Developing a Model-driven Socio-environmental Auditing Tool

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Abstract

Responsible enterprises have many options when it comes to selecting a socio-environmental auditing (SEA) method, however, since every method comes with its own tool, organisations are unable to find tool support for the methods they adapt or develop in-house. Consequentially, organisations are forced to 1) spread their data accross multiple tools and create a single aggregated report manually or 2) develop their own tool. We propose the conceptual meta model of an SEA method, which we rely on to subsequently design the openSEA tool. This proof of concept tool supports any SEA method that can be described using the conceptual meta model and as such successfully decouples SEA method from SEA tool. We evaluate our through conducting interviews with two responsible enterprises.

1 Introduction

Responsible enterprises adhere to ethical values, taking care of their impact in society and on the environment. This is becoming an increasingly important topic due to the introduction of many (inter)national laws and regulations [10] on this subject. These enterprises, including small and medium enterprises (SMEs), are interested in knowing their current standing with regard to this topic. The outcome of such an assessment may serve a range of purposes: communication (e.g., marketing), comparison (e.g., responsible consumerism), or continuous improvement (e.g., reengineering the organisations to be more sustainable). We refer to the activity of performing these assessments as *socio-environmental auditing* (SEA), which we define as the systematic, documented, periodic and objective evaluation of how well individuals, companies, municipalities or countries are performing in terms of their impact in society and on the environment [9].

Today, many proposals for SEA methods exist, ranging from international standards (e.g. ISO 26000, ISO 14000 [2, 1]) to local initiatives (e.g. REAS Spain [8]) and responsible enterprise networks (e.g. ISEA, SAN [3, 18]). It is within this collection that we identify a significant issue. While it is possible for organisations to combine multiple methods into their own, an SEA tool that is just as flexible currently does not exist. All of the SEA methods outlined in this paper come with their own tool (figure 1). For some, this amounts to a

relatively simple Excel sheet [13] while others have developed more elaborate (web) applications [20, 7]. As a result, organisations are unable to decouple SEA method and tool and are instead forced to either (1) use multiple tools or (2) develop their own. Often, organisations then release their newly created method and accompanying tool for others to use, unknowingly adding to the problem.

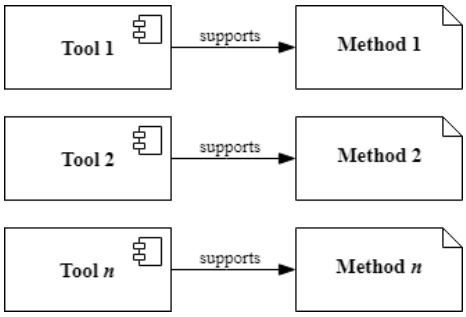

Figure 1: Tightly coupled SEA methods and tools

We identify six possible situations of SEA method usage within organisations and groups of organisations that illustrate this problem (figure 2):

a) The organisation uses a single method and its tool. In this situation, there is no immediate issue. Once the organisation intends to evolve its method by extending it or adding a second however, the problem becomes more apparent.

b) A single organisation uses several disjoint methods and is as such forced to use multiple tools. Creating a single aggregated report has to be done manually.

c) Similar to situation b, a single organisation uses two methods. In this case, the two methods are partially overlapping in that there are common data points between them. The organisation is not only forced to use multiple tools, but also to enter the same information more than once.

d) A network of organisations uses the same model and tightly coupled tool. Similar to situation a, the problem does not become apparent until the organisation intends to evolve the network's method or add a second, resulting in situation e.

e) An organisation within a network intends to measure other things in addition to its network's standard method. In addition to having to use multiple tools and possibly entering information more than once, if the second tool does not allow for partial data entering, the organisation is forced to complete two full reports.

f) When an organisation joins a second network, for example to achieve additional certification levels, this again results in the organisation being forced to use multiple tools and possibly enter information more than once.

The goal of this paper is to create the conceptual meta model for SEA methods and to introduce a new SEA tool supporting this conceptual meta model. We aim to prove that any method that can be described by the conceptual

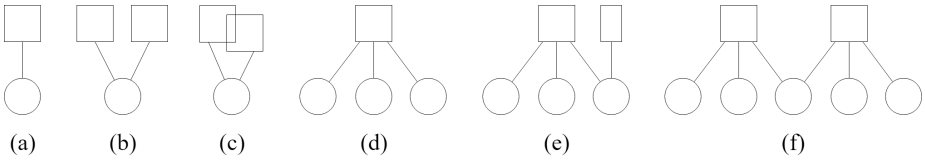

Figure 2: Six possible situations in which organisations (circles) may use an SEA method and tightly coupled tool (boxes).

meta model is supported not only by its own tool, but also by our tool. We aim to support each of the six situations outlined in figure 2 with the new tool. Furthermore, this paper paves the way for the creation of a more elaborate ecosystem of SEA-related tools in which the proposed tool, openSEA, is the first. Other tools and applications in the ecosystem include (1) an SEA modeller, (2) a repository of SEA methods, and (3) a repository of best practices for openSEA to suggest (figure 3).

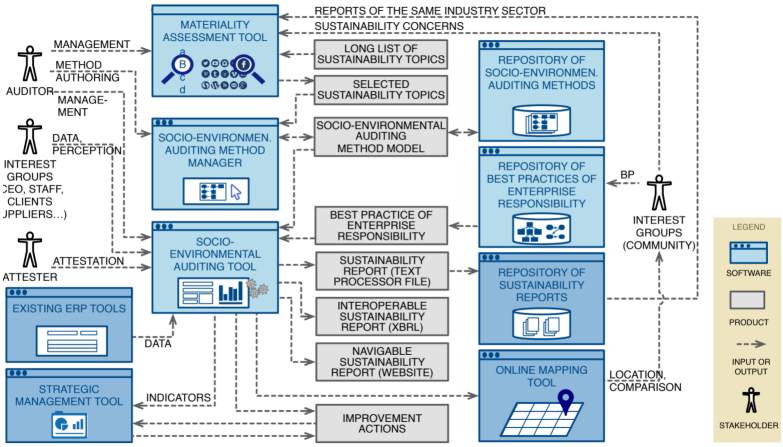

Figure 3: The envisioned ecosystem with openSEA being the socio-environmental auditing tool. Image created by S. España following research on responsible enterprises. [9]

This paper is structured as follows. In section 2 we detail our research method. Throughout the remainder of this paper, we make three concrete contributions to literature:

- Section 4 proposes a conceptual meta model of an SEA method, detailing the decomposition of a single SEA method. We use this conceptual meta model throughout the paper;
- Section 5 presents on a high level the architecture and implementation of a new SEA tool that implements the conceptual meta model;
- Section 6 reports on the validation of both the conceptual meta model and openSEA.

To conclude we discuss our work and explore future research opportunities in section 7.

2 Research Method

The structure outlined previously is based on Wieringa's Design Science framework [21]. For each of the three contributions we make to literature we identify a corresponding research question and phase within the framework:

RQ1 (Problem investigation, section 3) What is the current state of the art with regard to socio-environmental auditing and what are the implications? We intend to indicate the scale of the problem.

RQ2 (Solution design, sections 4 and 5) What does the conceptual meta model of SEA methods look like? We intend to implement the conceptual meta model in a proof of concept tool called openSEA.

RQ3 (Solution validation, section 6) Can the conceptual meta model of SEA methods describe any SEA method, and subsequently, is the proposed SEA tool capable of supporting any SEA method?

To answer the above research questions, we identify four distinct steps. It is important to note that this study is very much opportunity-driven. Given a number of potential user wanting to try the tool before research had begun development was started without having a predefined set of requirements. As such, where development would ideally take place between steps three and four, we have decided against explicitly including this step and opting for an agile approach instead. Development took place throughout the execution of the steps below.

Step 1: Multivocal Literature Review — While systematic literature reviews [16] are valuable, they do not include so called "grey" literature (non-published, nor peer-reviewed sources of information [19]). We feel that it is important to include both the state-of-the-art *and* the state-of-the-practice in order to sufficiently explore currently available SEA tools. We use both Google Scholar and Google to search for all combinations of the query fragments in table 1. Because of the specificity of these terms, we only consider the first two pages of search results. With ten results on every page, the number of initial results is 1800. We then proceed to discard the duplicate URLs and examine the remaining sources more closely. To ensure all and only relevant sources are included, we include or exclude the remaining sources based on the following criteria:

- We include sources that directly describe one or multiple tools. Reviews or aggregated reports that compare a number of *methods* are discarded, while comparisons of multiple *tools* are not.
- We exclude sources that describe tools we are unable to access. For the tool to be properly analysed as part of step 2 of this research method, access is required.

Step 2: Analyse existing SEA tools — We examine the remaining tools from step 1 in order to describe the state of the art and practice with regard to SEA. We assess the tools on the following subjects:

- The tool's ability to support more than one method;

Table 1: Multivocal literature review search queries.

Field	Activity	Solution
environmental	impact assessment	tool
social	audit	system
sustainability	reporting	software
socio-environmental	auduting	
	impact measurement	

- The degree to which the tool allows for user customisation (i.e., not measuring a certain thing).

Through our findings in this analysis we are able to answer RQ1 and illustrate the scale of the problem.

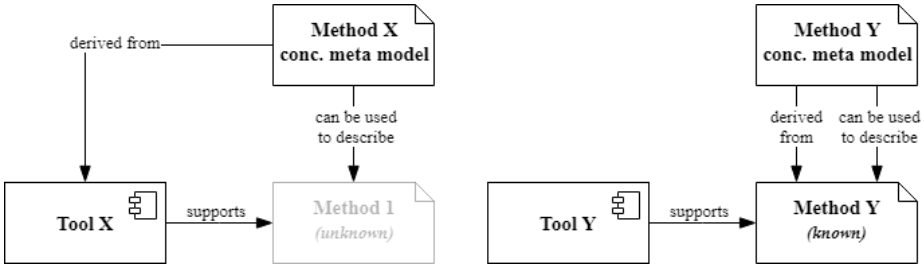

Figure 4: In the event that we have no information about the method but we do have access to the tool, it is still possible to derive the method's conceptual meta model. If the method is know, we derive the conceptual meta model from it or its description.

Step 3: Conceptual meta model construction — From the remaining tools from step 1 we select three, for each of which we create a conceptual meta model. We argue that, for the cases in which we have access to the tool but not to any description of the method, we are still able to derive the conceptual meta model of the method from the tool itself because the tool supports the method (figure 4, left). In the event that we do have access to the method, we create the conceptual meta model using the method or its description (figure 4, right). Next, we generalise the three conceptual meta models and create a final conceptual model of SEA methods at the same level of abstraction. Through doing so, RQ2 is answered. We argue that, if the final conceptual meta model is the generalisation of a set of conceptual meta models derived from a set of SEA methods which are supported by a set of tools, and we have a tool that supports the final conceptual meta model, this tool supports the original SEA methods (figure 5).

Step 4: Validation — In order to answer RQ3 we apply the conceptual meta model from step 3 in two responsible enterprises. We create the configuration file representation of (a sample of) their method and show representatives from the responsible enterprises how the proposed tool supports their method. During this demo and non-structured interview, the interviewees are asked to think out loud as they receive the demo. This way, feedback is gathered both on

the conceptual meta model of SEA methods (are the interviewees satisfied with the choice of concepts and their relationships?) as well as the implementation of the conceptual meta model. We seek to answer the following question during these interviews, which in turn contribute to answering RQ3: *To what degree are organisations able to describe their method using the conceptual meta model of SEA methods?* Since we also aim to validate the tool's ability to support multiple SEA methods, we evaluate the six situations posed in figure 2 and provide argumentation and evidence for or against the proposed tool's support.

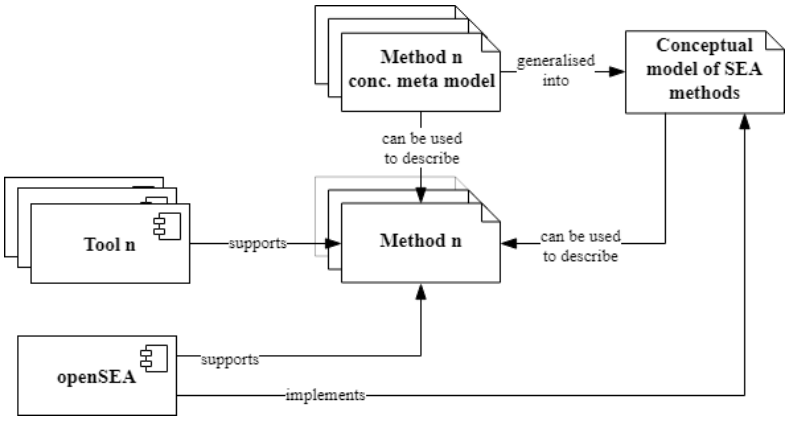

Figure 5: Given a set of tools and method descriptions which are abstracted into method-specific conceptual meta models, which are then generalised into a final conceptual meta model of SEA methods which is then supported by the proposed tool, we claim that the proposed tool supports the original set of methods.

3 Current State of The Art

From the 1800 initial sources we immediately discard all identical URLs using Excel's COUNTIF function, resulting in 551 sources. In a second round of filtering, we discard an additional 508 sources (figure 7). The majority of discarded sources refer to a method as a tool (or "means") to perform socio-environmental auditing. While this is valid, within the scope of this study we are only looking for tools. 10 additional duplicate sources are discovered whose URLs are different but point to the same resource. We discard an 31 additional sources, 24 of which have non-functional websites and seven offered no apparent option to try or receive a demo of the tool.

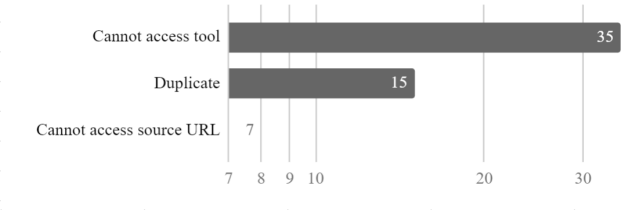

Figure 6: Reasons for discarding an additional 57 tools, resulting in the final 13

The remaining 43 sources contain information on a total of 62 tools. This mismatch is caused by certain sources containg links to multiple tools (up to 14 in one case), which are all included in the study. Of these 62 tools, two originate from an academic source. We add an additional 8 tools the authors are already familiar with to this set, resulting in a number of 70 tools in total. In a third round of filtering, we remove another 15 duplicate and seven non-functional websites. 35 tools have no public signup page and instead offer demos. We discard these 35 tools as none of our demo requests are granted. Having discarded 57 tools (figure 6), 13 remain, the names and URLs of which have been made available in table 2.

Table 2: All tools resulting from the multivocal literature review (some URLs shortened for presentational purposes).

Name	**URL**
Rapport	`http://rapport.io/`
Measurabl	`https://www.measurabl.com/`
The EAT	`https://goo.gl/GjNA8V`
ToSIA	`http://tosia.efi.int/`
LM3	`https://www.lm3online.com/`
PLUREL iIAT	`https://goo.gl/e6BCQq`
POSDAT	`https://goo.gl/DzMLFS`
EHE EAT	`https://goo.gl/q47ykj`
B Impact Assessment	`https://goo.gl/x6JzDM`
Green IT	`http://greenit.s-i.ch/`
REAS Social Audit	`http://www.auditoriasocial.net/`
Common Good Balance Sheet	`https://www.ecogood.org/`
PSAT	`https://sustaintool.org/`

Within the 13 tools, we find only a single tool, Measurabl, that supports exporting its recorded data in multiple formats (GRESB [4], CDP [6], GRI [15]), arguably supporting more than one method. Five paper tools are easily extended, however we would not argue that these tools support multiple methods. The other 8 tools offer no configurability. A more extensive analysis was performed for all 13 tools, the results of which have been made available in appendix A.

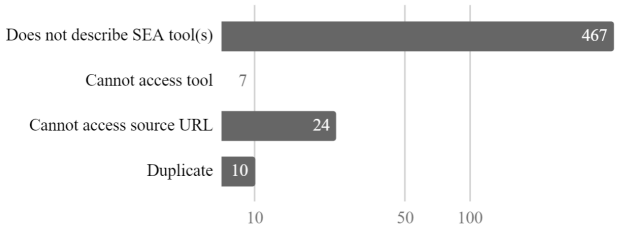

Figure 7: Reasons for discarding 508 sources

4 A Conceptual Meta Model of Socio-environmental Auditing Methods

From the analysed 13 tools, we select three (bold in table 2). For each, based on the available inputs within the tool, we create a conceptual meta model (figures 13, 12, and 14). Measurabl supports GRI [15], and REAS Social Audit and the Common Good Balance Sheet support their own methods. Within these three conceptual meta models, we generalise the concepts (table 3) and construct the conceptual meta model of SEA methods.

Table 3: Common concepts in Measurabl, Common Good Balance Sheet and REAS Social Audit's conceptual meta models.

Common name	**Measurabl**	**CGBC**	**REAS SA**
Category	GRI Standard	Ethical value	Principle
Indicator	Reporting	Sub-indicator	Indicator
Metric	*Implicit in Indicator*	Cell	Question

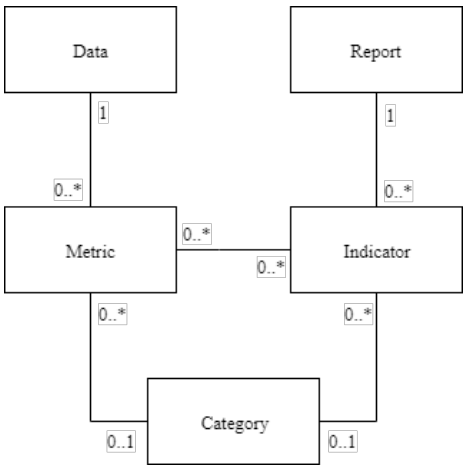

Figure 8: Conceptual meta model of SEA methods

Figure 8 shows a UML class diagram for SEA methods. In section 5 we extend this diagram with attributes for each of the classes. In the following subsections we elaborate on the selection of concepts.

4.1 Report

A socio-environmental auditing method always yields a report of sorts. Some organisations may perform an audit every six months, others once every year, but in every case the result is an aggregated overview on the organisation's current standing that we refer to as a `Report`.

4.2 Indicator

Through an `Indicator`, an organisation is able to express its current standing with regard to an aspect of the broader subject (e.g. the amount of sustainably sourced energy the organisations uses on a yearly basis). Often, an indicator is a computed value, meaning it combines multiple data points into a single value or conclusion.

4.3 Metric

A data point (partially) making up the value for an `Indicator` we refer to as a `Metric`. Metrics are not communicated directly to the audience, but are instead added, subtracted, counted, or run through a more complex formula or transformation in order to be turned into an `Indicator` value.

4.4 Data

The `Data` object describes the values for `Metric` concepts and as such represents the dataset that the `Report` is based upon.

4.5 Category

In the case of an organisation measuring many things, we allow both `Metric`s and `Indicator`s to be grouped within a `Category`.

5 A New Socio-environmental Auditing Tool

The goal of this study was to develop a conceptual meta model for SEA methods and build a tool that supports it. Having created the conceptual meta model of SEA methods, next, we describe some additions that were made to the conceptuel meta model for it to be used in a tool, present a high-level overview of openSEA's architecture, and provide sample input and output.

5.1 Additions To The Conceptual Meta Model

Within the conceptual meta model we introduce seven additional concepts, resulting in the conceptual meta model for openSEA (figure 9). Below for each of the introduced concepts we provide argumentation as well as brief descriptions.

- `Model` — The concepts from the conceptual meta model for SEA methods in figure 8 need to be represented in a format that openSEA understands. We capture the concepts in `Report` as well as some basic information such as a name in the `Model`. The `Model` is provided to openSEA as a YAML ("YAML Ain't Markup Language") configuration file. Every `Report` is to have its own `Model` attached in order to allow for changes between auditing moments.
- `User` — To support authentication and authorisation, we introduce the `User` concept.

- `Organisation` — Within the tool, a representation of the organisation that is performing socio-environmental audits is needed. The `Organisation` concept is used to link `Report` concepts to.
- `Network` — We identified that often groups of organisations use the same SEA method with a governing organisation brought in place as well. We support this phenomenon by grouping `Organisation` entities within a `Network`. Opposite to an `Organisation`, a `Network` may provide a `Model` for its child `Organisation`s to use in their `Report`s.
- `ReportItem` — Within the `Model`, we have added the concept `ReportItem` in order to decouple `Indicator`s from the generated `Report`. This concept describes an item in the `Report` and allows for combining multiple `Indicator` entities into, for example, a single chart.
- `Certification` — While preparing for one of the interviews for validating the tool, the need to specify certification levels became apparent. To adress this, the `Certification` concept was introduced to the `Model`, allowing the user to describe multiple levels of certification.
- `Requirement` — To allow the user to describe multiple requirements that have to be met in order to qualify for a certification level, the `Requirement` concept was introduced. One `Certification` concept may have multiple `Requirement`s. A single `Requirement` describes what a single `Indicator` should look like in order to meet the `Certification` (e.g. locally sourced employees should be more than 50% of the entire workforce).

5.2 Architecture and Technology Overview

We have previously established the reasoning behind beginning development before any of the results of step one, two, or three of the research method were apparent. As a result, architectural and technological decisions had to be made without any scientific support. The below tradeoffs were made with a strong preference for convenience.

Platform selection. Modern-day web technologies are extremely versatile, to the point where it is possible to write native applications using JavaScript and CSS (e.g. React Native and Electron for mobile and desktop native applications respectively [12, 14]). The decision was made to base openSEA on these technologies in order to publish the tool as a web application initially, but to allow for future publication of native applications on other platforms such as Windows or Mac.

Language and/or framework selection. openSEA is written in TypeScript, a superset of JavaScript, using the React framework [17, 11]. React applications consist of components that exist indepently from others, allowing for changing, adding, and removing components without affecting the rest of the application. It was this versitility in addition to previous experience in using the framework from the authors that lead to the selection of React for openSEA.

Back-end solution. Firebase is a mobile and web applications development framework that provides services such as a database that synchronises to connected clients in realtime and web hosting for free. Not having to set up and maintain a back-end environment for openSEA was the primary reason for

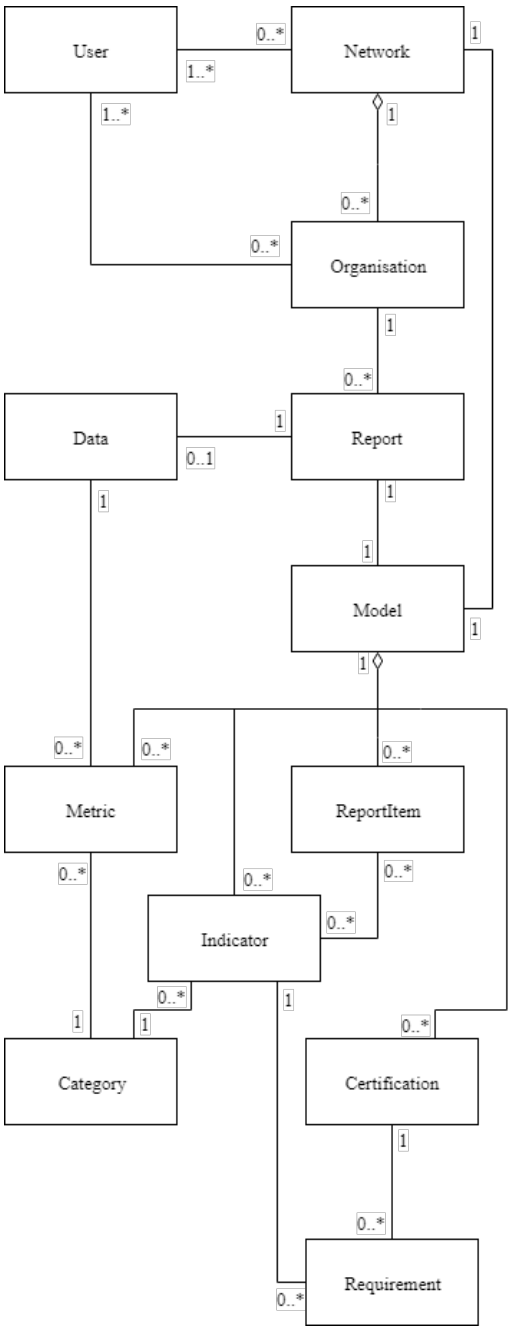

Figure 9: Conceptual meta model of openSEA

selecting Firebase. Of the extensive offerings in the Firebase suite, openSEA uses the following:

- Firebase Firestore (database)
- Firebase Authentication
- Firebase Hosting

The potential vender lock-in to Firebase has been mitigated by developing a set of middleware functions decoupling openSEA's core functions from Firebase, allowing openSEA to use generic functions that may be replaced to communicate with any other back-end openSEA may end up using as the tool matures. Because Firebase is a Google project and the free tier gives the user no control over where and how the data is stored, we strongly recommend that once openSEA moves past its prototype phase, Firebase is replaced with a custom solution.

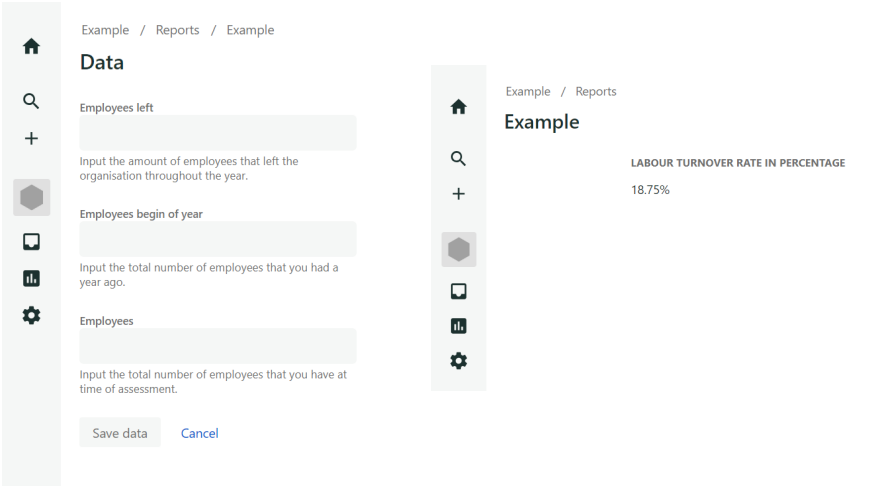

Figure 10: Example openSEA input (left) and output (right) based on the example model in code snippet 16

5.3 Sample Input and Output

The conceptual meta model for openSEA (figure 9) visualises the basic entities and components within the tool. We extend this with attributes for each of the concepts in the openSEA UML class diagram (figure 15). The `Model` entity is described by a YAML configuration file (see figure 16 for an example). Using this model in a report, the user is presented with the input fields corresponding to the metrics from the model. Any changes in the data is immediately reflected in the report's overview, again, according to the `ReportItems` object in the model.

6 Validation

Representatives from two responsible enterprises participated in non-structured interviews to validate and improve the conceptual meta model of SEA methods

and the openSEA tool. The first responsible enterprise, Competa, is a member of the Fair Trade Software Foundation (FTSF). The full FTSF auditing method, which has not been paired with a tool yet, was implemented in an openSEA configuration file prior to the interview. The second responsible enterprise, Rootability, has developed and made available the University Sustainability Assessment Framework (UniSAF) which comes with its own Excel tool. We have only implemented a subset of UniSAF's indicators and metrics in an openSEA configuration file due to time considerations. During the interviews, each of the representatives received a demo of the tool showing their own network or organisation along with a number of reports (based on fictional data), all according to the model of their respective SEA method that had been made in advance. The representatives for Competa and Rootability agreed to the recording of the interviews and were encouraged to comment on everything they heard and saw freely. The customer journey as it was shown to Competa has been made available as a series of screenshots in appendix G.

During the interviews, it quickly became apparent that all 74 FTSF indicators and three certification levels are supported to a satisfactory level. Competa's representative mentioned that "this is exactly what we're looking for" and that they would begin using the tools very soon. When specifically asked about their opinion on the selected concepts, both organisations respond positively. Rootability's representative however would not classify Rootability as a network per se, even though in order to group organisations using the UniSAF method doing so is the only solution. Rootability's representative also brought up a different method that had not been prepared for this demo, asking whether there was support for a gamification element where points are assigned to indicators and certification levels are met based on a total score. Since none of the methods that the conceptual meta model is based upon had any element of gamification, this element did not make it into the final conceptual meta model in figure 8. As a result, it would not be possible to describe this particular method with the proposed conceptual meta model.

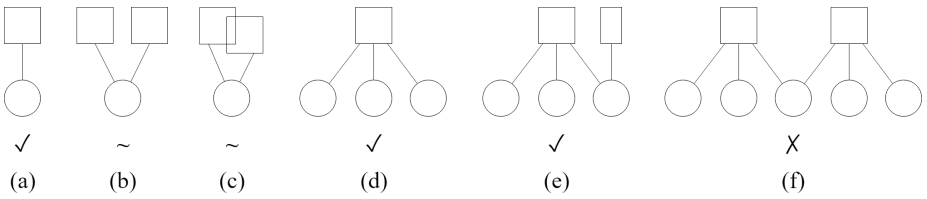

Figure 11: Six possible situations in which organisations (circles) may use an SEA method and tightly coupled tool (boxes), and whether openSEA supports these situations.

In the final step of validating the conceptual meta model and openSEA, we look at the degree to which the tool supports the six situations outlined in section 1. Figure 11 outlines the outcome of this validation through a checkmark to indicate that the situation is supported, a cross to indicate that the situation is not at all supported, and a tilde to indicate that the situation is partially supported. Below, we discuss each situation.

a) An organisation using a single method is what was shown in the interviews. For Competa we used the Fair Trade Software Foundation method, and for

Rootability we created a fictional university and used the UniSAF method. This situation is supported in openSEA.

b) Using two disjoint methods is partially supported in openSEA. It is not possible to use two seperate configuration file representations of two methods, however, merging the two disjoint methods into one, resulting in situation a, is fully supported.

c) Partially overlapping methods are also partially supported for the same reason as situation b. In order to fully support both situation b and c, openSEA would require a model management implementation [5]. That would allow it to intelligently merge two disjoint or two partially overlapping methods into one, while currently this action has to be performed manually.

d) A network prescribing a standard model is also supported within openSEA. For Competa, we created the FTSF network and added Competa to it. Competa's reports are able to use the method prescribed by the FTSF.

e) Because each report has its own model representation of a method (figure 9), we also support situation e. Whenever a report is created, the user has the option to use the network's or upload his own, in which case the two are merged. Again, model management would be required in order to better detect changes between the two, however currently it is possible for users to measure additional things.

f) This situation is not supported as organisations can only be part of one network. This is in line with the conceptual meta model.

7 Conclusion and Further Research

Although many socio-environmental auditing tools exist, a tool that is flexible enough to support multiple auditing methods or any combination of auditing methods does not. In this paper, we have argued that the tight coupling between SEA methods and SEA tools presents a problem to practitioners and that a tool that decouples method from tool is needed. This paper laid down some theoretical foundations for such a tool as it contributed a conceptual meta model of SEA methods. Based on this theoretical contribution, we designed and created openSEA, a prototype tool that implements the conceptual meta model and, as such, supports any SEA method that can be described using the conceptual meta model. The results from our evaluation, demonstrating the feasibility and relevance of this work and answering the research questions posed in section 2, show that:

- 12 out 13 (92%) analysed tools are bound to a single method, and there are no reasons to believe the tools that the authors were unable to access are any different, thus solidifying the authors' suspicion of the scale of the problem;
- The conceptual meta model identifies the correct concepts within SEA methods and can be used to describe at least five SEA methods but is unable describe at least one SEA method because of a gamification element that was not present in any of the methods the conceptual meta model was derived from;

- openSEA supports any method that can be described using the conceptual meta model, meaning it supports at least five SEA methods. It fully supports three out of the six situations for SEA method use (figure 11), has partial support for two, and has no support for one.

Threats to Validity. *Internal validity* threats focus on how a study is conducted. Within this study, selection bias is a threat that we acknowledge. We feel it is important to stress that both validation cases were selected based on convenience as we were familiar with the organisations, but not on likeliness to have a positive attitude towards the conceptual meta model or the tool. Additionally, because of the opportunity-driven and agile nature of the project, the authors operate under the assumption that organisations are actually wanting to use more than one method. We can reasonly assume that the tight coupling of SEA method and tools poses a problem, but the question remains whether practitioners experience this as such. *External validity* threats reduce the generalisability of the results. The conceptual meta model is based on three methods and was applied for two others, arguably supporting five methods. While testing more methods makes for a stronger case, we feel this study has sufficiently mitigated this threat to a point where the results are generalisable to a satisfactory level. *Construct validity* threats influence the degree to which a study measures what it expected to measure. Within this study, we identify and acknowledge two threats. Firstly, we have made claims about supporting SEA methods, but no research has been done on what it means to support an SEA method. We cover measuring and reporting, which we feel are the most important aspects, but there may be more. Lastly, a combination of experimenter expectency and hypothesis guessing is present within the validation interviews. The goal was to find evidence that supports our claim that openSEA supports multiple methods, and the interviewees were well aware of this, even though they were never told explicitly.

Further research. This paper paves the way for future work. Within the ecosystem of envisioned tools (figure 3) there are many more additions to be made, including to openSEA itself. We intend to implement functionality allowing users to compare organisations within networks and run benchmarks. Research may be done on how to implement model management within openSEA, which wil allow it to not only support two more of the six situations from figure 2, but also versioning of models and improved verification of models by detecting incorrect references. Finally, additional studies may point out the validity of our assumptions. For example, research may be done to investigate whether organisations are actually wanting to use more than one SEA method.

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Appendices

A Existing SEA Tool Analysis Results

A.1 General information

General information about the tool was gathered. We provide a brief description and the name and mission, vision and/or goal of the organisation behind the tool.

Name	Description	Organisation	Mission / Vision / Goal
Rapport	Rapport helps you measure, track, and reduce your business's environmental impact.	Rapport	Our mission: Democratize sustainability. Our approach: Intuitive tools, engaging data, and transparency.
Measurabl	Measurabl gives companies the ability to automatically collect utility data, report on sustainability performance, and identify energy and water efficiency opportunities while simplifying reports to global sustainability benchmarks like GRESB and CDP.	Measurabl	Our mission is to make it possible for any organization to understand, act and report upon sustainability despite its size, resources or expertise.
The EAT	Paper auditing method based on 10 principles.	Dementia Training Australia	Mission: To improve the care and wellbeing of people living with dementia, and the wellbeing of staff delivering their care, by providing or brokering nationally consistent, high-quality knowledge translation services to aged and health care staff, managers and other professionals. Vision: All people living with dementia, regardless of care setting and location, receive high-quality, evidence-based care that enhances their health and wellbeing.

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Name	Description	Organisation	Mission / Vision / Goal
ToSIA	ToSIA analyses environmental, economic, and social impacts of changes in forestry-wood production chains, using a consistent and harmonised framework from the forest to the end-of-life of final products.	Eforwood Project	Website hacked
LM3	LM3 enables people to identify where changes need to be made to improve local economic impact and benefit to communities.	Impact Measurement Ltd.	Unlisted
PLUREL iIAT	Integrated Impact Analysis Tool for assessing impacts of urbanisation in Europe on the sustainability regions.	PLUREL	Unlisted
POSDAT	POSDAT captures the presence or absence of the features listed in measured within five domains: activity spaces, environmental quality, dog information, amenities, safety.	University of Western Australia	Unlisted
EHE EAT	Set of tools of which the one we've looked at determines whether a care home is dementia friendly.	The King's Fund	Our vision is that the best possible health and care is available to all
B Impact Assessment	Tool to measure an organisation's social and environmental impact.	B Lab	Our vision is that one day all companies compete not only to be the best in the world, but the Best for the World® and as a result society will enjoy a more shared and durable prosperity.
Green IT	Green IT Global is a not-for-profit coalition of Green IT focused organisations forming a collaborative ecosystem, and this is their accompanying tool.	Green IT	Detailed manifesto, however the gist is that the organisation's goal is to reduce CO2 emission.
REAS Social Audit	The Social Audit methodology of the Alternative and Solidarity Economy Network of the Basque Country (REAS Euskadi) aims to serve as a characterization tool for Solidarity Economy organizations, measure their social impact according to their objectives and the means used to achieve them and serve as a learning process that can be integrated into the normal planning cycle , monitoring and evaluation of our entities.	REAS	REAS Euskadi aims to achieve the greatest possible strengthening and recognition of the solidarity economy of the Basque Autonomous Community, fostering the promotion of experiences and instruments that generate transformative alternatives in the economic sphere.

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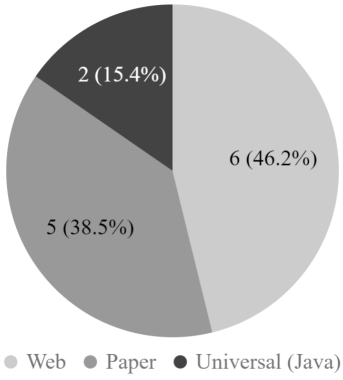
Name	Description	Organisation	Mission / Vision / Goal
Common Good Balance Sheet	The contribution to the common good is assessed and scored through the Common Good Matrix. It allows a systematic examination of all activities from a 360 degree perspective and really focuses on the essentials.	The Economy for the Common Good	The Economy for the Common Good describes an economic system that is built on values that promote the common good. It is a transformational lever, economically, politically and socially.
PSAT	The Sustainability Framework and Assessment Tool was developed at the Center for Public Health Systems Science (CPHSS), a public health research center at the George Warren Brown School of Social Work at Washington University in St. Louis.	Center for Public Health Systems Science (CPHSS)	Our mission at the Center for Public Health Systems Science is to create sustainable solutions to public health problems. We achieve this by connecting research and evaluation. The Center's vision is to shape public health systems and policies, leading to healthier individuals and communities.

A.2 Platforms



Name	Platform
Rapport	Web
Measurabl	Web
The EAT	Paper
ToSIA	Universal (Java)
LM3	Web
PLUREL iIAT	Universal (Java)
POSDAT	Paper
EHE EAT	Paper

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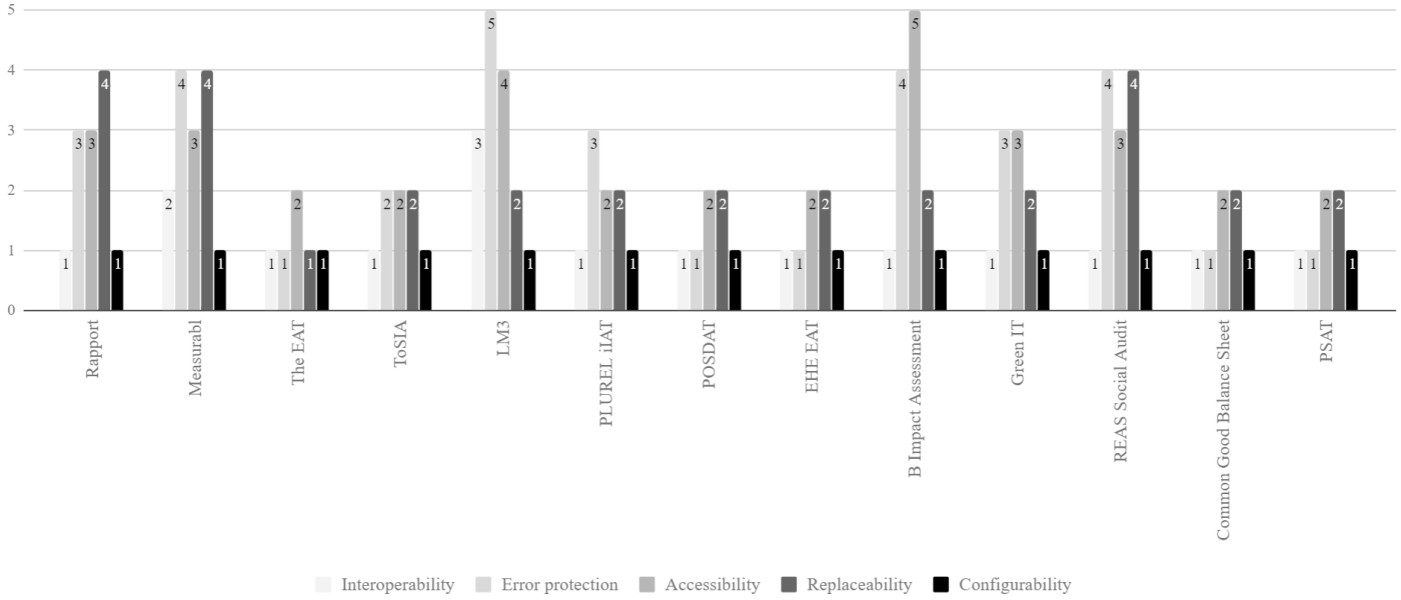

Name	Platform
B Impact Assessment	Web
Green IT	Web
REAS Social Audit	Web
Common Good Balance Sheet	Paper
PSAT	Paper

A.3 ISO/IEC Quality Criteria

The tools were scored ranging from 1 to 5 on a number of ISO/IEC quality criteria.

B Conceptual Meta Model for Measurabl

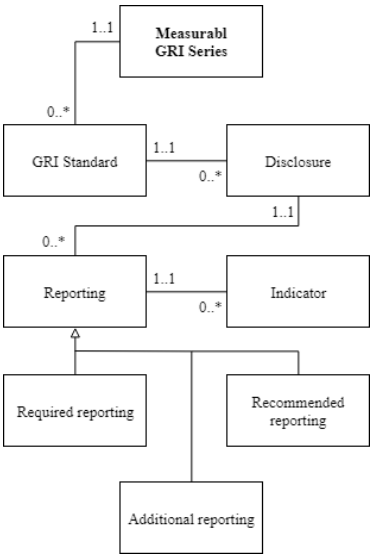

Figure 12: Conceptual meta model for Measurabl

C Conceptual Meta Model for REAS Social Audit

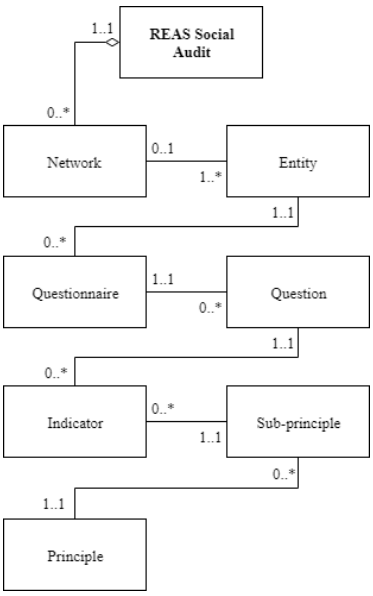

Figure 13: Conceptual meta model for REAS Social Audit

D Conceptual Meta Model for Common Good Balance Sheet

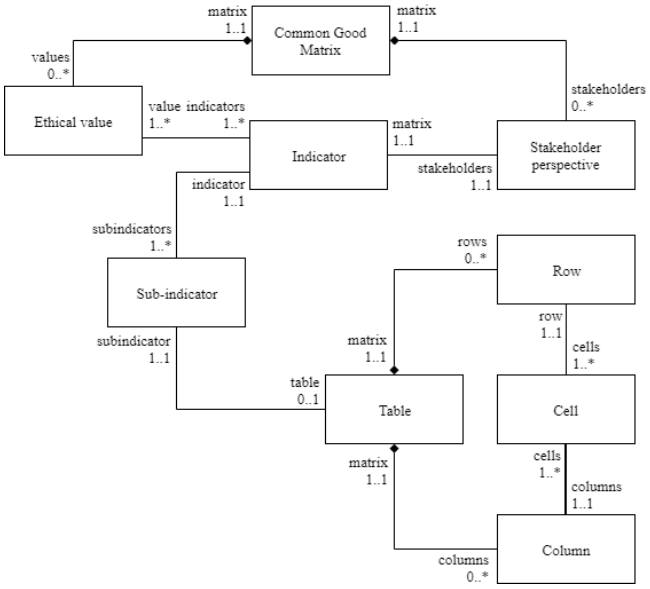

Figure 14: Conceptual meta model for the Common Good Balance Sheet

E UML Class Diagram for openSEA

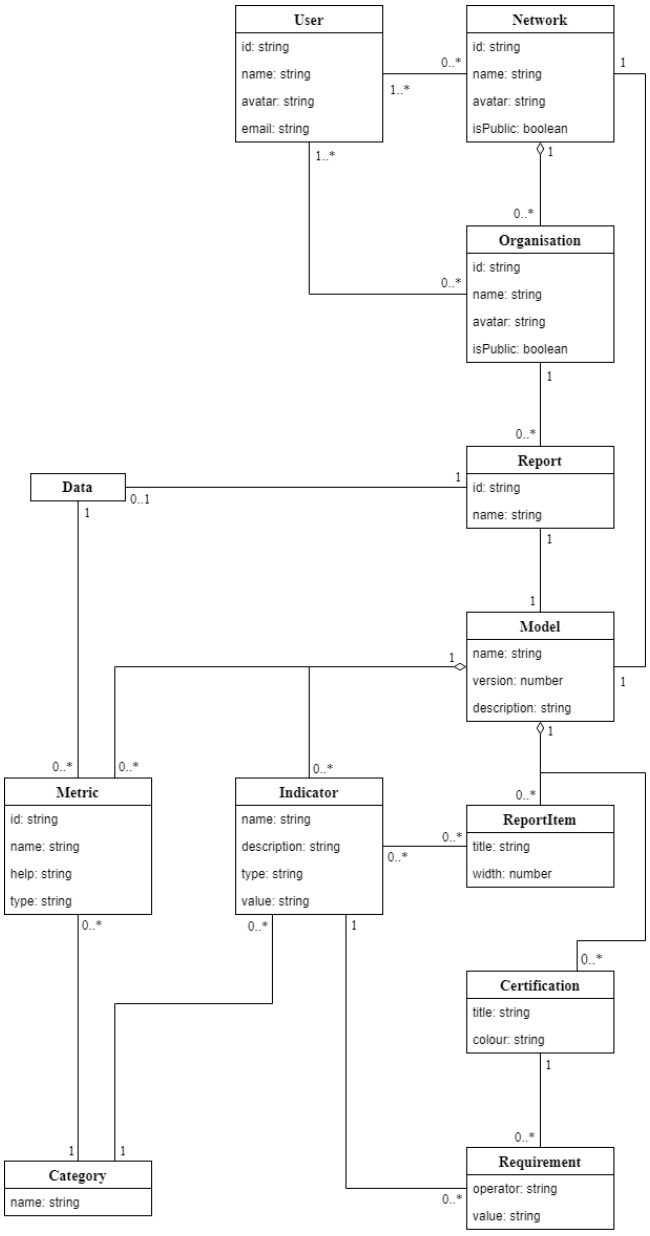

Figure 15: Conceptual meta model for openSEA

F Sample openSEA Configuration File

```
name: Example
version: 1
metrics:
  empl_total:
    help: >
      Input the total number of employees
      that you have at time of assessment.
    name: Employees
    type: number
  empl_left:
    help: >
      Input the amount of employees that
      left the organisation throughout the
      year.
    name: Employees left
    type: number
  empl_lyear:
    help: >
      Input the total number of employees
      that you had a year ago.
    name: Employees begin of year
    type: number
indicators:
  labour_turnover:
    description: >
      Rate at which employees leave the
      organisation
    name: Labour turnover
    type: percentage
    value: empl_left / ((empl_total + empl_lyear) / 2) * 100
reportItems:
  - name: Labour turnover rate in percentage
    value: labour_turnover
```

Figure 16: Example YAML configuration file.

G openSEA Customer Journey

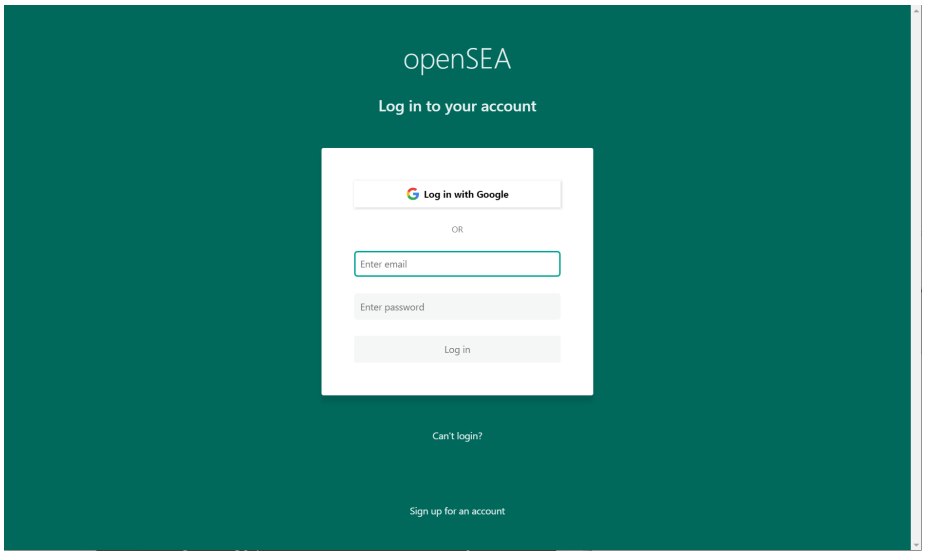

Figure 17: Logging in.

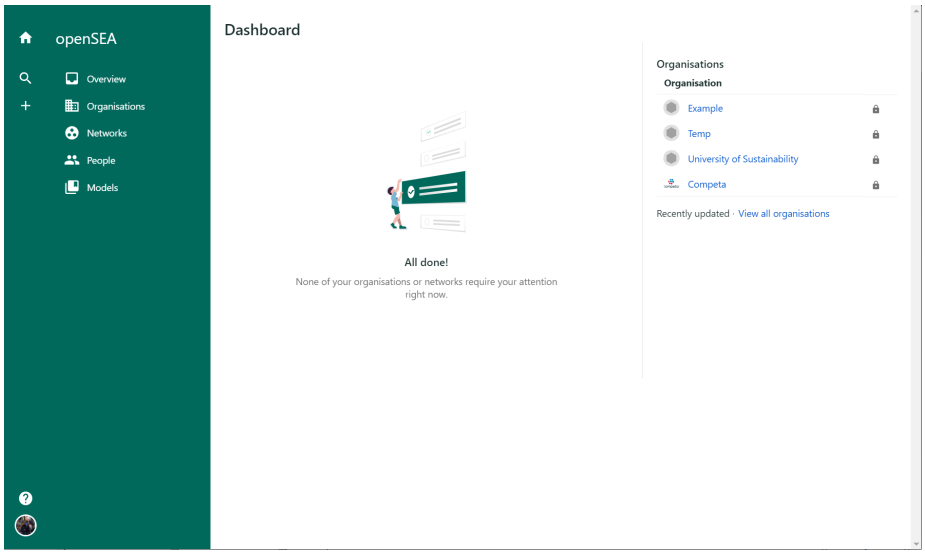

Figure 18: The user's dashboard.

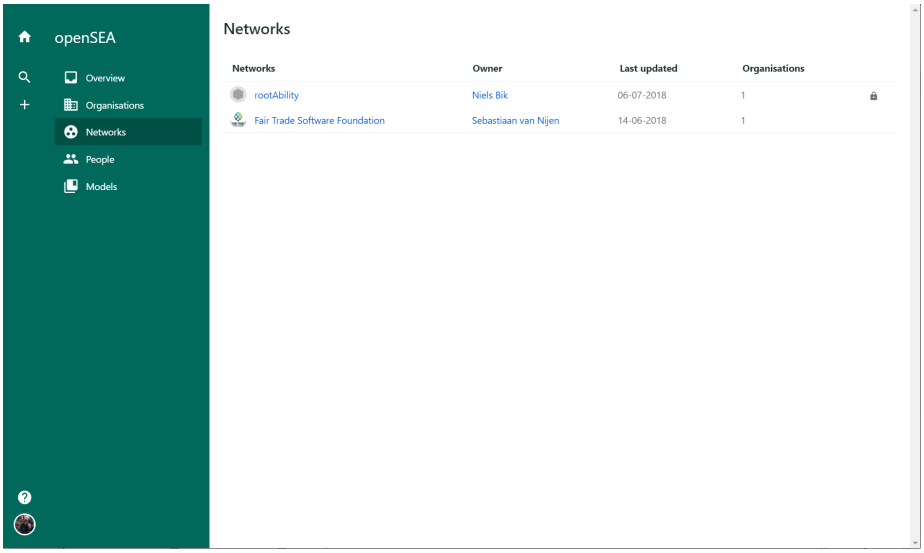

Figure 19: All networks that the user has access to.

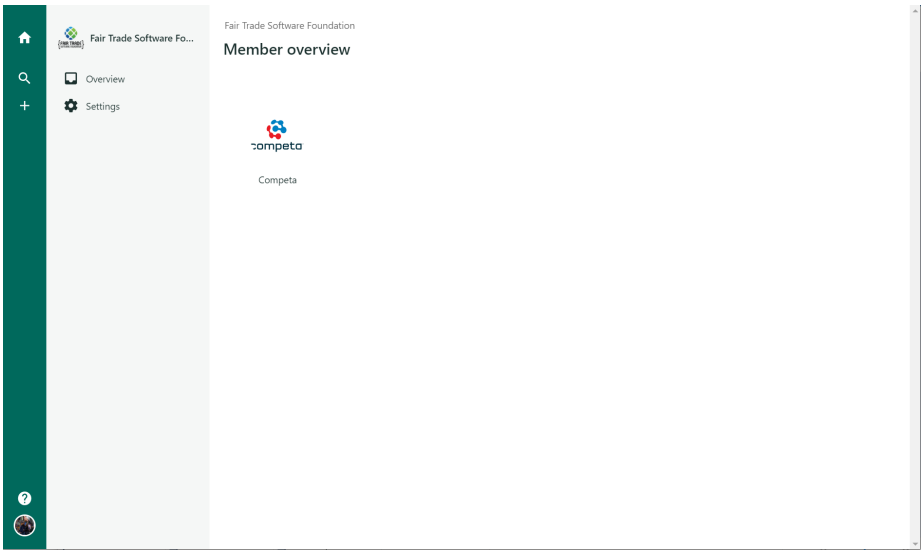

Figure 20: The network's dashboard.

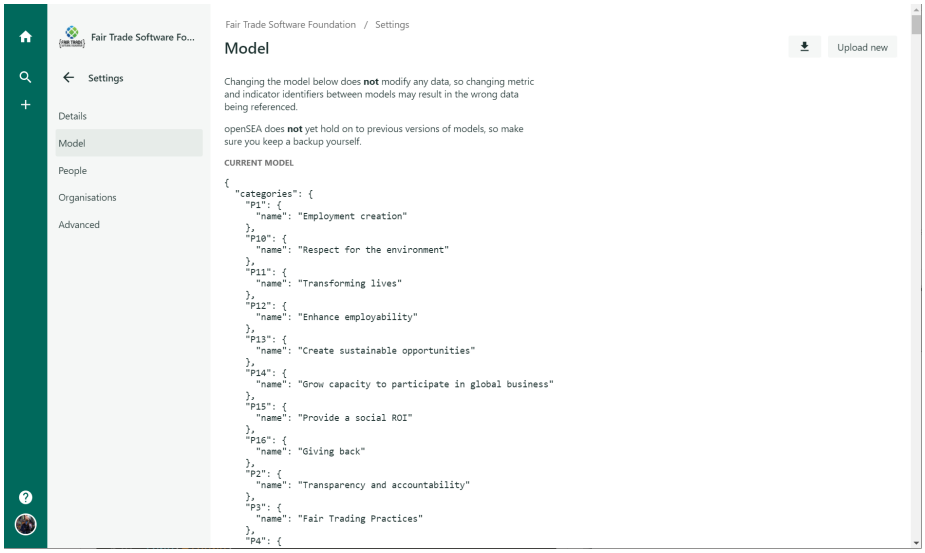

Figure 21: The model as prescribed by the network.

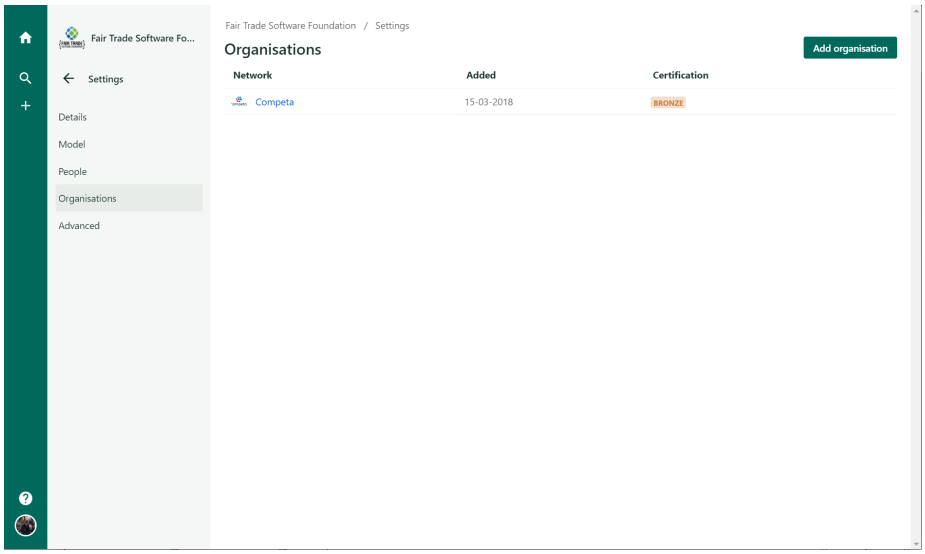

Figure 22: An overview of the organisations in the network, currently just one.

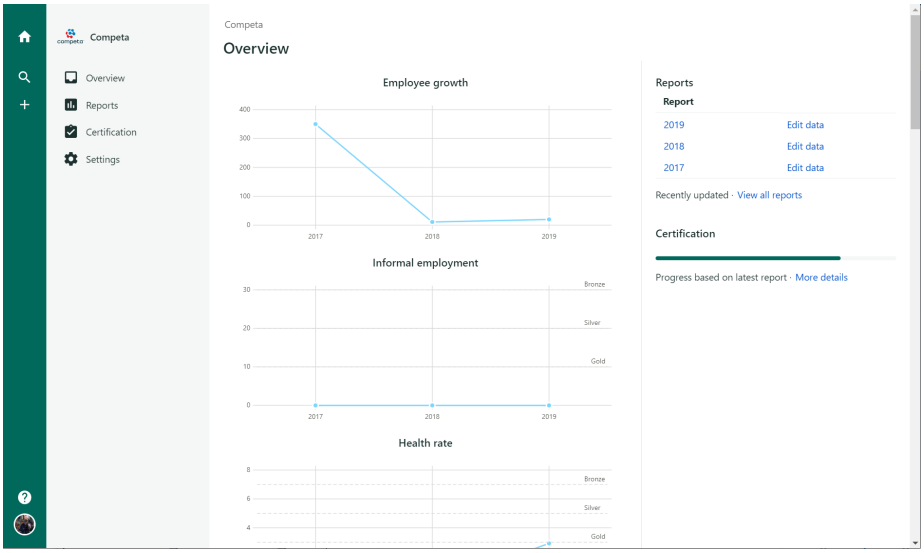

Figure 23: The organisation's dashboard.

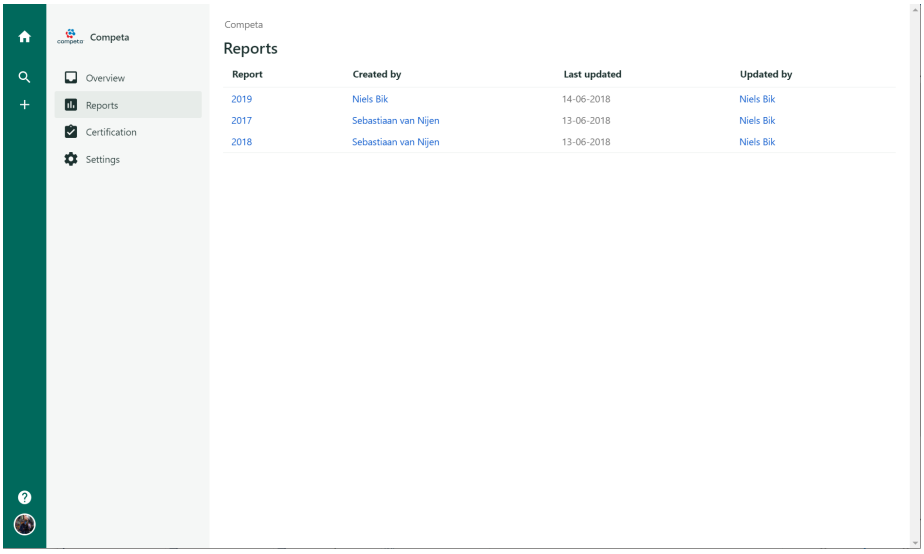

Figure 24: All of the organisation's reports.

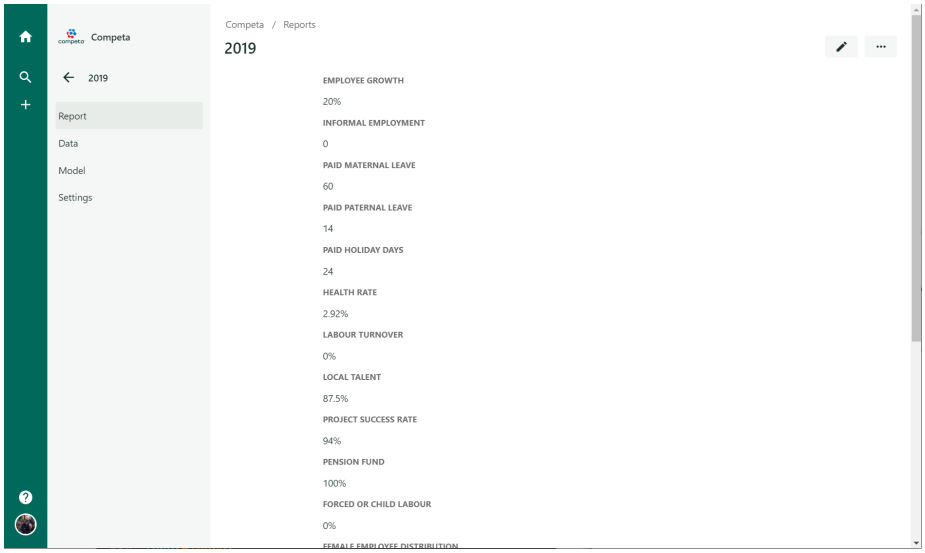

Figure 25: The report's overview. This is where the `ReportItem` elements are displayed.

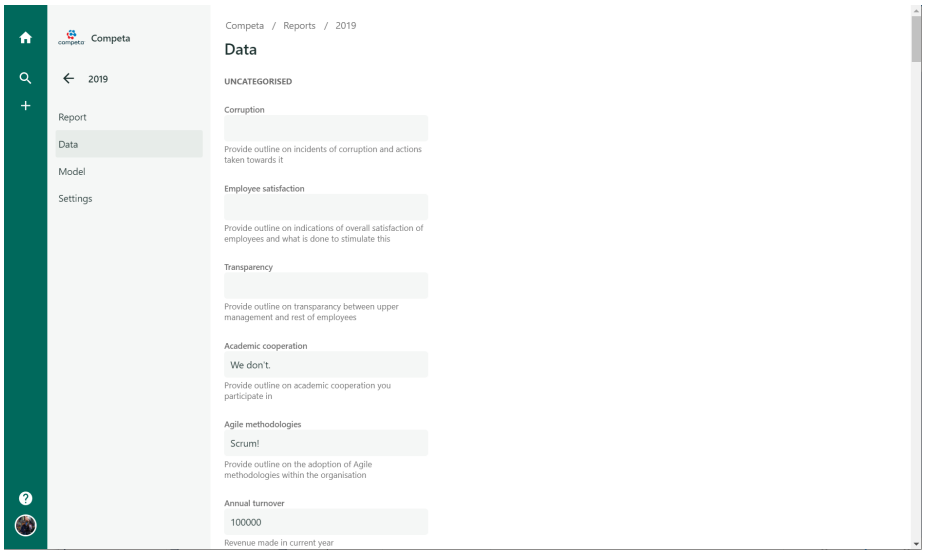

Figure 26: The report's data page. Here, the user adds data for the `Metric` elements in the model.