transparency in private organisations is also needed to build trust among the stakeholders and to prevent corruption [36].

The term transparency is interpreted differently among many authors. Some describe it as a state that all information is disclosed to users [37]. Others consider it as communications among stakeholders [38]. But the central idea of transparency sticks to information disclosure [16] [39]. Transparency is considered as a non-functional requirement which needs to be addressed in the early stages of requirements elicitation. Leite and Cappelli [16] initialised the systematisation of

transparency and suggested a systemised SIG of Transparency using the NFR Framework. Figure 1 shows their Transparency SIG, and Table 2 presents the definition of the Softgoals and sub-softgoals that satisfy the transparency NFR. The author identifies a set of sub-softgoals that can help achieve Transparency. Zinovatna et al. [40] analysed privacy and transparency and illustrates how they affect each other in SIGs. Cysneiros et al. [41] carried out an initial study on NFRs for self-driving cars and found out that transparency plays an essential role in building customer confidence. A survey has been conducted by Mills et al. [13] proving that having more transparency in the laboratory will improve public perception, acceptance and support for animal research. Hagelin et al. [42] suggest that such openness is also needed in order to increase confidence in science, scientists and the regulatory system, as well as to eliminate the controversy of the use of animals in animal studies.

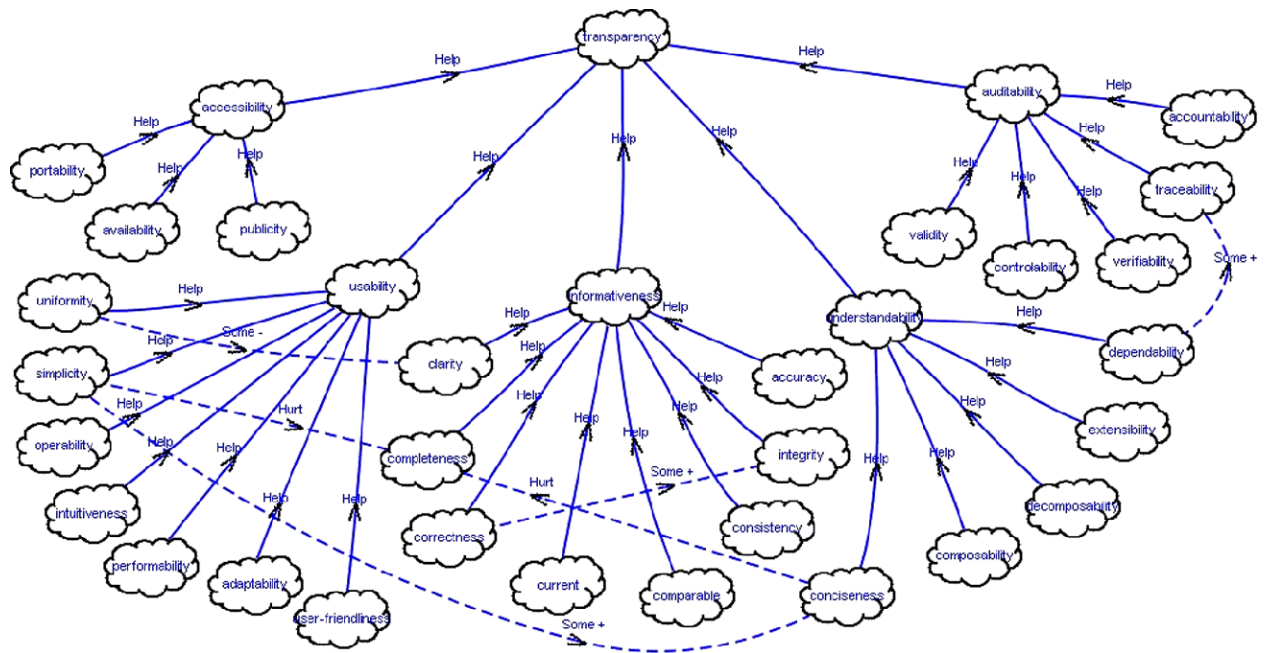


Figure 1 - Transparency SIG from Leite and Cappelli [16]

NFR Framework characteristics	Definitions
Accessibility	The quality of being easy to meet deal with
Portability	The quality of being light enough to be carried
Availability	The quality of being at hand when needed
Publicity	The quality of being open to public view
Usability	The quality of being able to provide good service
Uniformity	The quality of lacking diversity or variation
Simplicity	The quality of being free from difficulty or hardship or effort
Operability	The quality of being treated by surgical operation
Intuitiveness	The quality of being spontaneously derived from or prompted by a natural tendency
Perform ability	The ability of giving a good performance
Adaptability	The ability to change (or be changed) to fit changed circumstances
User-friendliness	The ability to use easily
Informativeness	The quality of providing or conveying information
Clarity	The ability to be free from obscurity and easy to understand
Completeness	The quality of being complete and entire; having everything that is needed
Correctness	The quality of being conform to fact or truth
Current	The quality of occurring in or belonging to the present time
Comparable	The ability to be compared
Consistency	The ability to express logical coherence and accordance with the facts
Integrity	The quality of being undivided or unbroken completeness, or totality with nothing wanting
Accuracy	The quality of being near to the true value
Understandability	The quality of comprehensible language or thought
Conciseness	The ability to express a great deal in just a few words
Composability	The ability to put together out of existing material
Decomposability	The ability of separating into constituent elements or parts
Extensibility	The quality of being protruded or stretched or opened out
Dependability	The quality of being dependable or reliable
Auditability	The ability to examine carefully for accuracy with the intent of verification
Validity	The quality of being valid and rigorous
Controllability	The ability of being certain of something
Verifiability	The quality of being tested (verified or falsified) by experiment or observation
Traceability	The quality of following, discover, or ascertain the course of development of something
Accountability	The quality of being explained; made something plain or intelligible

Table 2 - Definitions for the types used in the Transparency SIG from Leite and Cappelli

[16]

3. Research Objectives

The purpose of this research starts by understanding the requirements for transparency and the options to achieve transparency among the three different stakeholder parties in the context of conducting animal experimentation. Although in many situations these three groups do not agree with each other, there are critical requirements that they are all in favour of, and there are also some close to home points that need to be avoided. The outcome of this thesis is a set of SIG catalogues that would help researchers to understand requirements for transparency in the animal research domain. The refinement SIGs can also be a tool to help software engineers to evaluate and choose which solutions would be more suitable to be used in the environment where they are working. Given the fact that different laboratories have different priorities, goals and political needs to be balanced, likely a set of requirements and solutions that will work for one laboratory may not work for another. Therefore, presenting a set of possible solutions would favour developers to build software that will adhere better with the environment where the software will run. In addition, it will provide configurable solutions that can be used throughout the software lifecycle accordingly to changes in policies, politics and procedures. Consequently, this thesis does not aim at proposing one single solution that would

satisfice all stakeholders. It will propose a set of possible solutions illustrated in the SIGs mentioned above that will help each laboratory to build or adapt their software in a way that transparency can be provided in such a way that would minimise conflicts and yet respect the preferences, legal constraints and convictions of each laboratory.

To achieve this goal, there will be two main objectives. The first objective will be focused on the current status of transparency in animal experimentation. By conducting a structured systematic literature review, this work will elicit a comprehensive set of requirements that could either help or hurt transparency goals. Note that it is important not only to understand which properties a software should have to promote transparency but also be aware of solutions that would jeopardise transparency as well as answers to transparency that would compromise other requirements.

Once these requirements and possible solutions are captured, the next objective is to identify the catalogues and categorise all the acquired requirements and solutions into the catalogues using SIGs.

Building software to research laboratories is a new domain. Add to that the need to support some laboratories that carry out research using animals that are part of

their experiments. This is a combination that is unheard of in the software development area and the more knowledge we can add to help software engineers and stakeholders to elaborate on the necessary requirements for the software the better software specification we will have . We believe that building a knowledge base based on peer-reviewed literature is a way not only to advance the current state of the art in both domains but also might trigger the interest of other researchers to follow up this work.

4. Methodology

4.1. Research Questions

The central presumption of this thesis is that the use of catalogues helps to elicit more and better solutions to satisfy NFRs. There are empirical evidence suggesting it [43] [44] [45] [46]. Therefore, developing a set of catalogues modelling different solutions to provide transparency to software controlling laboratories that use animals in experiments will help to mitigate existing problems among different categories of stakeholders. I state the research questions as follows:

RQ1: What are the three different groups of stakeholders looking for in Transparency in animal experimentation?

In this research question, we focus on the needs of each party and classify their needs based on the similarities.

RQ2: How to achieve transparency in animal experimentation and satisfy the needs of the three stakeholders?

Since NFRs are very difficult to satisfy completely, it is hard to please all side of the stakeholders. In this research question, we will combine the softgoals among the three stakeholders and conclude the findings to provide solutions.

4.2. Systematic Literature Review

To collect the data needed for transparency in the animal experimentation domain for answering the research questions, a structured systematic literature review has been carried out. The systematic literature review is proposed to summarise the existing literature in a structured and non-biased method [47]. The systematic literature review steps include literature searching, literature selecting and literature analysing.

The first step is the literature searching. The goal is to determine the possible keywords for searching the term “Transparency” in the domain “Animal Experimentation”. The keywords used for substitutions of transparency were “transparent”, “openness”, “disclose” and “disclosure”. The similar keywords of “animal experimentation” are “animal experiment”, “animal test”, “animal testing”, “animal research”. The keywords were applied to Google Scholar. Google Scholar provides a powerful search engine that crawls across many up-to-date databases. Table 3 shows the keyword strings used for the search in Google Scholar.

Fixed keywords	"animal" OR "animals" "experiment" OR "testing" OR "experimentation" OR "test" OR "research"
Collocated words	<ol style="list-style-type: none"> 1. Transparency 2. Transparent 3. Openness 4. Disclose 5. Disclosure

Table 3 - Keyword strings used for the Search

The numbers of outcomes were massive after the first attempted search. For example, transparency "animal" OR "animals" "experiment" OR "testing" OR "experimentation" OR "test" OR "research" gives 534,000 results, and it is impossible for a human to read 534,000 different results. Therefore, ALLINTITLE search restriction was applied to search keywords only in titles to limit down the outcomes. Normally, in the process of the systematic review, the first filter for eliminating non-suitable literature is to do title reading to eliminate irrelevant literature, duplicate results, and papers that are not written in English. "ALLINTITLE" is a restriction term

that Google Scholar provides, excluding articles that do not have the keywords in the titles automatically, which is similar to eliminating irrelevant literature in the first step. Table 4 shows the differences in the number of results after applying the restriction "ALLINTITLE".

Search string	Original results	ALLINTITLE Results
transparency	534,000	22
transparent	1,140,000	4
openness	313,000	18
disclose	310,000	0
disclosure	1,100,000	2
Total	3,397,000	46

Table 4 - Number of Results Before and After the ALLINTITLE Application

Aside from eliminating papers that do not contain keywords in their titles, other filters such as articles that are not in English, duplicated results, and other irrelevant articles based on the Systematic Literature Review process are also applied. After

the first-round check and elimination, 26 papers were kept for the next step of Systematic Literature Review is abstract reading

In the second step of the Systematic Literature Review processes, abstract reading was applied. The peer-review process determines if the articles are relevant to the study. Three articles were eliminated because they are communication letters between the editors of the journals and the authors of the papers. Therefore, 23 publications were kept.

In the third steps of the Systematic Literature Review processes, two more publications were eliminated. One of the publications [48] is a document of presentation slides without credible sources of references. The other publication [49] was removed from the analysis process due to it is a comment on the declaration of openness on animal research with no valuable information to this research. The third step left 21 publications on hand.

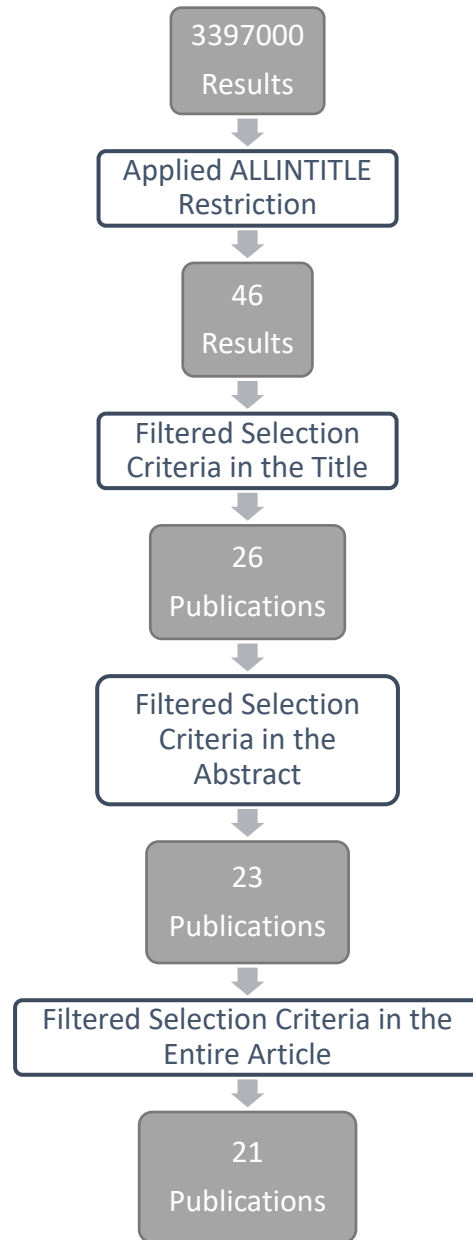


Figure 2 - The Processes of Systematic Literature Review

4.3. Selection Criteria

The selection criteria, which applied in the systematic literature review, are stated as follows.

4.3.1. Inclusion Criteria

- (1) Publications that are from reliable sources (i.e. journals, conference papers).
- (2) Government and Industry reports that are relevant to the research questions.
- (3) Publications that contain the searching terms in their titles.

4.3.2. Exclusion Criteria

- (1) Publications that are not written in English.
- (2) Duplicated results.
- (3) Studies that deal with Transparency but not focus on animal experimentation.
- (4) Studies that deal with Transparency but only mention animal experiment as secondary objectives.
- (5) Studies that do not discuss transparency in the animal experimentation domain.
- (6) Opinions, editorials and comments that are lacking associated papers.

4.4. Snowballing

There might be papers that are missing due to the “ALLINTITLE” restriction. Some papers do not contain the keywords in their titles or other important alternative terms are not applied in the Systematic Literature Review search. In order to reduce biases, and make sure that publications are not being eliminated due to the “ALLINTITLE” search restriction, the snowballing method is applied. Snowballing method [50] captures the references (Backward snowballing) and the citations (Forward Snowballing) of the existing papers on hand, the obtained papers then to be filtered by certain selection criteria. The publications that are useful to this thesis are kept. The 21 papers from the results of Systematic Literature Review are used as “initial papers” to apply the snowballing method to avoid biases.

4.4.1. Backward Snowballing

In the Backward snowballing stage, the publications were captured from the references of the 21 initial papers. Eventually, 501 papers were obtained in the reference sections of the publications.

During the first filtering procedure, similar to the Systematic Literature Review processes, title-reading was applied. Publications were removed due to being

irrelevant, duplicated and not in English. The first screening process left 219 papers on hand.

In the second step of backward snowballing, selection criteria are applied in the abstracts of the 219 articles on hand. Studies that deal with Transparency but not focusing on animal experimentation or only mentioning animal experiment as secondary objectives, studies that do not discuss transparency in the animal experimentation domain or opinions, editorials and comments that are lacking associated papers are filtered out, which results in 29 articles left.

the third step, the selection criteria are being put on all sections of the publications.

Publications that are considered not relevant and lacking references were removed, which led to 25 publications in total.

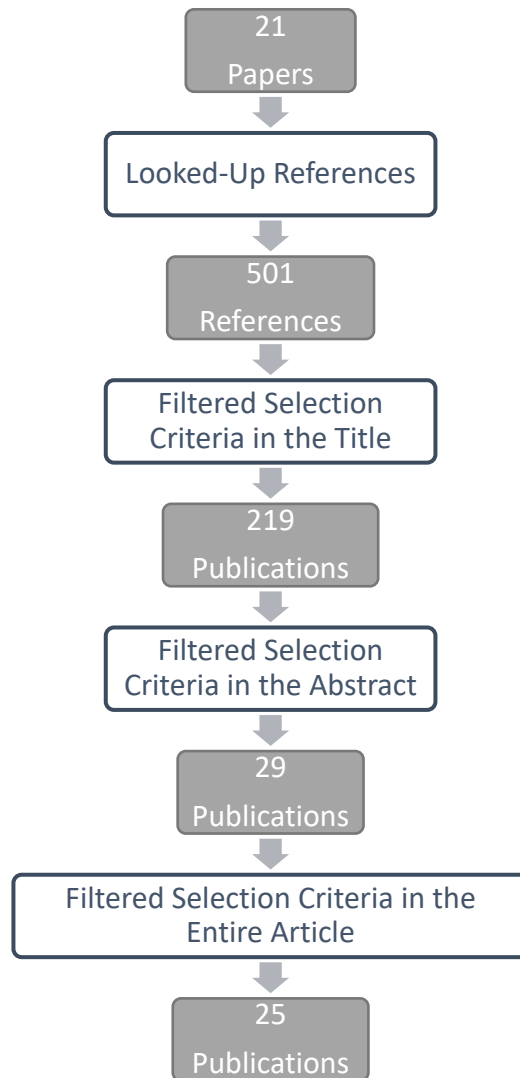


Figure 3 - Processes of Backward Snowballing

4.4.2. Forward Snowballing

In the stage of forward snowballing, 133 articles were obtained by checking cited-by on Google Scholar.

During the first filtering procedure, 41 papers were kept after the first round of

selecting with title-reading. Non-English, irrelevant, and duplicate papers are removed. Abstracts of the 41 papers are being analysed in the second round of filtering. 11 publications are kept in this round after applying the selection criteria and are proceeded to the third step of filtering. In the third step, the same as the Systematic Literature Review method and backward snowballing method, the selection criteria are applied in the full article. The peer-reviewed process left 9 articles in total.



Figure 4 - Processes of Forward Snowballing

Method	Literatures	Amount
Systematic Literature Review	[51][3][4][52][53][54][13][9][55][56] [57][58][59][60][61][62][63][64][65][66] [67]	21
Backward Snowballing	[68][69][70][71][14][15][8][72][42][1] [73][74][7][12][75][76][77][2][78][79] [80][81][82][83][84]	25
Forward Snowballing	[85][86][87][88][89][90][91][92][93]	9
Total		55

Table 5 - List of References Identified

4.5. Building the SIG Catalogues

A total of 55 publications from the result of the Systematic Literature Review and Snowballing Methods were analysed to build the SIG Catalogues. The analysing processes were based on peer-review of the articles. The requirements and solutions to achieve transparency were extract from the articles. It is necessary to identify all requirements and solution options from the publications obtained. For example, in O’Sullivan’s study [3], the author states

“...We ordinary New Zealanders, have no idea because all the meetings of the

Animal Ethics committees [AECs] which approve experiments are conducted in secret their meetings are not advertised, and members of the public cannot even obtain copies of the agendas or minutes of their meetings...”

MEETINGS ARE NOT ADVERTISED is identified as a softgoal that hurts Transparency. The public wishes to obtain copies of AGENDA, and MINUTES are also recognised as solutions/requirements to satisfy Transparency. Once all the solutions were obtained from the articles, they were classified into high-level catalogues based on similarities. These solutions and requirements subsequently were transferred into sub-softgoals and operationalisation softgoals of transparency using SIGs. The linkage and relationships between each softgoals and operationalisations were identified based on their positive contributions (make, help) or negative contributions (hurt, break) [32] to their related parent softgoal.

Leite and Cappelli [16] proposed a catalogue to guide software engineers to develop transparent software. Their work was not used as the basis for building the catalogues presented in this thesis.

The catalogues and the operationalisations in this thesis were identified and classified by the author of the thesis and cross evaluated with the solutions for Transparency proposed by Leite and Cappelli [16] and Zinovatna et al. [40]. The

resulting SIGs were assessed for correctness and completeness by the advisor.

The SIGs were built in the StarUML with the extension of RE-Tool embedded [94]. StarUML is an open-source software modelling tool that is compatible with UML 2.x standard, supports all UML diagrams, provides a user-friendly interface to drag and drop UML diagrams easily.

5. Transparency Catalogues from Different Perspectives

The need for transparency in animal experimentation exists among the three groups of stakeholders. Because of the positions where they are standing against each other, the actual requirements representing their needs are different. For example, the animal advocacy groups desire that members of the laboratory can be known to the public. However, researchers think differently. They believe that if their identities are exposed under the public, it might endanger privacy and result to be assaulted. Since different stakeholder might be looking for different requirements, this chapter will demonstrate the catalogues that were abstracted from the System Literature Review process in the perspectives of animal advocates, researchers, and mediators.

The catalogues are presented in SIGs. The context explains the definition of operationalisation softgoals. An operationalisation softgoal in the SIG is connected to its explanation in the text through the same alphabetical pointer on the softgoal and at the begin of the explanation, and it can be traced back to the original source through references. For example, *label (A)* which appeared in the operationalisation softgoal in the SIG, is connected to the same *label (A)* in the context. The following paragraph describes the meaning of the operationalisation and can be traced back

to its primary resource through the references list. Figure 5 shows an example of how the SIGs are presented and linked to the context of the thesis.

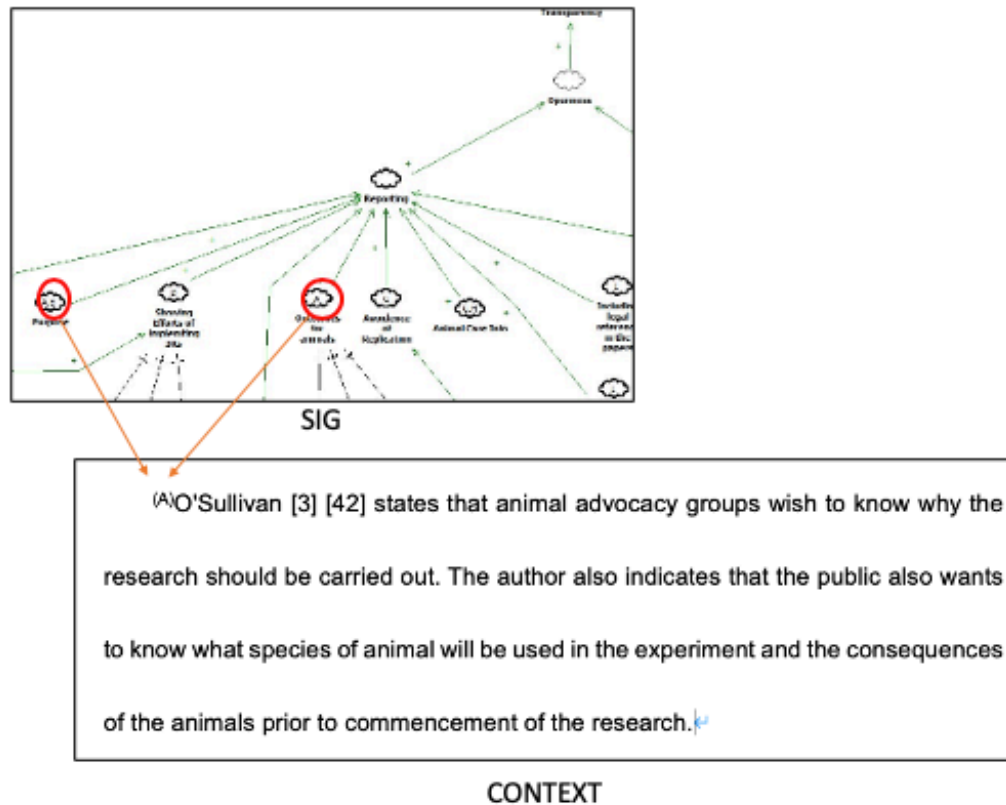


Figure 5 - An Example of How the SIGs Are Presented

5.1. Transparency Catalogues from the Animal Advocates' Perspective

The needs for Transparency in the Animal Advocates Groups are discussed in the Openness, Informativeness, Understandability, Trust, Audit, and Accessibility catalogues. These high-level catalogues stand for what the animal advocacy groups are looking for from their perspectives. The following sections describe these high-

[78] [91] [9] [60] [80]. People are interested to see more information from the reports.

The installation of CCTV [9] in the lab is also discussed.

^(A)O'Sullivan [3] [54] states that animal advocacy groups wish to know why the research should be carried out. The author also indicates that the public also wants to know what species of animal will be used in the experiment and the consequences of the animals prior to commencement of the research.

^(B)Lund et al. [76] also agree that explaining the purpose of the research will increase the supporting rate of the animal researches. In their study, they conducted a survey to investigate how the public assesses the animal research. They found out that the purpose of the research and the estimation of pain level are important factors that affect the public's acceptance.

^(C)Paul [78] organised a survey asked the participants to “draw a line” on the phylogenetic tree about their acceptance of the species that they feel fine to be used in experimentations. The author found out that most people refuse to draw a line and concluded that specifying the species of animal in use, especially using invertebrates will increase the acceptance rate.

^(D)Pound and Blaug [52] state that showing the effort of implementing the 3Rs principle is also interested to the public. The 3Rs refer to Replacement, Reduction

and Refinement. Replacement means to avoid or replace the use of animals.

Reduction means to minimise the number of animals used in the experiment.

Refinement means to minimise animal suffering and improve welfare.

^(E)Aske et al. [60] suggest expanding the 3Rs into 5Rs by adding "Rigour" and "Reproducibility". Rigour refers to that the scientific design has to be robust and unbiased with full transparency in reporting, and the results will let others reproduce the research.

^(F)Eisen et al. [91] also point out the importance of the use of animal statistics. They discuss the consequences of some common poor reporting manners that failed to report any statistical analyses or included inappropriate statistics.

^(G)The British organisation Understanding Animal Research (UAR) commissioned Ipsos MORI conducted a public dialogue and published a report about public perceptions about animal research [9]. In the report, many different aspects of requirements in the animal experiment are pointed out by the interviewees. These requirements include being more specific on statistics of animal use by adding actual numbers of animal use, percentage of different species being used, and the comparison between how many animals planned to be used and how many were used. The interviewees also show strong interest in knowing the severity of the

procedure, i.e. the level of pain by a scale of mild, moderate and severe with examples and images. After the experiments are finished, they are interested in knowing the outcomes for the animals. They want to know if the animals in the laboratory are dead, cured or being used in other procedure. If the animals are dead, they desire to understand the reason why, and how the animals are killed. The information about animal care before, during, and after the procedure are also important. They are interested in knowing how animals are treated in the laboratory not only when the experiment is being conducted but anytime in general. Some interviewees point out that they are not clear about if similar research was done before. They want to see that the researchers to show the efforts to find out a way to avoid replications. Another interviewee also asked about some questions related to the 3Rs principles (Replace, Reduce, Refine). He is interested in knowing why a species of animal is being chosen, why there are no alternatives, and if there are any possibilities if the experiments can be conducted without animals. An interviewee also suggested installing CCTV in the laboratories to keep the researchers under surveillance, when he was told that it could hurt the privacy of the researchers, he then compromises on that the film footage can be restricted to inspectors only.

^(H)Pifer et al. [80] also show that animal care information is considered as one of

the most critical factors that affect public attitudes towards animal research and should be disclosed.

⁽¹⁾Varga et al. [90] suggested that including legal references in the papers by showing legal statements that the article follows the rules is crucial for reporting. They also advise providing all of the ethical approval documents, including all relevant documents from the approval process in the report. Both ways will also enhance trust in the reports.

Both aspects of openness, which are reporting and use of CCTV in the laboratory, have a negative impact on privacy. Figure 7 presents the Openness SIG and its operationalisations impact on Transparency from animal advocates' perspectives.

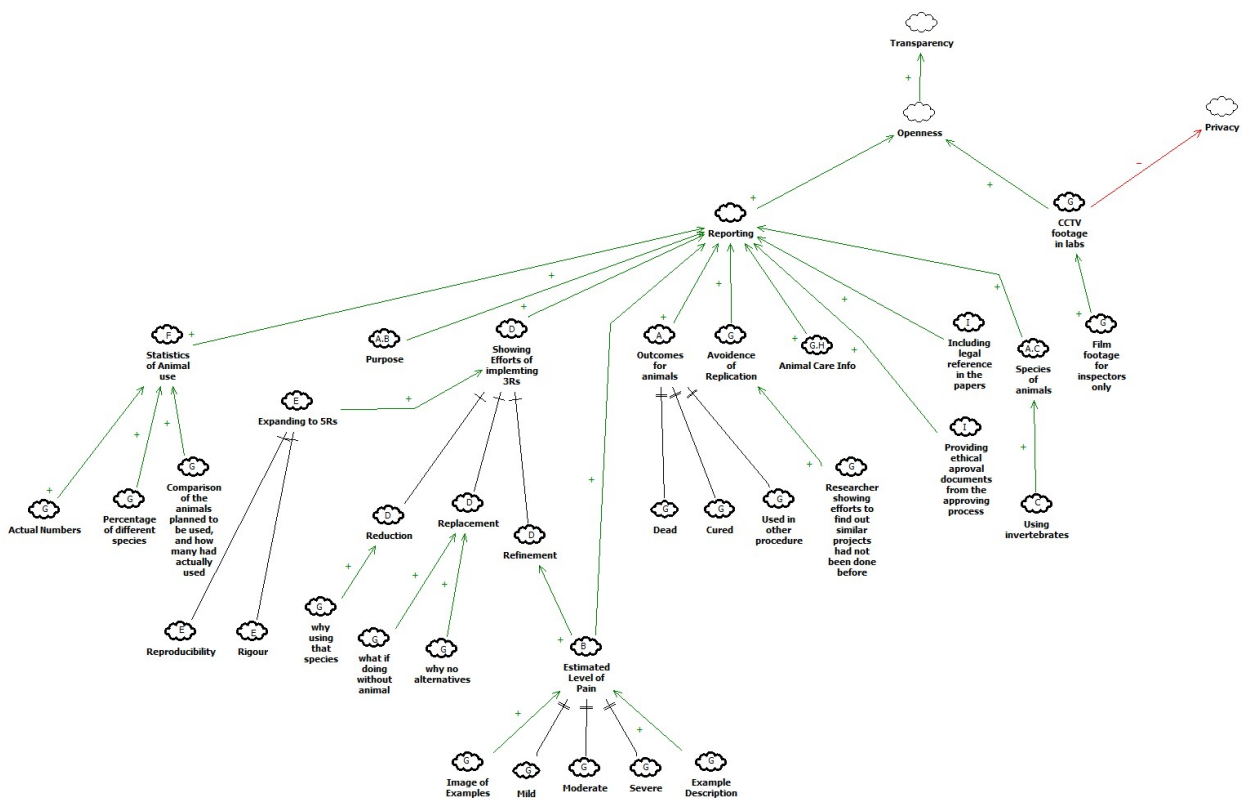


Figure 7 - Openness SIG from the Animal Advocates' Perspectives

5.1.2. Informativeness

Informativeness is another important topic that was brought to discussion.

Operationalisations such as balanced information [54] [3] [58], bias-free information [52] the completeness [58] of the available information and reporting research practices through journals once the research protocol is complete [54] [3] are being discussed.

^(A)O'Sullivan [54] [3] concluded that many people are not satisfied to learn about the research practices through journals once the research protocol is complete. The

author also suggested that balanced information on the value and the need for animal research must be made available to the public to increase public perception. Balanced information refers to not only focusing on one side of the research but provide the opposite view of the research as well to see the whole picture.

^(B)Merkes et al. [58] echo on the idea of balanced information and suggest that cost-benefit analysis information should be made available rather than providing results. In the same study, they also point out the issues of not being complete in some reports. They found out that some reports they accessed are in a redacted and abbreviated form. Essential details about ethical review and research protocol information are lacking. The information provided should be complete enough to reproduce and analyse the study.

^(C)Pound and Blaug [52] bring up the idea of bias-free information. They are aware of that many unsuccessful researches and negative findings are not reported. Researchers tend to report successful studies only. The authors suggest that it could be solved by external scrutiny.

Informativeness has a positive contribution to transparency. Operationalization options such as balanced information, bias-free information and completeness consequently have a positive impact on transparency as well. Reporting research

practices through journals once the research protocol is complete hurts informativeness; hence, it will hurt transparency. Figure 8 presents the Informativeness SIG and its operationalisations impact on Transparency from the animal advocates' perspectives.

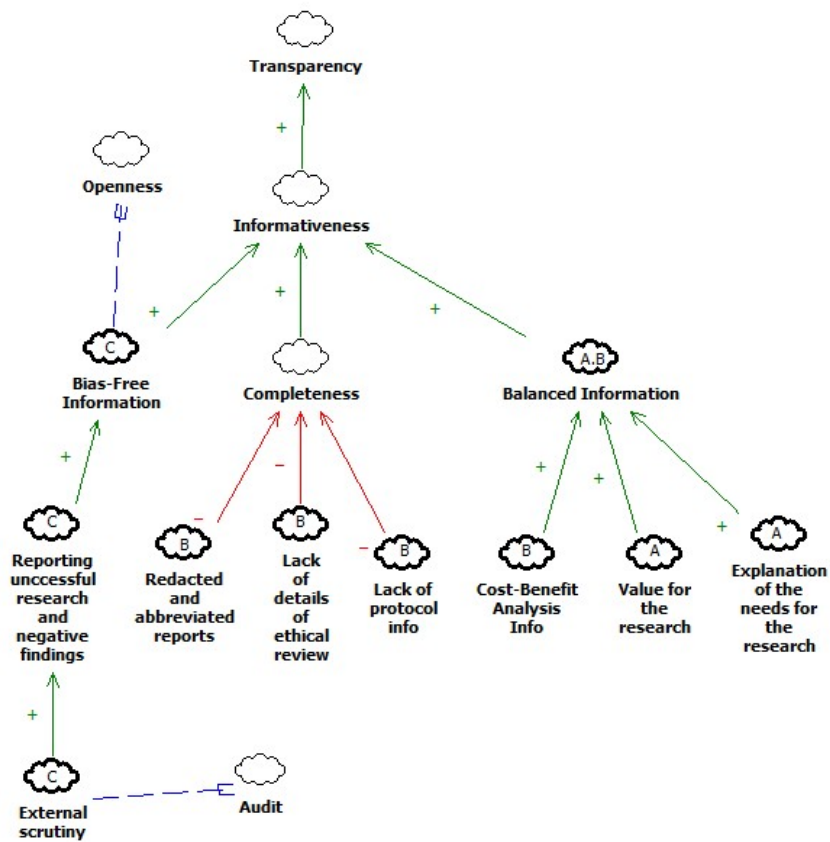


Figure 8 - Informativeness SIG from the Animal Advocates' Perspectives

5.1.3. Understandability

Understandability is another important sub-softgoal to satisfy transparency.

The animal advocate groups believe that there are two main goals to achieve it, tailored information [53] and minimising the difficulties [91][9][3][54][58] for the readers to use the information.

^(A)Eisen [91] state in the study that minimising the difficulties for the readers to use the information is an important goal.

^(B)Many studies [9][3][54][58] indicate that the public understanding of scientific terms is shallow. They will not be able to understand professional reports and papers.

^(C)In Ipsos MORI's report [9], some interviewees suggest using images and films to help to understand the scientific procedures. ^(D)O'Sullivan [3] [54] suggest providing information by the publication of a plain-language summary is the solution for lowering the use of scientific terms. ^(E)Merkes et al. [58] also point out that the European Parliament require research projects to provide non-technical summaries. The lay summary should include in the format of a brief background, the aim of the study, the necessity of using animals with consideration of alternatives, and the outcomes of the study.

^(F)Yeates and Reed [53] argue that transparency should be aimed to inform the readers, and information should be tailored to the needs of the audience. In other words, readers should be able to select the information they need.

Understanding the information provided is also another sub-softgoal to satisfice transparency. Scientists have to make sure the audience understand the information. Operationalisations such as tailored information and minimising the difficulties for the readers to use the information have a positive impact on understandability; therefore, they also positively affect the satisficing of transparency. Figure 9 illustrates the Understandability SIG and its operationalisations impact on Transparency from the animal advocates' perspectives.

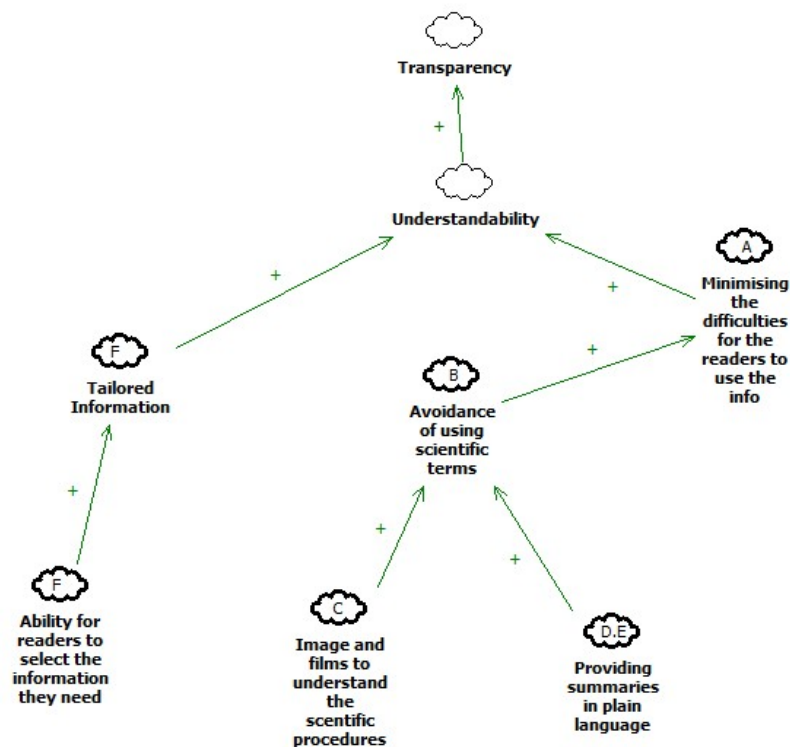


Figure 9 - Understandability SIG from the Animal Advocates' Perspectives

5.1.4. Trust

Trust is discussed in doubts in self-openness, and doubts about the agenda of being open [9].

^(A)Ipsos MORI's report [9] point out that some interviewees are questioning about the agenda to be transparent. They think the organisation must be onto something or will benefit from being more open. Some interviewees also have doubts in self-openness, they believe the reports and documents that the laboratories provide are not credible, convincing and trustworthy, however, if a trusted third party can look into the documents, they might feel more comfortable.

Lack of doubts in self-openness has a positive impact on trust, and auditing by external parties is also a way to satisfy it. Figure 10 demonstrates the Trust SIG and its operationalisations impact on transparency from the animal advocates' perspectives.

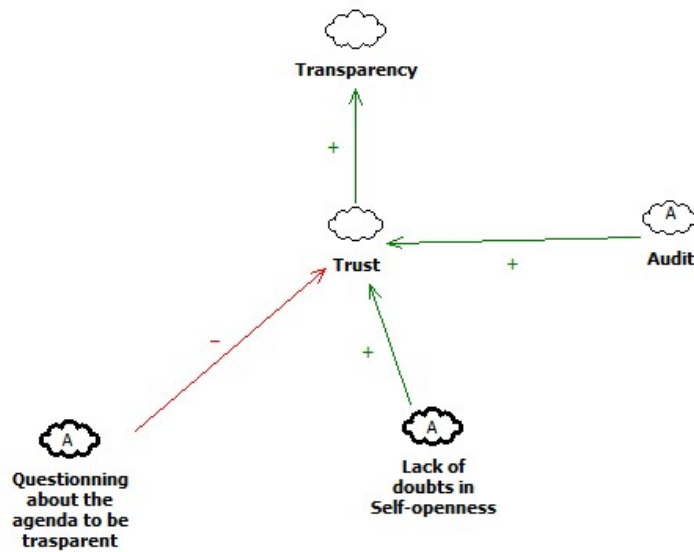


Figure 10 - Trust SIG from the Animal Advocates' Perspectives

5.1.5. Audit

Audit is discussed in the topics such as public involvement [3][54][52], public scrutiny[9] [52] [70], making legal references available [90] and providing ethical approval documents [90].

^(A)Varga et al. [90] state that including legal references in the papers to show that the papers follow the rules is a way for the public to review the legality of the procedure easier. They also advise providing all of the ethical approval documents, including all relevant documents from the approval process in the report.

^(B)Pound and Blaug [52] argue that public involvement can help to ensure

research integrity, and enhance public accountability and state that researches lack of public involvement are predicted to be considered flawed.

^(C)Both Ipsos MORI's report[9] and Pound et al. [52] emphasise the importance of either external scrutiny or public scrutiny. Pound et al. indicate that animal advocacy groups are seeking for external scrutiny of animal experiment institutions and for the institutions to communicate openly. Ipsos MORI's report states that many people feel that openness without the evidence of external scrutiny is not credible or convincing. The report suggests that public scrutiny by animal welfare campaigners.

^(D)Both Eisen et al.[91] and Basel Declaration Society [70] discuss the public scrutiny by advising the involvement of animal experts in designing and analysis of animal studies.

^(E)O'Sullivan [3][54] shows that the public is looking for to involve in the research. They are interested in the meetings for approving the researches. They are seeking the research approval information to be made available and desire to know what experiments are being approved, why the experiments are being approved, and who makes the decision to approve research.

Audit is a way to verify the information provided. It has a positive contribution to Transparency. Its operationalisations such as public involvement, public scrutiny,

making legal references available and providing ethical approval documents have a positive impact on Transparency as well. Figure 11 is the Audit SIG and its operationalisations impact on Transparency from the animal advocates' perspectives.

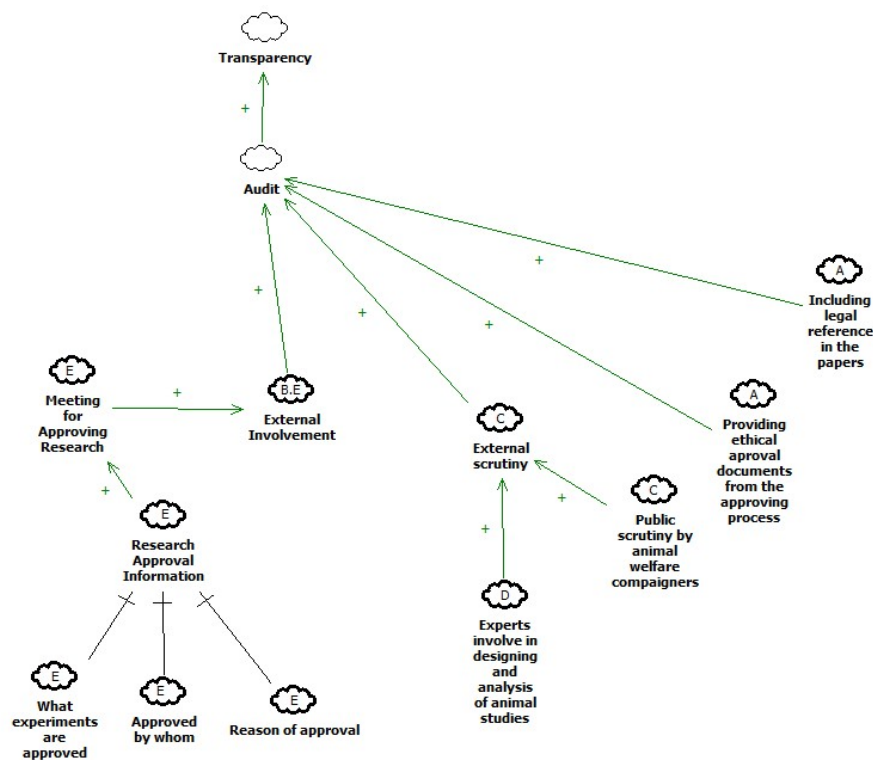


Figure 11 - Audit SIG from the Animal Advocates' Perspectives

5.1.6. Accessibility

Accessibility is another catalogue to be discussed in the form of making the information reachable. Ability to access the information about the research [54], ability to obtain the information of the approval meetings [3], advertising the meeting

[3] and maximising the number of people a publication can reach [91] are mentioned.

^(A)O'Sullivan [3] shows that people feel that the approving meetings are not advertised; therefore, they are even aware that a meeting is being held. Aside from the advertisement of the meetings, the author also argues that people are not able to obtain the copies of the meeting agenda and minutes. They also point out that the participants of the meetings are unknown.

^(B)Eisen et al. [91] echo on the idea of advertisement. Their study shows that der to achieve transparency, maximising the number of people a publication can reach is also crucial.

^(C)In another O'Sullivan's study [54] indicates that the public is not satisfied to access the experiment information after the fact. They expect to obtain the information in a timely manner and prefer to access the information before the commencement of the experiment protocol.

It is true that if the information is not accessible, it cannot be considered to be transparent. Accessibility plays an important role to satisfice transparency. Consequently, its operationalisations such as the ability to access the information about the research, ability to obtain the information of the approval meetings, advertising the meeting and maximising the number of people a publication can

reach are mentioned also impact transparency positively. Figure 12 is the Accessibility SIG and its operationalisations impact on Transparency from the animal advocates' perspectives.

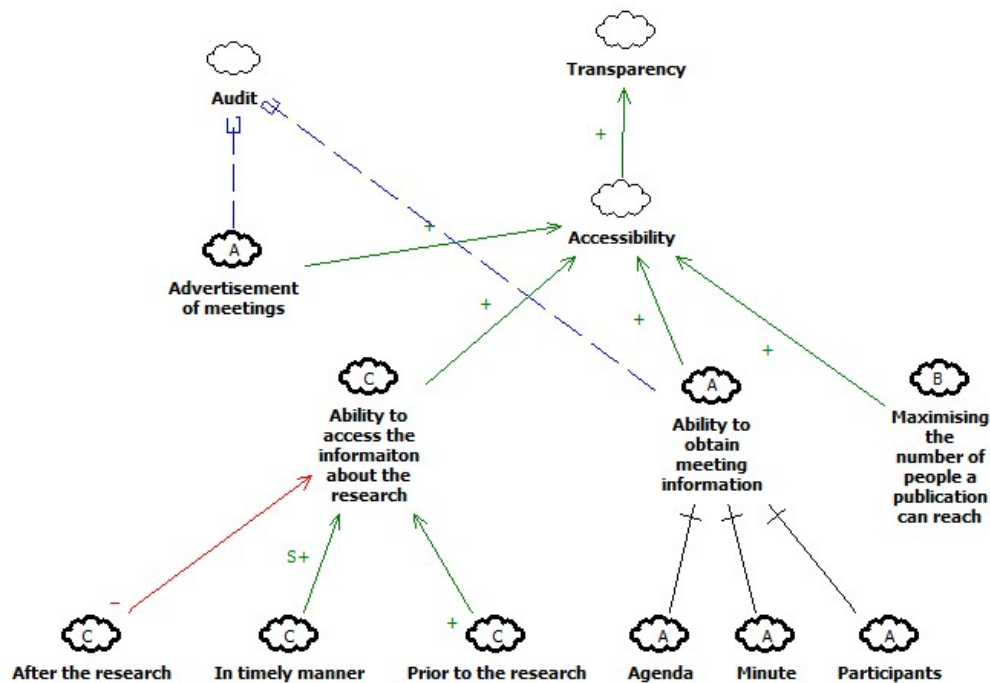


Figure 12 – Accessibility SIG from the Animal Advocates' Perspectives

5.2. Transparency Catalogues from the Researchers' Perspectives

The requirements for Transparency exist among the researchers in the catalogues of Openness, Public Awareness, Accuracy, and Accessibility. The high-level catalogues are extracted from the researchers' perspectives. The following sections describe these high-level catalogues in detail and present the

^(A)many researchers [3] [54] [4] [90] hold opinions from another point of view. They bring up that the anxiety about being transparent will cause danger to personal safety leading to scientists' hesitation about being more open, which cause the scientists not being open. ^(B)Homberg et al. [62] suggest that selective openness is a way for scientists to control the information they want to disclose. Such information should be controlled by the research community instead of media or animal advocate groups. They also refer to the flexibility of the boundaries of openness and secrecy.

^(C)McLeod and Hobson-West [4] echo on the topic and propose cautious openness. The authors state that some research institutes argue the obligations and risks to provide more information to the public would compromise other responsibilities of the institution.

^(D)Ipsos MORI's report [9] also suggests using serial numbers for the identities of researchers instead of disclosing real names and information.

^(E)Varga et al. [90] also mention the fear in the scientists that openness in the laboratories might leads to public oppositions and assaults from anti-vivisectionists. They propound that users should obligatorily register access to the information to reduce the risk of abuse.

^(F)Jarrett [56] [65], on the other hand, suggests anonymised reporting and

leaving the researchers to decide how much further information they want to reveal.

^(G)Reporting is another topic discussed by Eisen et al. [91]. They discuss the consequences of poor reporting manners that failed to report any statistical analyses or included inappropriate statistics and bring up the idea of accurate reporting.

^(H)Kilkenny et al. [7] at the same time, pointed out that many peer-reviewed research publications failed to report important information about experimental and statistical methods base on their survey.

^(I)Andrews et al. [88] also indicate some general statistics presentation problem of using bar charts, line charts, standard deviation, and P-value. They argue that P-values do not reveal the magnitude of the effect, the variability of the responses, and the biological relevance of the findings, and suggest a more transparent method of data presentation by providing confidence interval estimates of the parameters of interest. In the same study, they also point out the positive impact on reporting standards by using ARRIVE Guidelines when reporting in-vivo experiments.

^(J)McGrath and Lilley [89] also suggest similarly to use ticking boxes of the Arrive Guideline Checklist for reporting.

^(K)Aside from reporting guidelines, Basel Declaration Society [70] argues that all researchers should upload all primary and raw data in a database.

^(L)Tillmann [61] point out some important parameters for reporting. She argues that different housing condition might influence brain changes in research animals and suggests that it is crucial to report the housing conditions in the laboratories including number and sex of animals in a cage, model and size of cage and lid, presence and type of any enrichment in the cage, and frequency of cage change. Description of temperature and lighting in the room, nutrition type and feeding regimen are also necessary. In addition, she also suggests reporting behavioural tests, behavioural changes and results, and drug intervention including drug dosage, volume, and frequency.

Both aspects of personal safety protection and reporting have a positive influence on openness. Therefore, they also positively impact transparency. Figure 14 presents the Openness SIG and its operationalisations impact on Transparency from the researchers' perspectives.

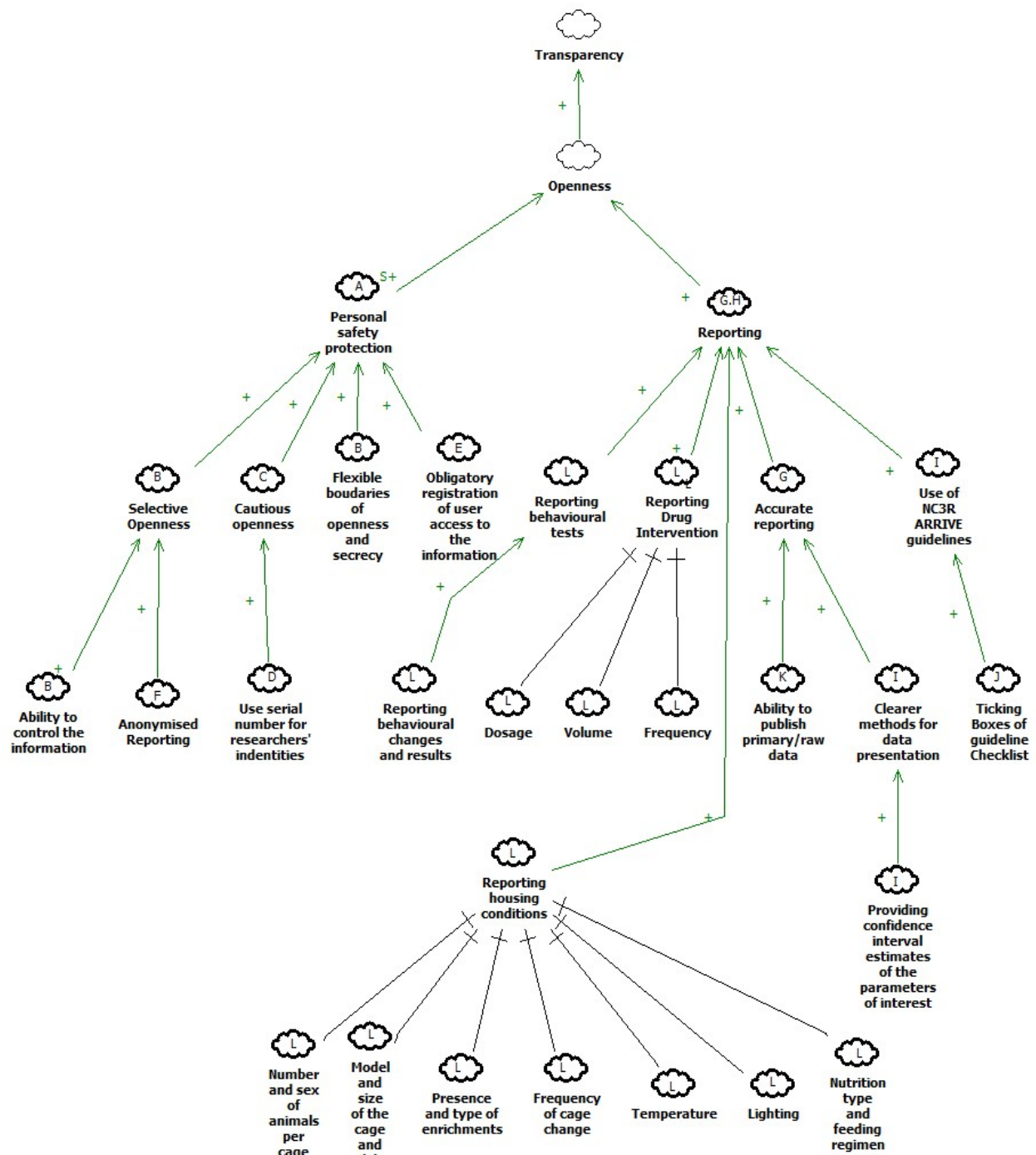


Figure 14 - Openness SIG from the Researchers' Perspectives

5.2.2. Public Awareness

Public ignorance [3][54] is discussed by many authors to hurt transparency, including manipulations of public ignorance by animal advocates [3], misunderstanding and misinformation [4], selective quotations from research works[4], and lack of interest and lack of understanding in science. The enhancement of public awareness, on the contrary, will promote transparency by preparing common questions [57].

^(A)O’Sullivan [3] [54] claims that animal rights extremists have hijacked the debates of the use of animals in experiments, and manipulate public ignorance to benefit their positions.

^(B)McLeod et al. [4] also state that many scientists are upset by the selective quotations from work to be used as a means to intimidate the public against them. Such misunderstanding and misinformation can be mitigated through transparency.

^(C)Paul [78] surveyed the views of scientists and animal advocate groups about animal experimentation. The animal researcher participants think the animal rights campaigners lack interest in and understanding of science.

^(D)Martínez [57] indicates that the lack of communications between the researchers and the public will leave a gap that others will try to manipulate. She

suggests scientists be prepared with most-asked questions from people, and this information must be integrated internally on bulletins, on the intranet that exchange inside information, in seminars or other dissemination available.

Increasing public awareness has a positive impact on transparency. Manipulations of public ignorance by animal advocates, misunderstanding and misinformation, selective quotations from research works, and lack of interest and lack of understanding in science have negative contributions to public awareness. Preparation of most-asked questions will promote public awareness and has a positive impact on transparency. Figure 15 demonstrates the Public Awareness SIG and its operationalisations impact on Transparency from the researchers' perspectives.

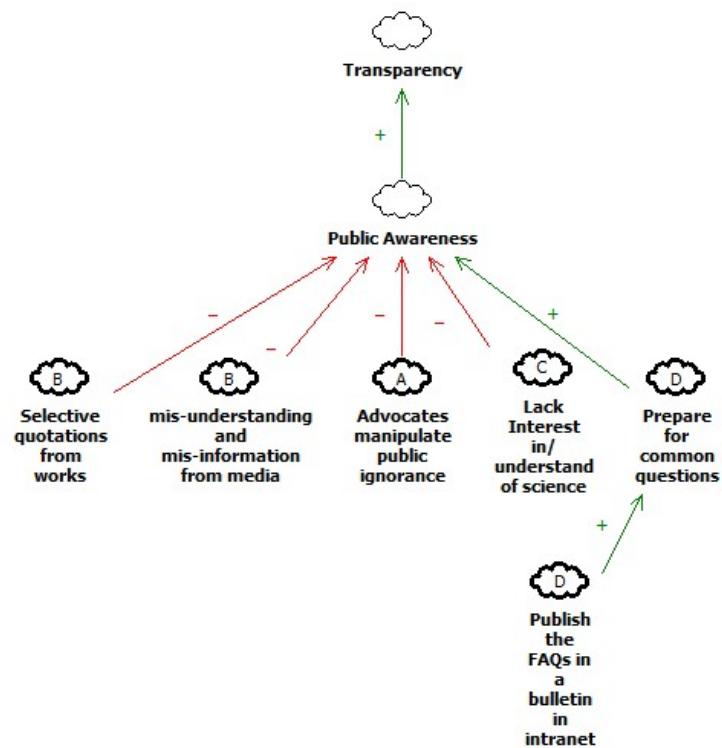


Figure 15 - Public Awareness SIG from The Researchers' Perspectives

5.2.3. Accuracy

Operationalisation options for Accuracy including bias-free information [52][91] [70] [90] [88] and avoiding underpowered studies [91] [89] [87] are discussed in the studies.

^(A)Pound et al.[52] discuss bias-free information in there study. They point out that many unsuccessful researches and negative findings are not reported. Researchers tend to report successful studies only.

^(B)Eisen et al. [91] also echo on the topic. They claim that poor reporting also causes publication bias that only positive results are published, while negative studies are not reported. In the study, the authors discuss the consequences of badly reported researches. They state that poorly reported studies cannot be validated, and do not have enough details to replicate or analyse in the future. The authors also discussed studies with too small sample size, i.e. underpowered studies may result in a false-negative, or false-positive result.

^(C)McGrath et al. [89] [87] argue that to avoid underpowered studies, researchers should ensure the most appropriate number of experiments in the research design rather than the smallest number. An insufficient number of experiments are more likely to lead to more animal being used eventually due to bias.

^(D)Basel Declaration Society [70] has similar suggestions on the topic of avoiding biases. They suggest that researchers should be encouraged to include the manuscripts that describe negative results in the reports. They claim that reporting negative studies will be an effective measure to avoid unjustified duplication by others and can avoid unnecessary use of animals and resources in the future. Besides, they also suggest that authors should publish all primary and raw data for open access to others. In the same declaration, they argue that researchers should

provide the methods to avoid bias, such as blinding and randomisation, should be reported.

^(E)Andrews et al. [88] also comment on the issue that researchers usually do not report negative and neutral data. They point out that researchers are pressured to publish only positive studies in highly-impact journals and suggest mitigating the problem by requiring all scientist to register all researches online. In the same study, they also give out suggestions to reduce experiment biases at the designing phase. They recommend reducing bias and aid transparency by carefully considering internal and external validities to reduce biases. Internal validities such as randomisation, concealed allocation and blinding, sample size, eligibility criteria, and statistical methods should be considered in the experiment designing phase. On the other hand, external validity considerations such as animal characteristics, housing, experimental procedures, previous treatments and reproducibility should be considered as well. Since the internal validities and external validities are different to each study. They need to be addressed and considered accordingly.

^(F)Varga et al. [90] also recommend that to improve transparency, the mandatory registration of all animal studies is needed though it is complicated and challenging. They argue that animal researches should be following the steps of studies using

human subjects, to register online and can be accessed freely and internationally from the WHO platform.

Methods for reducing biases are mostly discussed in the publications to achieve accuracy. Operationalisations such bias-free information and avoiding underpowered studies are discussed in the studies and have positive contributions to Accuracy, which positively impacts Transparency. Hence, the positive operationalisations of Accuracy have positive impacts on Transparency as well. Figure 16 shows the Accuracy SIG and its operationalisations impact on Transparency from the researchers' perspectives

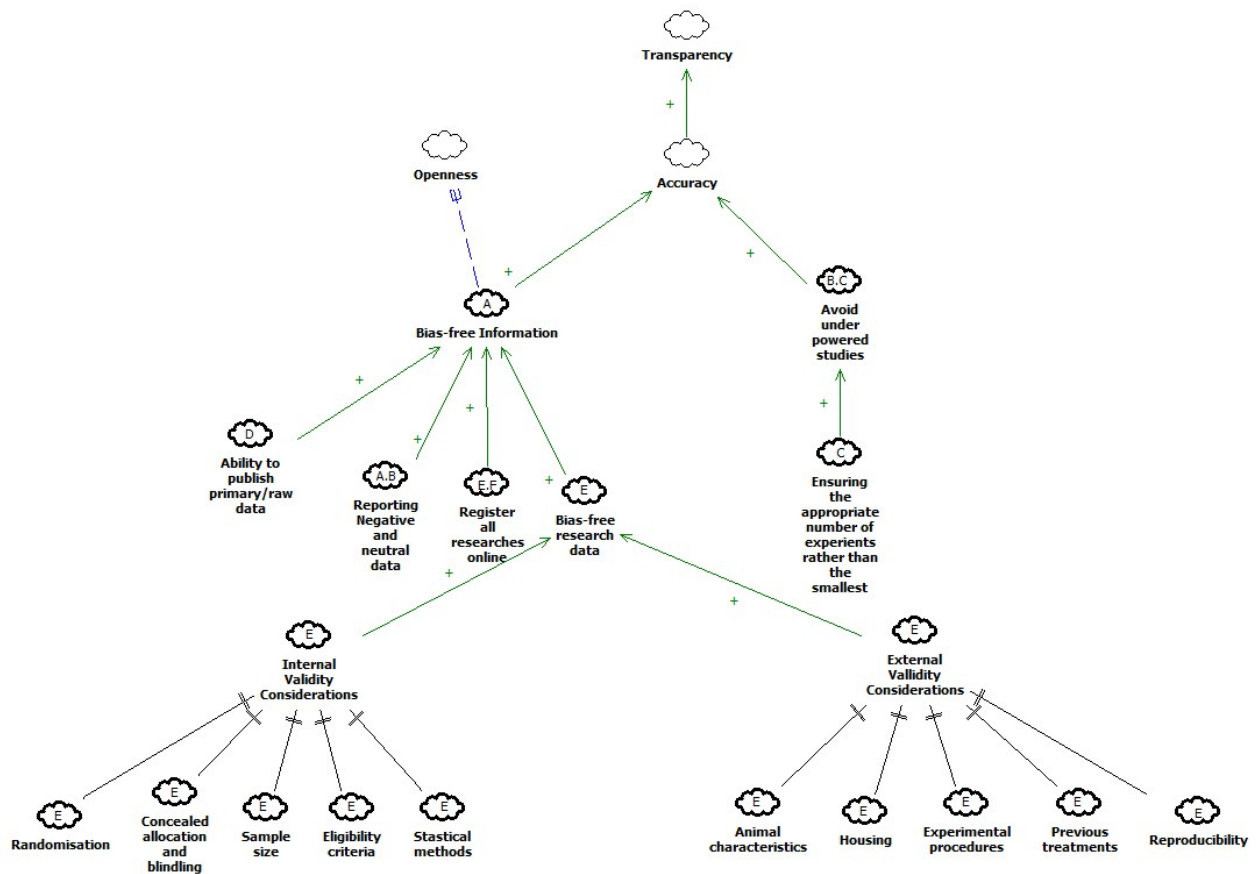


Figure 16 - Accuracy SIG from The Researchers' Perspectives

5.2.4. Accessibility

Researchers desire to have access to the information mostly regarding their studies. Such as the ability to access to the past researches [68], ability to access the data and materials related to the research [71], use of searchable data repositories [71], and one centralised accessing point [57] are discussed as the operationalisations of Accessibility.

^(A)Anderson et al. [68] claim that researchers do not have access to review the

decision processes about research studies. Therefore, they have to reinvent the processes on their own when they are designing a similar experiment. Because of the difficulties of accessing the past studies, they cannot reproduce and consider the previous processes of judgements to align their decisions.

^(B)Basel Declaration Society [71] declares that the ability to access the data in publicly accessible repositories can potentially lead to reducing the number of animals used in research. The searchable and curated repositories could eliminate the difficulties for the scientists to refine the experiment protocols from existing studies. They also suggest that published papers should include clear information about how to access the data and the materials that are related to the paper.

^(C)Martínez [57] has a similar opinion about that research information and data should be stored in one single centralised, and easily accessible point.

Operationalisations of accessibility such as the ability to access to the past researches, ability to access data and materials related to the research, use of searchable data repositories and centralised accessing point are positively affecting Accessibility. They, therefore, have a positive impact on transparency as well. Figure 17 presents the Accessibility SIG and its operationalisations impact on Transparency in the researchers' perspectives.

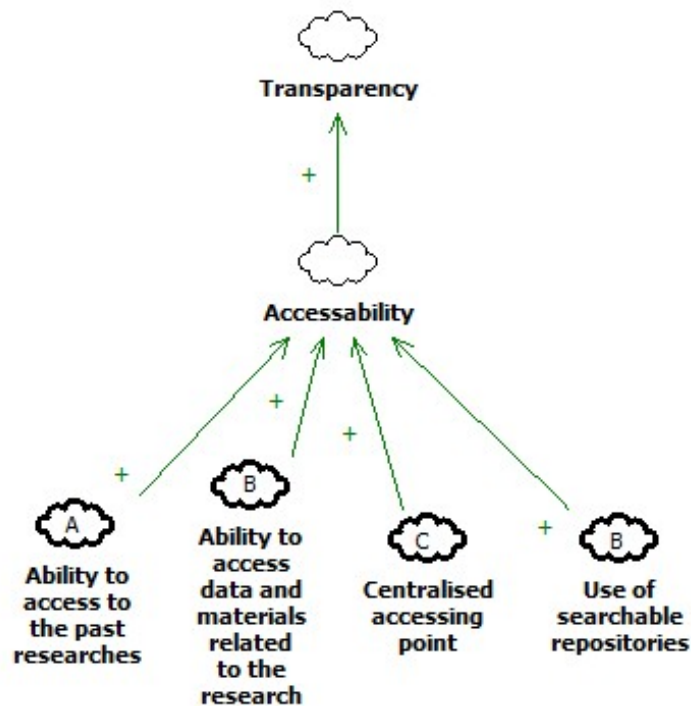


Figure 17 - Accessibility SIG in the Researchers' Perspectives

5.3. Transparency Catalogues from the Mediators' Perspectives

Mediators such as governments, non-government organisations, and journal publishers are also seeking solutions for achieving Transparency. Catalogues such as Openness, Informativeness, Accuracy, Accessibility, Trust, and Audit are identified as high-level catalogues from the articles. The following sections describe these high-level catalogues and show the decompositions of sub-softgoals and solutions of these high-level catalogues from mediators' perspectives.

to engage with animal researches. She points out that numbers of animal used, species type, and the level of harm are to be reported. However, the author criticises that reporting animal use statistics alone is not enough. Animal use statistics are lacking research process information, and there is no way for the public to understand the whole picture of animal studies solely with the statistics.

^(B)McGrath et al. [77] also refer to the same idea of reporting animal use information. They suggest that species, strain and total number used must be published. They also mention that if the study uses anaesthetics or analgesics, information such as initial and subsequent doses of anaesthetics and analgesics and method of accessing, especially after the administration of neuromuscular blocking drugs, must be described clearly. Anaesthesia vital signs, including blood pressure, heart rate, and blood gases, must be monitored and stated in the report as well. Conditions of animal maintenance are also required to be stated, such as food, water, lighting, dark cycle, as well as the compliance information with ethical guidelines.

^(C)Hadley [72], on the other hand, also suggest publishing animal use statistics. The author emphasises on what and how animals are going through with respect of pain and suffering and categorises research protocols into "observation with minor interference", "animal unconscious without recovery", and "major physiological

challenge". Observation with minor interference refers to the research procedure would not hurt the animal's welfare, and there is no pain or suffering. Animal unconscious without recovery indicates that animals are under anaesthesia, and the pain is minor. Animals are killed after the procedure without regaining consciousness. Major physiological challenge denotes that the research procedure is carried out when animal remains conscious and would cause a moderate to a large degree of pain to the animal. The author also points out that the United States Department of Agriculture (USDA) categorises researches according to the existence of pain and drug use on animals.

^(D)Such a survey regarding reporting of pain management was also conducted by Carbone et al. [93]. The authors suggest that pain level descriptions are usually missing from the papers. Pain management information, such as analgesia, is seldom mentioned. Lacking this information will not allow future studies to reproduce the data.

^(E)McLeod [86] and Jarrett [65] refers to Understanding Animal Research, an organisation in the United Kingdom that promotes and supports animal research interest, requires its signatories to report annually about the commitments to the declaration.

^(F)Confidentiality Cause is discussed by McLeod and Hobson-West[4]. They refer to that the Home Office in the UK makes it a crime for the public servant to divulge any information that the researcher does not want to disclose in the Animals (Scientific Procedures) Act 1986. Some groups criticise it to be a confidentiality clause or a secrecy clause. However, the Home Office claims that the Act is to protect the personal details of the researchers.

Reporting and reporting annually to the mediator are the operationalisations to Openness. They both have positive impacts on Openness, therefore, on Transparency. Confidentiality Cause on the other has some negative impact on Openness. Figure 19 presents the Openness SIG and its operationalisations impact on Transparency from the mediators' perspectives.

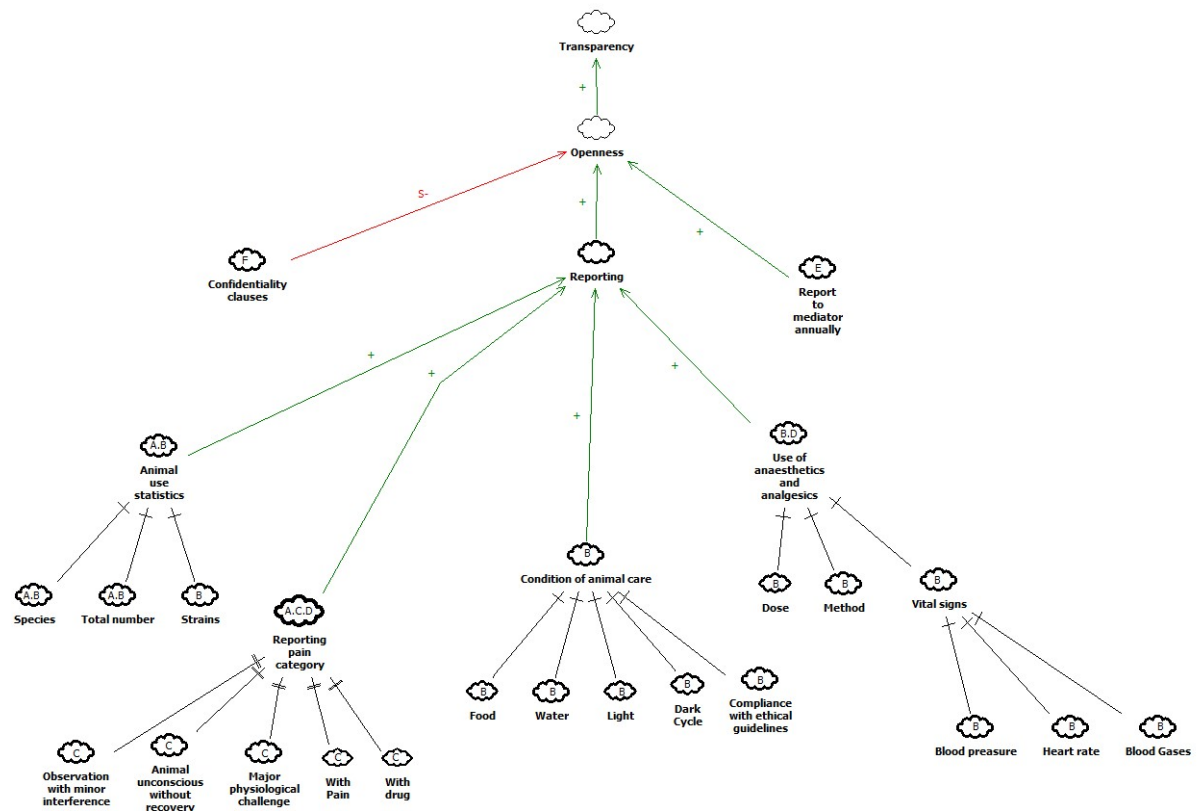


Figure 19 - Openness SIG from the Mediators' perspectives

5.3.2. Informativeness

Informativeness is another requirement that is identified from the literatures.

Both the use of reporting guidelines[77] [70] [74] [73] [59], and press release preparation [72] are identified as the operationalisations of Informativeness. Large amounts of raw data [55] are considered to be not informative.

^(A)McGrath et al. [77] [59] list many organisations such as the International Committee of Medical Journal Editors, the Committee on Publications Ethics, British

Journal of Pharmacology and so on, that support the use of reporting guidelines to improve reporting quality. They point out that several journals have agreed to publish guidelines and incorporate these guidelines into their instructions to authors.

^(B)Basel Declaration Society [70] also shows that many journals have different guidelines since they have not yet adopted unified guidelines. They suggest that organisations should establish common guidelines and requirements regarding the reporting of design, execution, and analysis of studies which animals are used. These joint guidelines should be implemented by all journals and would be the most effective measure to prevent faulty researchers.

^(C)Kilkenny et al. [74] also comment on that using reporting guidelines can improve the quality of reporting and maximise the output of researches by optimising the information to be published. They suggest improving the reporting of animal experiments by the ARRIVE Guidelines. The ARRIVE Guidelines referred to as Animal in Research: Reporting In Vivo Experiments, consist of a checklist of 20 items stating the minimal information that should be disclosed. They claim that the use of ARRIVE guidelines is not to restrict the form of the structure of reporting, but rather providing a standardised checklist for the researchers to prepare their reports and papers.

^(D)Hooijmans et al. [73] also suggest using another guideline, the Gold Standard Publication Checklist (GSPC). Although there are some overlaps that both ARRIVE guidelines and GSPC cover, the GSPC covers more than the reporting of researches. The GSPC focuses on the planning, designing, execution and reporting of animal experiments. The guidelines describe and require items in more detail. These details not only make it easier for the scientist to design and perform the experiments but also help to improve the quality of the research design. In the same study, the authors recommend researchers to review both ARRIVE guidelines and GSPC and choose the most suitable one.

^(E)Hadley [72] advises that the laboratories should be prepared to produce press releases for the public. The media is seeking information such as the number of animals being used, level of pain and suffering, and findings of the research. Since the journalists are not research experts, such official information from the laboratories would make the journalist much easier to ensure the details are covered before publishing on the media.

^(F)Balls [55] reviews different guidelines and requirements of reporting and states that “Simply making information available is not sufficient to achieve transparency. Large amounts of raw information in the public domain may breed opacity rather than

transparency.” The author explains that the information provided needs to be made some meaningful comments concerning animal experimentation.

Both the use of reporting guidelines and press release preparation are the operationalisations of Informativeness, which has a positive contribution to Transparency. The two operationalisations, in consequence, positively impact on Transparency as well. Large amounts of raw information, however, hurt Informativeness. Figure 20 presents the Informativeness SIG and its operationalisations impact on Transparency from the mediators' perspectives.

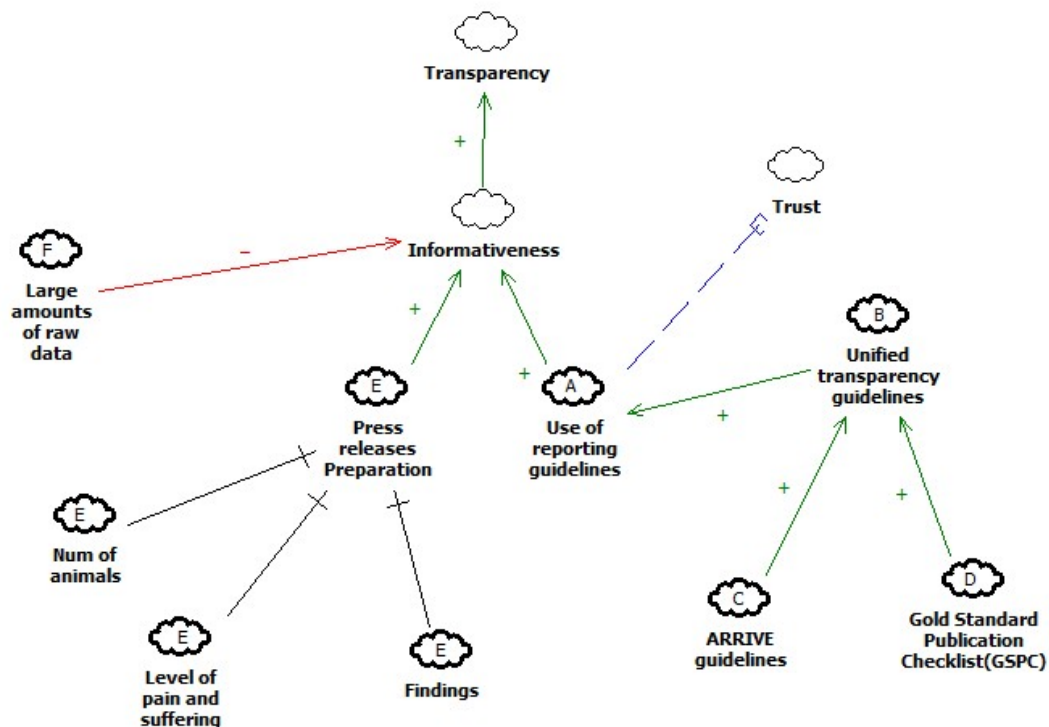


Figure 20 - Informativeness SIG from the Mediators' Perspectives

5.3.3. Accuracy

Accuracy is also identified from the literature. The authors discuss accuracy as the ability to replicate the study [77], avoidance duplicated studies [73], and detailed reporting [74] [77] [59].

^(A)Kilkenny et al. [74] state that good reporting is essential for peer review and to inform future studies. The details of the experiments and the presentation of the key results are crucial for peer review and to be used and referenced in future studies.

^(B)McGrath et al. [77] echo on the same idea about details, which must allow others to replicate the study. They state that scientific reports should be able to be adequately judged, therefore, the reports must be clear and explicit. They suggest that journals to require the authors to provide and state adequate ethical standards and statistical treatment in the papers. He also pointed out that the British Journal of Pharmacology [59] requests authors to provide primary data, including all negative data in a supplementary file. Such data could provide other researchers with the opportunity to analyse differently.

^(C)Hooijmans et al. [73] indicate that the British Journal of Pharmacology has provided guidelines for authors regarding the animal researches. The BJP suggests that systematic reviews can result in better interpretation of existing studies and to

avoid duplicated studies. Both consequences lead to the prevention of unnecessary animal use and time loss.

Accuracy helps to satisfy Transparency. The ability to replicate the study, avoidance duplicated studies, and detailed reporting and described are identified as the operationalisations of Accuracy and have positive impacts on Transparency as well. Figure 21 illustrates the Accuracy SIG and its operationalisations impact on Transparency from the mediators' perspectives.

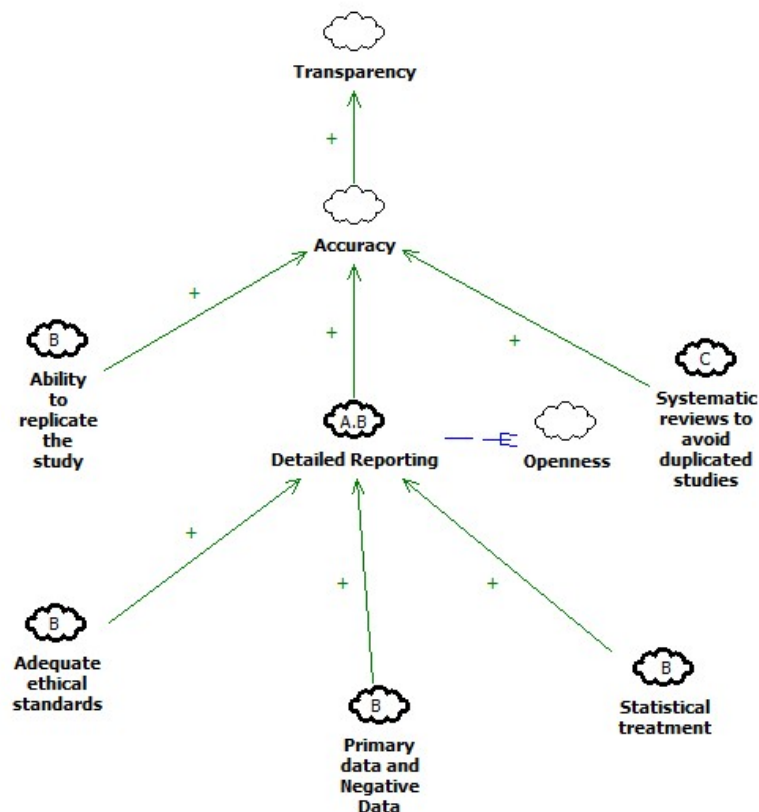


Figure 21 - Accuracy SIG from the Mediators' Perspectives

5.3.4. Accessibility

The ability to access to the information has been known to be one of the sub-goal for transparency. It is also discussed in the aspects of animal use statistics not accessible by interested parties [54], and the sharing of data between researchers [86].

^(A)Sharing of animal use statistics data has been discussed by O’Sullivan [54] to let the public engaging with animal researches. However, the author points out a problem that reporting animal use statistics alone is not enough. The data have to be made available for the public to access it. The animal use statistics data are considered useless they are accessible by interested parties.

^(B)McLeod [86], on the other hand, points out that both Understanding Animal Research and Basel Declaration Society are looking forward to the sharing of data between researchers. Both organisations state the importance of open access and sharing of research results. They aim to build solidarity among all research institutions by encouraging research institutes to sign joint declarations. Hence, the greater sharing of data between research sections is enhanced.

Both animal use statistics not accessible by interested parties, and sharing of data between researchers are discussed as the operationalisation for accessibility.

Animal use statistics not accessible by interested parties has a negative impact on accessibility. And sharing of data between researchers has a positive impact on accessibility. Figure 22 demonstrates the Accessibility SIG and its operationalisations impact on Transparency from the mediators' perspectives.

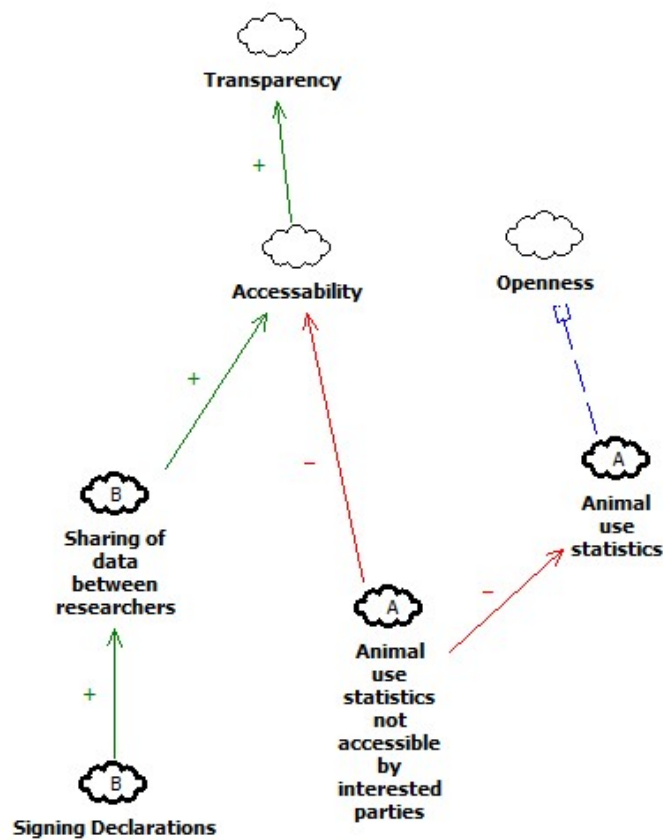


Figure 22 – Accessibility SIG from the Mediators' Perspectives

5.3.5. Trust

Many authors mention trust as one of the most critical sub-softgoals for

satisficing transparency. The major topics discussed in this category include licensing by the government [69] [52] [58] [81], deal with NC3Rs(National Centre for the Replacement, Refinement and Reduction of Animals in Research) guidelines [89], busting the myth of animal research [9], expressing researchers own values [86], revealing information of funders [9], disclosing conflicts of interest [67]. These operationalisations are seen as the solutions for satisficing Trust.

^(A)Both Ipsos MORI [69] and Pound et al. [52] indicate that the Home Office in the UK requires licences to start an animal study. There are three types of licences. Animal researchers are required to obtain licences. Not only personal and establishment licences should be obtained, but also licence of the project. The Home Office will conduct a harm-benefit assessment to decide whether to grant permission to the project to start or not. However, Pound et al. point out that the assessment processes are conducted behind the closed doors. People do not trust the righteousness of the evaluation. The authors suggest auditing by the public to increase trust.

^(B)Both Merkes [58] and Rickard [81] indicate that the National Health and Medical Research Council (NHMRC) in Australia also has a similar approach for licensing. The NHMRC requires scientists to evaluate the benefit to human and the

wellbeing of animals involved by applying the 3Rs before granting the licence. The author also suggests revealing licence holder names, i.e. the name of the institution rather than the name of the individual holder under the Freedom of Information Act. However, the request was refused by the government due to security concerns.

^(C)McGrath and Lilley [89] state that many journals require the authors of the paper not only ticking the box with the guidelines of the National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs) for reporting but stating where in the manuscript they have dealt with the requirements.

^(D)McLeod [86] indicates that scientists are rarely encouraged to speak about their values and their thoughts about their research on animals. He suggests that scientists should be encouraged to express their values of morals and ethics to increase in terms of building trust with society.

^(E)Ipsos MORI's report [9] points out that there are many interviewees have misconceptions about animal studies. They believe that a large number of animal experiments are conducted for cosmetics, researchers can use great apes, all procedures are severe, the sectors do not consider animal welfare and so on. Ipsos MORI suggests that research institutes to bust the myth by demonstrating the statistics to the public proactively and allow the public into the research laboratories

where possible. The organisation also advises publishing the information of funders to increase the trust in the public.

^(F)Kurata [67] indicates that because of the reason that many scientists often conduct translational research collaborating with clinicians, the Japanese government and many other research societies request its members to disclose conflicts of interest.

Operationalisations such as licensing by the government, dealing with NC3R, busting the myth of animal research, expressing researchers own values, revealing information of funders and disclosing conflicts of interest have positive contributions on Trust. Hence, these solutions have positive impacts on Transparency as well. Figure 23 presents the Trust SIG and its operationalisations impact on Transparency from the mediators' perspectives.

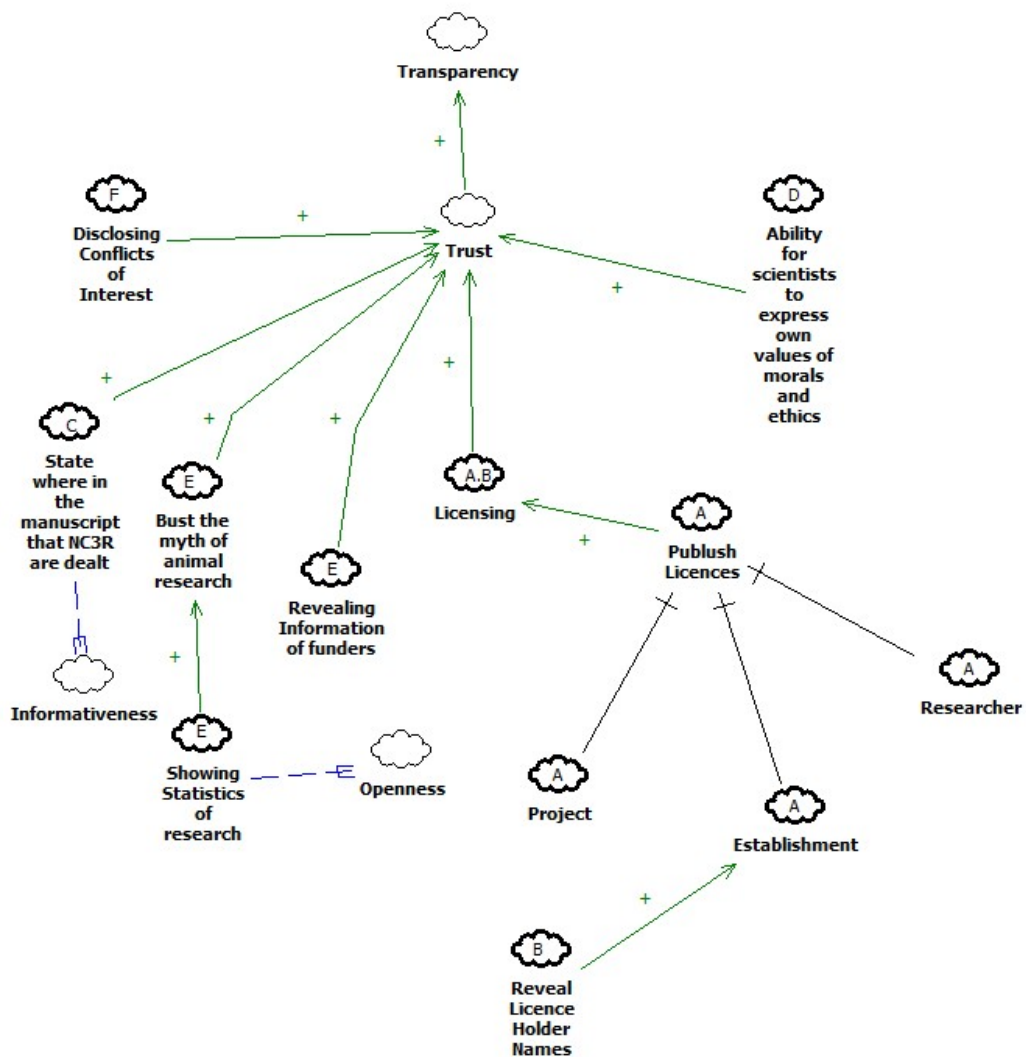


Figure 23 – Trust SIG from the Mediators' perspectives

5.3.6. Audit

Audit is discussed in the aspect of public involvement [79] [75] [72] [92] by including different groups in the animal research society to increase diversity.

^(A)Philips [79] interviewed Vicky Robinson and quotes that she is worried that the

MORI poll data might lead to polarised debate and will lead to an extreme discussion on animal research.

^(B)Leslie [75] has pointed out a similar concern. The author shows that the Institutional Animal Care and Use Committee (IACUC) usually consists of mostly scientists, which is an example of a group polarisation. These tendency of like-minded groups of people are likely to lead to the same decision. The IACUC requires each committee to increase the diversity of perspectives by fulfilling the demands. For example, at least one member shall be a doctor of veterinary, at least one member shall not be affiliated in any way with the facility. The author suggests adding representatives from animal advocates groups to the committee to increase the diversity of perspectives.

^(C)Increasing the diversity of perspectives is also discussed by Ormandy et al. [92]. The authors reviewed literature and found out that many factors affect people's attitude towards animal study and state that it is important to obtain public opinions about animal research and to engage a variety of different stakeholders.

^(D)Similarly, Hadley [72] also suggests to include laypeople in the institutional ethics committees to increase the legitimacy of the meetings.

Public Involvement is considered as the operationalising softgoal for Audit. It has

a positive impact on Audit. In consequence, public involvement impacts positively on Transparency as well. Figure 24 shows the Audit SIG and its operationalisations impact on Transparency from the mediators' perspectives.

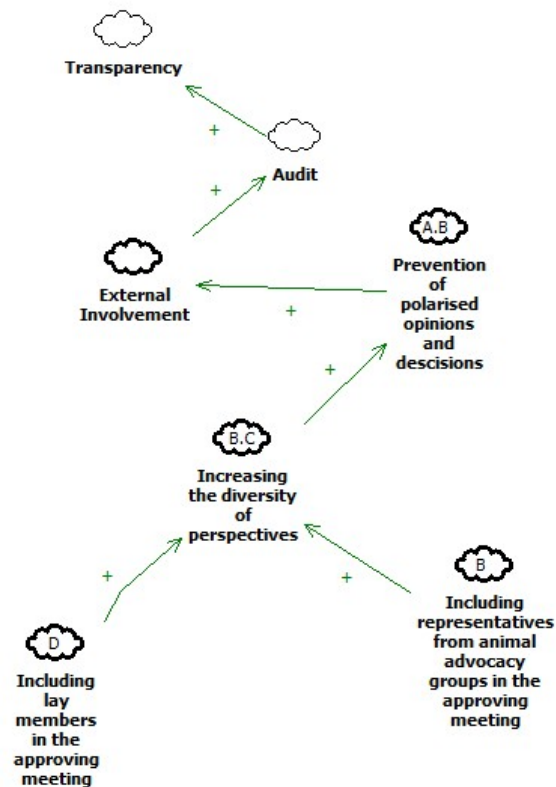


Figure 24 - Audit SIG and Its Operationalisations from the Mediators' Perspectives

6. The Overall Catalogues from the Combination of All Perspectives

To identify the relationships of the requirements among different stakeholders, it is necessary to combine all the SIGs. In this section, similar softgoals from various stakeholders' perspectives are merged, and the sub-softgoals that satisfied them are also presented together to contribute the merged softgoals. Softgoals from one stakeholders' perspective that can be satisfied by the softgoals from others' perspectives are filed under the same catalogue as well. Eight high-level catalogues are identified as the sub-softgoals for Transparency from analysing different perspectives. The eight catalogues which are seen as the decompositions for satisficing the NFR Transparency are openness, informativeness, accessibility, understandability, trust, public awareness, accuracy and audit. These catalogues were identified and classified by the author of the thesis and then taken to cross-evaluate with Leite and Cappelli [16] for similarities, correctness and extensions. After cross-evaluating with the solutions for Transparency proposed by Leite and Cappelli [16], the sub-softgoal Accuracy is considered to be a decomposition of informativeness and has a positive relationship to informativeness in Leite and Cappelli's work. Public Awareness is also associated with Understandability. The

6.1. Openness

Openness is the most discussed topic among all the catalogues. Each group of stakeholders have their requirements and solutions for being openness. The main discussions in this catalogue are all clinging to the idea of making more information available and personal safety issues regarding being open. ^(A)To protect the scientist's personal safety, selective openness gives the researchers the power to control over the information they want to provide. ^(B)Anonymised Reporting is also another solution for selective openness. ^(C)Cautious openness protects researchers' identities by using serial numbers. ^(D)Requiring users to register first before access to the data is another approach to provide safety to the scientists. In the same time, ^(E)the government also should pass confidentiality bills to protect the safety of scientists, but the boundaries should be considered carefully because it could hurt openness. ^(F)Some people suggest providing CCTV footages in the laboratories; however, it could possibly hurt the Privacy. ^(G)Making the footage solely for inspectors is a solution to deal with the problem.

^(H)Reporting is the most discussed and complicated sub-softgoal of openness because every stakeholder seeks for different information to be reported. Reporting animal use statistics have been brought up many times. Reports should also include

the purpose of the research, animal care information, housing conditions, use of drugs, anaesthetics and analgesia, pain information, and outcomes for animals. Use of NC3R guidelines can also help the reporting process to deal with the 3Rs. Scientists should also try to avoid replication of past studies by systematic reviews.

^(l)The information should be reported to the mediators at least once per year.

Detailed operationalisations of Reporting are presented in a separate SIG in Figure 27 instead of showing along with the Openness SIG.

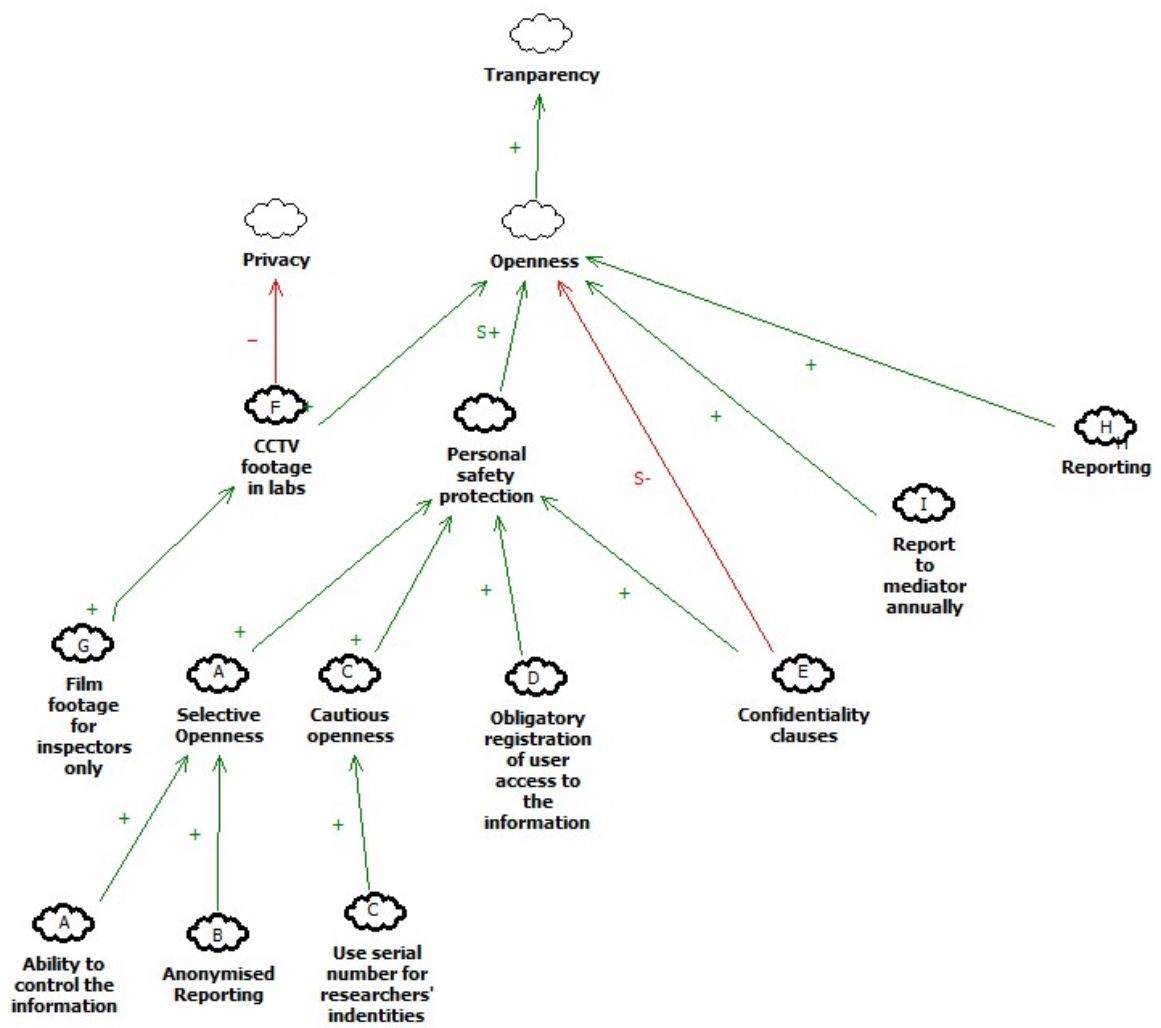


Figure 26 - Overall Operationalisations of the Catalogue Openness

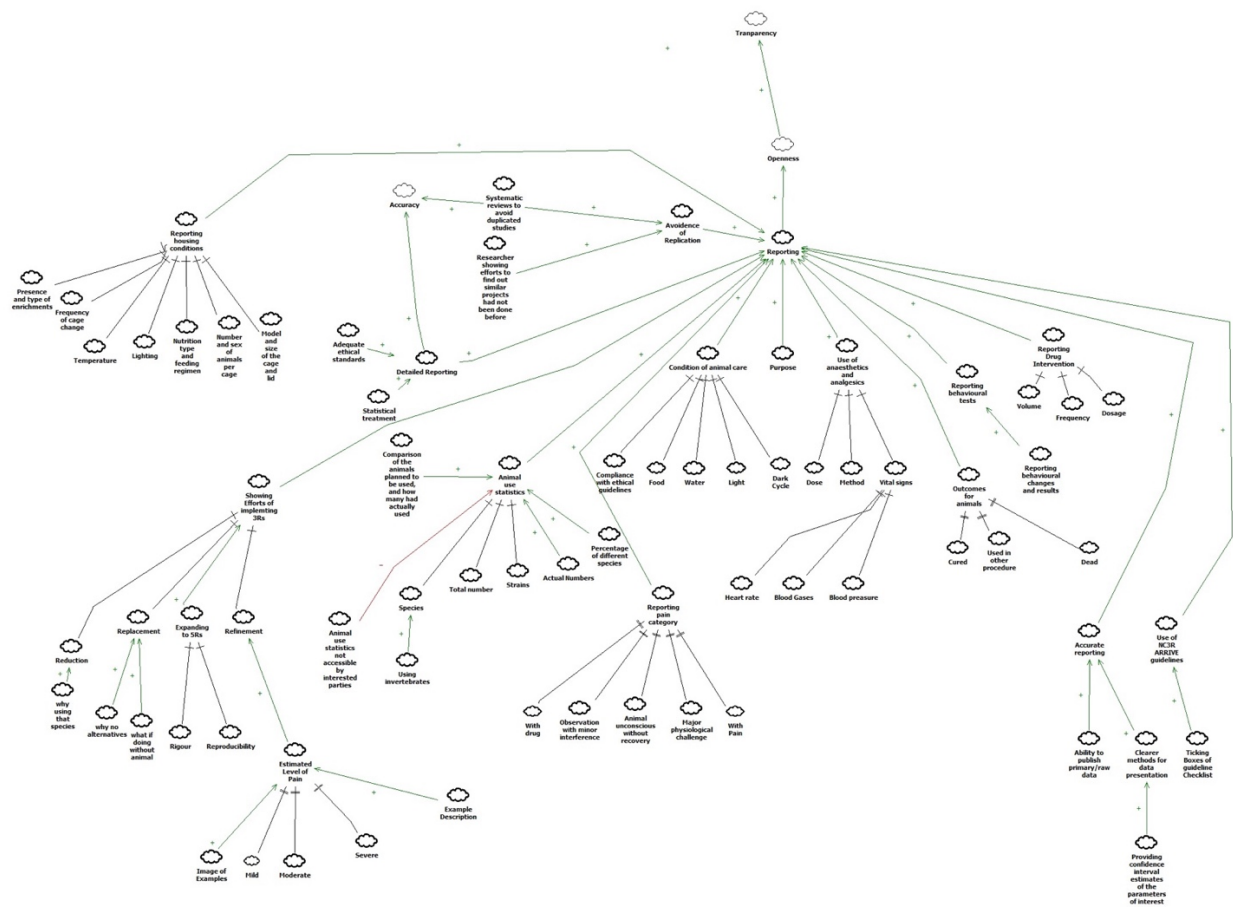


Figure 27 – Detailed Operationalisations of Reporting Softgoal

6.2. Informativeness

Informativeness is described as the quality of conveying information. ^(A)Accuracy is an important feature to show the quality of the information delivered. ^(B)The information should be accurate enough for the scientists to replicate the study, and ^(C)scientists should avoid duplicated studies by conducting systematic reviews. ^(D)Bias-Free information is also crucial to maintain accuracy. To prevent biased studies reporting, ^(E)all researches should be registered. ^(F)Researchers should be

able to publish all primary and raw data. ^(G)Unsuccessful researches and neutral/negative finding should be reported as well. ^(H)To provide bias-free research data, internal validity and external validity should be considered at the designing phase. ^(I)Detailed reporting, including Statistical Treatment and Adequate Ethical Standards, also help Accuracy. ^(J)Underpowered studies should be avoided by ensuring the appropriate number of experiments rather than to smallest.

Other decompositions such as ^(K)preparing for the press release, ^(L)use of report guidelines, and ^(M)balanced information are considered affecting informativeness positively. ^(N)The press release should cover numbers of animal used, level of pain and suffering and the finding of the research. ^(O)The use of unified reporting guidelines such as ARRIVE guidelines and GSPC is proven to improve the quality of the information provided. ^(P)To provide balanced information, scientists should explain the needs and the value of the research after conducting a cost-benefit analysis.

^(Q)Completeness is another attribute to be seen that satisfies informativeness. ^(R)Researchers should try to avoid redacting and abbreviating results once published. ^(S)Details of ethical reviews and research protocol information should be provided completely.

(T) Simply making large amounts of raw data without other explanation hurts

informativeness in mediator and animal advocates' perspectives.

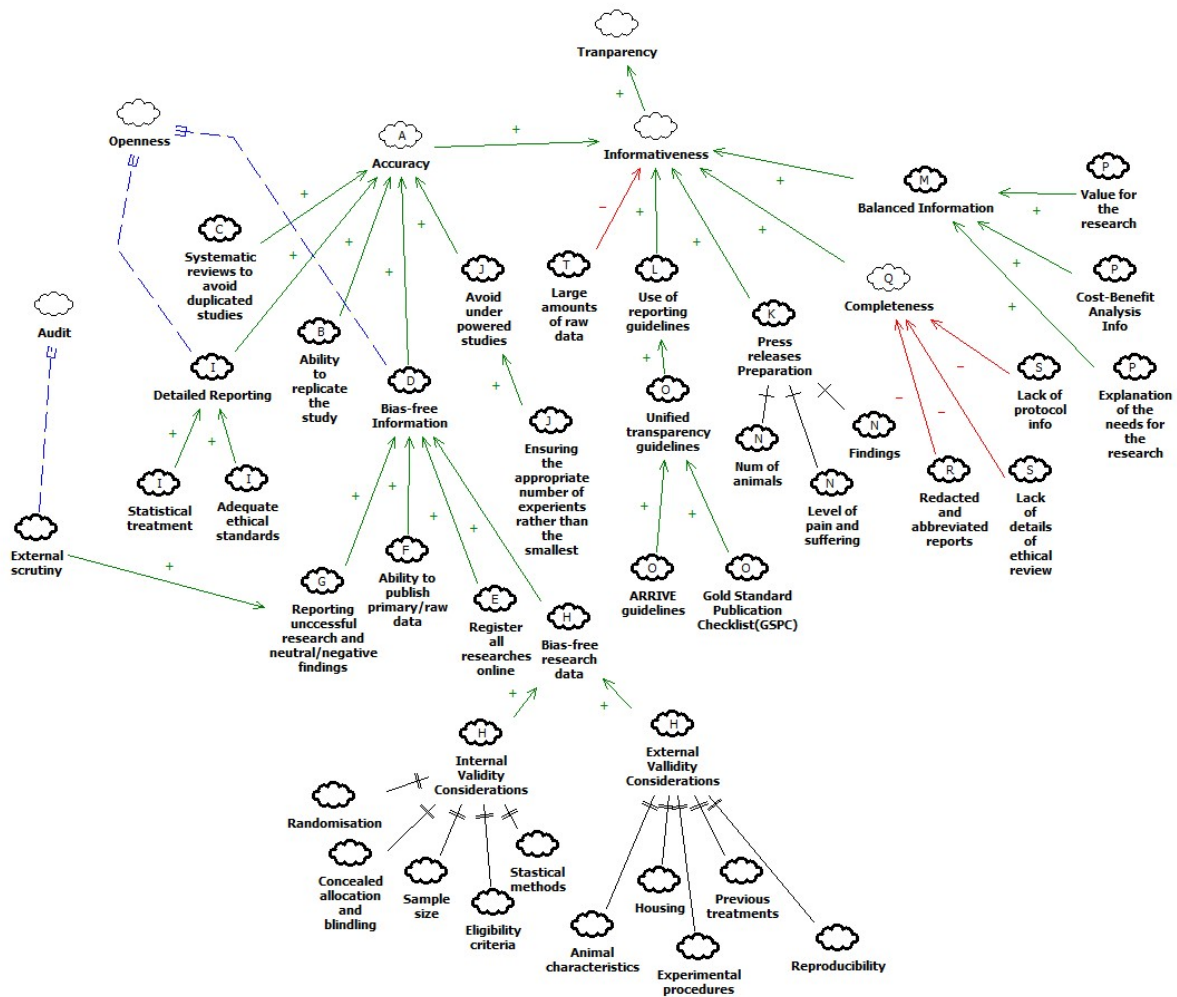


Figure 28 - Overall Operationalisations of the Catalogue Informativeness

6.3. Understandability

Understandability is a non-functional requirement that describes the information

provided should be comprehensible by the audience. ^(A)Minimising the difficulties for the readers to use the information is one of the sub-softgoals. ^(B)Scientists should try to avoid scientific terms and provide summaries in a plain language aside from the papers. ^(C)Images and films are also helpful to understand the research procedures. ^(D)Tailored Information, the ability for the users to choose the information they need, is also beneficial to satisfy Understandability. ^(E)Public awareness is also discussed to affect Understandability positively. ^(F)However, selective quotes from scientific works, misinformation from media, advocacy manipulates public ignorance, and lack of interest in science are claimed to hurt public awareness. ^(G)To promote Public Awareness, researchers should prepare for FAQs, and this information should be shared among all the scientists.

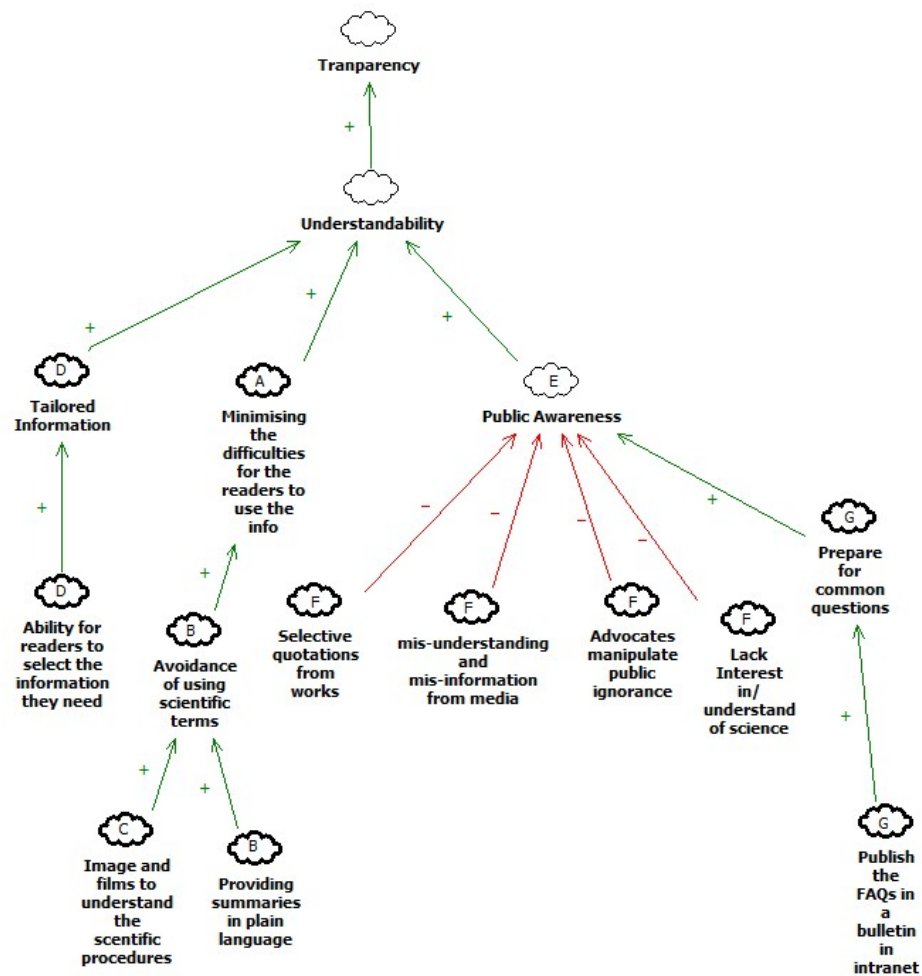


Figure 29 - Overall Operationalisations of the Catalogue Understandability

6.4. Accessibility

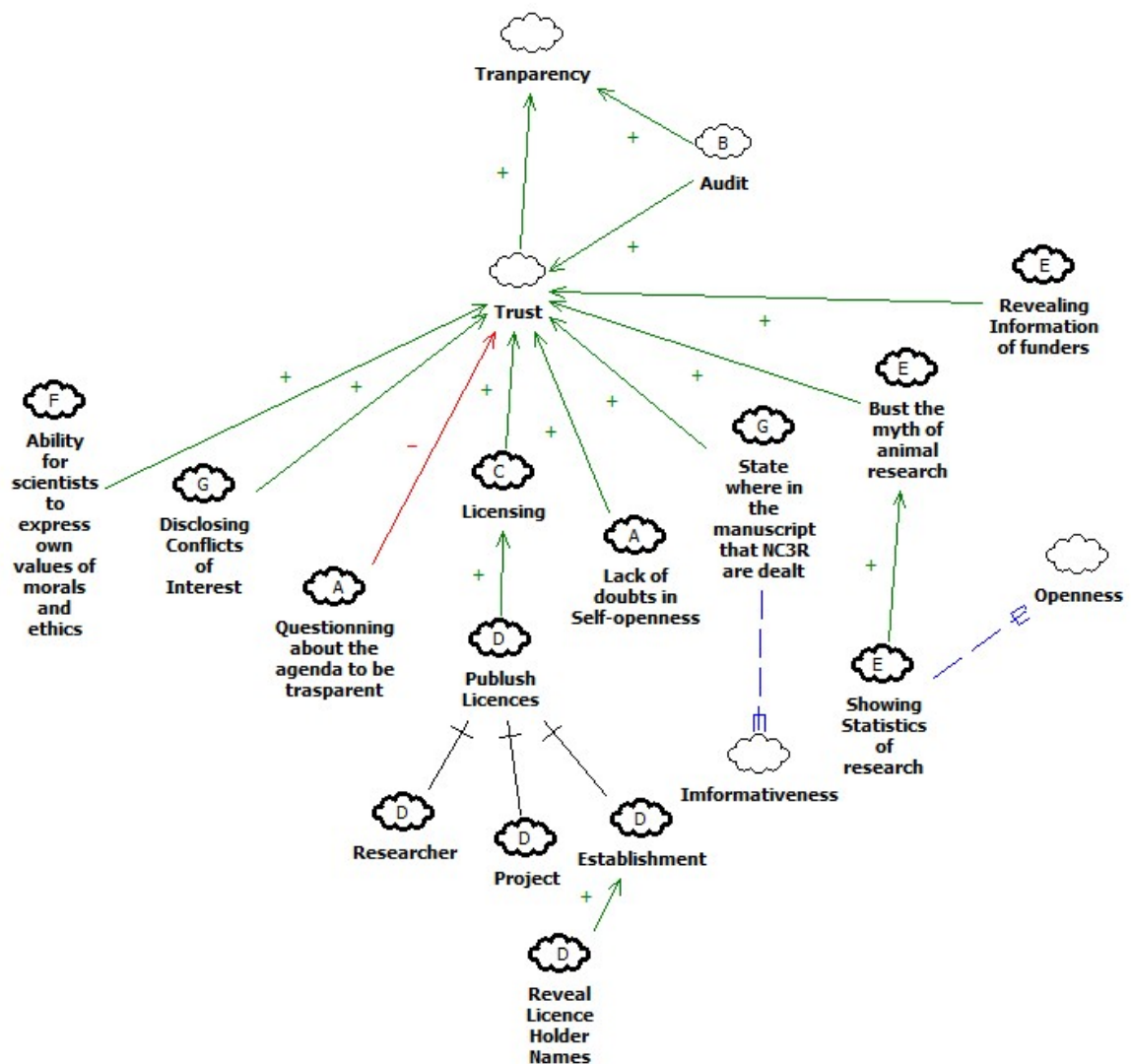
Making the information easier to be obtained is considered as the core idea of Accessibility. ^(A)Maximising the number of people which a publication can reach is one of the sub-goals for Accessibility. ^(B)The ability to access to past studies and the data and materials related are regarded as the operationalisations of accessibility.

^(C)The mediators are also hoping the researchers to share data with each other by arranging joint declarations.

^(D)The information about the approval meetings should be advertised. ^(E)All the information regarding the meeting minutes, participants and the agenda should also be made available for the interested parties after the meetings are finished. As for the research information, ^(F)it is better to make the information available before the research. In a timely manner is also acceptable rather than after the research. ^(G)The reporting of animal use statistics helps the Openness catalogue. However, it is useless if it is not available to the interested parties. ^(H)Such information should be stored in a centralised accessing point, in researchable data repositories to make it easier to be accessed.

trust. ^(D)All different types of licences have to be published and the name of the licence holder should be made available as well. ^(E)Some researches show that people do not trust scientists because they think most animal researches are operated in order to make cosmetic products for profits. Such misconception has to be busted by showing statistics of researches and revealing the funders. ^(F)Researchers should express their own values of morals and ethics to let the public know they are not cold-blooded. ^(G)The scientists also have to clearly state their conflicts of interest and where the NC3R are dealt with in their research report.

Transparency could lead to trust in general. People tend not to trust the organisation if it is not transparent, however, people are also questioning about the agenda to be transparent, and do not believe the information that researchers provide. Such fact makes Trust a self-contradicting topic because transparency and trust satisfy each other. It is to be believed that the research sectors have to make the first move and efforts to make the public trust.



6.6. Audit

Audit is able to help Trust, and which has a positive contribution to Transparency. Audit itself also has a positive impact on Transparency as well. Audit is described as the ability to examine the information provided. To verify the

information, ^(A)providing ethical approval documents and legal references can be helpful. ^(B)External involvement by holding meetings and include lay members and representatives from animal advocacy groups to increase the diversity of perspectives helps Audit as well. ^(C)The information of the meetings should also be made available for the public to examine. ^(D)External Scrutiny by animal welfare complainers and involving experts in the studies to help to design and analysing researches also have a positive impact on Audit.

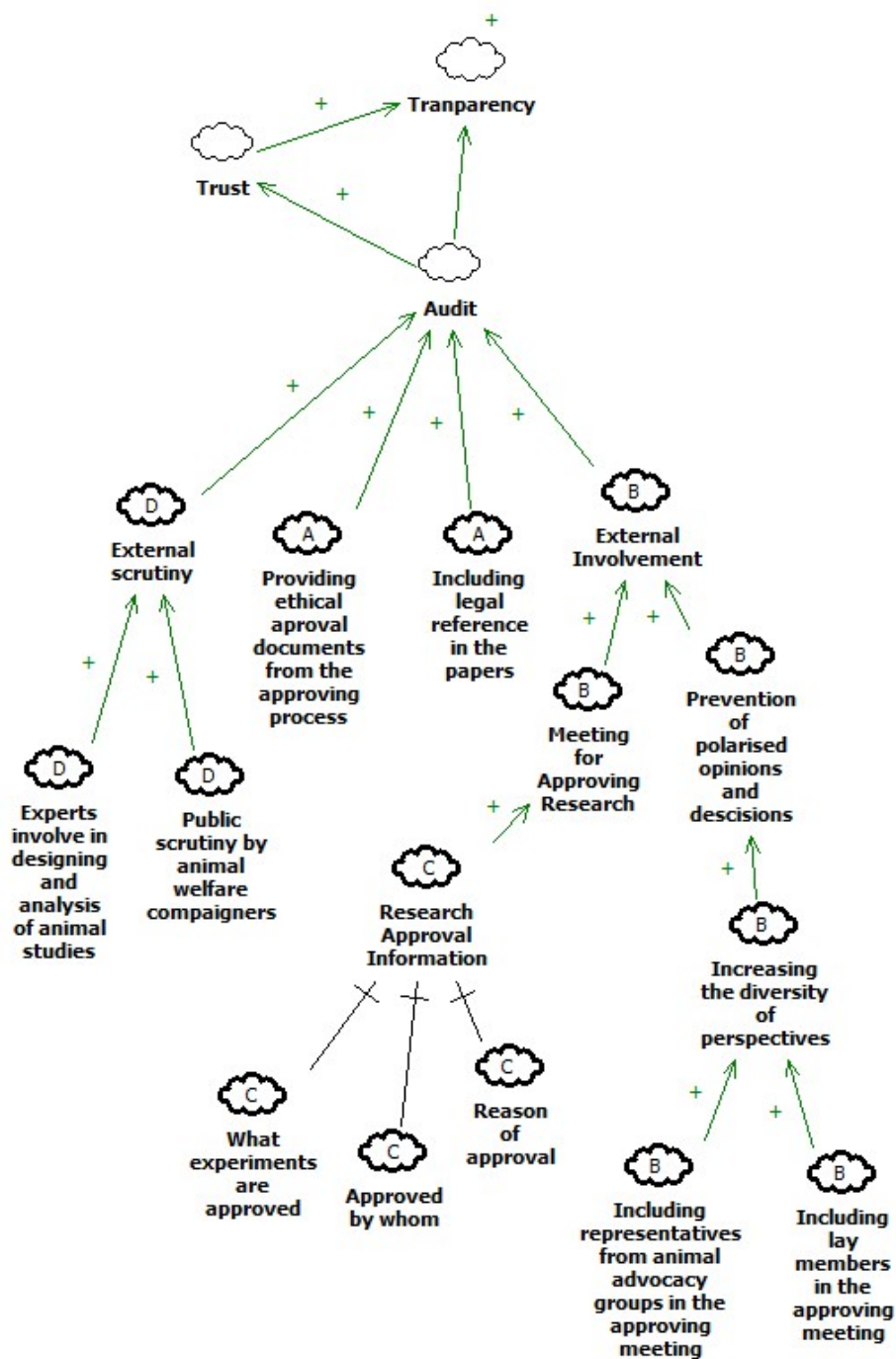


Figure 32 - Overall Operationalisations of the Catalogue Audit

7. Reusing the SIG Catalogues Knowledge

This thesis does not aim at promoting a systematic method to use the catalogues.

An initial approach to reuse solutions expressed in catalogues can be found in [33].

We believe that catalogues can be used regardless of the approach to developing software. It is supposed to be used as a source of knowledge to be reused by software engineers to help to reason about possible solutions to address NFR satisficing needs during a project. The usefulness of using catalogues have been suggested by works that tested it before [43] [33] [44] [95]. Hence, this work does not intend to propose a specific method to reuse the knowledge expressed in the catalogues, but instead, it brings the collected knowledge that could guide the reuse of this knowledge exploring a set of solutions that can be adapted to each project individually. Different laboratories in different countries and using different types of animals will require different solutions to promote transparency in their software in order to build trust among stakeholders and mitigate conflicts.

Even though Section 6 shows consolidated catalogues compiling the different viewpoints, we believe it is essential to make all the catalogues available to improve the chances of a software engineer to fully understand the possible conflicts and optimise a solution to adopt the necessary trade-offs involving different stakeholders.

7.1. Usage of the Catalogues and Mitigating Conflicts

The catalogues in Section 5 are proposed to understand the requirements of each stakeholder. The SIGs show as many requirements and solutions as possible to tackle the needs for being transparent in the animal experimentation domain. In order to understand the requirements, one simply just looks up the SIGs, and all the suggested solutions along with the original references that could be used to understand further the reasoning expressed in the SIG for the use of this solution.

However, to mitigate the conflicts, the consolidated catalogues in Section 6 are suggested. Catalogues in Section 6 consider all sides of the needs and still aim at achieving Transparency. The proposed SIGs were put together according to similarities. Following the operationalisations in the SIGs would help to mitigate the conflicts. For example, one of the conflicts between the animal advocacy groups and the researchers relies on the fact that on one side, that the animal advocates want everything in the laboratory to be opened up, but on the other side, scientists want to keep their personal identity safe. The combined Openness SIG would be an intuitive tool to follow. Simply tracing down the Reporting softgoal and Personal Safety softgoal under Openness Catalogues in Section 6.1 would obtain the possible solutions that are satisficing the transparency NFR.

The catalogues showed in Fig 5 can be then consulted to allow software engineers to expand their understanding about the problem. Solutions in all catalogues are also linked to the literature used as the source of the knowledge if further analysis is needed.

The following sections show applied cases of the usage of the catalogues.

7.2. The Case of Not Understanding Stakeholders and Lack of Communication

The US organisation People for the Ethical Treatment of Animals (PETA) has been protesting against Texas A&M University and accusing of torturing dogs and cruelly breeding sick dogs in the laboratory for many years [96] [97].

The laboratory was built for studying Duchenne, a genetic disease that would slowly break muscles and kill the patient eventually. The behaviour of the disease is similar on dogs. According to the Dallas Morning News [98] which was granted permission to enter the laboratory in 2019, both the University officials and the PETA activists hold different opinions against each other in the news report.

7.2.1. The PETA's Side of the Story

In 2016, PETA released a video claiming that the dogs in the Texas A&M laboratory were being tortured. The video showed that the dogs were kept in a bad environment, stepping on their own faeces and being fed with gruel. PETA also accused the lab of breeding genetically sick dogs for the research. With this kind of innate genetic disease, the dogs live with pain and die in agony slowly. PETA has been picketing on campus and holding campaigns to close up the laboratory.

7.2.2. The Researchers' Side of the Story

The researchers claimed that the laboratory is necessary in order to study the cure for the rare genetic disease. They defended that the dogs are not in pain, and would be euthanised at the age of 6 months. The so-called “gruel” is just commercial-branded food mixed with water. They also denied treating dogs badly and breeding dogs for the research. The researchers also claimed of getting death threats and compromising their personal safety from the activists, so they hide the laboratory in secrecy.

7.2.3. The Mediators' Side of the Story

The Dallas Morning News obtained breeding records showing that the laboratory was misrepresenting that the dogs were not bred on site. The school officials said that they were not intentionally hiding the truth and were mistakenly giving out the information because of a mistake by a former spokesman of the laboratory. To reveal the truth, the Dallas Morning News was granted limited access to entering the laboratory, and the school officials were hoping to show to the public that the dogs are treated well with care. However, the researchers in the laboratory prohibited the reporters from taking pictures and video. As the breeding notes were released, there were different voices online doubting the truthfulness of the news and the laboratory.

7.2.4. Solutions to the Conflicts

This paper presented a set of possible solutions to mitigate the conflicts that are shown in the case.

Firstly, the animal activists were unclear with the housing conditions of the lab dogs. The housing conditions, such as the size of the cages, type of food, feeding regimen, and type of enrichments, should have been reported according to the Openness catalogue under Reporting softgoal. Estimated level of pain and the

outcomes of the research animals are also concerned by the activists, which are also presented under the Reporting softgoal as well. Secondly, the researchers were worried about their personal safety being compromised. The solutions are also described in the Openness catalogue under Personal Safety Protections softgoal. Using serial numbers to represent personnel and publishing the report, anonymously could be the prevention of personal information leak. The researchers keep emphasising the necessity of the research, but according to the Informative catalogues of this thesis, they should explain the needs of the research and the value of the research. Thirdly, the journalists were prohibited from recording video and taking photos in the lab, which caused doubts to the news report and the lab. The public desire to understand what is happening inside the laboratory. The Understandability catalogue shows that image and video will help the public to understand researches better. Lastly, due to lack of communications between the laboratory and the school officials, the school officials did not receive the correct information from the researchers, which caused the misinformation incident. According to the thesis, the solutions are presented in Informative catalogue and Understandability catalogue, under press release preparations and preparing for common ask questions respectively. The researchers should prepare for the official

press release with the information such as the animals being used and the evaluation of levels of pains, and such information should be stored on the intranet on campus to share with the outside of the laboratory, with the school officials. To prevent the laboratory from being secretly conducting experiments, or using animals without permissions, external scrutiny and external involvement from the public and experts could be the possible solutions, which are shown in the Audit catalogue in the thesis.

Many of the above-used operationalisation could have been implemented in the software used by the laboratory to administer the daily operations of the laboratory. The operationalisations can be used to build a software program that will help and stimulate laboratories to act transparently. It can also be used to orient laboratory managers on how to behave to minimise conflicts, and some of the solutions above illustrate it.

7.3. The Case of an Undercover Footage

Another laboratory was facing its closure in Hamburg, Germany in 2019. Due to an undercover video published by the Cruelty Free International, a British Organisation, and Soko Tierschutz, a German organisation, showing that the laboratory animals were being kept in squalid conditions, and there was obviously no

pain assessment for the experiments of the monkeys in the lab [99] [100]. The undercover footage also showed that the monkeys were restrained by braces during the experiments. Some of the monkeys were being kept in cages that were less than a cubic metre, according to The Guardian [99].

The inspectors of the German authority visited unannouncedly and observed that the monkeys were kept in far too small cages. The laboratory was also fined 300 euros because they bred laboratory dogs without permission. However, the lab said that the authorities had never objected them to breed animals.

7.3.1. Solutions to the Situation

According to the SIGs that were proposed by this thesis, the laboratory should have followed and reported the estimated levels of pains of the research animals and the housing conditions of the animals in the laboratory. The housing conditions, such as the size of the cages, type of food, feeding regimen, and type of enrichments, should have been reported according to the Openness catalogue under Reporting softgoal. These requirements and solutions which are most concerned topics by animal advocates and mediators are presented under the Reporting Softgoal to achieve Transparency. Video footages of the laboratories should also be kept and

ready for the inspectors, which is demonstrated under the Openness Catalogue. The laboratory also claimed that the authority never rejected their activities of breeding lab animals, but it was still fined. To solve the situation, the laboratory could have provided ethical approval documents and legal references for the research according to the Audit Catalogue.

The SIGs that are proposed by this thesis suggested a set of solutions, which could have solved the conflicts and problems if they were implemented by the research sectors. The SIGs demonstrate existing requirements and solutions for the laboratories and can be used as a knowledge tool to build software to adapt and tackle the Transparency NFR and mitigate possible conflicts in the future.

7.4. Reusing in Software Engineering

Indeed, some laboratories may consciously choose not to follow these possible solutions. However, in many situations, laboratories may not perceive these situations as problems and having these solutions available can help the system analysts building laboratory software to inquire laboratories about the possibility of leaving the software prepared to provide ways to mitigate possible conflicts. If nothing else in the case of significant conflict that is evaluated by authorities where the

laboratories are considered in non-conformity with the rules, solutions may already be ready to be used in the software allowing the laboratories to cope with a new reality in a very short period of time. For example, the engineer could build a section to remind the scientist to reduce biased research to satisfy Informativeness Catalogue by showing internal and external validity sections with the descriptions of each factor. Compliances to the guidelines in the Informativeness could be implemented as checkboxes to help the scientists dealing with the guidelines. The engineers may also could turn operationalisations under reporting into columns to let the scientist record and report their experiments. Engineers may also choose to set some columns as mandatory according to the regulation of the experiment to prevent the researchers from bypassing reporting certain information. Once an audit is needed, the information would be ready for the inspectors to examine. The thesis presents general possible solutions and requirements to let the engineers and laboratories to build software programs. The engineers could choose any methods to adapt the solutions into the software programs.

8. Conclusion

It is known that the use of animals in the laboratories is controversial, and there have been numerous debates and conflicts regarding the topic. Therefore, the demands for transparency in animal experimentation are getting higher and higher due to the awareness of animal welfare among different stakeholders in the animal experimentation domain. The animal advocates society, the researchers and the mediators are all calling for being more open despite the opposite positions they are standing. All these groups claim that the public opinions are on their side, and thus, the other groups should fulfil their needs. This thesis identifies requirements and possible solutions from the literature through the perspectives of different stakeholders. It provides a knowledge base of possible solutions for achieving transparency and mitigate the differences among various stakeholders, which will help the laboratories to adopt software that offers a level of transparency for the research process. It will also help to mitigate current problems involving researchers, mediators and groups contrary to the use of animals.

This thesis presents a pilot study of organising knowledge and building SIGs for transparency in animal experimentation domain. Due to political constraints, the result of this thesis was collected from past literature through the Systematic

Literature Review method, and not involving existing stakeholders. We could only obtain feedback from a former IT professional of an organisation that uses animals for experiments. The feedback indicated that the knowledge base, despite being in a format that is not well known by software engineers, can be understood and some of the solutions presented there could potentially mitigate problems that this software engineer experienced before.

Future work will target to obtain more specialised feedback and resulting in SIGs that can be further replicated. Involving existing stakeholders to build more SIGs and performing experiments on using the results as references to develop software programs are to be conducted. We will also investigate different ways to represent knowledge rather than SIGs to facilitate reuse.

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