A Framework for Evaluating Knowledge Sharing Behavior Enabled by Good Practice Repositories: An Application to openBest

A thesis presented for the MSc. Business Informatics

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Abstract

[BACKGROUND] The traditional way of running a company is outdated. Businesses realize that they must take steps to become more responsible. This involves identifying topics of interest, assessing performance on these topics, planning improvement where necessary, and implementing these improvements. This project focuses on planning improvement steps. Here, organizations determine and plan the actions required to improve performance on ethical, social, and environmental (ESE) topics. The challenge in this phase is to close the gap between high-level goals and concrete actions. The treatment of (interorganizational) knowledge sharing using good practices in good practice repositories is suggested to address this challenge. By sharing good practices, organizations can reuse the knowledge and experience of other organizations to determine steps to become more sustainable. Research reported in the scientific literature has often focused on describing good practice repositories and other knowledge-sharing tools, claiming their expected impact on the knowledge-sharing behavior of the stakeholders. However, evaluating such behavior and validating the knowledge-sharing impact of good practice repositories remains challenging. [OBJECTIVE] This research aims to provide a framework to assess the knowledge-sharing behavior enabled by good practice repositories. [METHODOLOGY] We design a knowledge-sharing behavior measurement framework to evaluate knowledge-sharing enabled by a good practice repository (GPR). The framework is implemented in an existing model-driven good practice repository proof of concept called openBest. The implemented measurement framework is applied in a laboratory setting using students as surrogate end users. During this empirical test, we collect knowledge-sharing behavior data by monitoring the activity in openBest and collect measured KS activity using the implemented knowledge-sharing behavior measurement framework. These are compared to assess the quality of the measurement framework. We then analyze the measured KS data and investigate how it allows the assessment of knowledge-sharing behavior. Moreover, we investigated the extent to which knowledge-sharing behavior occurs in openBest during the empirical test using measured and monitored activity data. [RESULTS] The measured knowledge sharing behavior reflects the monitored knowledge-sharing behavior that we could observe. Furthermore, the measured data are of high quality since no (unexplainable) inconsistencies were observed between the monitored and measured activity data. Additionally, the measured data did not show (unexplainable) flaws in completeness and order. Furthermore, the measured data are suitable for frequency and time analyses involving activities related to KS. It is not suitable for qualitative analysis and, for this, manually monitored data can be used. KS activity measured during the test is mostly limited to the execution of tasks, as only limited additional activities related to KS were observed. [CONCLUSION] The measurement framework we propose allows for assessing quantitative knowledge-sharing behavior enabled by a GPR because the framework captures accurate KS behavior data in a suitable format for quantitative analysis. For qualitative data analysis, the framework is not suitable and, for this, self-reporting or monitored data can be used. The implemented measurement instruments seem suitable for the intended analysis but could be expanded in the future by including more fine-grained activities. The KS activity recorded during the empirical test was mostly limited to the performance of the tasks, but overall there was a some more observed action than expected.

Keywords: *Good practices, Good practice repositories, Improvement planning, knowledge sharing, Measuring knowledge sharing behavior, openBest, Sustainability*

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List of concepts and acronyms

Abbreviation	Concept
ESE	Ethical, Social and Environmental
ESEA	Ethical, Social and Environmental Accounting
GP	Good Practice
GPR	Good Practice Repository (in this report, it refers to generic GPRs)
CSR	Corporate Social Responsibility
IOKSS	Interorganizational knowledge sharing system
IP4ESET	Improvement planning for Ethical, Social, and Environmental topics (the third phase of the SBEIC cycle wherein organizations determine and plan the required actions for improving their performance on ESE topics).
IR	Improvement Repository (a theoretical running example of a minimal GPR)
KM	Knowledge management
KMS	Knowledge management system
KS	Knowledge sharing
MDA	Model-driven architecture
MDD	Model-driven development
MDE	Model-driven engineering
openBest	Open-source good practice repository that is developed at Utrecht University.
openBest v1.0	The version of openBest prior to this project.
openBest v2.0	The more mature version of openBest developed during this project.
SBEIC	Sustainability and Business Ethics Improvement Cycle

1 | Introduction

1.1 Motivation

The traditional way of running a company is outdated. Profit, above all, as a business model, is being scrutinized increasingly, and businesses realize that they must take measures to become more responsible (Coenen, 2020; Jilani, 2020). The process of becoming an increasingly responsible organization often involves a continuous improvement cycle that results in organizational re-engineering (Adèr, 2020; Plomp, 2020b). Adèr (2020) proposes the Sustainability and Business Ethics Continuous Improvement Cycle (SBECIC) to structure this improvement cycle by describing four distinct phases. The SBEIC phases are illustrated in Figure 1. The output of the phases enables consecutively: determining goals for ethical improvement, assessing the current ethical performance of an organization, planning for improvement, and following up on the corrective actions.

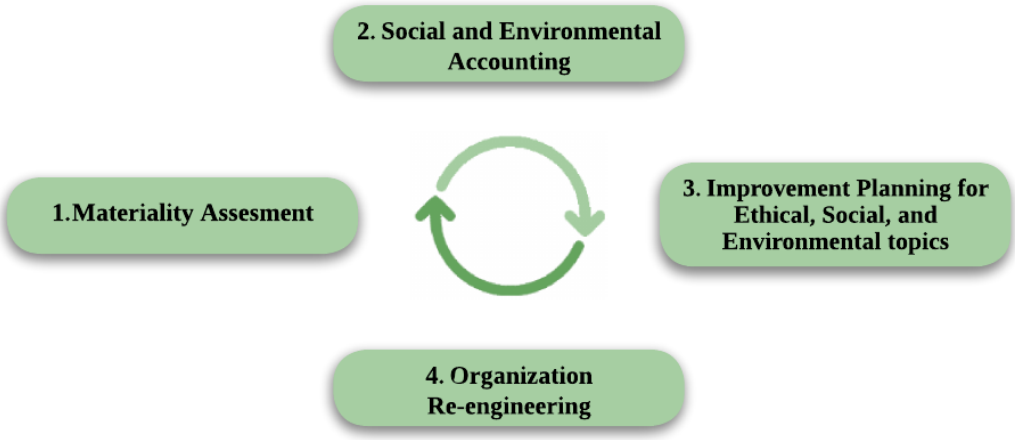


Figure 1: The Sustainability and Business Ethics Improvement Cycle (SBEIC)

This project focuses on the Improvement Planning for Ethical, Social, and Environmental Topics (IP4ESET) phase. In the IP4ESET phase, organizations determine and plan the actions required to improve their performance on ethical, social, and environmental topics. The main challenge in this phase involves closing the gap between high-level goals and concrete actions (Adèr, 2020). This means that while organizations know **what** aspects they want to improve, they are unaware of **how** these improvements can be achieved (Adèr, 2020; Plomp, 2020b). To address this challenge, the treatment of interorganizational knowledge sharing using good practices is suggested (Coenen, 2020; España and Brinkkemper, 2016; Plomp, 2020b). These good practices describe the steps to take to achieve the improvement goals. The idea behind this is that by sharing good practices, organizations can reuse the knowledge and experience of other organizations to determine steps to improve their performance on ESE topics and become more sustainable. The challenge observed in this approach is the limited infrastructure available for sharing these good practices. Furthermore, existing tools are closed and only contain good practices from single organizations, making them unreachable and unusable for organizations in other domains (Al-Ashaab et al., 2013; Plomp, 2020b). This reduces the knowledge sharing

capabilities of these tools (Plomp, 2020b). Due to this, there is initially a knowledge gap that can be described as: 'The need for infrastructure to increase the sharing of knowledge of good practices containing improvement steps on ESE topics within networks of responsible organizations.'

Knowledge sharing using good practices has been explored in previous master's and bachelor's projects and research at Utrecht University. The result of these efforts is an open-source model-driven Good Practice Repository (GPR) that stores Good Practices (GP) containing action steps successfully taken by other organizations (Coenen, 2020; Jacobs, 2021; van der Pijl, 2020; Plomp, 2020a, 2020b). This proof of concept is called openBest. openBest as a treatment to enhance knowledge sharing is currently not validated in the field. The main reason is that openBest is not validation ready. This is because it lacks instruments to evaluate the behavior of knowledge sharing it facilitates. Moreover, openBest is not mature enough in terms of functionalities to be validated. This lack of knowledge-sharing behavior evaluation instruments for assessing KS enabled by a GPR forms the main challenge in this project. While some good practice repositories on ESE topics are constructed, their effects on enabled knowledge sharing have often not been scientifically investigated. Evidence of this can be found in the lack of results when searching for concepts such as 'good practice repository effects', 'measurement of good practice repository enabled knowledge sharing' and variations of these queries in scientific search engines such as Google Scholar. Moreover, knowledge management literature highlights the need for quantitative action research on knowledge management tools (like GPRs) to explore further the practical aspects of knowledge management applied in sustainability (Martins et al., 2019). Next to this, in Plomp (2020b), we see that expert opinion supports the theoretical usefulness of a GPR on sustainability topics. However, the effects the GPR has on KS on sustainability topics have not been assessed. This means that an effort should be made to provide a framework for assessing the knowledge sharing behavior enabled by a good practice repository. Consequently, the knowledge gap can be phrased as: '*The need for a framework to evaluate the knowledge sharing behavior enabled by a good practice repository*.' In this project, we take on this challenge by designing a framework for evaluating GPR-enabled knowledge sharing. We implement this into openBest to prepare it for future validation activities. For this, we make openBest more mature by designing and implementing additional features based on previous projects that laid the basis for openBest. This is because we think the current version of openBest may not be usable by organizations in action research settings because it has only minimal functionality (Plomp, 2020b).

1.2 Problems observed

While there has been an effort to address the challenges associated with a lack of infrastructure for sharing good practices on ESE topics with a model-driven good practice repository as a treatment, this treatment has not been validated in the field. As said before, the main reason is that it is not validation ready. This is because the good practice repository does not feature any measurement instruments that could be used to scientifically assess its effects on knowledge sharing behavior. Moreover, research reported in the scientific literature has often focused on describing good-practice repositories and other knowledge-sharing tools, claiming their expected impact on the knowledge-sharing behavior of stakeholders. However, evaluating this behavior and validating the impact of good practice repositories on knowledge sharing remains challenging.

1.3 Research goal

The main goal of this research is to provide a framework for assessing knowledge sharing behavior enabled by good practice repositories.

1.4 Research questions

To achieve this goal in a structured and rational way, we formulate the following research questions. Each of the three questions refers to one stage of the design cycle (Wieringa, 2014). We explain the intended approach behind each question.

RQ1: What are relevant factors that influence interorganizational knowledge sharing among the members of a network of responsible organizations?

First, we must investigate what factors influence the knowledge-sharing process. This is required for us to know what factors are at play in the process of (inter) organizational knowledge sharing. We can use this information to construct a framework of situational factors to characterize knowledge-sharing settings. In addition to this, the findings provide a contextual framework that can be used to embed other findings.

RQ2: How can knowledge sharing behavior enabled by a good practice repository be assessed?

We intend to investigate how knowledge-sharing behavior can be evaluated in the context of interorganizational knowledge sharing enabled by knowledge-sharing tools like good practice repositories. Next, we make a theoretical contribution by proposing an evaluation framework. Then, we will prove the concept of the framework by implementing it in a concrete case. in particular, we will implement the knowledge-sharing behavior evaluation framework in openBest.

RQ3: To what extent does the implemented knowledge sharing behavior evaluation framework allow for assessing knowledge sharing behavior enabled by a good practice repository?

We plan to validate the proof of concept, that is, to investigate the extent to which the evaluation framework implemented in openBest allows assessing the knowledge-sharing behavior of its users.

1.5 Contributions

This project develops a theoretical framework for measuring observable knowledge-sharing behavior in a good practice repository. Next, we implement the theoretical instrument into a good-practice repository and perform an empirical test in a laboratory environment. Moreover, we further mature a good practice repository proof of concept by implementing features to make it a more realistic functioning proof of concept. The resulting effort is that the model-driven good-practice repository is further matured and made validation ready. This means that the contributions of this project are as follows:

Scientific

- Design of a theoretical knowledge sharing behavior framework for assessing knowledge sharing behavior in a good practice repository.
- Empirical test efforts for the knowledge-sharing behavior evaluation framework.

Engineering

- Implementation of the knowledge sharing behavior framework into a model-driven good practice repository.
- A more mature and validation-ready model-driven good-practice repository proof of concept.

1.6 Thesis outline

The remainder of this thesis is structured as follows. In Chapter two, we present an overview of the research method. Here, we justify and structure the research. Chapter three provides some background knowledge to illustrate the concepts used in the rest of the thesis. In chapter four, we present our findings of the problem investigation. Herein are the findings of the structured literature review on knowledge sharing and the construction of a situational factor profile framework. In chapter five, we investigate and design the knowledge-sharing behavior evaluation framework. Chapter six describes the implementation of the knowledge-sharing behavior evaluation framework into openBest. Chapter seven discusses the application of the knowledge-sharing behavior evaluation framework embedded in openBest in a laboratory setting. Chapter eight discusses what we have learned from openBest through these efforts. In chapter nine, we discuss the results related to the *kn*owledge-sharing behavior evaluation framework, and finally, in chapter ten, we draw conclusions based on the interpreted results.

2 | Research method overview

In this section, we elaborate on the research method. This project is structured following the Design Science principles defined by Wieringa (2014). This is reflected in the research method design consisting of the phases: Problem investigation, treatment design, and treatment validation. In Figure 2, the research method is schematically displayed in a process deliverable diagram constructed following the PDD method by van de Weerd & Brinkkemper (2009).

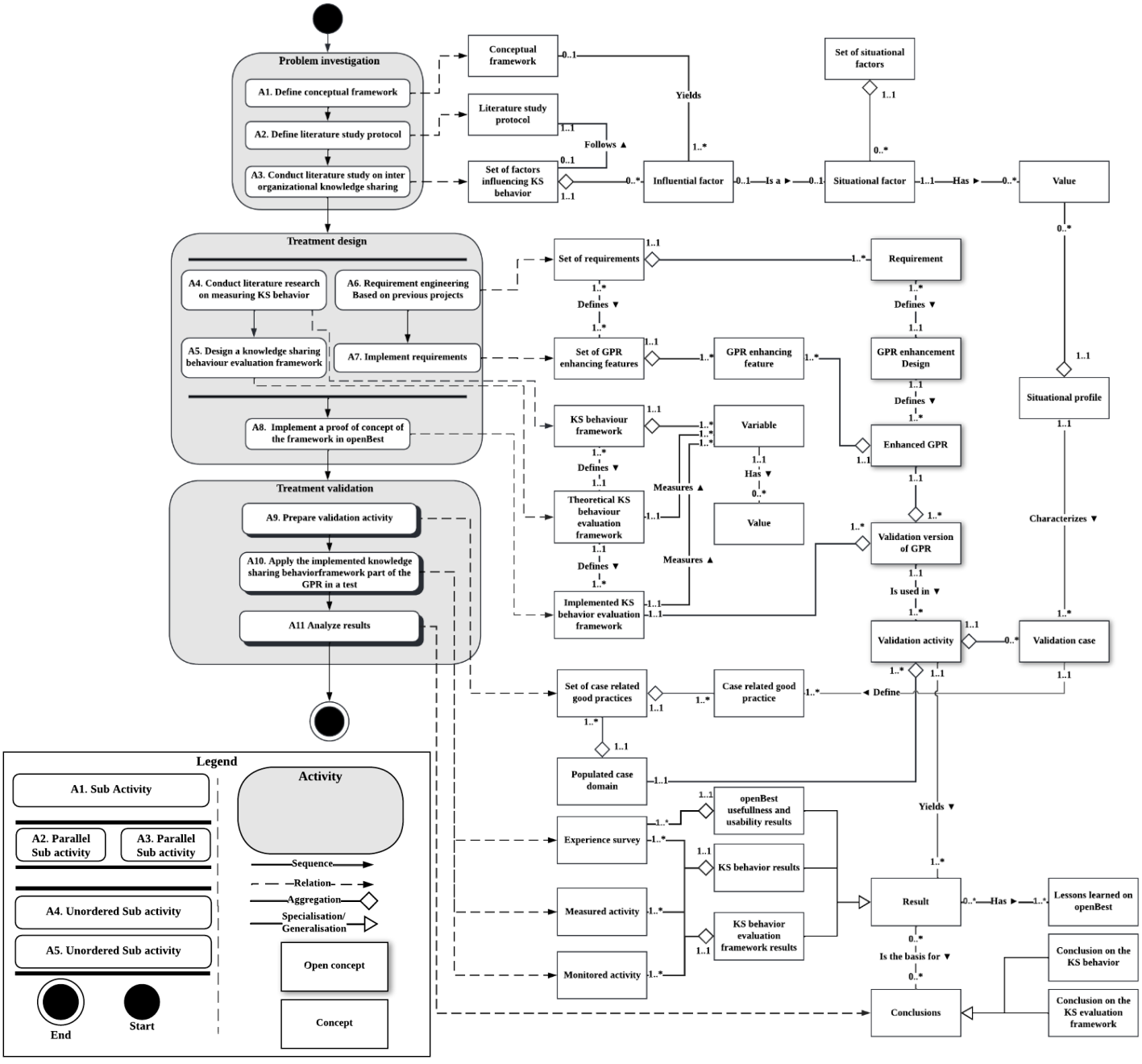


Figure 2: Research method PDD

2.1 Problem investigation

The problem investigation phase aims to get a clear picture of the research domain's current state. The first step in the problem investigation phase is to define a conceptual framework (A1) that can frame the research problem. The conceptual framework is constructed following an informal method involving (grey) literature produced by related Utrecht University projects and serendipitous findings. This conceptual framework constitutes the background knowledge of this project. Next, we conduct a literature study in which we investigate RQ1. Following the Definition of a Literature Review Protocol (A2), we conduct a systematic literature review (SLR) on factors that influence knowledge sharing within networks of responsible organizations (A3). This systematic review of the literature involves investigating the nature of knowledge and knowledge sharing and the factors that could influence them in an interorganizational setting. The activities of the SLR provide the foundation for further research phases. Moreover, the influence factors are used to formulate situational factors that characterize KS cases. These situational factors are combined in a situational profile used to characterize the KS aspects of use cases of openBest. The product of the problem investigation phase consists of a conceptual framework that provides insight into the context of the project and situational profiles. Together, this forms the basis for the subsequent research phases.

2.2 Treatment design

In the treatment design phase, RQ2 is investigated. For this, we consult the literature on knowledge-sharing behavior (A4). We then develop a theoretical framework for evaluating knowledge sharing behavior that contains variables and their possible values for evaluating knowledge sharing behavior in a GPR (A5). Using this theoretical knowledge-sharing behavior framework, we design theoretical procedures for collecting, retrieving, processing, and analyzing knowledge-sharing behavior data. At the same time, we continue to develop an existing model-driven good-practice repository proof-of-concept. For this, we formulate a set of requirements to improve the good practice repository by looking at previous projects (A6). These requirements are then implemented (A7) to improve the proof of concept. When the good practice repository has reached a more mature state, we implement a proof-of-concept of the knowledge-sharing behavior evaluation framework in the good practice repository (A8).

2.3 Treatment validation

In the treatment validation phase, efforts are made to answer RQ3. For this, we prepare a validation activity (A9) as an empirical test. This involves tailoring openBest to be usable by the validation case audience by collecting good practices and populating a domain with these practices. This domain is tailored to the audience by formulating a fitting domain model. The empirical test is then executed (A10). During this test, the activities enabled by openBest and associated with KS processes are measured using the implemented knowledge sharing behavior framework. Moreover, data is collected by manually monitoring the participant's progress through the tasks in the domain. This yields measured and observed activity data. After the interactions with openBest, users complete a questionnaire in which they report their experiences

reflecting on their interactions with openBest. This yields experience survey data. These collected data comprise the KS data results, i.e., how much KS is observed in the openBest and KS behavior evaluation framework results, i.e., how well does the knowledge-sharing behavior evaluation framework function. These data are then analyzed (A11) to establish to what extent the implemented framework allows one to assess the knowledge sharing behavior enabled by a good practice repository effectively addressing RQ3. Next, we also get an impression of the KS behavior enabled by openBest. In addition, using the experience survey, we also get an impression of openBest usability and usefulness as perceived by the participants. Moreover, as part of efforts to get organizations to participate in the test, we had several discussions from which we also got an impression of their opinion on openBest. The latter two combined yield lessons we learned about openBest during this project.

Note that here the treatment validation phase is modeled using three closed activities. These are more elaborately illustrated and discussed in Figure 41 in Chapter 7.

2.4 Overview of literature review methods

In the method, there are some applications of the literature review. The purpose and methods of these literature review activities are illustrated in Table 1.

Table 1: Overview of literature review methods

Element	Purpose	Methods
Background knowledge	Definition of concepts and sketch of the context of the research.	Informal: a multivocal method involving findings from the SLR for RQ1, related projects, and serendipitous findings. This exercise constructs a basic framework for interpreting other results and gives an overview of previous research and the current state of openBest and other GPRs. The reason for the multivocal approach is that established scientific literature may lack the specificity of the GPR topic exhibited in previous work in the project line.
RQ1	Structured literature review to find factors of influence active in the knowledge sharing process. The factors are used to construct organizational profiles containing environmental factors.	Formal SLR is a structured method involving the SLR activities described by Okoli (2015). The SLR method and its application can be found in Appendix A: SLR protocol.
RQ2	Literature review to construct a framework to evaluate knowledge sharing.	Informal: using findings of background knowledge and RQ1 as a starting point for research into measuring knowledge sharing.

3 | Background knowledge

This chapter lays the conceptual basis for the rest of the report and illustrates the background required to understand the rest of the thesis. The background knowledge is constructed using previous projects, serendipitous findings, and literature found while investigating the other research questions.

3.1 Sustainability

Sustainability is an ambiguous term because a definition of sustainability depends on the context in which it is applied. Next, there is some disagreement on the domain and reach of the concept (Coenen, 2020; Kuhlman & Farrington, 2010; Martins et al., 2019). This is worsened by the fact that; sustainability is often discussed without providing a satisfactory definition or any definition. Moreover, the literature rarely mentions if they refer to sustainability as a goal or sustainability as sustainable development (Coenen, 2020). To address this ambiguity for this project, we follow the distinction of UNESCO (2015) between sustainability and sustainable development. Here, sustainability refers to a "Paradigm for thinking about the future in which environmental, societal, and economic considerations are balanced in the pursuit of an improved quality of life," and sustainable development refers to the steps taken to reach that goal (UNESCO, 2015). In this project, sustainable development is a more relevant concept because the evaluation framework we develop is meant for a good practice repository for documenting the steps for becoming more sustainable. As a result, we need a definition of sustainable development. For this, we look at the frequently used definition that is also used in related projects (Coenen, 2020; Kuhlman & Farrington, 2010). This definition is:

Definition 1: Sustainable development

> "Sustainable development is the one that meets the needs of the present without compromising the ability of future generations to their own needs" (United Nations General Assembly, 1987, p43).

A sustainable organization's performance in moving toward sustainable development can be defined as harmonizing its Social, Economic, and Environmental (ESE) performance (Al-Ashaab et al., 2013; Coenen, 2020; Jilani et al., 2021).

3.2 Corporate Social responsibility

Corporate Social Responsibility (CSR) is a concept that is closely related to sustainability. Like sustainability, there is no consensus on a definition of CSR. The contested meaning of CSR can be attributed to national differences and the diverse fields in which CSR is applied (Coenen, 2020; Plomp, 2020b). For this project, a general definition of CSR must be formulated instead of domain-specific because the repository is usable in several domains. For this reason, we use the definition of CSR, as seen in Coenen (2020). The definition is as follows:

Definition 2: Corporate Social Responsibility (CSR)

> CSR is the continuing commitment by businesses to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families and the local community and society at large (Coenen, 2020, p16).

CSR is not a new concept but has only recently progressed from ideology to reality (Latapi et al., 2019). Although only recently becoming a reality, many enterprises already consider it vital to define their societal roles and apply ESE norms to their operations (Lindgreen & Swaen, 2010). The motivation for addressing CSR varies between organizations, some organizations are driven by moral and ethical themes, and others might be interested in CSR for purely economic reasons (Plomp, 2020b).

3.3 Responsible organizations

Responsible organizations pay particular attention to CSR (Plomp, 2020b). Following this characterization of responsible organizations, it would be possible to assume that any company actively engaged in CSR can be called a responsible organization (Coenen, 2020). However, paying attention to CSR might not characterize a responsible organization, as it could be an attempt at greenwashing (Coenen, 2020). For this reason, we choose to uphold the definition of España and Brinkkemper (2016) as it does not mention a relationship between CSR and responsible organizations:

Definition 3: Responsible organizations

> "A **responsible organization** is an organization that performs according to ethical values, taking care of the impact of their activities on society and on the environment, beyond its legal obligations" (España & Brinkkemper, 2016, p3).

3.4 Improvement cycle

Organizations planning to become more responsible can use an iterative approach by going through the phases in the Business Ethics Continuous Improvement Cycle (BECIC). The steps in the cycle are materiality assessment, social and environmental accounting (SEA), improvement planning for ethical, social, and environmental topics (IP4ESET), and organizational reengineering (Adèr, 2020). The phases have the following definitions:

- **Materiality Assessment** - Determine which sustainability and business ethic topics are relevant and important for the organization.
- **Ethical, Social, and Environmental Accounting (ESEA)** - The assessment of the social and environmental effects of an organization's actions is reported.

- **Improvement Planning for Ethical, Social, and Environmental Topics (IP4ESET)** - The strategic management process that determines short- and long-term actions needed to improve an organization's social and environmental performance.
- **Organizational Re-Engineering** - Execute the improvement actions of the IP4ESET phase.

The results of the phases enable: determining goals for ethical improvement, assessing current performance on ESE topics of an organization, planning for improvement, and eventually following up on the planned improvement steps.

As mentioned before, we focus on the IP4ESET phase in this project. In the IP4ESET phase, organizations determine and plan the actions required to improve their performance on ethical, social, and environmental issues. The challenges in this phase involve closing the gap between translating high-level goals into concrete actions (Adèr, 2020) and the lack of mature and validated infrastructure to support these activities (Plomp, 2020b).

3.5 Knowledge

The concept and theory of knowledge, also known as epistemology, have intrigued many scientists and philosophers. All this research has spawned a plethora of definitions of knowledge. It is challenging to accurately define the qualities of knowledge because of these diverse viewpoints and disciplines of study, as claims regarding aspects of knowledge might be different, even contradictory, from these varying viewpoints (Yang & Wu, 2008). A comprehensive review of the various definitions of knowledge is beyond this project's scope. Therefore, we choose to maintain a definition of knowledge that appears commonly in the related recent literature, along with some variations. This definition is:

Definition 4: Knowledge

> Knowledge can be defined as information that has value, it can take the form of a person's experience, value standards, or norms, including documents, technical reports, information, know-how, and standards of professionalism (Sensuse et al., 2021, p2).

3.5.1 Knowledge types

Knowledge can be explicit or tacit. Explicit knowledge, known as 'know-what' knowledge, is structured and can be written down (Ipe, 2003; Razmerita et al., 2016). This type of knowledge can be easily shared and communicated between stakeholders. These stakeholders then possess this knowledge without having to have the same experience (Aljuwaiber, 2016; Wang et al., 2021). Within explicit knowledge, a further split can be made between rationalized and embedded knowledge, where rationalized knowledge is general, context-independent, standardized, and public, and embedded knowledge is context-dependent, narrowly applicable, personalized, and potentially sensitive knowledge. Because rationalized knowledge has been separated from its original source and is independent of individuals, it is often shared. Embedded knowledge is not likely to be easily shared due to the attached context, personal information, or sensitive nature

(Ipe, 2003). Tacit knowledge consists of procedural knowledge and skills that individuals have acquired based on personal experience (Razmerita et al., 2016). Tacit knowledge is knowledge that is not written or structured. Because of this, tacit knowledge is more challenging to share. Tacit knowledge sharing, therefore, requires more time and effort than explicit knowledge sharing (Aljuwaiber; Razmerita et al., 2016). Unlike explicit knowledge, tacit knowledge is more subjective and personal and has more significant economic and innovative values (Wang et al., 2021). The characteristics are summarized in Table 2. The general schematic categorization of knowledge is illustrated in Figure 3.

Table 2: Characteristics of primary knowledge types

Explicit (know-what)	**Tacit (know-how)**
Structured	Semi-structured, unstructured
Can be written down	Cannot be (easily) written down
(Generally) Easily shared	More challenging to share
Objective	Subjective
	More significant economic and innovative values

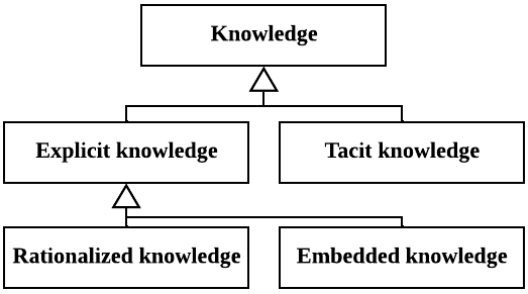


Figure 3: Categories of knowledge

3.5.2 Knowledge value

Knowledge is a critical resource that must be effectively managed for effective organizational performance (Nooshinfard & Nemati-Anaraki, 2014). Consequently, knowledge is essential for organizational success and has been suggested as the primary mechanism for creating economic value (Pang et al., 2020; Sensuse et al., 2021). Because of this, facilitating the creation, sharing, and utilization of knowledge is becoming ever more critical for organizations (Zheng, 2017). As a result, organizations use various methods to support these activities, including knowledge management and knowledge management mechanisms (Sensuse et al., 2021; Zheng, 2017). Central to these efforts is the process of knowledge sharing.

3.5.3 Knowledge sharing

There is a growing realization that knowledge sharing is critical to knowledge creation, organizational learning, and performance achievement (Ipe, 2003; Sensuse et al., 2021). KS can increase work efficiency, company innovation, and facilitate learning processes. This makes KS essential for organizations. As a result, there is much interest in enabling KS. This interest has made KS the subject of many studies, leading to many definitions (Pang et al., 2020). There is much discussion about what KS entails and when knowledge can be regarded as shared. In the knowledge management literature, KS is considered a collection of actions facilitating the

exchange of tacit and explicit knowledge between two or more parties (Razmerita et al., 2016; Wang et al., 2021). KS occurs on various levels, including interpersonal, group, and organizational (Aljuwaiber, 2016). In a more general sense, KS occurs when an individual's knowledge is understood, absorbed, and used by others (Sensuse et al., 2020; Zheng, 2017). As said before, KS is assumed to be a relationship between two or more parties. One party, the owner of knowledge, is to possess and externalize the knowledge, and the other party, the receiver of knowledge, is to receive and reconstruct the knowledge (Zheng, 2017). This process results in knowledge being jointly possessed by the parties engaged in the KS process (Ipe, 2003).

KS is often considered individual behavior that is voluntary, intentional, and proactive (Lee, 2021; Zheng, 2017). However, KS can be controlled by environmental factors (Zheng, 2017). The effectiveness of the sharing activity can be negatively affected by barriers or positively influenced by so-called drivers or motivators. These barriers and drivers are referred to as factors of influence. In the next chapter, we investigate these factors of influence in more detail. In Figure 4, the process of knowledge sharing is schematically illustrated.

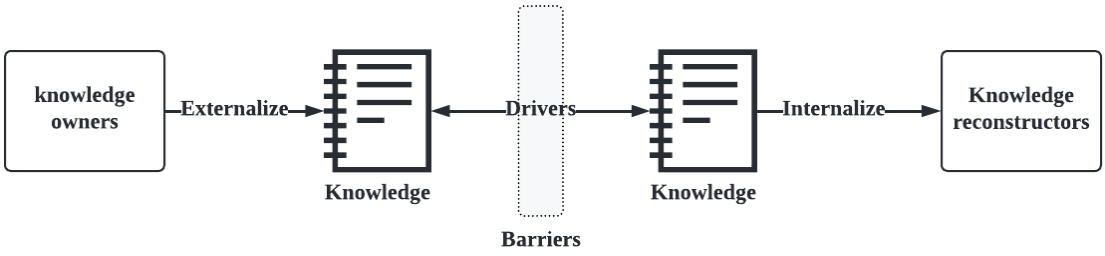


Figure 4: A Simple Model of Knowledge Sharing (adapted from Zheng, 2017, p53)

It should be noted that, in a strict sense, knowledge itself cannot be shared, as it cannot be freely distributed. This is because knowledge cannot exist outside the individual's mind (Usoro et al., 2007). This means that knowledge is required to externalize as the knowledge holder and rebuild as the knowledge receiver (Zheng, 2017).

Knowledge sharing levels

KS is an important social interaction process in organizations and occurs between individuals, groups, organizations, or networks of organizations (Nooshinfard & Nemati-Anaraki, 2014; Ipe, 2003; Razmerita et al., 2016; Soekijad & Andriessen, 2003).

At the individual and group levels, KS involves knowledge donation and collection between individuals and groups (Razmerita et al., 2016). At the organizational level, KS is the process of collecting, organizing, transferring, and supporting organizational knowledge so that knowledge is available to all stakeholders (Razmerita et al., 2016). At the interorganizational level, knowledge is shared between organizations grouped in a (strategic) KS alliance. This means that knowledge owners and knowledge receivers can span organizational boundaries. Organizations in such an alliance can be competitors. This means that there can be a balance between sharing and withholding information and feeding the network less than gaining from the network (Soekijad

& Andriessen, 2003). On the inter-organizational level, KS can help organizations avoid reinventing the wheel for a specific challenge another organization has tackled before. This can reduce redundant work (Nooshinfard & Nemati-Anaraki, 2014).

In this project, we are interested in all these levels of KS. Although a good practice repository can be designed for interorganizational KS, it still requires one or more individuals from the organizations to share and receive knowledge actively. Furthermore, for interorganizational KS to occur, knowledge must first be shared vertically within an organization before horizontal knowledge sharing between organizations occurs (Nooshinfard & Nemati-Anaraki, 2014). As a result, all these levels of KS influence interorganizational KS and are relevant to this project. The relationship between the levels of KS involved in interorganizational KS is illustrated in Figure 5.

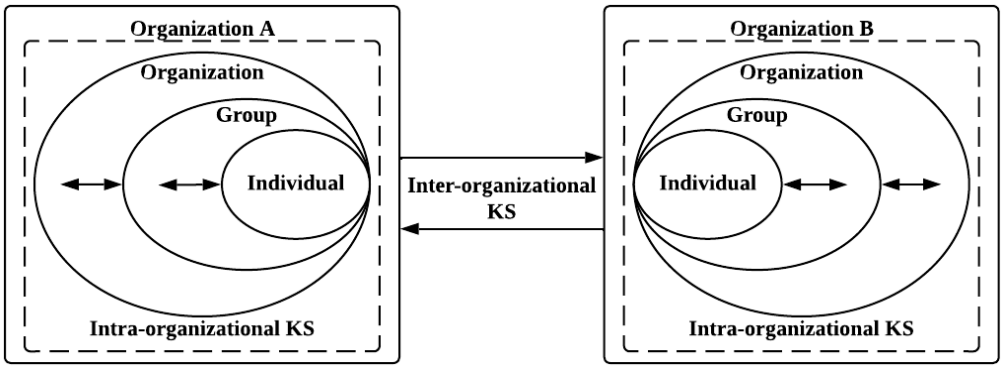


Figure 5: Schematic overview of KS levels involved in interorganizational KS (adapted from Nooshinfard & Nemati-Anaraki, 2014)

Knowledge sharing modality

KS can be conducted in offline and online environments. The difference is how KS communication is mediated (Charband & Navimipour, 2016; Sensuse et al., 2021). Online KS is the type of KS that is computer-mediated. This type is increasing in popularity because of corporate social media and other IT developments. Online KS can involve web-based software that enables individuals to interact and collaborate virtually (Majchrzak et al., 2013; Sensuse et al., 2021). Offline KS does not feature any technologically mediated digital communication. The primary offline KS mechanism is face-to-face communication. Face-to-face discussion provides a rich medium for information exchange. These mechanisms can indirectly reduce differences in status between the parties involved, encouraging interaction by increasing trust, familiarity, and the possibility of collaboration. This, in turn, improves the knowledge-sharing process (Cabrera & Cabrera, 2015; Sensuse et al., 2021). This means that, while technology is beneficial in facilitating information exchange, offline KS also affects the success of KS and the collaboration process. As a result, online KS should not replace face-to-face interactions.

3.5.4 Knowledge management

Definition 5: Knowledge management (KM)

> Knowledge management (KM) can be defined as identifying and using collective knowledge in an organization to gain and maintain a competitive advantage (Aljuwaiber, 2016; Ipe, 2003; Jilani et al., 2020).

KM can help organizations map their knowledge assets, use them, and enable stakeholders to find knowledge (Aljuwaiber, 2016, Zheng, 2020). KM comprises several processes where knowledge sharing is considered the most important (Jilani et al., 2020; Nooshinfard & Nemati-Anaraki, 2014). Knowledge management defines the active mechanisms of knowledge sharing in the organization. This kind of knowledge-sharing mechanism is a structural or organizational tool that promotes knowledge-sharing. This mechanism can use technology, but is not required (Sensuse et al., 2021). An example of a knowledge-sharing mechanism is face-to-face communication. There is no universally best KS mechanism. As a result, organizations tend to use multiple different mechanisms (Sensuse et al., 2021).

The activities related to KM can be tool supported. Such a system is known as a knowledge management system (Zheng, 2017). Such systems can involve organizational social media, knowledge repositories, and bulletin boards (Cabrera et al., 2006; Majchrzak et al., 2013; Razmerita et al., 2016). These systems are designed to help users share knowledge in both tacit and explicit forms (Sensuse et al., 2021). A particular type of KMS is an inter-organizational knowledge-sharing system (IOKSS). This type of KMS is used by multiple organizations in horizontal interorganizational KS (Al-Busaidi & Olfman, 2017).

In the context of sustainability, KM is regarded as a new paradigm of development to enhance the performance of ESE topics. KM is believed to be used as a basis for sustainable development practices. For this, information must be exchanged on a global scale. Due to this, KM can play an essential role due to its ability to facilitate sharing of information from different sources (Martins et al., 2019).

3.6 Good Practices

Definition 6: Good practice

> A good practice (GP) can be defined as: "A pattern that is a proven solution for problems in the three dimensions of sustainability" (Coenen, 2020, p 18), with the three dimensions of sustainability being: social, environmental, and economical.

Good practices can take many forms but may be any repeatable fragment of a model or process that carries contextual information (Coenen, 2020). Good practices can aid responsible organizations in their mission by providing a set of steps that an organization can follow to

achieve a specific sustainable development goal. Additionally, good practices can be used to prevent organizations from having to find solutions to problems that already have a proven solution (Coenen, 2020). Consequently, good practices can be a tool for enabling enhanced knowledge management. In Appendix A: Example of a good practice, an example of a good practice is illustrated.

It should be noted that good practices are also sometimes referred to as best practices. Until recently, this has been the case in the Software for organizational responsibility research line, and the term is also observed in the literature. In this project, we follow the research line in referring to good practices in recognition of the fact that there cannot be a single best practice for a given situation. The term best practice is still used in openBest and the collected datasets. Nevertheless, we uphold the term good practice in this thesis where possible.

3.7 Good practice Repositories

Many knowledge management systems take the form of a knowledge repository (Cabrera et al., 2006). Such a repository can be defined as: "A shared database of information on engineered artifacts produced or used by an organization" (Plomp, 2020b, p40). A knowledge repository allows involved parties to exchange knowledge by posting documents in a database accessible to all other involved parties (Cabrera et al., 2006). Although these repositories can play an essential role in facilitating knowledge flows, the repositories cannot guarantee that knowledge exchanges will occur (Cabrera et al., 2006).

España and Brinkkemper (2016) suggest a repository of good practices. This knowledge repository facilitates storing and retrieving patterns contained in good practices from the IP4ESET phase in a central repository accessible to cooperating organizations. Such a repository is referred to as a good-practice repository (GPR). In Figure 6, the setup of a GPR is illustrated.

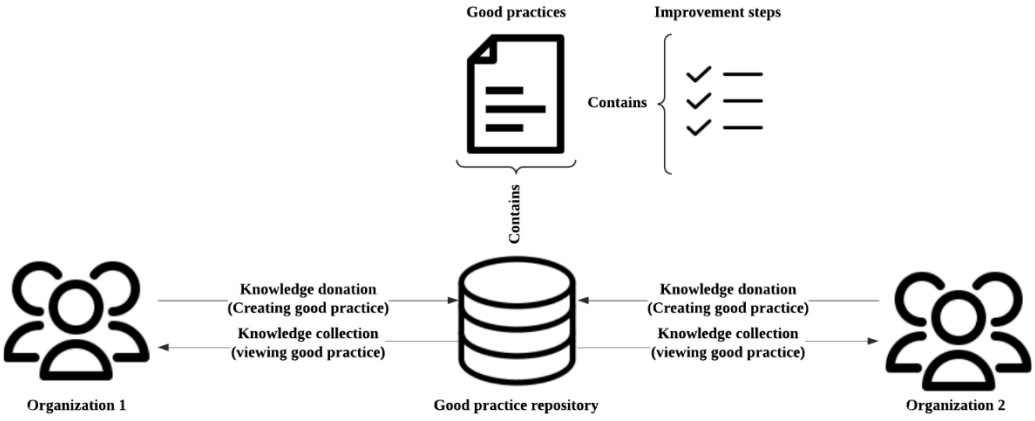


Figure 6: Schematic overview of a generic good practice repository

Currently, some GPRs are constructed to enhance knowledge sharing on sustainable topics. These GPRs typically lack the flexibility to be helpful to varying organizations. GPRs often include GPs from a single source, which hinders interorganizational knowledge sharing. In addition, the GPR

infrastructure is often not flexible enough to accommodate the specific functional needs of various organizations. These factors decrease the usefulness and effectiveness of the tools (Plomp, 2020b). This lack of tools that support the sharing and documenting of good practices is also observed in other literature (Al-Ashaab et al., 2013).

Good-practice repositories are not the only option for generating action steps in the IP4ESET phase (Jacobs, 2021). An alternative is external advice. External advice is a method where a company relies on external advice to create improvement plans. This advice often comes from sustainability-focused organizations that help create a sustainable agenda and offer companies support in choosing focus areas for improvement. In addition to this, large consultancy firms also offer sustainability advice. This advice does not have to differ fundamentally from the advice of sustainability-focused organizations (Jacobs, 2021). The external advice method is very successful for companies partnered in strategic partnerships. A flaw is that the amount of these partnerships is limited because sustainability-focused organizations and consultancy firms can only support a limited number of organizations. In practice, these partnerships are made with large organizations. Due to this, smaller companies cannot get the same level of support. As a result, this method is unsuitable for smaller organizations engaged in IP4ESET activities (Jacobs, 2021). Another method involves modeling and following improvement cycles that contain action plans that guide companies to improve on ESE topics. Several modeling techniques can help companies in selecting fitting good practices. An example of such a model is the sustainability assessment by fussy evaluation (SAFE). This model combines a variety of sustainability indicators and determines a plan of action based on the performance of these indicators. Each indicator belongs to a specific sustainability category. Analysis of an individual indicator provides information on approaches to improving the ESE topics and sustainable categories combined form the ESE assessment of the entity. The main limitation of models for good practice selection is the skill required to create a useful model. This skill is not common in many smaller companies, making the modeling approach unfeasible. The second limitation is that the models are a simplification of reality. This makes it difficult to consider all relevant factors. Lastly, models do not generate good practices. They are the input, not the output. As a result, modeling is beneficial in assessing the ESE status of organizations but lacks the tools to generate improvement steps in the form of good practices (Jacobs, 2021). The limitations of alternative approaches make a GPR the most accessible solution for the collaborative generation of action steps in the IP4ESET phase (Jacobs, 2021).

3.8 Responsible networks

As mentioned before, responsible organizations aim to become more responsible, and they can participate in the activities contained in the SBEIC cycle. In the IP4ESET phase, organizations plan for improvement. This involves thinking of steps to achieve a sustainability goal. For this, they can team up with other responsible organizations to share their knowledge consisting of experiences, plans, and steps to reach sustainability goals. This partnership is a collaborative effort that aims to share skills, expertise, and knowledge. This benefits the collaborators and

allows them to focus on common objectives like becoming more responsible (Nooshinfard & Nemati-Anaraki, 2014; Rathi et al., 2014). In this project, we refer to such groups as responsible networks. Generally, reasons for entering partnerships include tradition, protecting organizational reputation, leveraging technology and networks, and moral imperatives (Al-Busaidi & Olfman, 2017; Rathi et al., 2014). Partnerships can take different forms, such as alliances, agreements, coalitions, joint ventures, nonprofit business alliances, and virtual communities (Lee, 2021; Rathi et al., 2014). In addition to benefits, networks and collaborations also incur costs and risks for participating organizations. Barriers to entering a network involve a lack of trust, difficulty in fostering commitment, compromising independence, the complexity of joint projects, and cultural differences (Nooshinfard & Nemati-Anaraki, 2014). Some responsible networks include the Economic for the Common Good Group (ECG)[1]. These responsible networks form online networks where the organizations engage in interactions, share knowledge, build relationships, and provide mutual assistance (Charband & Navimipour, 2016). For this knowledge sharing, the responsible networks can use an IOKSS, like a good practice repository, to document their steps for improvement planning in the form of good practices.

3.9 Model-Driven Development

In Model-Driven Engineering (MDE), the model is the central artifact in the software engineering process. In MDE, there are models at varying levels of abstraction. Each model expresses some aspects of the system specification. An advantage of this model sequence is that it allows for adaptation to change as changes to lower abstraction levels do not affect higher abstraction levels. Moreover, using models at different levels of abstraction leads to more abstract thinking about software development. (Plomp, 2020b). A subset of MDE is Model-Driven Development (MDD). MDD focuses on describing systems using abstract models and transforming these models into system implementations using model compilers or executing the models using model interpreters. Using models to influence system implementation and execution increases the flexibility of the development process (Plomp, 2020b). Model-Driven Architecture (MDA) is a subset of MDD that promotes the use of abstract models that are independent of the implementation platform and specified along the Meta-Object Facility (MOF) language (Plomp, 2020b). MDD enables high variability. Using abstract models ensures that the choice of platform and technology does not affect the models and the other way around. Because of this, models are not subject to changes at the implementation level, ensuring that system specification does not have to be completed during the design time (Plomp, 2020b).

[1] https://www.ecogood.org/

3.10 openBest

Definition 7: openBest

> openBest is an open-source model-driven good practice repository proof of concept. openBest has been developed to facilitate the knowledge-sharing infrastructure to aid organizations in the improvement planning activities in the IP4ESET phase. The repository was developed by Plomp in 2020 and has been extended with community-based feedback features (van der Pijl, 2020) and good-practice filter and organizing features (Jacobs, 2021).

In openBest, organizations can engage in knowledge sharing using good practices containing information suitable for their context. The organizations can create good practices that other organizations can view to get inspired for their improvement planning steps. Organizations can evaluate the qualities of good practices by rating and commenting. This way, a sense of community-based feedback is promoted. Organizations are grouped into domains. These domains constitute networks of responsible organizations. Each domain can have a tailored model. This model determines the content of the good practices and structures the display of these good practices. This model is created and edited by the domain administrator. In Figure 9, the schematic overview of openBest is illustrated.

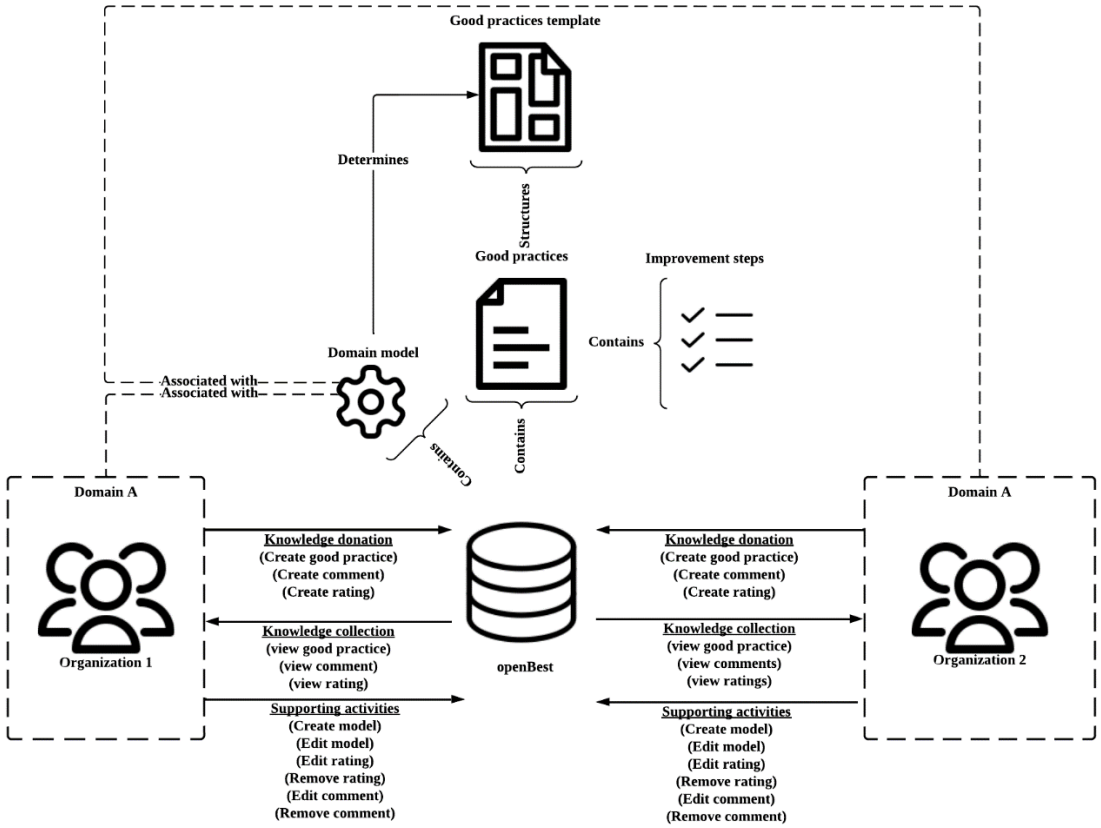


Figure 7: Schematic overview of openBest v1.0

openBest is designed following MDD principles, specifically MDA principles, and caters to different contexts by allowing customizable forms of good practices on ESE topics. The form of these GPs is determined by the model that a domain administrator defines in openBest. This way, organizations can have the elements relevant to them in their good practices. The other part of the model, which constitutes the core model, is predetermined following research on elements commonly present in good practices (Coenen, 2020; Plomp, 2020b; van der Pijl, 2020).

3.10.1 The origin of openBest

Activities related to the SBEIC cycle and, more specifically, improvement planning have been the topic of research at Utrecht University. During this research, it is observed that while many organizations know **what** they want to improve, they are unsure **how** to achieve those goals (Adèr, 2020; Plomp, 2020b). A solution is sought in documenting and sharing patterns proven to aid in achieving the said goals. To aid this approach, tool support in the form of a good practice repository is suggested by España and Brinkkemper (2016). This repository can convey the steps required to achieve a sustainability goal documented in good practices and serve as a vehicle for sharing these steps across organizational boundaries. As we have seen before, there are some GPRs that organizations use these often lack the flexibility and openness to be usable by more organizations. One reason is that GPRs often use branch-specific GP templates, making the GPR less usable for other organizations that require different GP templates. Consequently, a flexible GPR that allows varying GP templates should be developed to improve practice.

3.10.1.1 Coenen (2020)

Coenen (2020) researched the content of good practices used in practice and literature. 8 GPRs and multiple literature descriptions of theoretical GPRs were analyzed. The result of these activities is an overview of the elements present in the optimal good practice. These elements are shown below in Figure 8.

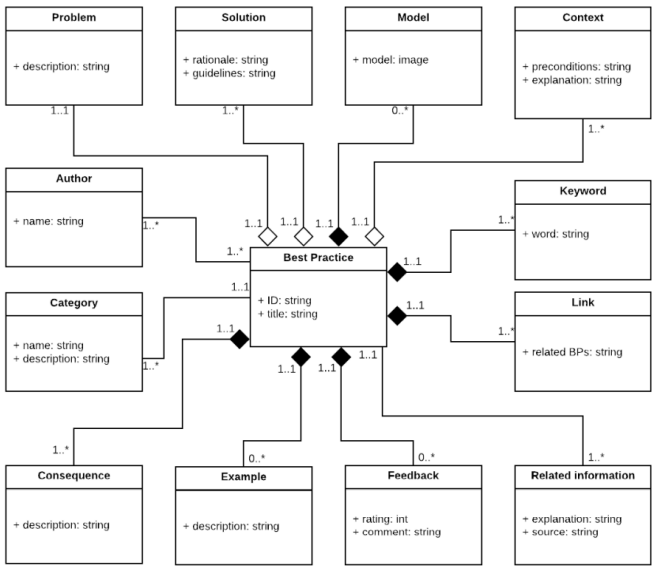


Figure 8: UML class diagram of an optimal GP (extracted from Coenen, 2020)

The optimal GP contains many elements. It could be argued that some elements are less useful for some contexts than others. In addition, the substantial number of elements could make creating a good practice in a GPR a time-consuming task, which may reduce individuals' willingness to engage in such an activity. Therefore, a flexible GPR should allow customizable good-practice contents to accommodate varying contexts.

Coenen also investigated the functionalities present in existing GPRs. The result of this effort is an overview of features present in state-of-the-art GPRs. These features are combined into what is called the optimal GPR. The feature model of this optimal GPR is shown below in Figure 9.

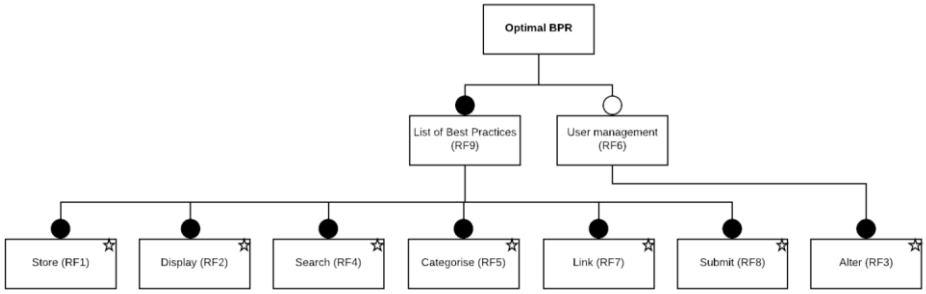


Figure 9: Feature model of an optimal GPR (extracted from Coenen, 2020).

When comparing the optimal GPR to the feature models of existing GPRs, the conclusion is that there is a lack of common ground between these feature sets. Moreover, no examined GPR possessed all the optimal GPR feature model features (Coenen, 2020).

3.10.1.2 Plomp (2020b)

With these shortcomings and challenges of state of the art mapped, Plomp (2020b) set out to develop a treatment for sharing knowledge in the form of good practices, following the suggestion of España and Brinkkemper (2016). Plomp (2020b) phrased the main shortcomings of current GPRs as a lack of flexibility and extensibility. Moreover, he supported the notion of Coenen that no (known) existing GPR possessed all optimal GPR features and added that existing GPRs lack crucial features that allow organizational knowledge sharing. The solution proposed by Plomp is a model-driven good-practice repository. The model-driven design allows for the flexibility that the other GPRs lack. The model in this context defines the structure and contents of good practices and allows the customizability of the structures and contents. This allows organizations from varying backgrounds to develop their model and have their own custom GPR. Within openBest, these contexts are referred to as domains.

In openBest, the domain model determines the GP template and the associated collections. This model is configured following a domain-specific language (DSL) called the openBest language (OBL). The OBL dictates the possible structures present in the model. A distinction is made between abstract and concrete syntax models. The abstract syntax defines the vocabulary of OBL, and the concrete syntax expresses the notation of OBL and is therefore influenced by the choice

of technology. The DSL output is a textual model that openBest can interpret to determine functionality. These models are used by openBest to initiate and structure the database for a given domain. By the design of Plomp, these models must be in JSON format, so the choice of JSON influences the concrete syntax of OBL as the model notation. Models created using OBL in the openBest model editor have been evaluated for semantic consistency and syntactic correctness by Plomp. The results were that no inconsistencies were found. Due to this, Plomp concluded that the quality of openBests models is high.

As we have seen, the ideal GP contains many elements. This can make creating good practices time-consuming. However, not having mandatory elements could make the GPs minimal and less usable. As a result, a balance is sought. This balance was determined by Plomp (2020b) and Coenen (2020). The result of this scoping effort is a core model for openBest. The core model contains features that are present in all models built using openBest. The core model of Plomp (2020b) is visualized in Figure 10.

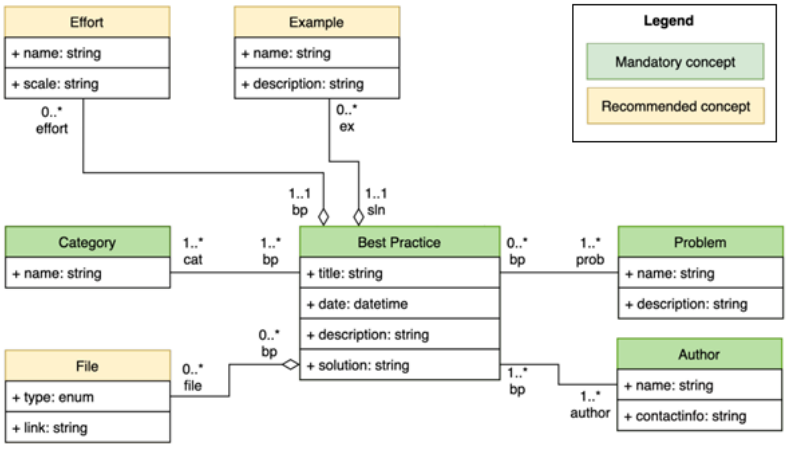


Figure 10: OBL core model (adapted from Plomp, 2020b)

With the OBL and functional design in place, Plomp started the development of the proof-of-concept. The result is a website that allows users to create models that instantiate domains. In these domains, the users can create and view the good practices of other users. After the conclusion of Plomp's project, openBest contained all the features determined by Coenen and Plomp to be essential to allow flexible customization to allow all the GP features, also determined by Coenen, to be accommodated.

3.10.1.3 Van der Pijl (2020)

During this time, another observation was made by España. This observation is that, in the context of GPRs, there is often a lack of community-based feedback. Because of this, it is often unclear what the result is of applying good practice. Next, there is no insight into a good practice's perceived qualities. This sparked another (bachelor) project related to openBest. This project investigated how features to foster community-based feedback in GPRs could be implemented. The result of this effort was that flexible, multidimensional rating mechanisms and threaded

comment sections should be implemented to foster community-based feedback. These features are also added to openBest following the model-driven approach. First, this was already the paradigm used during development. Second, during the project, it was shown that the rating is very subjective to the context and should be customizable per domain. These activities altered the DSL and resulted in a new core model, as shown below in Figure 11. The changes are contained within the red square.

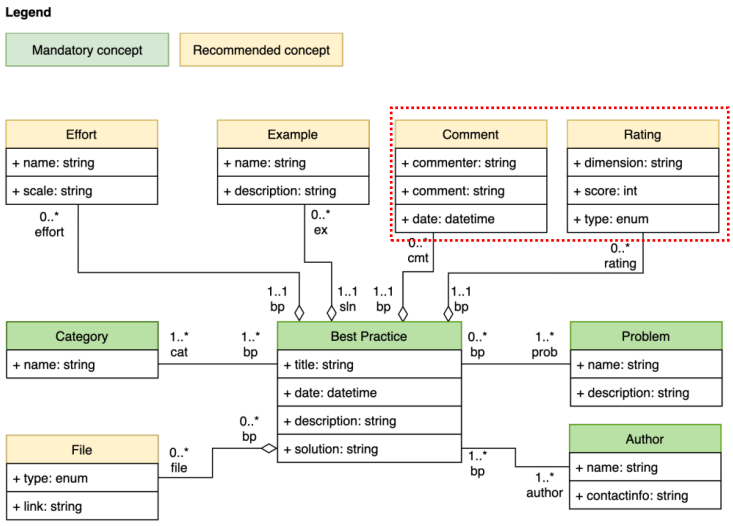


Figure 11: The OBL core model expanded with comment and rating tables (extracted from Plomp, 2020b)

3.10.1.4 Jacobs (2021)

The version of openBest at that point covered most of the functional requirements outlined by Plomp (2020b) and Coenen (2020), but some implementations left some more refinement to be desired. One example is Coenen's search and filter requirement (2020), which dictates that users should be able to filter, search for, and select good practices. At this point, some features in the form of a search bar allowed for free-form search input. However, they offered too little flexibility. As a result, another openBest-related project was started by Jacobs (2021). Jacobs investigated how filtering and selection could best be implemented into a GPR to find the most fitting GP for a given situation. For this, he examined multiple GPRs and state-of-the-art filtering mechanisms. From this, Jacobs distilled two principles for the optimal GPR filtering mechanism. Firstly, the information should be accessible without prerequisite knowledge, and secondly, the information should be accessible without entering selection criteria. Combined, these two principles entail that, contrary to the search functionalities of openBest at that point, filtering mechanisms should suggest the items for which filtering is possible and suggest the possible filtering values (e.g., enumerations over free input text). Jacobs extended openBest with these filtering mechanisms contained in a filtering modal and adjusted the OBL to accommodate determining filtering mechanisms for a given domain. This resulting openBest version is where this project begins. This version of openBest is denoted as version v1.0.

3.10.1.5 Timeline

The attributions we described can be summarized using the following timeline and events.

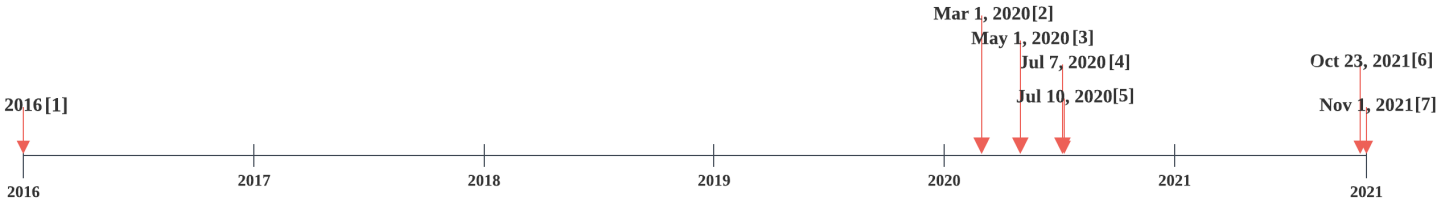


Figure 12: Timeline of the origin of openBest and research into IP4ESET

Table 3: Events leading up to this project

Event	Date[2]	Description	Reference
[1]	2016	Brinkkemper & España propose a repository of good practices for documenting and sharing improvement steps.	España & Brinkkemper (2016)
[2]	1-3-2020	Adèr investigated the improvement planning (IP4ESET) phase and identified the action-intention gap in improvement planning; Adèr also investigated the potential possibilities of developing a versatile and model-driven tool that supports the IP4ESET phase.	Adèr, M. (2020)
[3]	1-4-2020	Coenen investigated the state-of-the-art good practice repositories to determine optimal GPR functionalities and GP contents. This would form the basis for the tool requirements.	Coenen (2020)
[4]	7-7-2020	Plomp, building on the previous research, designed and implemented a model-driven GPR proof of concept called openBest. He also designed the family of validations method for validating model-driven tools and performed initial model validations on the semantic and syntactic qualities of the models.	Plomp (2020a;2020b)
[5]	10-7-2020	Van der Pijl designed and implemented community-based feedback features in openBest to foster qualitative and quantitative feedback on GPs and made an effort to validate these features.	Van der Pijl (2020)
[6]	23-10-2021	Jacobs designed and implemented more elaborate filtering and searching functionalities to enhance GP browsing.	Jacobs (2021)
[7]	1-11-2021	This project starts.	

[2] Note that to this author, the precise durations of projects are unknown. Consequently, markers are placed using the known hand in date of the project or the publication date of the scientific source.

3.10.2 State of openBest

Now that we understand the layers of development and the origins of openBest, we discuss the state of openBest in terms of implementation technique and functionality.

3.10.2.1 Client-side Architecture

The client-side architecture describes the code's architecture in terms of functionalities fetched by the client and executed in their browser instance. Currently, we distinguish four sets of functionalities contained in modules in openBest v1.0:

- **Editor module** - is used by domain administrators to create and instantiate textual domain models. The module produces the JSON model used by the interpreter module.
- **Interpreter module** - interprets the textual models created in the editor module, stores the results, and handles requests for feature sets used by other modules to structure their input and output.
- **GP entry module** - is used by users to store good practices. The input form features depend on the interpreter module.
- **GP viewing module** – is used by users to view good practices. The layout and structure of the good practices are determined by the feature set retrieved from the interpreter module. This is also the module that contains community-based feedback features.

This structure is illustrated in Figure 13.

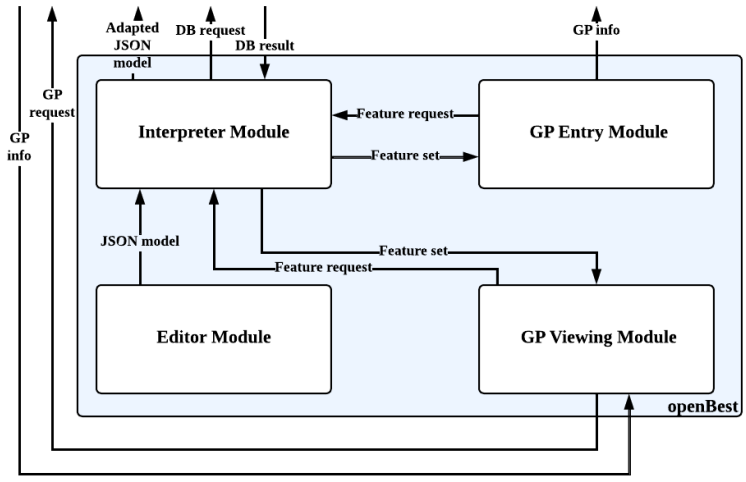


Figure 13: High-level FAM of openBest v1.0 (adapted from Plomp, 2020b)

3.10.2.2 Server-side Architecture

The server-side architecture describes the setup of the functionalities contained or executed on the openBests hosting and database platform. openBest is hosted in Firebase. For the database, openBest employs a NoSQL database called Firestore. The database only allows for text-type data types. The data types are subject to some limitations and constraints. A complete discussion is beyond this project's scope, but for those interested, more information can be found in the Firebase documentation (Firebase, 2022b).

The database is hierarchically structured by alternating levels of documents and collections. A document can contain information and have associated collections. These collections are, in turn, populated by documents that can also have subcollections (Firebase, 2022a). In this context, a document could be a good practice, and the collection could be all good practice documents together. This is illustrated below in Figure 14.

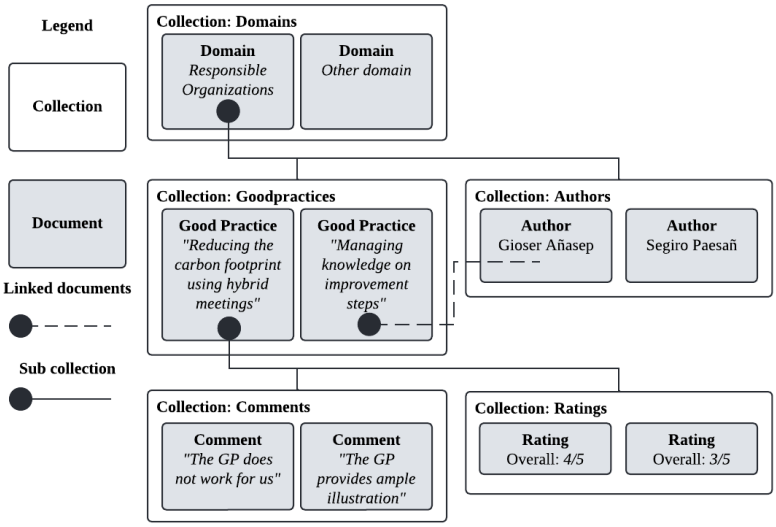


Figure 14: Firestore data model (adapted from Plomp, 2020b)

The structure of this database is determined by the model created in openBest. The NoSQL database structure has the main advantage of allowing flexibility because there is no schema describing how data should be structured before instantiation. Next, the hierarchical structure is well described using JSON (JavaScript Object Notation). This makes the combination of JSON and a hierarchical database a good one (Plomp, 2020b). There are also some drawbacks. First, the database does not have relations, as seen in relational SQL schemas. This makes linking and finding related documents challenging. Consequently, each relationship should be documented using references in both documents involved. Second, the Firebase structure does not allow a new collection to be instantiated empty. This means that when a new collection is created, the collection should have at least one document to start with. Plomp (2020b) turned this requirement from a drawback into an advantage. This is because this initial document, called '#collection document' (i.e., good practice document, author document), contains the representation of the database of the domain models. More concretely, this document contains the structure of the collections documents determined in the domain model. Consequently, it can serve as a template for other documents in that collection. This way, all documents in a collection have the same features.

3.10.2.3 Functional state of openBest

Functional coverage

The state of openBest, prior to this project, contains all elements as described by Coenen, denoted with C-RF# (2020)[3]. There is an account-based log-in system where only authorized accounts can access their specific domain. In addition, there is a role system that allows a user and a domain administrator (C-RF6). The user can create and view good practices, while the domain administrator can make models and create and edit domains. When a user logs into openBest, he can create and store good practices (C-RF1, C-RF8). In this good practice, he can have linked documents such as examples or authors (C-RF7). Based on the domain model, the user can also categorize good practices based on the organization's categorization framework (C-RF5). If the user wants to see other good practices, he can navigate to the list of good practices (C-RF9) and search for a specific good practice using keywords or assigned categories (C-RF4). If he finds the good practice, he is looking for, he can display the GPs' content (C-RF2). Editing and removing good practices is also possible, but only the domain administrator can currently do this in the database itself (C-RF3).

Development challenges

openBest is model-driven. Although this allows flexibility that is not achievable through other means, it complicates the development of new features. Due to the model-driven nature, the development of the tool must cater to all outcomes of the models. This means some features that work in one domain can be problematic in others. An example of this is found in the styling of the content. While in the work of Plomp (2020b), the individual elements of the GPs are styled nicely, this is not present in the version prior to this project. Another example is that some of the features developed earlier do not function entirely in the latest version, and this is because some technical issues are only exhibited in some domains. Although we acknowledge both being present and functioning in the earlier work, we cannot use them now. This means that some effort must be made to put the repository into shape.

3.10.2.4 Conclusion functional state of openBest

openBest currently features most of the core requirements formulated by previous projects. The implementation of some of these features could be improved because they are not always fully functional. In addition to this, the features encompass the core requirements. This means that while the core stands, the overall functionalities are minimal. This means that an effort should be made to expand openBest features by looking at how the core can be expanded. This way, we think a more reliable and complete version of the openBest can be created.

[3] Please see 'Appendix E: Requirements from related projects' for all requirements formulated by Coenen

3.11 Conceptual relationships

In this chapter, we discussed the background and context of the research. In the figure below, the relationships between the discussed concepts are illustrated.

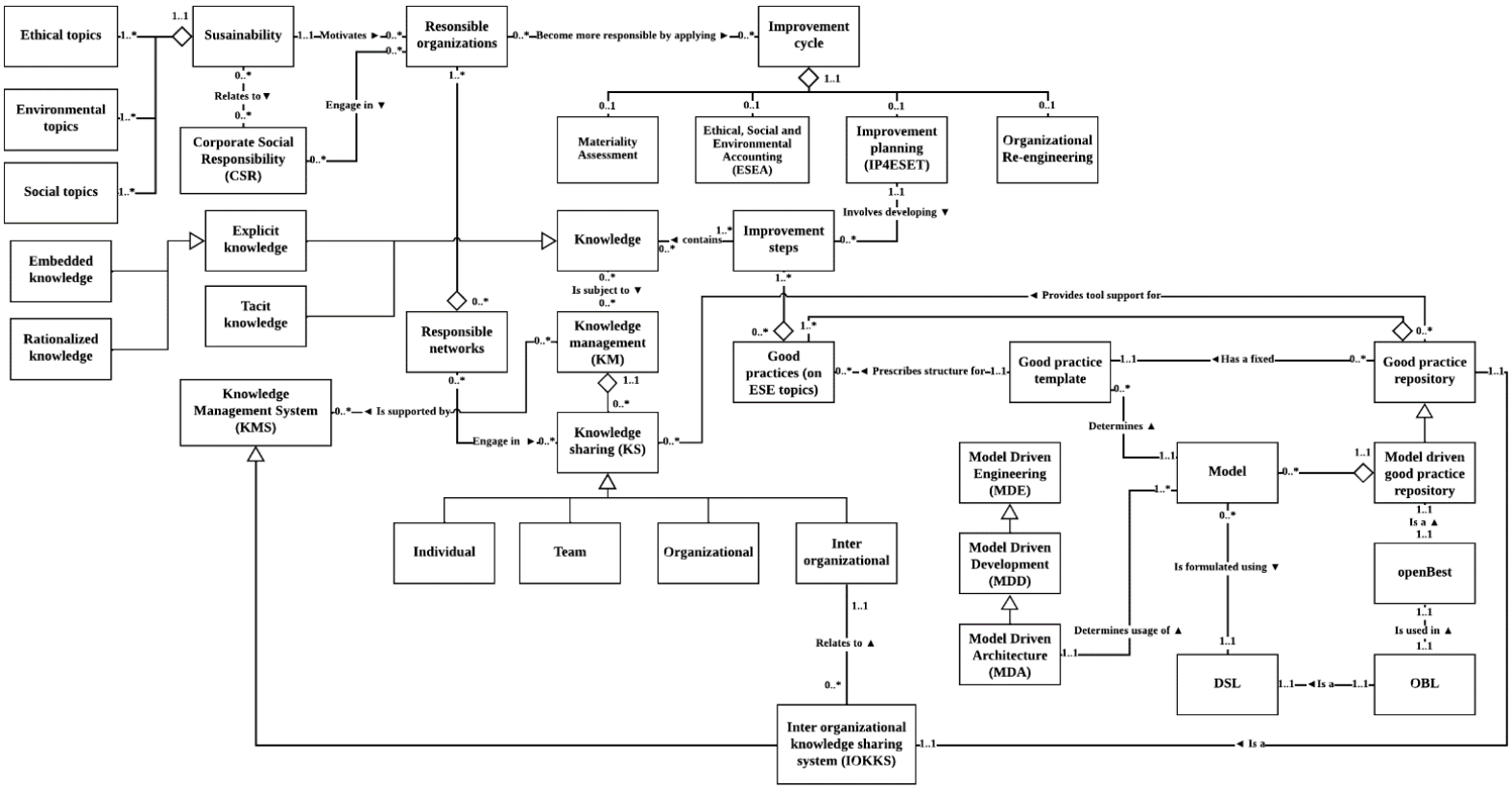


Figure 15: Relationship diagram of the background concepts

In the diagram above, responsible organizations are motivated by sustainability topics like ethical, social, and environmental topics and consider them in their business model by engaging in CSR. To become more responsible, organizations can follow activities related to the improvement cycle. Among these activities is improvement planning. This phase involves developing improvement steps. These improvement steps can be documented as good practices and shared in good-practice repositories. In this project, we regard the improvement steps as knowledge. This knowledge can be explicit (embedded or rationalized) or tacit. In the scope of the project, we expect the knowledge to be explicit. This is because the improvement steps can be expressed as text. Knowledge is subject to knowledge management, of which knowledge sharing is the process of interest. Knowledge sharing can occur on an individual (interpersonal), team, organizational, or interorganizational level. Responsible organizations can participate in responsible networks. These responsible networks share information on ESE topics across organizational boundaries. For this, the responsible can use an interorganizational knowledge sharing system to support KS activities. An example of such an IOKSS is a good practice repository. These good-practice repositories contain the good practices with the improvement

steps we described earlier. A special type of good-practice repository is a model-driven repository. Such a repository employs models that determine the content of good practices. The model-driven repository is constructed following the model-driven architecture paradigm. In this way, organizations from varying contexts can use the tool. The models are formulated using a domain-specific language. The GPR we use in this research is openBest. OpenBest is a model-driven good-practice repository proof of concept. openBest is constructed following the model-driven architecture paradigm, and models are formulated using openBest's DSL called openBest language (OBL). The models dictate the database structure, the contents of good practices, and the way they are displayed per domain.

4 | Factors influencing knowledge sharing

In this chapter, we discuss how we answer RQ1 *What are relevant factors that influence interorganizational knowledge sharing among the members of a network of responsible organizations?* For this, we first describe the factors influencing interorganizational knowledge sharing we found in a structured literature review. The protocol of which can be found in Appendix B: SLR Protocol. With the factors of influence, we then define the situational factors that can be used to describe a situational aspect of use cases of a GPR. These factors together form situational profiles, which can be used to characterize the situation of networks of organizations using GPRs. We use the situational profiles in chapter seven to formulate expectations regarding knowledge sharing behavior in the empirical test.

4.1 On factors influencing knowledge sharing

Knowledge sharing and factors influencing KS have been the subject of much research. Consequently, many industry, business, and culture-specific frameworks are constructed to structure KS influence factors. During these activities, many factors of influence have been identified. For example, there are hard influences, such as technologies and tools, and soft influences, such as intention, motivation, and trust (Nooshinfard & Nemati-Anaraki, 2014). These influences can be positive or negative. Negative factors are also referred to as barriers, while positive factors are referred to as drivers. Some factors, such as technologies and tools, can be controlled, while others, such as intrinsic motivation, are easily influenceable (Nooshinfard & Nemati-Anaraki, 2014). The literature covers factors of influence on all KS levels we discussed earlier (individual, intraorganizational, and interorganizational). While in this project, we are interested in the factors of influence on interorganizational KS, we are also interested in the individual and intraorganizational works because individuals are often considered to be the actual knowledge workers that can make or break the efforts for KS and the organizations have to have good internal KS before efforts can be made to engage in KS with other organizations (Soekijad & Andriessen, 2003). In the literature, the factors of influence are often grouped into factor dimensions. These dimensions, while diverse, typically include the following[4]:

- Individual factors
- Organizational factors
- Technological factors
- Nature of knowledge factors
- Interorganizational factors

In this project, we use these dimensions to categorize the factors of influence to structure this chapter.

[4] See Appendix C: Knowledge sharing dimensions for an overview of the dimensions and the rationale for upholding these dimensions.

It should be noted that the identified factors can belong to multiple dimensions simultaneously due to some overlap between them. This is reflected in similar factors being classified into different categories by different authors in the literature, resulting in many similar but slightly different frameworks. In this project, we assign the factors to the most similar dimension, as seen in the literature.

4.1.1 Individual factors

Individual factors are factors influencing individuals involved in the knowledge-sharing process. These factors can influence individuals at all levels of knowledge sharing (interpersonal, group, organizational, interorganizational).

4.1.1.1 Motivation

The success of knowledge management depends on the intention of individuals to share knowledge (Gagné, 2009; Nooshinfard & Nemati-Anaraki, 2014). Resources are limited, and individuals only share knowledge if there is sufficient perceived benefit or strong personal motivation (Ipe, 2003; Nooshinfard & Nemati-Anaraki, 2014). This means that the motivation and intent of knowledge providers are critical for putting in the effort and resources required to engage in KS and overcome concerns about knowledge ownership (Quigley et al., 2007). This also applies to the knowledge recipient, whose motivation influences how he is willing to seek, accept, and utilize knowledge from knowledge providers (Quigley et al., 2007). Consequently, the intention and motivation to have effective KS should be present for both the knowledge provider and the knowledge recipient (Quigley et al., 2007).

Two types of motivation can be distinguished, extrinsic and intrinsic motivation (Razmerita et al., 2016):

Intrinsic motivation	Intrinsic motivation refers to motivation present within an individual driven by a desire or enjoyment of the task or the desire to assist others. Intrinsic motivation is independent of extrinsic factors such as pressure or incentives. Intrinsically motivated individuals are more likely to participate in KS, increasing their knowledge and, in turn, the organization's knowledge (Lin, 2007; Nooshinfard & Nemati-Anaraki, 2014; Razmerita et al., 2016). The intrinsic motivation influences are expected reciprocity, perceived ability, perceiving knowledge as power, enjoyment in KS or helping others, and a sense of belonging (Ipe, 2003; Zheng, 2017).
Extrinsic motivation	Extrinsic motivation is external to the individual and influenced by external factors such as expected rewards after performing an activity. Extrinsic motivation in knowledge sharing is based on the perceived balance between the cost and expected benefits of knowledge sharing. KS will occur if the benefits exceed or equal the cost (Ipe, 2003; Razmerita et al., 2016). Therefore, many organizations have reward systems that increase the benefit of motivating employees to share knowledge (Razmerita et al., 2016). In addition, organizations investigate ways to reduce the cost by, for instance, implementing tool support that makes it more accessible and less time-consuming to participate in KS (Razmerita et al., 2016).

As we have seen, intrinsic and extrinsic motivation heavily influence knowledge-sharing behavior (Razmerita et al., 2016; Zheng, 2017). Therefore, some effort should be made to motivate KS. Cost, benefits (rewards), expected reciprocity, perceived ability, perceiving knowledge as power, enjoyment of KS or helping others, and a sense of belonging can influence this motivation (Ipe, 2003; Nooshinfard & Nemati-Anaraki, 2014; Wang & Noe, 2010; Zheng, 2017). We have seen that organizations that are promoting KS are trying to influence the balance between cost and benefit by lowering cost and increasing benefit to foster motivation. In addition to imposing monetary or other organizational rewards to increase benefits, Organizations can implement gamification elements such as points or badges combined with goal setting in their knowledge management environments (Holzer et al., 2020; Quigley et al., 2007). Other approaches for fostering motivation are emphasizing group performance, having explicit norms for knowledge sharing, having KS as a core value of the organization by involving it in performance assessment and recognizing those that go beyond to participate in KS, and fostering good relationships between potential knowledge providers and recipients (Ipe, 2003; Quigley et al., 2007). Next, meeting employees' psychological needs can foster (intrinsic) motivation (Zheng, 2017). While these and many other factors have been found to influence motivation, it should be noted that motivating potential knowledge holders to share knowledge may not translate into them sharing knowledge; the same is true for knowledge receivers (Quigley et al., 2007).

4.1.1.2 Personal characteristics

When it comes to personal characteristics such as age, education, and work experience, there are multiple ways they influence KS. First, personal characteristics can affect the relationship between knowledge providers and recipients. Second, personal characteristics such as openness, proactiveness, responsibility, expertise, and confidence influence how an individual engages in KS (Nooshinfard & Nemati-Anaraki, 2014; Wang & Noe, 2010; Zheng, 2017). When an individual has a high level of openness, he has a high level of interest in the thoughts and perspectives of others, which makes him more inclined to engage in KS. On the other hand, individuals with introversion characteristics are lonely, poor communicators, and shun social contact, impairing KS (Zheng, 2017). If a person has a proactive personality, he perceives the existing environment as not binding. A proactive individual actively explores new ways to affect the external environment, and this proactive personality has been shown to affect KS positively (Zheng, 2017). Furthermore, individual responsibility is associated with a tendency to be more willing to participate in KS (Zheng, 2017). Next, individuals with higher expertise are more likely to engage in KS. This also depends on the confidence of individuals in sharing knowledge with others. Individuals more confident in their ability to share knowledge are more likely to participate in KS (Nooshinfard & Nemati-Anaraki, 2014). A concept related to confidence is self-efficacy. Self-efficacy is "the belief in one's capabilities to organize and execute courses of actions required to manage prospective situations" (Razmerita et al., 2016, p5). Individuals with higher levels of self-efficacy are more inclined to set high-performance objectives for themselves (Quigley et al., 2007). In the context of KS, self-efficacy is seen as enhancing KS (Tohidinia & Mosakhani, 2010).

4.1.1.3 Time

The lack of time required to engage in KS is a crucial factor that affects the frequency of knowledge sharing, and the lack of time is considered a barrier to KS (Razmerita et al., 2016). As said above, efforts are made to reduce this barrier by introducing IT systems, potentially reducing the time required to participate in KS (Charband & Navimipour, 2016; Razmerita et al., 2016).

4.1.1.4 Trust and relation

The relationship between the parties involved in KS influences the individual's cooperation and willingness to participate in KS. Trust plays a vital role in this relationship (Nooshinfard & Nemati-Anaraki, 2014). Consequently, trust has significantly influenced KS (Nooshinfard & Nemati-Anaraki, 2014; Razmerita et al., 2016; Zheng, 2017). Some even argue that trust is the most influential factor for effective KS (Zheng, 2017). In the context of this project, trust can be defined as: "The belief that another party will behave as expected and not take advantage of the situation" (Razmerita et al., 2016, p. 5). Trust influences the interaction between individuals and how much they want to learn from each other and share their knowledge (Nooshinfard & Nemati-Anaraki, 2014). Perceptions of trustworthiness based on competence, honesty, generosity, and behavioral reliability can provide confidence in future actions, increasing the closeness of relationships (Sensuse et al., 2021; Usoro et al., 2007). This means that trust is tied to the closeness of a relationship (Nooshinfard & Nemati-Anaraki, 2014). This closeness of the relationship is closely related to collaboration, which influences KS. Trust can encourage individuals to work together with a team, reduce conflicts that can hinder KS, and increase collaboration among individuals in an organization or among organizations that improve KS. As a result, trust is crucial in a collaborative environment and, by extension, to KS (Charband & Navimipour, 2016; Nooshinfard & Nemati-Anaraki, 2014; Sensuse et al., 2021). Trust is believed to be facilitated by engaging in trustworthy actions, such as being honest, following through on commitments, and having a high degree of openness (Quigley et al., 2007; Usoro et al., 2007). As we will see in the following sections, trust is a significant influence factor at more levels of KS.

4.1.1.5 Fear

Fear has been identified as an essential barrier factor of influence. Many types of fear can inhibit the sharing of knowledge. These include fear of criticism, fear of giving up power, fear of personal feedback, general anxiety, and fear of losing face (Nooshinfard & Nemati-Anaraki, 2014; Razmerita et al., 2016). For an example of how fear can inhibit KS, consider the fear of losing power. Knowledge holders have a monopoly on a subject, and this monopoly is threatened by sharing knowledge on that subject. Such knowledge holders fear the loss of superiority and some special interests because of their reduced monopoly. Consequently, they are less willing to engage in KS, which poses a social dilemma (Yang & Wu, 2008; Zheng, 2017).

4.1.1.6 Take away individual factors

Individual factors of influence on knowledge sharing include intention, which is partly determined by attitude (influenced by extrinsic and intrinsic motivation), personal characteristics

(such as demographics and personality), time available for KS, trust between the parties, and fear-induced by consequences of sharing or withholding knowledge.

4.1.2 Organizational factors

The organizational factors of influence on KS consist of organizational culture, structure, systems, and other elements of the organizational climate that can encourage or inhibit knowledge creation and sharing within organizations (Razmerita et al., 2016; Tohidinia & Mosakhani, 2010). Many organizational factors encourage KS, and the most crucial factors are reward systems (Sensuse et al., 2021), management support (Razmerita et al., 2016), organizational structure, and organizational culture (Nooshinfard & Nemati-Anaraki, 2014).

4.1.2.1 National culture

National cultural factors have been found to impact KS behavior (Razmerita et al., 2016). For example, national cultures that feature collectivism exhibit more tendencies to KS behavior (Razmerita et al., 2016). Additionally, national culture is related to and, to some extent, determines organizational culture. Organizational culture is highly influential and can influence knowledge sharing to a great extent (Razmerita et al., 2016).

4.1.2.2 Organizational culture

Organizational culture plays a role in creating, sharing, and using knowledge and is critical in adopting KS-related information systems (Razmerita et al., 2016; Sensuse et al., 2021). Each organization has its own unique culture. This culture is reflected at visible and invisible levels. The visible culture of an organization involves its values, mission, and philosophy. The invisible part concerns the norms and values of employees (Razmerita et al., 2016). Both parts influence KS. As part of their visible organizational culture, organizations should support and encourage their employees to engage in KS (Razmerita et al., 2016). This is because the organizational culture can positively influence the motivation of employees to participate in KS (Razmerita et al., 2016). Another aspect of organizational culture is to what extent the organization is creative. An organization with a creative culture can have a multilevel effect on KS. Organizations with a creative culture support staff interaction, encouraging all kinds of KS. This creative culture has been identified as one of the key factors promoting knowledge sharing (Zheng, 2017). An organizational culture that encourages people to compete harms KS. The organizational climate that features individual competition is a barrier to KS and can induce knowledge hiding as an act of self-preservation to maintain a competitive advantage over fellow employees (Jilani et al., 2021; Zheng, 2017). On the contrary, an organizational culture centered on cooperation induces KS (Zheng, 2017).

4.1.2.3 Organizational strategy

Another influencing factor is the availability of a clear corporate strategy, business objectives, and goals. KS is hampered by a lack of strategy and defined business objectives (Razmerita et al., 2016). In contrast, the presence of organizational goals can motivate people to participate in KS and collaboration (Sensuse et al., 2021).

4.1.2.4 Organizational structure

An organizational structure illustrates the organization's inner workings and guides how employees interact in organizational tasks (Cabrera & Cabrera, 2005; Nooshinfard & Nemati-Anaraki, 2014). As we have already seen, these interactions are a central element in facilitating KS. As a result, the organizational structure should induce these interactions. When considering organizational structures, we can distinguish between more strict formal structures and more flexible informal structures. The inequality induced by a strict structure can be a significant barrier to KS that may impact interactions between employees, dampening KS (Nooshinfard & Nemati-Anaraki, 2014; Razmerita et al., 2016). Less formal and more flexible structures facilitate more communication and interaction, improving people's willingness to cultivate a critical attitude in interpreting information and encouraging people to participate in KS (Nooshinfard & Nemati-Anaraki, 2014). This means a more egalitarian organizational structure is more favorable for KS as it creates more opportunities and willingness to engage in KS (Cabrera & Cabrera, 2005). Next, a less centralized organizational structure (involving more informal meetings and open workspaces, among others) can induce employee interaction and encourage individuals to engage in KS (Nooshinfard & Nemati-Anaraki, 2014). Overall, we have seen that the organizational structure should be organized to foster interaction between employees. This can be done by having a flexible, informal, and decentralized structure (Nooshinfard & Nemati-Anaraki, 2014).

4.1.2.5 Management leadership

Managerial leadership is another significant influence on KS on the organizational level (Lin, 2007; Nooshinfard & Nemati-Anaraki, 2014). Managerial leadership is critical to ensure that KS is facilitated. It, for instance, determines the presence of a supportive climate and the resources (time) provided for engaging in KS (Lin, 2007). In addition, management support for KS is associated with employee perceptions of the organizational KS culture and commitment to KS, which influences the quantity and quality of knowledge sharing (Cabrera et al., 2006; Lin, 2007; Nooshinfard & Nemati-Anaraki, 2014).

4.1.2.6 Organizational KM mechanisms

The organization shapes and determines the KM mechanics employed. These, in turn, influence the opportunities to share knowledge. The (amount of) opportunities to share knowledge significantly influences how frequently KS occurs (Gagné, 2009; Ipe, 2003). These organizational KM mechanisms are tied to organizational structure and culture.

4.1.2.7 Rewards

As said above, organizational rewards can play a role in motivating people to participate in KS. This is required because the lack of perceived benefits for the parties involved is a barrier to KS (Razmerita et al., 2016). To address this, incentives, including recognition and rewards, are recommended to foster KS (Cabrera et al., 2006; Nooshinfard & Nemati-Anaraki, 2014). However, incentives alone have a weak, sometimes insignificant, or even adverse, influence on KS (Al-Busaidi & Olfman, 2017; Lin, 2007; Quigley et al., 2007). These effects can be strengthened when

mutual norms for KS are developed between the parties. Additionally, rewards and incentives must be supported and reinforced by organizational structures emphasizing KS's value (Quigley et al., 2007).

4.1.2.8 Shared mental model

Organizational knowledge tends to be fuzzy and closely attached to knowledge holders, making it challenging to define and share knowledge (Ipe, 2003). A solution to this is having a shared mental model. A shared mental model means that the parties involved have similar or compatible knowledge structures for related things. This knowledge structure helps them describe, interpret, and construct knowledge easily understandable by others with the same mental model. As a result, a shared mental model positively affects KS (Zheng, 2017).

4.1.2.9 Diversity

Similar employees tend to interact more with each other than nonsimilar employees (Razmerita et al., 2016). This similarity can be based on permanent characteristics such as sex and age or subjective characteristics such as cognition and attention (Zheng, 2017). When the differences between employees are too significant, it may hinder KS (Zheng, 2017). In addition, heterogeneity can lead to individuals feeling isolated because they are in the minority in some personal characteristics. These individuals are then less prone to engage in KS. Furthermore, these isolated members are less likely to agree with others in a heterogeneous team (Zheng, 2017). In that sense, it can be argued that homogeneity between the parties involved can enhance KS. However, some argue that the opposite is true and that heterogeneous groups benefit knowledge sharing. This group heterogeneity should then be found in cultural heterogeneity and complementary skills (Lauring & Selmer, 2012).

4.1.2.10 Take away organizational factors

The group of organizational factors is the most distinct group of characteristics in the literature because most sources agree that organizational factors are instrumental in KS. The factors we have seen are national culture, organizational culture, organizational strategy, organizational structure, leadership, management support, organizational KM mechanics, rewards, shared mental model, and diversity.

4.1.3 Technological factors

With more mature information technologies, information technology and its use have been recognized as essential enablers for KM and KS (Razmerita et al., 2016; Pang et al., 2020). This means that even though we discuss technological factors as a group of factors, it is also a significant influence factor itself. Although KS technology is beneficial, its effect is determined by its extent and effectiveness in use (Pang et al., 2020). This is supported by a knowledge management system developer at Ernst & Young that said: “If people do not want to share, even giving them the best technology in the world is useless” (Zheng, 2017, p53). This means that although information technology is not always considered the primary aspect of knowledge management, it can improve KS by making it more efficient (Zheng, 2017). This nuance is often

missed by organizations who overemphasize systems and tools rather than the core component being (the individuals involved in) KS within and among organizations (Nooshinfard & Nemati-Anaraki, 2014). In these instances, the introduction of new technology has failed because inadequate attention was paid to the nontechnical or human factors, which are critical determinants of the effectiveness of the KS technology (Cabrera & Cabrera, 2005). For this reason we have also examined individual and organizational factors in this chapter.

4.1.3.1 Influence of technology on KS

Information technology can potentially support knowledge storage, processing, retrieving, and sharing (Nooshinfard & Nemati-Anaraki, 2014). Technology may improve information self-efficacy, connectivity, and efficacy (Razmerita et al., 2016). At the same time, technology can also demotivate users when technology is difficult to use (Razmerita et al., 2016). However, technology is considered a positive factor of influence on KS. For example, the level of technology usage has been found to positively affect KS behavior (Tohidinia & Mosakhani, 2010). For another example of how information technology can enhance KS consider the cost-benefit consideration involved in the (extrinsic) motivation for KS on all levels. Here, it is critical to either reduce costs or increase benefits. An excellent way to reduce perceived cost is to have tool support that simplifies KS and reduces the time it takes to engage in KS (Cabrera & Cabrera, 2005). This is possible because technology can reduce the costs associated with KS due to time and distance (Nooshinfard & Nemati-Anaraki, 2014). The cost can be further reduced by training people to use the tool (Cabrera & Cabrera, 2005). Another advantage of technology in this domain is that it can help in knowledge retention. This is required because companies cannot have long-term human capital, and their knowledge can be lost when they leave (Cabrera & Cabrera, 2005; Zheng, 2017).

4.1.3.2 Interaction induced by ICT

Technology and, more specifically, ICT can eliminate significant barriers related to interaction and communication. This is because ICT provides a richness of transmission channels. This richness breaks the barriers of time, space, geographical distance, and organizational departmental or hierarchical barriers (Nooshinfard & Nemati-Anaraki, 2014; Zheng, 2017). Additionally, the richness allows multimodal KS. For example, images are embedded in explanations in online communities to aid tacit KS (Charband & Navimipour, 2016). However, interaction mediated by online technologies can be less effective than face-to-face communication (Usoro et al., 2007). Although these technology-enabled communication channels support the creation, storage, and other KS processes, they are not the only factors required to enable KS successfully (Nooshinfard & Nemati-Anaraki, 2014).

4.1.3.3 Take away technological factors

This section has seen some influential factors in the technological dimension. The literature discusses technology as a major (often misused) influence factor. Technology is hailed as an enabler of richer communication by removing geographic, time, space, and organizational barriers and is discussed as a significant positive influence on KS. An often overlooked detail in

this regard is that technology can only partially enhance KS and that individual and organizational factors more heavily influence KS.

4.1.4 Nature of the knowledge being shared factors

Another cluster of conditions can be found in the characteristics of shared knowledge. These influence factors refer to the knowledge being shared and not to the parties involved in the KS.

4.1.4.1 Type of knowledge

The nature of the knowledge that is shared influences the efficiency and extent to which KS occurs. For this, we look at the types of knowledge discussed in Section 3.5.1. Tacit knowledge tends to be more challenging to share than codified explicit knowledge because the more codifiable and teachable knowledge is, the easier it is to transfer it (Soekijad & Andriessen, 2003). This does not mean that all explicit knowledge is equally sharable because there is a difference between rationalized and embedded knowledge. Because rationalized knowledge has been separated from its original source and is independent of specific individuals, it is often shared. Embedded knowledge is not easily shared due to the attached context, personal information, or other sensitive content (Ipe, 2003).

4.1.4.2 The topic of knowledge

In addition, the content of the knowledge in question determines the willingness of the parties to share it. For example, parties are often willing to share knowledge through experiences regarding processes, expertise, finished projects, insights into other individuals and organizations, and information on publications on knowledge domains. Knowledge that parties are less willing to share consists of plans and market developments, proposals for research, new projects, and knowledge of strategically important clients and models, methods, or instruments (Soekijad & Andriessen, 2003).

4.1.4.3 Take away knowledge being shared factors

As seen in this section, it is not just the organization or the individual that influences the KS process. Another factor of influence is found in the knowledge that is being shared. Two major factors are the type of knowledge and the topic of knowledge. Some types of knowledge are easier to share than others, and the topics of knowledge can influence the willingness of parties to participate in KS.

4.1.5 Interorganizational factors

Interorganizational factors are factors that influence the sharing of knowledge between organizations. This is the level of knowledge sharing in which two or more organizations share their organizational knowledge. At the interorganizational level, all the factors previously discussed are at work. This is because knowledge first moves vertically through the organization through individual, group, and organizational levels before being horizontally shared with other organizations (Nooshinfard & Nemati-Anaraki, 2014). As a result, many of the factors of influence on the interorganizational level seen in the literature resemble those of other levels that we have

seen in previous sections, like trust, rewards, information as power perception, availability of time, a shared common ground (cognitive model) (Al-Busaidi & Olfman, 2017; Charband & Navimipour, 2016; Nooshinfard & Nemati-Anaraki, 2014). In addition, there are also factors unique to the interorganizational level, such as the difference and proximity between organizations in terms of geographical, organizational, and technical distance and differences in origins, values, and cultures (Al-Busaidi & Olfman, 2017; Charband & Navimipour). Other factors include organizational boundaries of bureaucracy and perceived risk of participating, which is related to trust (Al-Busaidi & Olfman, 2017).

4.1.5.1 Trust and relation

In the literature, trust and its effect on the relationship between organizations are commonly cited as a significant factor of influence on interorganizational KS (Mentzas et al., 2006; Nooshinfard & Nemati-Anaraki, 2014; Soekijad & Andriessen, 2003; Usoro et al., 2007). Trust between the parties directly influences their openness, as shown in the willingness to engage in KS (Mentzas et al., 2006). In addition to this, observable trusting behavior of both parties during interactions is essential for long-term partnerships. As a result, the success of KS is heavily influenced by the regulation of interorganizational relationships, which in turn is influenced by trust (Mentzas et al., 2006). Trust, therefore, influences the nature of organizational relationships and the extent and nature of shared knowledge (Panteli & Sockalingam, 2005). This trust can stem from positive experiences with knowledge sharing in alliances or with a specific partner (Soekijad & Andriessen, 2003). Another way to foster trust involves having high openness (Usoro et al., 2007). Other factors influencing interorganizational trust are having shared values and goals, the degree of embeddedness (which is the degree to which alliance relationships are facilitated using trust, mutuality, and flexibility), and the presence of an influence strategy (which refers to a wide range of different means used by organizations to motivate other organizations toward joint activities and overcome resistance) (Chen et al.,2014).

4.1.5.2 Organizational proximity

Another factor of influence is the proximity between the organizations involved. This proximity can influence their relationship and their ability to participate in KS. Three dimensions of proximity relevant in interorganizational KS can be distinguished: geographical, organizational, and technological proximity. Geographical proximity refers to the geographical distance between organizations. Organizations in the same area have more geographical proximity than organizations in different areas. Geographical proximity promotes face-to-face communication and brings companies together. This yields richness in communication and facilitates the exchange of explicit and tacit knowledge. Therefore, greater geographical proximity increases knowledge sharing (Nooshinfard & Nemati-Anaraki, 2014). Organizational proximity refers to the similarity between organizations. The similarity between organizations generates a capacity to combine information and knowledge from the collaborating organizations and transfer tacit knowledge and other non-standardized resources. As a result, organizational proximity also allows KS (Nooshinfard & Nemati-Anaraki, 2014). Technological proximity is based on shared

technological experiences and knowledge bases. If organizations are technologically close together, they can share their knowledge bases, increasing the possibilities for KS (Nooshinfard & Nemati-Anaraki, 2014).

4.1.5.3 Take away interorganizational factors

In this section, we have seen several factors that are active at the interorganizational KS level. Although the number of factors is small, many factors (also) acting on the other levels are also cited in interorganizational KS literature. These include trust, culture, time, rewards, and motivation.

4.2 Situational factors

Here we discuss the factors of influence as seen in the background knowledge and the factors of influence sections. For each factor of influence, we list its source, name, a short description, and whether they are feasible to assess in a research project. Next, we describe related situational factors that we think we can assess per factor of influence. We included a list of values we think the situational factor can take for each. These values are based on the values discussed in the source sections with influence factors. Moreover, we add a category for each situational factor, later used to structure the situational profile. Any situational factors could be based on the factor of influence and the possible values of the situational factors. In this list, we attempt to merge any similar factors of influence discussed in the background knowledge and the factors of influence. Next to the factors of influence seen in the literature, there are also some factors we thought to be of interest that is not explicitly named in the literature. These have the source denoted 'own input.' In the source column. The situational factors are contained in Table 4 below.

Table 4: Situational factors

Source	Name	Description	Feasible to assess?	Situational factor	Category	Values
Background knowledge/ Factors of influence - *nature of the knowledge being shared*	Type of the knowledge	The type of knowledge that is shared has been established to influence the effort and willingness to share knowledge significantly. As we have seen, some types are more sensitive or perhaps tacit and, therefore, more challenging to share, while others are easier to share.	Yes, we think this factor can be assessed as it is derivable from descriptions organizations can provide.	Type of the knowledge being shared.	Knowledge being shared	Explicit (embedded, rational), Tacit. A short textual explanation could be added to specify further.

Source	Name	Description	Feasible to assess?	Situational factor	Category	Values
Background knowledge	KS level	The KS level describes the level at which the KS is set to occur. This influences how we regard KS and the factors of influence (i.e., interpersonal KS is not subject to interorganizational factors, but the opposite is not true)	Yes, we think this factor can be assessed as we can observe who is set to engage in KS.	KS level	KS interactions	Inter-personal, team, organizational, interorganizational.
Background knowledge	KS modality	KS modality describes the modality in which the communication related to KS is conducted.	Yes, we think that the modality of the KS can be assessed as we can observe how the KS is conducted.	KS modality	KS interactions	(online, offline)
Background knowledge / Factors of influence – *Technological factors*	KS tool support	The KS tool support entails tool support for the KS activities. Examples we named were KMS and IOKSS. In the technological factors section, we learned that the user's efficacy primarily determines the effects of the tools in using the tool	Yes, we think we can assess the KS tool being used and estimate the user's efficacy in using the tool.	KS tool support	KS interactions	Free form describing any KS tools involved in the KS processes
				KS user efficacy	KS interactions	Very low, low, medium, high, very high
Factors of influence – *Individual factors* /	Motivation	From the literature, we conclude that motivation is an important condition for both the knowledge provider and the knowledge	Partly, we acknowledge that motivation may not be directly observable, but we think that we can attempt to assess the	Motivation to act as a knowledge provider	Motivation	Extrinsic/ Intrinsic, along with a short explanation.

Source	Name	Description	Feasible to assess?	Situational factor	Category	Values
Organizational factors / Technological factors / Inter organizational factors		recipient on all levels of knowledge sharing.	motivations by evaluating motivational influences like incentives and rewards.	Motivation to act as knowledge recipient	Motivation	Extrinsic/ Intrinsic, along with a short explanation.
Factors of influence – *Individual factors*	Personal characteristics	We have seen that personal characteristics influence the degree to which an individual is willing to engage in KS. These characteristics included demographic information such as sex, age, and prior work experience. However, there were also characteristics more tied to personality traits like openness. Moreover, other traits were internal to the individual, such as perceived self-efficacy and confidence.	Partly, In the scope of a research project, we think that (aggregates of the) demographics are feasible situational factors. The internal personality-linked factors of influence may be too challenging to assess and are, therefore, not feasible to consider in the situational profile.	Age	Personal characteristics	Distribution over common age categories (I,e 10% 20-25, 80% 25-30, and 10% 30-35) of all involved in KS.
				Sex	Personal characteristics	Distribution of gender of all involved in KS.
				Education	Personal characteristics	Distribution of completed or following education of all involved in KS.
Factors of influence – *Individual factors / Organizational factors / Inter organizational factors*	Time	We have seen that time considerably influences KS on the varying levels we have discussed. It can be a barrier in case of limited time and an enabler if sufficient time is allotted to engage in KS.	Yes, the time factor of influence can be described by the amount of time available for KS and the frequency it is set to occur.	Time	KS interactions	Free form describing the amount of time available for the KS activity and the frequency in which it is expected to occur.

Source	Name	Description	Feasible to assess?	Situational factor	Category	Values
Factors of influence – *Individual factors / Inter organizational factors*	Trust	Trust has been discussed as one of the most important influence factors on various levels of KS. Moreover, it is seen as a condition for KS to happen.	Partly, we think that direct inference of trust levels as part of a research project may be challenging as trust is a multifaceted, complex concept. On the other hand, some expectations can be drawn using indicators and inducers of trust, like closeness in the relationship or network coupling.	Trust in the network	KS network characteristics	Very low, low, medium, high, very high
Factors of influence – *Individual factors / Organizational factors*	Fear	The fear associated with KS can act as a barrier. We have seen several types of fear, such as fear of the loss of superiority.	No, We think this fear cannot be feasibly assessed as part of a project as it may be internal or unconscious. We think this fear may be connected to the nature of the knowledge being shared factor, i.e., does the knowledge provide a competitive advantage that the individuals can fear losing by sharing that knowledge. Therefore this factor does not provide a situational factor, but its sentiment, i.e., the competitive advantage, is considered part of knowledge factors' nature.	None	None	None

Source	Name	Description	Feasible to assess?	Situational factor	Category	Values
Factors of influence – *Organizational factors*	National culture	The national culture can influence the extent to which KS is native to the stakeholders and to which KS will occur.	No, We think national culture may be too multifaceted to be grasped into a single or small group of factors. Additionally, the national culture may not be feasible and relevant when examining international inter-organizational KS.	None	None	None
Factors of influence – *Organizational factors*	Organizational culture	The organizational culture is said to influence KS both as a driver and as a barrier, depending on whether it encourages KS or not in its visible and invisible cultures.	No, while we think we can assess the visible parts of the organizational culture, we cannot assess the invisible parts reducing the overall clarity of the culture.	None	None	None
Factors of influence – *Organizational factors*	Organizational strategy	The organizational strategy expressed in its goals influences KS as it can influence the motivation to engage in KS.	No, while we think that we can ascertain their strategy and goals for some organizations, this may also be internal to many organizations. As a result, we cannot get a clear picture of all organizations in the network.	None	None	None
Factors of influence – *Organizational factors*	Organizational structure	The organizational structure influences KS in how knowledge travels through the organization. We found two distinct structures in the literature with	Yes, we think that depending on the situation, it is feasible to assess the structure of the organizations	Organizational structure	Organizational characteristics	Formal (hierarchical), informal (horizontal)

Source	Name	Description	Feasible to assess?	Situational factor	Category	Values
		their own KS effects.				
Factors of influence – *Organizational factors*	Organizational leadership	Organizational leadership described the extent to which organizational leadership supported KS.	No, we think that we cannot assess the true support. We can only make a guess based on the extent KS is observed per organization in the network.	None	None	None
Factors of influence – *Organizational factors*	Organizational KM mechanisms	The organizational KM mechanisms influence KS by determining the opportunities for engaging in KS.	No, we have seen that KM mechanisms can be complex and unique to organizations, and we do not think they are feasible to assess for all organizations of a KS network.	None	None	None
Own input	Organizational characteristics	Like the personal characteristics, we think organizational characteristics like its size and branch can illustrate the situation of the KS network activities.	Yes, the organizational characteristics can be assessed as part of a project because both the size and the branch of organizations are often public knowledge found on their corporate sites or social media profiles	Size	Organizational characteristics	Distribution of the organization sizes in the network.
				Branch	Organizational characteristics	Distribution of the branches in the network.
Factors of influence – *Individual factors / Organizational factors / Inter organizat*	Rewards	Rewards and incentives have been linked to the motivation to engage in KS.	Yes, we think we can assess the rewards and incentives depending on the KS level.	Incentives	Motivation	Free form description of the incentives in place to encourage KS on the relevant KS interaction levels.

Source	Name	Description	Feasible to assess?	Situational factor	Category	Values
ional factors						
Factors of influence – *Organizational factors*	Shared mental model	Having a shared mental model makes KS easier as all parties refer to the same concepts	Yes, we can assess the presence of a shared (mental) model as we think it could be derived from having a shared background or common goal. It can also be linked to the knowledge being shared.	Shared model	KS interactions	Free form description of the shared model
Factors of influence – *Organizational factors*	Diversity	The diversity within an organization has been described as an ambiguous influence on KS. Some sources state that homogeneous groups engage more in KS, while others support heterogeneous group structures.	No, we think diversity is too ambiguous and multi-faceted to be assessed as part of a situational profile.	None	None	None
Factors of influence – *Knowledge being shared factors*	The topic of the knowledge being shared	The topic of the knowledge being shared influences the willingness and effort required to share the knowledge.	Yes, We think we can assess the topic of the knowledge because it	The topic of the knowledge being shared	Knowledge being shared	Free form description of the knowledge being shared.
Factors of influence – *Inter organizational knowledge sharing factors*	Organizational proximity	Organizational proximity has been found to influence KS in terms of geographical, technical, and organizational proximity.	Partly, we think we can assess geographical and organizational proximity to some extent. Technical proximity may be too challenging as we think it is too elaborate to be easily assessed.	Geographical proximity	Knowledge network characteristics	Free form description of the geographical proximity
				Organizational proximity	Knowledge network characteristics	Free form description of the organizational proximity

Source	Name	Description	Feasible to assess?	Situational factor	Category	Values
Background characteristics Factors of influence – *Inter organizational* Own input	Network characteristics	Like the personal characteristics, we think there are some situational factors not explicitly named in the literature review that could be used to describe the situation. For this, we propose the network size, in terms of organizations, the total number of interacting individuals, The presence of network goals, the network coupling (i.e., the number of links/connectedness in the network)	Yes, we think we can assess all these network characteristics in the scope of a research project.	Network size	Knowledge network characteristics	Free form description of the number of participating organizations and the total number of participating individuals.
				Network goals	Knowledge network characteristics	A free-form description of the goals of the network. (pursuing common goals, partly pursuing common goals, not pursuing common goals, etc.)
				Network coupling	Knowledge network characteristics	Describes the coupling of the network, which describes the connectedness of the network members. (high, medium, low)

4.3 Situational profile

This section combines the situational factors we identified into a situational profile framework. In this framework, we attempt to simplify situational factors and, where possible, merge similar factors to construct a simple, concise, but comprehensive situational profile. For this, we group the factors per category. We first list the KS level independent factors (i.e., factors that apply to most levels) and then progress from the lowest level of KS (personal) to situational factors of the highest KS level (inter-organizational). The resulting situational profile structure is displayed below in Table 5.

Table 5: Situation profile framework

Category	Situational factor	Description	Possible values
KS interaction	Interaction level	Describes the expected level of interaction. For example, are representatives of organizations engaging in KS, or are all individuals of participating organizations expected to engage in KS.	(Inter-personal, team, organizational, interorganizational)
	Modality	Describes the modality of KS communication.	(online, offline)
	Tool support	Describes the tools involved in the KS efforts	Free form
	KS tool user efficacy	Describes the extent to which the users can effectively use the tool support.	Free form
	Time	Describes the frequency and time available for KS.	Free form
	Shared mental model	Describes the presence of shared common ground in a mental model.	Free form
Motivation	Motivation for acting as a knowledge provider (linked to the interaction level)	Describes the motivation for engaging in KS as a knowledge provider on the interaction levels identified in the interaction level factor.	(Extrinsic, Intrinsic, both, neither) along with a short explanation
	Motivation for acting as a knowledge recipient (linked to the interaction level)	Describes the motivation for engaging in KS as a knowledge receiver on the interaction levels identified in the interaction level factor.	(Extrinsic, Intrinsic, both, neither) along with a short explanation
	Incentives	Describes the incentives for engaging in KS activity on the interaction level identified. (can be used to illustrate motivation further)	Free form

Category	Situational factor	Description	Possible values
Knowledge being shared	Type of knowledge being shared	Describes the type of knowledge that is being shared. In the case of openBest, this is most likely mostly embedded knowledge with some explicit rationale. This is because the knowledge is written down in GPs but is context-dependent and embedded.	(Explicit (embedded, rational), tacit)
	Topic of the knowledge being shared	Describes the topic and contents of the knowledge that is being shared.	Free form describing the content of the knowledge
Personal characteristics	Age	Describes the age distribution of the individuals involved in the KS interactions.	Distribution over common age categories (I,e 10% 20-25, 80% 25-30, and 10% 30-35) of all involved in KS.
	Sex	Describes the gender distribution of the individuals involved in the KS interactions.	Distribution of gender of all individuals involved in KS.
	Education	Describes the distribution of the educational background of the individuals involved in the KS interactions.	Distribution of completed or following education of all involved in KS.
Organizational characteristics	Organization size	Describes the average number of employees of the organizations involved in a domain.	Numerical Range
	Organization branch	Described the branch distribution of the organizations involved in the KS interactions	Free form
	Organizational structure	Describes the structure of the organizations involved in the KS interactions.	(Formal (hierarchical), Informal (horizontal))
Knowledge network characteristics	Network size	Describes the size of the network. This can be a combined factor of the number of organizations in a domain and the expected total number of individual users interacting.	Numerical Ranges
	Network goals	Describes whether the network of responsible organizations pursues a common goal or not. A common goal could be to be more responsible.	(Pursuing common goals, partly pursuing common goals, not pursuing common goals.)

Category	Situational factor	Description	Possible values
	Network coupling	Describes the coupling of the network. For example, to what extent are the organizations related to each other, and higher coupling implies more expected interactions.	(High, Medium, Low)
	Network geographical proximity	Describes the geographical proximity of the organizations in the network.	(High, Medium, Low)
	Network organizational proximity	Describes the organizational proximity of the organizations in the network.	(High, Medium, Low)
	Trust in the network	Describes the perceived trust the stakeholders defined at the interaction level have in the other stakeholders at the same interaction level. This is linked to the network coupling and the goal of the network.	(High, Medium, Low)

In this project, we use this situational profile to document the situation of our test case. This situational profile is used to draw expectations of the KS we expect to see in the test case. In future projects, wherein openBest is to be validated as a treatment for enabling knowledge sharing on ESE topics using good practices among responsible organizations. This situational profile can be used to characterize the varying validation cases. For this the values for the variables in the profile should be determined by analyzing the network of organizations.

5 | Designing a knowledge sharing behavior evaluation framework

This chapter proposes a framework for evaluating knowledge-sharing behavior for good practice repositories. First, we investigate how knowledge-sharing behavior can be theoretically evaluated. Then we design a theoretical knowledge-sharing behavior framework for identifying KS-associated actions in a GPR. We describe this behavior framework using a theoretical GPR. Next, we design a theoretical knowledge sharing behavior evaluation framework that enables us to record the KS-related actions we identified.

5.1 On measuring knowledge sharing

Knowledge sharing is challenging to measure (Lee, 2000; Ma & Yuen, 2011). This is because KS involves primarily internal processes and not directly observable variables. Due to this, measuring these variables is challenging. A search in Google Scholar that involves terms that couple knowledge sharing behavior to good practice repositories, such as *'(measuring OR assessing) AND knowledge sharing behavior AND (good practice repositories OR best practice repositories)'* shows that no effort has been made to develop knowledge sharing behavior evaluation frameworks or measurement instruments in the context of good practice repositories. This means that, to our knowledge, no knowledge-sharing behavior evaluation frameworks have been developed in our context. Consequently, we must look at knowledge-sharing behavior evaluation frameworks from other contexts.

Generally, we observe two main methods to measure online knowledge sharing behavior. The first is to count KS-related activity. In the context of online learning platforms, empirical studies often measure online knowledge sharing in terms of participation, interactions, time for KS, the usefulness of shared knowledge, and their relationship to an outcome (Ghadirian et al., 2014; Ho & Kuo, 2013; Ma & Yuen, 2011). For example, online discussions have been examined by assessing posted messages, collaborative learning environments have been examined by assessing interactional activity, and knowledge-building communities have been studied by investigating the knowledge sharing of learners with other members of the community (Ma & Yuen, 2011). In an experiment aimed at measuring KS behavior, Kuo and Young (2008) measured KS behavior by aggregating the frequency of two types of knowledge-sharing activities: transmission and absorption. The transmission and absorption actions include posting issues, participating in discussions, and responding to questions. They claim that this method is justified because it aligns with mechanisms present in the literature at the time. This is supported by a review of the literature on measuring KM performance by Shannak (2009). This review of the literature examined KMS performance evaluation frameworks used by organizations such as KPMG and Hewlett Packard. This examination showed that these organizations also use indicators like the number of good practices identified, number of contributions, active involvement, number of participating employees, number of postings/contributions, and number of downloads. This information can be collected using user surveys and maintaining an activity

log database. This shows that these organizations often refer to the activities recorded in the KMS to conclude the KS activities enabled by the KMS. Computer-based knowledge sharing is relatively easier to track because an individual's contributions to knowledge bases or online discussions are easily observable.

As we can see, in many cases, the monitoring and evaluation of online knowledge sharing are done by looking at the frequencies of interactions within the online environment. A drawback of this is that, according to some authors, it is challenging to measure KS simply by counting the frequency of interactions (Ghadirian et al., 2014; Ma & Yuen, 2011). Moreover, this approach emphasizes the product approach to knowledge, while quality and process are ignored (Yi, 2009). The other method, self-reporting, is suggested to address these shortcomings (Ma & Yuen, 2011). This self-reporting can be done using questionnaires. Ghadirian et al. (2014) describe various studies in the context of online learning platforms in which questionnaires are applied following the KS constructs (e.g., collection, donation). They illustrate that the perceived interaction measured with these questionnaires translates into actual knowledge-sharing behavior. An example of such a questionnaire is Yi's Knowledge-Sharing Behavior Scale (KSBS) (2009). This scale used to assess KS among academics measures knowledge-sharing behavior by considering various elements of the engaging parties, including interactions outside IT systems.

In our situation, we want to develop an evaluation framework that measures KS behavior in terms of KS-related activities enabled by a good practice repository. We think it is best to follow the school of thought about counting activity frequencies. The reason for this is that this could be automated, requires no additional effort from the user, and does not interfere with the knowledge-sharing process. Furthermore, we do not want to put effort into reporting knowledge-sharing behavior on the user's end as we expect that users may not be willing to fill in periodic questionnaires. These questionnaires can become quite elaborate, making it unlikely that users will complete them. As a result, we have chosen to pursue the approach in which the frequencies of activities are kept.

5.2 Designing a good practice repository knowledge sharing behavior framework

From the literature, we conclude that measuring knowledge sharing is challenging because it involves internal processes and interactions outside the GPR. Because of this, many variables, such as the extent of knowledge absorption, cannot be directly observed. As an alternative, the sources prescribe that we could look at explicit behavior, such as activities or interactions within a tool that can be measured. This means that the interactions happening in the GPR are used as a measurement construct for the knowledge-sharing behavior exhibited in the tool. This means that the activities supported by the good-practice repository are central to developing the knowledge sharing behavior evaluation framework. For this, we propose a method for designing the GPR-specific framework where the GPR-supported activities are first identified based on the stakeholders' goals. Next, the KS processes of interest are identified. When the activity and relevant KS processes are identified, they are mapped to each other. The result is an overview of all relevant GPR-supported activities and their associated KS process. Next, it is determined which variables can be collected for the activities. Examples include the activity name and the actor performing the activity. These variables and their possible values are then collected and form the basis for developing an instrument for recording these activities. Note that the method outlined here is based on the decomposition step of the family of validations method by Plomp, 2020. It was thought suitable here because it effectively describes steps to decompose a GPR top-down from stakeholders to its supported activities. The main difference between this proposed method and the decomposition step by Plomp is that instead of looking at implementation status and validation aspects of a given tool-assisted activity, we map KS processes to the activities. This means that as far as the decomposition is concerned, the methods are highly similar, but the mapping performed is based on different goals and yields different products. The proposed method for identifying KS behavior in a GPR is further illustrated in the PDD diagram below.

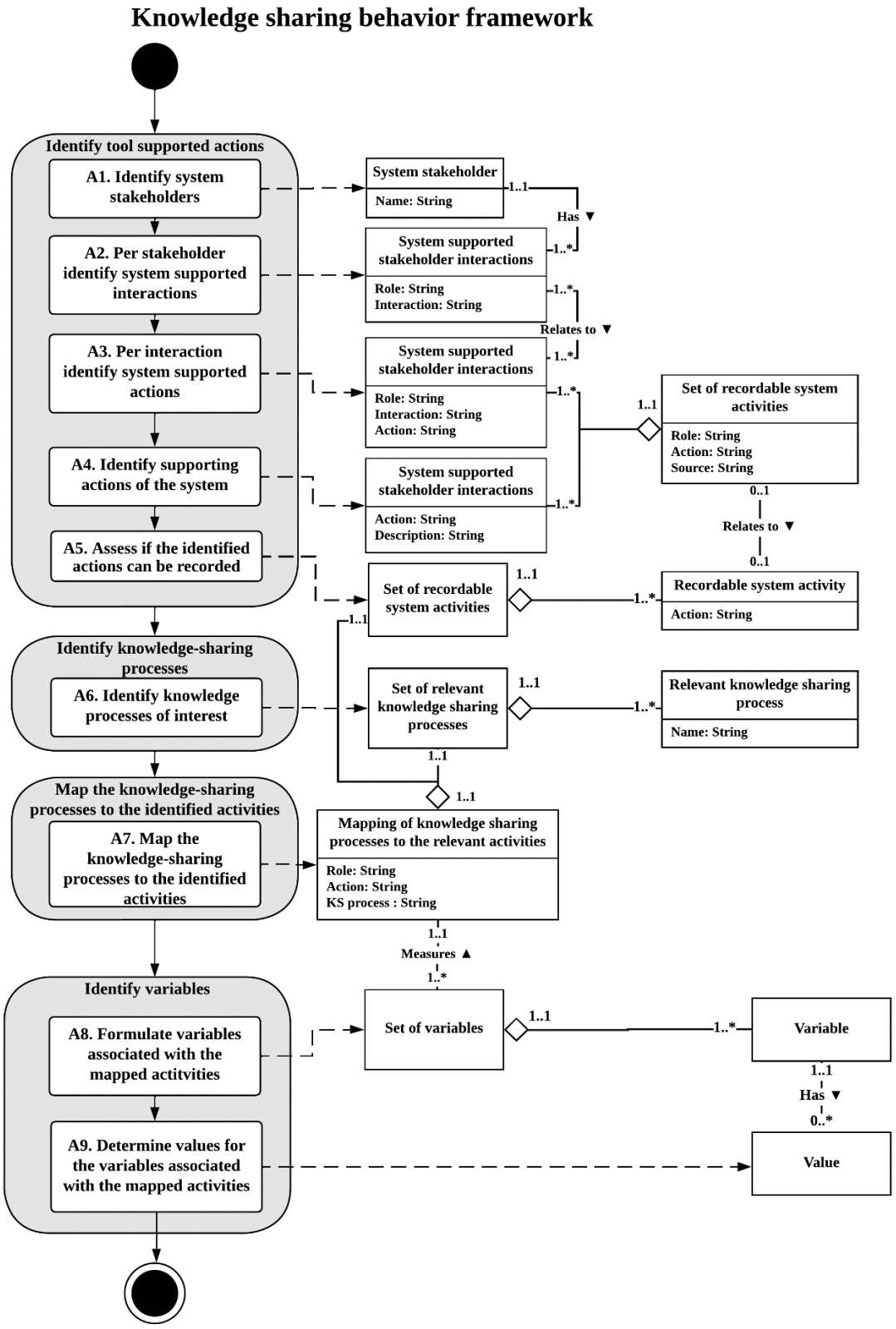


Figure 16: KS behavior framework PDD

SIR: A theoretical GPR running example

In the following sections, we illustrate these steps using a theoretical example, GPR. This example GPR, which we will call the Sustainability Improvement Repository (SIR), includes the features defined by Coenen (2020)[5] to be essential in a GPR. In SIR, a user can create and view good practices on ESE topics. This means that he wants to be able to submit (C-RF8), edit, or remove a good practice (C-RF3) and browse (C-RF4) and view the good practices of others (C-RF2). Next, an administrator manages the tool's users by adding or removing a user (C-RF6). Additionally, the administrator keeps the good practice repository in good shape by managing the good practices by editing or removing them (C-RF3). The GPR is built as a website with a database that stores the GPs (C-RF1) and features an account-based log-in feature (C-RF6). For a good practice template, SIR employs a simple structure. The GP document features a GP title, category, date of posting, description, and the name of the person who wrote it.

[5] For traceability we included the feature identifier (C-RF#) of Coenen's features as seen in Appendix E: Requirements from related projects per functionality named.

Step1: Identify tool-supported actions

We have seen that the activities facilitated by the KS systems are central in measuring KS behavior. However, these activities can vary between systems. Therefore, the first step of our method is to identify the activities that SIR allows. For this, the activities that the system allows need to be analyzed. For this, the system can be decomposed into the stakeholders, their interactions, and the actions the GPR can record. Effectively, we perform a role-based decomposition of the system. This analysis then yields a list of all recordable actions that a user can perform within the GPR that the GPR can record. The activities of this step are further elaborated on in the table below.

Table 6: Activities of the identify tool-supported actions step

<table>
<tr><th>Activity</th><th>Description</th></tr>
<tr><td>A1. Identify system stakeholders</td><td>The first activity involves identifying the stakeholders of the GPR. In our theoretical example, we can see two stakeholders: the user and the administrator.</td></tr>
<tr><td>A2. Per stakeholder, identify system-supported interactions</td><td>In this activity, we consider the stakeholder system supported interactions. These interactions are broad descriptions of what a stakeholder wants to do using the GPR. For SIR, we can identify some interactions for the stakeholders who correspond to roles within the GPR. These interactions are:

Table 7: Role-based interactions of the theoretical GPR
<table><tr><th>Role</th><th>Interaction</th></tr><tr><td>User</td><td>Create good practices</td></tr><tr><td></td><td>View the good practices of others.</td></tr><tr><td>Administrator</td><td>Manage the GPR</td></tr></table></td></tr>
<tr><td>A3. Per interaction, identify system supported activities</td><td>Per interaction, the associated tool-supported actions are to be identified. For this, the interactions can be explored within the GPR. By doing this, we can investigate which actions are associated with a given interaction. This substantiates how a GPR supports an interaction. For SIR, we used the description to determine the actions. This yields the following:

Table 8: Actions per interaction of the theoretical GPR
<table><tr><th>Role</th><th>Interaction</th><th>Action</th></tr><tr><td>User</td><td>Create good practices</td><td>Submit a good practice</td></tr><tr><td></td><td></td><td>Edit a good practice</td></tr><tr><td></td><td></td><td>Remove a good practice</td></tr><tr><td></td><td>View the good practices of others</td><td>View a good practice</td></tr><tr><td></td><td></td><td>Search/ Browse good practices</td></tr><tr><td>Administrator</td><td>Manage the GPR</td><td>All actions of the user</td></tr><tr><td></td><td></td><td>Adding a user</td></tr><tr><td></td><td></td><td>Removing a user</td></tr></table></td></tr>
</table>

<table>
<tr><th>Activity</th><th>Description</th></tr>
<tr><td>A4. Identify supporting actions of the system</td><td>Supporting actions like opening and closing a page or a good practice can also be mapped depending on the good practice platform. These additional supporting actions can provide a more fine-grained insight into the user's interactions. In our example case, this yields:

Table 9: Supporting actions of the theoretical GPR
<table><tr><th>Supporting action</th><th>Description</th></tr><tr><td>Log in</td><td>The activity where the user logs in to SIR</td></tr><tr><td>Log out</td><td>The activity where the user logs out of SIR</td></tr><tr><td>Open Page</td><td>The activity where the user opens a page in SIR</td></tr></table></td></tr>
<tr><td>A5. Assess if the identified actions can be recorded</td><td>Next, we must assess if the identified actions can be recorded within the GPR. For this, the GPR needs to be examined on the identified actions, and per action, it should be determined if they can be recorded. In our theoretical SIR GPR, we say that all activities can be recorded. Consequently, the following recordable actions are seen in SIR.

Table 10: Recordable actions in SIR
<table><tr><th>Role</th><th>Action</th><th>Source</th></tr><tr><td rowspan="8">User/ Administrator</td><td>• Submit a good practice</td><td>Stakeholder interaction</td></tr><tr><td>• Edit a good practice</td><td>Stakeholder interaction</td></tr><tr><td>• Remove a good practice</td><td>Stakeholder interaction</td></tr><tr><td>• View a good practice</td><td>Stakeholder interaction</td></tr><tr><td>• Search/ Browse good practices</td><td>Stakeholder interaction</td></tr><tr><td>• Log in</td><td>Supporting action</td></tr><tr><td>• Log out</td><td>Supporting action</td></tr><tr><td>• Open page</td><td>Supporting action</td></tr><tr><td rowspan="2">Administrator</td><td>• Adding a user</td><td>Stakeholder interaction</td></tr><tr><td>• Removing a user</td><td>Stakeholder interaction</td></tr></table></td></tr>
</table>

Step 2: Identify knowledge-sharing processes

The next step involves identifying the KS processes that the GPR enables. This is required to evaluate the KS behavior of the GPR later. Common KS processes involve knowledge collection and knowledge donation (Ghadirian et al., 2014; Kuo & Young, 2008; Nodari et al., 2016). These processes have slightly different names in varying sources, but they all refer to the same umbrella of KS processes. In other works, characteristics of the KS network are also used (Ganguly et al., 2011). The granularity and terminology used for the processes vary between the works. For example, Laudon & Laudon (2020) recognize more KS processes like Acquiring, Storing, Disseminating, and Applying. Depending on the later analysis requirements (i.e., what level of granularity is of interest), a set of these processes is to be selected for inclusion. The activity for identifying knowledge processes is elaborated upon below.

Table 11: Activity of the knowledge-sharing processes identification step

Activity	Description
A6. Identify knowledge processes of interest	This activity involves composing a list of knowledge sharing processes that the GPR supports. These processes typically include knowledge donation and collection but could vary depending on the granularity of the knowledge process identification and sources, as varying names are used to describe similar processes. For our example, GPR SIR, we select the processes of **knowledge collection**, **knowledge donation**, and (modifying) the **characteristics of the network**. In this case, knowledge donation refers to explicitly observable behavior, like creating good practices. Knowledge collection refers to the explicitly observable behavior where a user looks for and collects knowledge. This does not necessarily imply absorption and does not evaluate the quality of the collection but merely states that it occurs. The modification of characteristics of the network refers to any adjustments made to the characteristics of the network (i,e. members and size).

Step 3: Map the knowledge-sharing processes to the identified activities

Once we have constructed lists of activities and KS processes, it is time to link the activities to KS, the processes we identified to be of interest in the previous activity. The mapping activity is further illustrated below.

Table 12: Activity of KS processes and activity mapping step

Activity	Description
A7. Map the knowledge-sharing processes to the identified activities	Next, for each identified recordable activity, the most relevant KS process must be selected. There are no known guidelines for this selection, so the mapping remains arbitrarily. For our mapping, we follow the literature example of KPMG by Shannak (2009), which describes creating good practices as knowledge donation and working from there. In our example case, we used knowledge donation, knowledge collection, and the characteristics of the network.

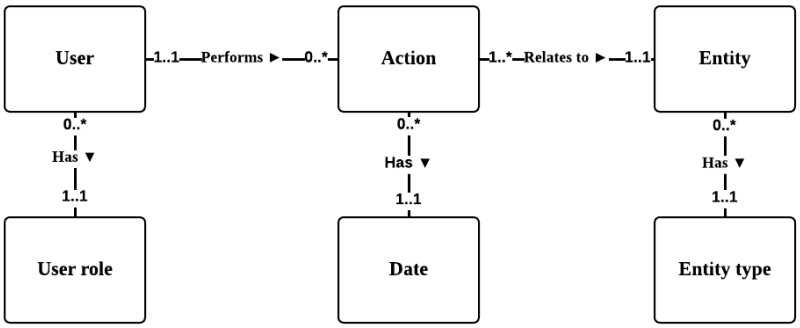
Table 13: Actions and their associated KS process for the theoretical SIR repository

Role	Action	Associated KS process
User	Submit a good practice	Knowledge donation
	Edit a good practice	Knowledge donation
	Remove a good practice	None
	View a good practice	Knowledge collection
	Search/ Browse good practices	Knowledge collection
Administrator	Adding a user	Modifying characteristics of the network
	Removing a user	Modifying characteristics of the network

Step 4: Identify variables

In this step, the variables of interest are further formulated. The activities for formulating the variables are elaborated upon in the table below.

Table 14: Activities of variable identification step

Activity	Description
A8. Formulate variables associated with the mapped activities	So far, we have established the roles (stakeholders), actions, and associated KS processes for the GPR. We should now consider what other variables related to the actions can be collected. For this, we look at common variables collected for activity logs, like **the resource** executing or initiating the activity, the **timestamp of the event**, or **data elements recorded with the event** (van der Aalst, 2012). In our case, this resource could be the user, the good practice, or other entities such as a page when a page is opened. For the resource, being a specific user or **entity**, like a specific GP, we can also consider its **(entity)type**. More concretely, we can record that a user opens good practice 'Teaming up for transportation' and that the good practice is of type good practice. Next, we can record the event's timestamp by polling the user's system time when the action is performed. Other elements that can be recorded with the event are the **user** and his **role**. From this, we see that we have **actions** (e.g., Creating, editing, removing) being performed by **users** who can have a **user role** (e.g., user, administrator) on a given moment (e.g., 1/6/2022 2:39 PM) that can be recorded with **a timestamp**. These actions are related to an **entity** that corresponds to the resource (e.g., good practice 'Reducing water waste"). This entity can also have an associated **entity type** (e.g., good practice x is a good practice). The variables and their links are illustrated in 19.  *Figure 17: Conceptual model of the variables* Note that the KS process related to an action is not linked to the data model. This mapping constitutes a separate table later joined with the activity data. This allows for more flexibility as the mapping can be easily altered after collecting the data. This is further discussed in the next section.
A9. Determine values for the variables associated with the mapped activities	Per variable, the possible values should be determined. Since the variables are based on the system process, we also encountered them during the earlier system decomposing activities, so we already have an impression of the possible values. For example, the **user role** can correspond to the stakeholders, and the **actions** are the mapped actions we described earlier. For the **user,** any appropriate unique ID can be collected. For the **entity type,** we can consider the entities in the GPR that are relevant in SIR. These are the user, the (web)page, and the good practice. For the

Activity	Description
	entity, any proper unique ID can be considered. Such an ID can later be cross-referenced with the entities dataset to gain additional information on the entity (e.g., looking for a GP ID to retrieve its title or category).

Table 15: Example of the variables and values for SIR

Variable	Type	Values
User	String	The users' account
User role	Enumeration	{Administrator, User}
Action	Enumeration	{open page, open good practice, open, create good practice, edit good practice, good practice, add user, add author, login, logout}
Entity type	Enumeration	{user, page, good practice}
Entity	String	ID of the entity to which the action applies
Date	Datetime	Dates using the datetime notation 'DD MM YYYY hh:mm:ss time zone'

5.3 Designing a good practice repository knowledge sharing behavior evaluation framework

Once the actions and the variables in the good-practice repository have been mapped, it is time to design an evaluation framework that fits our behavior framework. For this, we propose the following method. This method has four steps. In the first step, the action information is collected. Then the collected information is retrieved from the database, processed to be analysis-ready, and analyzed to conclude the GPR-enabled KS behavior. In the following sections, we illustrate all activities using the same example GPR, as seen in the design of the GPR KS behavior framework.

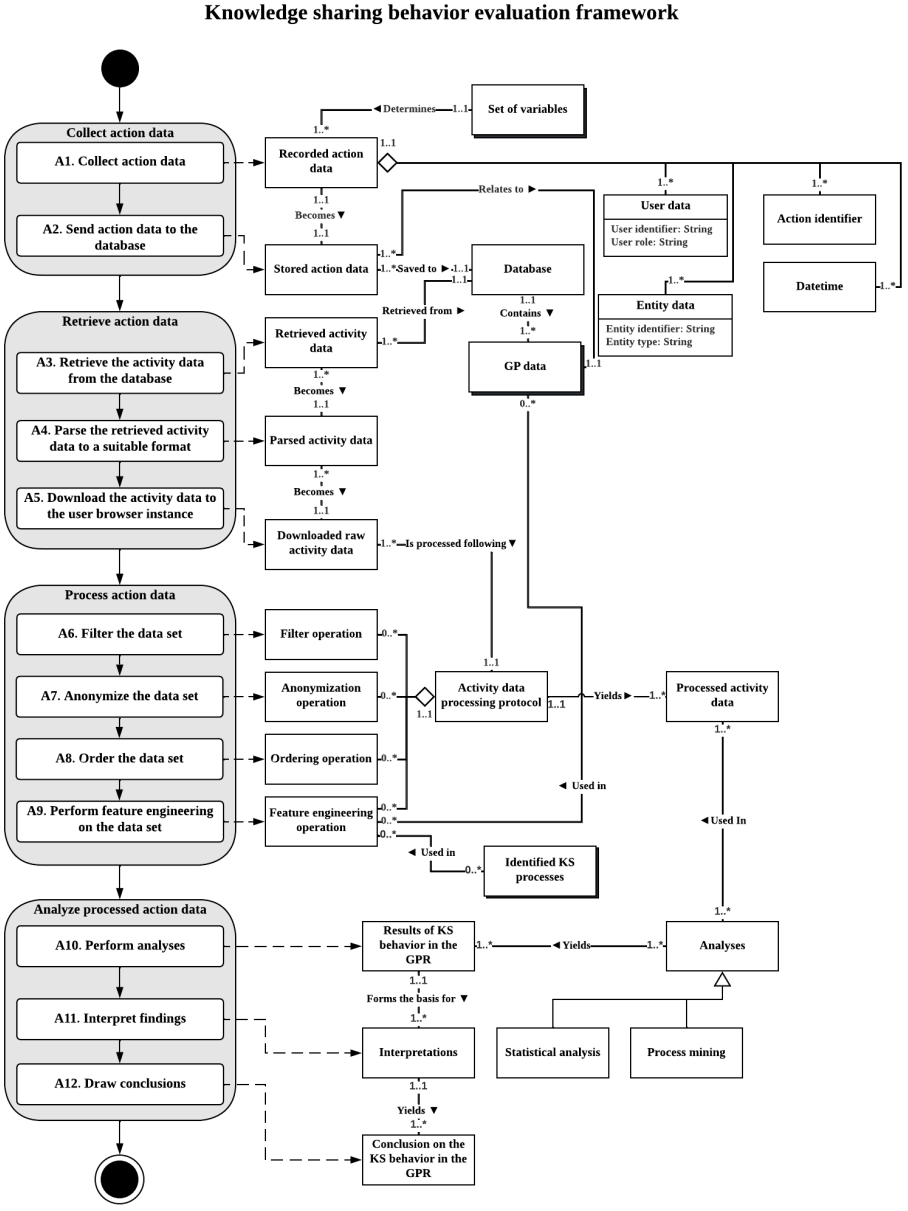


Figure 18: GPR KS behavior evaluation framework PDD

Step 1: Collect action data

In this step, the action data are collected by the GPR and sent to the database. The action data collection is based on the previously defined variables and values.

Table 16: Activities of the action data collection step

Activity	Description
A1. Collect action data	A procedure for collecting data associated with the identified activities should be designed. This involves designing a **trigger** (e.g., when the data should be collected) and a **data collection procedure**. For the trigger, the performance of one of the identified recordable activities can be considered. At the technical level, the call to the data collection function could be implemented in the event listener that captures the performance of such an action. For example, if a user opens a good practice, many functions are called. By implementing the caller of the data collection function in that routine, the collection function is called once the good practice is opened.
A2. Send action data to the database	Once all the activity data are gathered, the data is sent to the database of the good practice repository. The method depends on the platform, the good practice repository, and database services. For our SIR example, we can consider a simple post function for posting the bundled data to the database.

The proposed collection procedure is illustrated below in Figure 19.

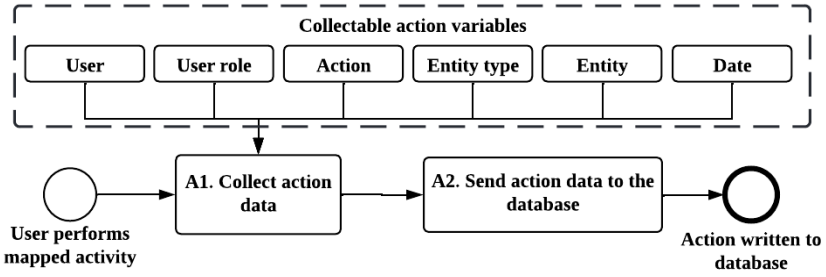


Figure 19: Overview of the activity data collection step

Step 2: Retrieve action data

Once we have collected data on knowledge-sharing behavior activity, we want to retrieve and analyze the data. For this, export functionalities are required either within the database of the good-practice repository directly or through the good-practice repository itself. For this, we suggest having an export functionality in the GPR itself so that a researcher does not need access and knowledge of the database. Ideally, this export yields a file containing all recorded activities and associated variables in a commonly used format, like a CSV. Because of this, we propose the structure elaborated upon in the table below.

Table 17: Activities of the retrieve action data step

Activity	Description
A3. Retrieve activity data from the database	First, the activity data should be retrieved from the database by the GPR. For this, SIR can send a fetch request to the database.
A4. Parse the data into a suitable format	The GPR then parses the data in a suitable format to be used by the researcher. Examples include CSV and XML. In our example case, SIR could process the received data and produce a CSV where each row corresponds to a recorded activity and the columns correspond to the identified variables.
A5. Download the parsed data to the user browser instance	Once the data has been parsed and put in a suitable format, the GPR must download the file to the user browser instance.

The proposed retrieval procedure is illustrated below in Figure 20.

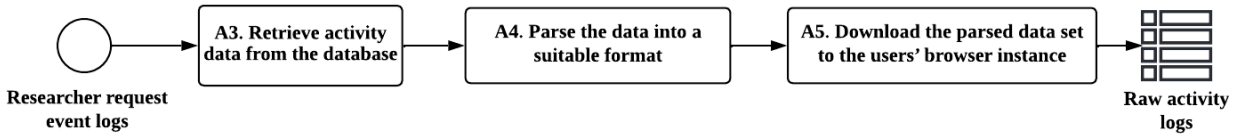


Figure 20: Overview of the action data retrieval step

Step 3: Process action data

Once the raw data logs are downloaded, the data set must be processed. These steps are required to transform the raw activity logs retrieved from the database into activity data that we can use in the analysis. The processing steps involve the following:

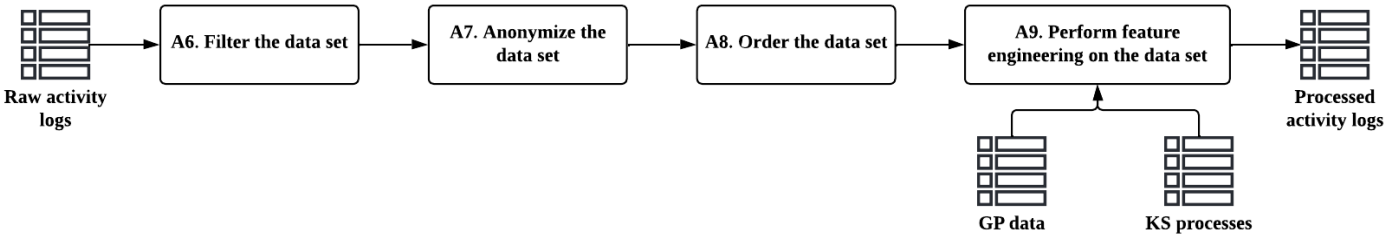


Figure 21: Overview of the activity data processing step

The actions per step are elaborated below.

Activity	Description	Rationale
A6. Filter the data set	The filtering activity can be used to clean the dataset by filtering out unrelated rows. In our setting, we will mostly focus on filtering out irrelevant data. In the SIR case, we at least suggest filtering the 'user' column to exclude actions of irrelevant actors (e.g., developer, researcher)	The reason for this exclusion is that the actions of these users are not relevant to the measurement because both are insider actors and not participants in the KS process.
A7. Anonymize the data set	Depending on the situation, the 'User' column will be anonymized. This can be done by constructing a secured translation table, only accessible by researchers, and replacing the username with the identifier in the translation table. After the anonymization has occurred, the translation table can be deleted. Alternatively, more advanced methods can be used.	Anonymization is required because the users of the good practice do not have to provide permission for their data to be used. They may be more inclined to provide permission for that anonymized logs of their activity may be used for scientific purposes.
A8. Order the data set	The collected data set can be ordered on two levels. The first level is the user in alphabetical order, and the second level is based on the date in ascending order. This provides the following structure: *Table 18: Example of ordered data* **User** | **Date** | **…** Participant A | 13-4-2022 11:32 | … Participant A | 14-4-2022 13:59 | … Participant B | 12-4-2022 9:12 | … Participant B | 13-4-2022 9:14 | …	The data set is ordered on these two levels so that the resulting list chronologically shows the activities recorded per case (participant). This way, we can easily assess the interactions per user.

<table>
<tr><th>Activity</th><th>Description</th><th>Rationale</th></tr>
<tr><td rowspan="2">A9. Perform feature engineering on the data set</td><td>Annotate KS process
The data set can be enriched by annotating the KS process associated with the activities described in Table 38. This yields the following:
Table 19: Example of KS process annotation
<table><tr><th>Action</th><th>KS process</th><th>…</th></tr><tr><td>Create good practice</td><td>Knowledge donation</td><td>…</td></tr><tr><td>Create good practice</td><td>Knowledge donation</td><td>…</td></tr><tr><td>Create comment</td><td>Knowledge donation</td><td>…</td></tr><tr><td>Open good practice</td><td>knowledge collection</td><td>…</td></tr><tr><td>…</td><td>…</td><td>…</td></tr></table></td><td>By annotating the associated KS process into the dataset, either by making a relational translation table (e.g., Creating good practice - knowledge donation) or filling in the values as an extra column in the interaction data. We can later perform an analysis based on the identified processes. The reason for annotating the KS process when the activity data is already collected is that this allows for flexibility in mapping the actions to KS processes (i.e., the mapping can be changed easily after the collection if needed.) this is more cumbersome when the information is linked at run time.</td></tr>
<tr><td>Annotate sessions
The data set can be enriched by annotating sessions. These sessions distinguish between idle time (e.g., not tasks related) and task-related time. Instead of looking at all activities of a user, we could only look at the user's data in a certain session. This eliminates idle time from consideration and provides more accurate estimates. There is no consensus on when a session can be considered finished. This is also a challenge present in the literature (He & Göker, 2000; Mehrzadi & Feitelson, 2012; Zakay & Feitelson, 2012). The sources each propose different methods for annotating sessions. The simplest method involves implementing artificial breaks in between sessions after 10-15 minutes based on common sense (He & Göker, 2000). Other methods are based on a personalized weighted time (Mehrzadi & Feitelson, 2012) or when a new log (indicating a new instance start) is registered (Zakay & Feitelson, 2012).</td><td>By annotating sessions, the event logs more accurately provide insight into the KS interactions of the user. Allows for distinguishing between active and passive time. These sessions can then be used as the case for further analysis. We are then analyzing a set of consecutive actions by a user instead of all actions of a user, including idle time. We think this allows more accurate process mining on action times.</td></tr>
</table>

After applying the processing activities, the data has been annotated with two additional concepts, sessions and KS processes. This yields a new data model, which is illustrated below.

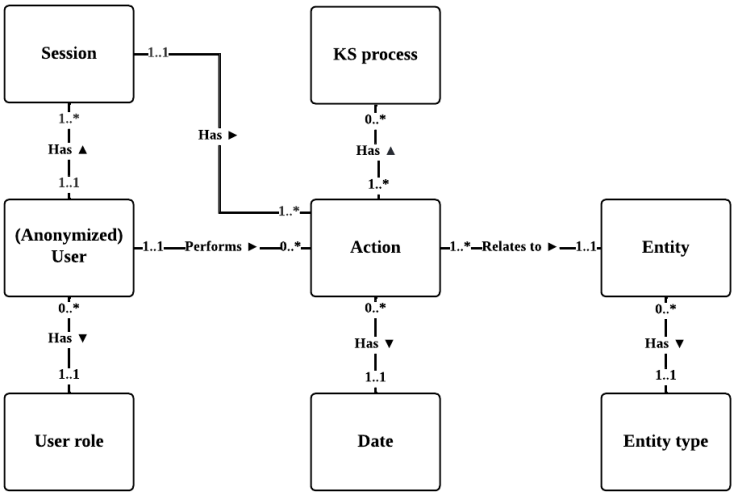


Figure 22: SIR activity data model after the processing steps

Step 4: Analyze processed action data

At this point, we have clean processed activity log data. It is time to perform some analyzes. These analyzes can provide insight into the actual quantitative knowledge-sharing behavior enabled by the GPR. For this, we need to consider activity-related variables are of interest. For this, we again look back at the identified activities and knowledge processes.

A10. Perform analyses

Next, we design and perform analyses based on the actions of the GPR and the perspectives of interest.

Table 20: Analyzes design subactivities

Activity	Description
Identify perspectives of interest	First, we need to identify what perspectives are interesting to investigate. These relate to the central elements in a GPR, and these typically involve users and good practices. Depending on the GPR setup, other relevant elements could be considered, such as improvement plans consisting of multiple GPs. In our effort to evaluate knowledge, sharing the perspective of those processes is also relevant. For SIR, the most relevant elements to consider are the users and the good practices.
Map activities to the perspectives	For the perspectives of interest, we identify and consider the relevant activities. For example, we can look at how many good practices the user has created. Next, we can investigate how many of the good practices created are removed. Other user actions we can investigate are the number of edits he made to his good practices. For knowledge collection, we can consider activities such as how many good practices were viewed by the user and the amount of general opened GPs. These measures can be considered on an individual basis, but there could also be distributions (e.g., who viewed most GPs). We can investigate the number of unique viewing users when considering GP as the central element. Again, these measures can be considered on an individual basis, but there could also be distributions (e.g., which GP is most frequently viewed).

<table>
<tr><th>Activity</th><th>Description</th></tr>
<tr><td>Identify variables per action</td><td>Once we have identified the activities per perspective, the possible variables for analysis should be determined. These variables could be used as the basis for visualizations and analysis. For our example case, the following variables can be thought of:
Table 21: Variables per perspective
<table>
<tr><th>Perspective</th><th>Action</th><th>Variables</th></tr>
<tr><td>User</td><td>Creating a good practice</td><td>• Number of created good practices.</td></tr>
<tr><td></td><td>Removing a good practice</td><td>• Number of deleted good practices.</td></tr>
<tr><td></td><td>Editing a good practice</td><td>• Number of edits made by the user
• Number of unique GPs the user has edited</td></tr>
<tr><td></td><td>Open a good practice</td><td>• Number of GP views by the user
• Number of unique GPs viewed by the user</td></tr>
<tr><td>Good practice</td><td>Open a good practice</td><td>• Number of edits
• Number of views
• Number of unique user views</td></tr>
<tr><td>Knowledge processes</td><td>Dependent on the mapping</td><td>• Number of occurrences of actions per process in total
• Number of occurrences of actions per user
• Number of occurrences of actions per GP</td></tr>
</table></td></tr>
</table>

Visualizing knowledge sharing behavior metrics

To analyze the above measures, (interactive) dashboards can be created. These dashboards could display time-series versions of the metrics earlier described. These visualized time series then indicate the KS interactions that occur over a given period. This could allow us to draw conclusions about KS and identify trends in usage. Technologies that can be considered to build such dashboards include Microsoft PowerBi and Tableau. Alternatively, a dashboard can be constructed from scratch using well-known Python frameworks combined with containerization. Below are examples of potential visualizations that can be made using the data of the theoretical knowledge sharing behavior measurement framework.

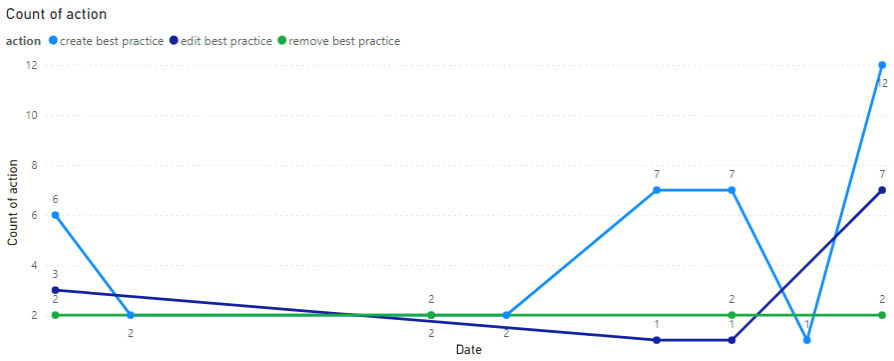


Figure 23: Example of a theoretical time series showing activity frequencies

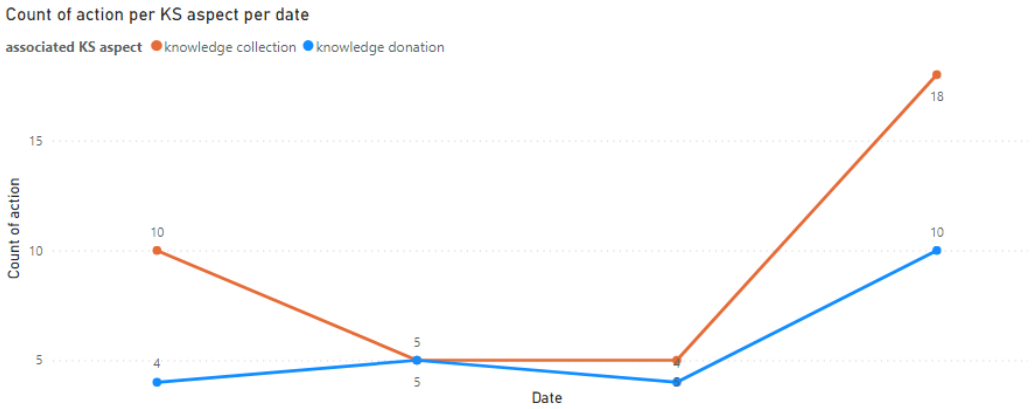


Figure 24: Example of a theoretical time series showing activity frequencies per KS process

Depending on the good-practice repository database platform and the choice of visualization approaches, the data retrieval can be performed automatically. Consider, for instance, the situation where Firebase is used as the good-practice repository database service, and PowerBI is used as visualization software. In such cases, PowerBI can be set up to query the good practice repository database directly. In this way, the data set can be retrieved at the push of a button in PowerBI. Next, the processing pipeline (i.e., filtering and ordering) can be implemented in such tools. A single tool could implement all the steps from data retrieval to visualization.

Following the statistical analysis approach described above may yield much information regarding the frequency of activities we associate with KS behavior. Unfortunately, it does not tell us **how** the KS interactions occur. To address this, process mining can be performed. The activity data can be analyzed and visualized using well-known process mining software like Disco. Using Disco, the user's interactions in the GPR can be analyzed. This can be done for the following metrics and variables:

Table 22: Metrics and variables available in Disco

Metric	Variable	Description
Frequency	Absolute frequency	The absolute frequency (count) of activities without considering cases.
	Case frequency	The frequency of the activities expressed in the number of cases.
	Max. repetitions	The maximum number of repetitions per activity within cases.
	Case coverage	The percentage of cases in which activity occurs.
Performance	Total duration	The sum of the durations of all occurrences of a given activity.
	Median duration	The median of the durations of all occurrences of a given activity.
	Mean duration	The mean duration of all occurrences of a given activity.
	Max. duration	The maximum duration of all occurrences of a given activity.
	Min. duration	The minimum duration of all occurrences of a given activity.

In addition, the visual process model created by the process mining tool can be examined. This way, it can be determined whether the users follow expected behavior patterns (i.,e *conformance checking*). (E.g., open GP → make rating → close GP and not close GP → Make rating → open GP). Any inconsistencies could indicate that some aspects of the good-practice repository must be adapted.

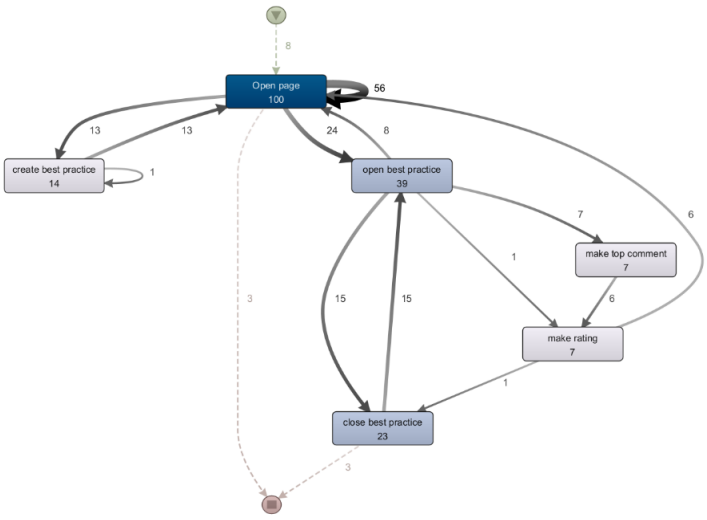


Figure 25: Example of a Disco process model displaying the activity frequency using mock data

Per perspective (e.g., user, domain, good practice, page), the absolute and relative frequencies can also be examined. This is dependent on the process mining technique being used and the mapping of its variables to the activity log variables. Below an example of such a mapping between the logs and the process miner Disco is illustrated.

Table 23: Example mapping of variables to Disco features

Variable		Disco feature
'User'	→	Resource
'Action'	→	Activity
'Entity'	→	Resource
'Datetime'	→	Timestamp
'Session ID'	→	Case ID

Per Disco feature, analyses can be performed. For instance, it can be determined which entity is most often used in cases. This could provide insight into what good practice is most often viewed. The same is true for the other variables. This is of interest because it provides rich information on KS behavior in the GPR.

A11 Interpret findings

The earlier defined analyzes provide results that can be interpreted. This interpretation depends on the framework for knowledge sharing behavior. Looking at the mock data for our theoretical GPR displayed above in Figure 23 and Figure 24, we see that overall the activities start at a normal level but increase during the end of our measurement window. The same can be said for the knowledge sharing processes. We did not perform process mining for our theoretical GPR as we did not have fitting mock data. However, provided that we had some, we could also interpret findings regarding order and timeframe of actions.

A12 Draw conclusions

From the interpreted findings, we should be able to conclude. In our example case, we can conclude that the KS facilitated by the GPR is increasing, but more observations are required to consolidate that conclusion further. Again, no process mining was performed for the theoretical GPR. However, otherwise, conclusions could include false or proper order of activities and common or outliers in terms of timeframe, indicating an aspect of the GPR could be further improved.

5.4 Theoretical challenges of the knowledge-sharing evaluation framework

Currently, we observe a few challenges with the theoretical framework for evaluating knowledge sharing. The first challenge is induced by recorded activities being sent directly to a database. Because of this, it is required to have a stable internet connection. The event logs could be malformed or sent in different orders if a user has connection issues during interactions with the GPR. This happens because these logs that constitute pending messages to the database are sent in a burst once the connection is restored. Due to this, the log order on the receiving end may differ from what was initially intended. Also, some logs can be lost. This could occur when a user performs some actions, loses connection, and ends the session by closing the window or browser instance. This way, the unsent logs may never be sent. This risk is mitigated by the fact that a web-based GPR does not function when the connection is lost. This means that creating GPs and navigating to different pages should not work when the connection is lost. Due to this, the lost logs are minimal because no actions can be performed in such a situation. This is not a solution to prevent any logs from being lost, but an effort is made to minimize the possibility. As a result, the measuring instrument should work adequately. However, because the logs are sent over the Internet, there is always a risk of data loss and data noise.

6 | A proof of concept of the framework: Implementing it into openBest

In this chapter, we discuss the implementation of the framework knowledge sharing behavior evaluation into openBest. First, we describe how we prepared openBest to implement the framework by designing and implementing features to further mature openBest. Next, we discuss how we enable openBest to measure knowledge-sharing behavior using the framework we designed in the previous chapter.

6.1 Preparation of openBest

In this section, we describe how we prepare openBest for the implementation of the knowledge sharing behavior evaluation framework and the empirical test. This preparation involves maturing and stabilizing openBest by implementing requirements to solidify existing functionality further and make it a more complete GPR. We end the section by describing openBest v2.0.

6.1.1 Maturing openBest

As we have seen in the background knowledge, openBest currently features many of the core requirements that were initially formulated. However, there is ample room for improvement because the core features offer limited interactions and functionality. Moreover, the current features can be improved to be more reliable. For this, we engineer requirements based on the previous projects and the activities we plan and implement a set of them. In this effort, we prioritize consolidating existing features and adding minor related features over implementing new features, as we think having a solid core functionality is better than having a more elaborate GPR while the core is not solid.

6.1.1.1 Requirement engineering

Requirement engineering based on previous projects

In this subsection, the requirements based on previous UU projects are investigated. For this, we look at Coenen (2020) and Plomp (2020b), who laid the theoretical groundwork for openBest. When we consider the features present in the optimal GPR as defined by Coenen (2020), as shown in Figure 9. We can say that all these features are implemented in openBest, to some extent. For some features, it could be argued that it is not sufficiently mature. For an overview, see Table 66 in Appendix E: Requirements . As shown in Table 66, all features are covered by openBest. However, some can be improved based on the current state. These are listed below in the table.

Table 24: Improvement points based on the requirements by Coenen

ID	Lacking functionality
C-RF2	openBest does not allow figures and tables to be present in openBest, which means that this has still to be done.
C-RF3	openBest does not feature editing or deleting of GPs.
C-RF4	openBest offers some basic search and filtering options, but this does not conform to the findings of Jacobs (2021). In addition to this, his implemented features do not function entirely.
C-RF9	openBest features a basic table with limited columns. This could hinder advanced filtering and search.

Plomp, 2020b implemented the functionalities described by Coenen (2020). In addition to this, he also formulated some additional requirements. Due to limited resources and time constraints, Plomp could not implement all the requirements found. The requirements formulated by Plomp that need to be implemented are found in Table 67. Note that this does not include an exhaustive list of all the requirements mapped by Plomp but rather a list of core requirements and requirements suggested by Plomp to be implemented next. The rationale for this scoping is to prioritize implementing core functionalities and ensure that the core works over implementing new functionalities, such as functionalities related to planning, context, and chaining GPs as part of interventions. Appendix H of Plomp (2020b) shows an exhaustive list of all these requirements.

There is some overlap between the points of improvement of Plomp and the core requirements of Coenen. For example, both emphasize the inclusion of images and enhanced filtering options, and these overlapping instances are merged in further deliberation to retain both specifications. From the previous projects by Plomp (2020b) and Coenen (2020), the following requirements are elicited:

Table 25: Functional requirements based on previous projects

ID	Description	Source
FR1	openBest must allow GPs to feature images and models.	C-RF2, P-RF6
FR2	openBest must allow GPs to feature external files.	P-RF6
FR3	openBest must allow GPs to be edited by the GP creator or a domain administrator in openBest.	C-RF3
FR4	openBest must allow GPs to be removed by the GP creator or a domain administrator in openBest.	C-RF3
FR5	openBest must allow advanced searching and filtering functionality conforming to Jacobs's (2021) notions.	C-RF4, P-RF7
FR6	openBest should have a more detailed table view with more columns to enable more advanced filtering.	C-RF4, C-RF9, P-RF7
FR7	The functionality of openBest should be extended by including functionality to create improvement plans. These plans can be constructed as the Theory of Change (ToC) linked to the work by Adèr (2020) and Plomp (2020b).	P-RF1

FR8	The information in improvement plans that include GPs should be used to define contextual information for GPs, allowing for an active recommendation of relevant GPs to organizations.	P-RF2
FR9	Other options for the inclusion of contextual information may also be researched, such as the inclusion and specification of organizational models (e.g., organizational charts or process models) in openBest.	P-RF3
FR10	The current functionality should be further developed to improve its usefulness.	P-RF4
FR11	The model editor requires further ability to adapt core model elements and more accessible specification of relationships.	P-RF5
FR12	openBest should be connected to other tools in the SBEIC software ecosystem.	P-RF8
FR13	openBest should allow users to search through repository instances of other domains to promote knowledge sharing between domains. This functionality needs to consider privacy-related issues; some organizations may not want to share knowledge with organizations outside their domain.	P-RF9

Requirement engineering based on test activities

openBest was originally developed as a proof-of-concept of the model-driven GPR treatment. The initial goal was to showcase a possible implementation of the described treatment. Due to limited resources, this proof-of-concept was tailored as much as possible to this goal. Consequently, the current state of openBest and the original requirements may not be sufficient for openBest to be used in test activities. In our opinion, the currently most pressing lacking features are the lack of support for multiple concurrent active domains and the lack of user management functionality in openBest.

Multiple concurrent active domains - openBest currently does not allow multiple domains to be accessible simultaneously. openBest allows for creating multiple domains, but only one domain can be active and accessible at the time. This is because the domain being accessed is based on the JSON model present in openBest's code. This happens because, at startup, openBest uses a locally stored model as a JSON string to determine the paths for all functions (e.g., retrieving good practices and viewing good practices). In effect, the model interpreter references a locally stored model. Due to this, the domain being accessed is determined by the model contained in the openBest code. This means that regardless of linked email addresses and domains, openBest can only allow one domain to be accessed at a time. This is because switching between domains is done in the deployed openBest code rather than based on the users' accounts. Figure 26 illustrates an abstraction of this openBest startup process from the perspective of openBest.

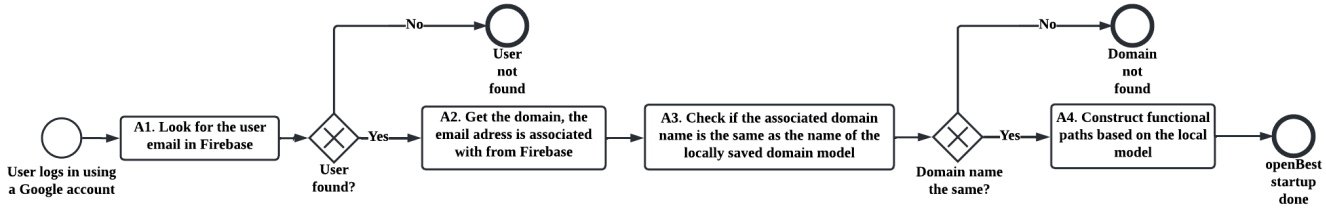


Figure 26: Excerpt of openBest v1.0 startup process

Due to this lack of an online model for determining paths, openBest does not allow multiple domains to be accessible by different users at a given time. This limits openBest in terms of possible use. As a result, the following requirement needs to be implemented: openBest should allow multiple domains to be active simultaneously, with users accessing their domain based on their account.

User management - Another requirement for the validation activity is administrator control over authors and users. In this way, the administrator can manage users more efficiently and make it easier for us as researchers to create accounts for test participants quickly. Moreover, external parties, such as organizations involved in future validation efforts, can easily involve the participants themselves. The administrator can then add a representative of the external party as an administrator, and this person could add the users from their party. In a showcase or experiment environment, as researchers, we could efficiently manage our users and add in users who, in turn, could involve more users. Currently, openBest does not have a user management interface. This means that assigning users to domains is purely textual in the Firebase database interface. This does not scale well and is not usable by external parties that could be involved for security and usability reasons. The security problem in this setting is that a user who needs to add a user to the database back-end requires access to the database. This is a security risk because all data are accessible to the user. The usability problem is that the database interface is not very user-friendly. It is challenging to navigate to the correct domain and collection. Moreover, a mistake is easily made because the user must explicitly define the account contents (e.g., user name, user email) in the database. In openBest, the 'users' collection is used to determine the role and membership of a user in a domain, and the 'authors' collection is used to link good practices with users and allow them, and only them and designated individuals, to edit or remove their good practice. Although the author and the user in question can be the same person, they are constructed as two different collections. This is because of the distinction in function as described above, and second, there can be users that are not authors (e.g., users with no GPs) and authors that are not users (e.g., an author of an imported GP). We think the administrator should be able to add authors and users without our intervention as a researcher because this would represent a more natural setting in which the domain administrator administers the domain. As a result, the following requirements are formulated:

Table 26: Requirements based on validation activities

ID	Description	Name
FR14	openBest should allow multiple domains to be active simultaneously, with users accessing their domain based on their account instead of a local model.	V-RF1
FR15	openBest should allow domain administrators to add users to their domain.	V-RF2
FR16	openBest should allow domain administrators to add authors to their domain.	V-RF3

Other requirements

It may be necessary to quickly set up and populate a domain for development and future projects. This is because development tends to invalidate a domain requiring the domain to be deleted and re-instantiated. Unfortunately, we can only (re) instantiate an empty domain void of good practices; this is not useful for development, showcasing, or validation efforts. Because of this, we need a functionality that allows one to populate the repository with the click of a button. An example is to populate the repository using good practices in Excel files. This way, we can separate the collection and entering of good practices into openBest from the input functionality of openBest. This allows for a rapid population that can be repeated when needed. This would also make setting up domains for showcasing and testing easier. Consequently, the following requirement is formulated:

Table 27: Requirements based on other sources

ID	Description	Name
FR17	openBest should allow populating the domain with good practices from Excel or other source files.	O-RF1

6.1.1.2 Requirement assessment

Because we have limited resources regarding development capacity and time, we must consider which requirements are feasible candidates for implementation to enhance openBest. We can consider prioritization metrics such as perceived complexity, estimated time required for implementation, concreteness level, relevance for the project, and openBest. This assessment can be found in Table 70 in 'Appendix G: Requirement Assessment.' Based on this assessment, we determine which requirements should be implemented. For each requirement, inclusion status and the rationale for this inclusion are recorded in Table 71 in 'Appendix H: Requirements and rationale for inclusion'). Below in Table 28, an overview of the included requirements is shown.

Table 28: Included requirements

ID	Description	Source
FR1	openBest must allow GPs to feature images and models.	C-RF2, P-RF6
FR3	openBest must allow GPs to be edited by the GP creator or a domain administrator in openBest.	C-RF3
FR4	openBest must allow GPs to be removed by the GP creator or a domain administrator in openBest.	C-RF3
FR5	openBest must allow advanced searching and filtering functionality conforming to Jacobs's (2021) notions.	C-RF4, P-RF7
FR6	openBest should have a more detailed table view with more columns to enable more advanced filtering.	C-RF4, C-RF9, P-RF7
FR10	The current functionality should be further developed to improve its usefulness.	P-RF4

ID	Description	Source
FR14	openBest should allow multiple domains to be active simultaneously, with users accessing their domain based on their account instead of a local model.	V-RF1
FR15	openBest should allow domain administrators to add users to their domain.	V-RF2
FR16	openBest should allow domain administrators to add authors to their domain.	V-RF3
FR17	openBest should allow populating the domain with good practices from Excel or other source files.	O-RF1

6.1.1.3 Requirement implementation

Below in Table 29, the requirements and their implementation status are listed.

Table 29: Selected requirements and their implementation status

ID	Description	Source	Implemented
FR1	openBest must allow GPs to feature images and models.	C-RF2, P-RF6	Partly
FR3	openBest must allow GPs to be edited by the GP creator or a domain administrator in openBest.	C-RF3	Yes
FR4	openBest must allow GPs to be removed by the GP creator or a domain administrator in openBest.	C-RF3	Yes
FR5	openBest must allow advanced searching and filtering functionality conforming to Jacobs's (2021) notions.	C-RF4, P-RF7	Yes
FR6	openBest should have a more detailed table view with more columns to enable more advanced filtering.	C-RF4, C-RF9, P-RF7	Yes
FR10	The current functionality should be further developed to improve its usefulness.	P-RF4	Partly
FR14	openBest should allow multiple domains to be active simultaneously, with users accessing their domain based on their account instead of a local model.	V-RF1	Yes
FR15	openBest should allow domain administrators to add users to their domain.	V-RF2	Yes
FR16	openBest should allow domain administrators to add authors to their domain.	V-RF3	Yes
FR17	openBest should allow populating the domain with good practices from an Excel or other source file.	O-RF1	Yes

For each requirement, a detailed implementation description can be found in 'Appendix I: Requirement implementation.'

6.1.2 Describing openBest V2.0

Following the activities described in the previous section, we have produced a more mature version of openBest. We refer to this version of openBest as version 2.0. In this section, we describe this version.

6.1.2.1 System Description

The figure below depicts the functional architecture model (FAM) of openBest. These FAM models show the high-level functionality of the system without providing unnecessary detail. The functionality is depicted using modules, submodules, their relationships, and the connection to an external system: the database platform. The choice for using the FAM method is because Plomp (2020) also used this method for describing openBest v1.0, and using the same method allows for traceability of changes between the projects and versions. The high-level FAM of openBest v2.0 is shown in Figure 27.

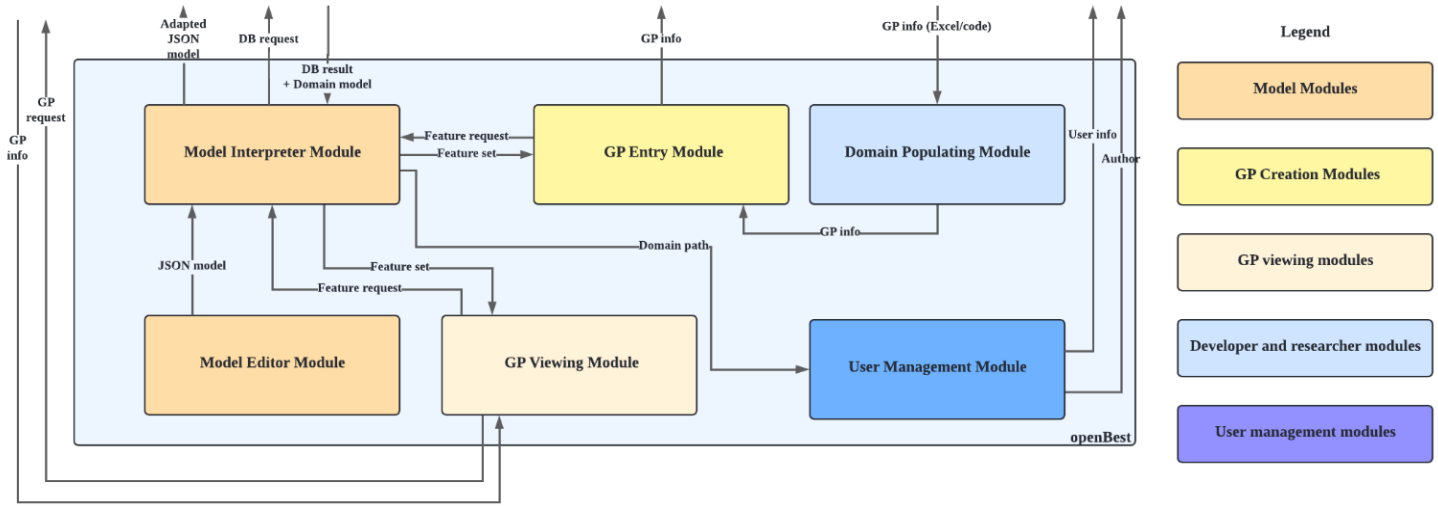


Figure 27: High-level FAM of openBest v2.0

We will now describe the modules present in openBest v2.0. Note that some modules have been renamed from the FAM of openBest v1.0. This is because multiple modules have similar names, such as #editor (model editor and GP editor). Hence the object, model, or GP is added before the module title.

Model Editor module

Is used by domain administrators to create and instantiate textual domain models. The models are created in an editor form and then compiled into a JSON model. The model is sent to the interpreter. The interpreter reads the models and determines the set of features of the repository based on the model. The model editor module has not been altered between openBest v1.0 and v2.0. Therefore, the resulting FAM model is identical to the one created by Plomp (2020b).

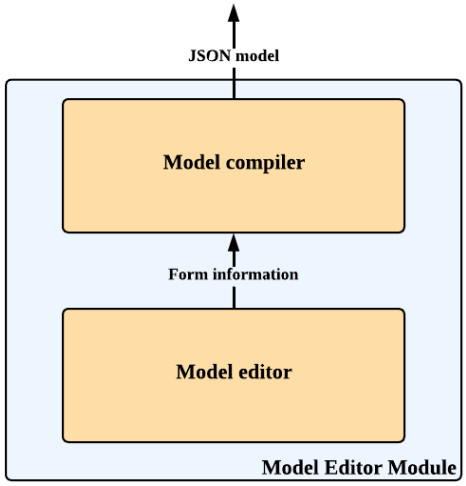


Figure 28: FAM of Model Editor

Model Interpreter module

Interprets textual models created in the editor module, stores results, and handles requests for feature sets. The interpreter module model has not changed between openBest v1.0 and v2.0. Therefore, the resulting FAM model is identical to the one created by Plomp (2020b).

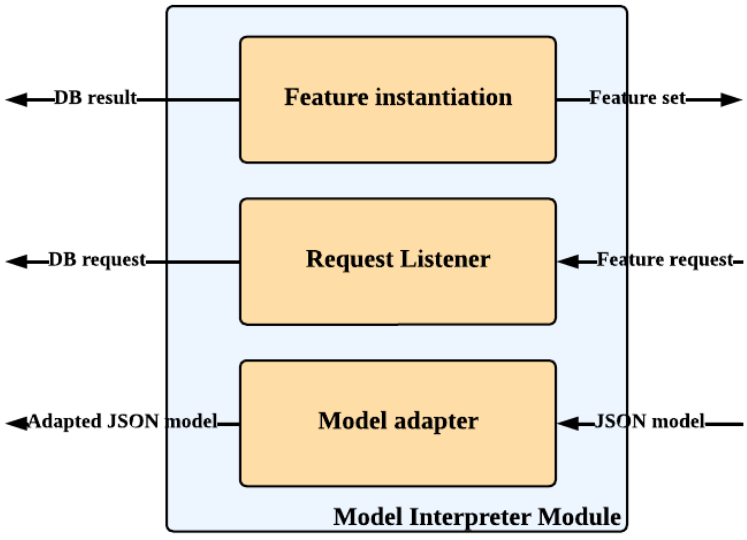


Figure 29: FAM of the Model Interpreter Module

GP Entry module

Is used by users to store good practices. The contents of the GP entry form depend on the set of features sent by the model interpreter module. The GP Entry module model has not changed between openBest v1.0 and v2.0. Therefore, the resulting FAM model is identical to the one created by Plomp (2020b).

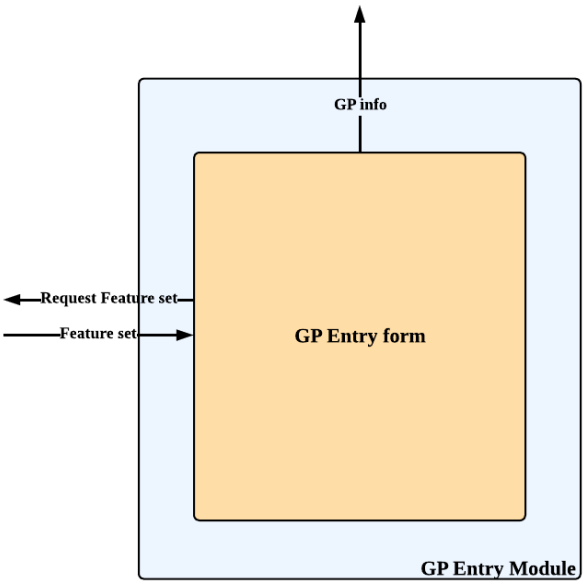


Figure 30: FAM of the GP Entry Module

GP Viewing module

Allows users to view, edit, and remove good practices. This module also contains community-based feedback features, GP editing, and removing features.

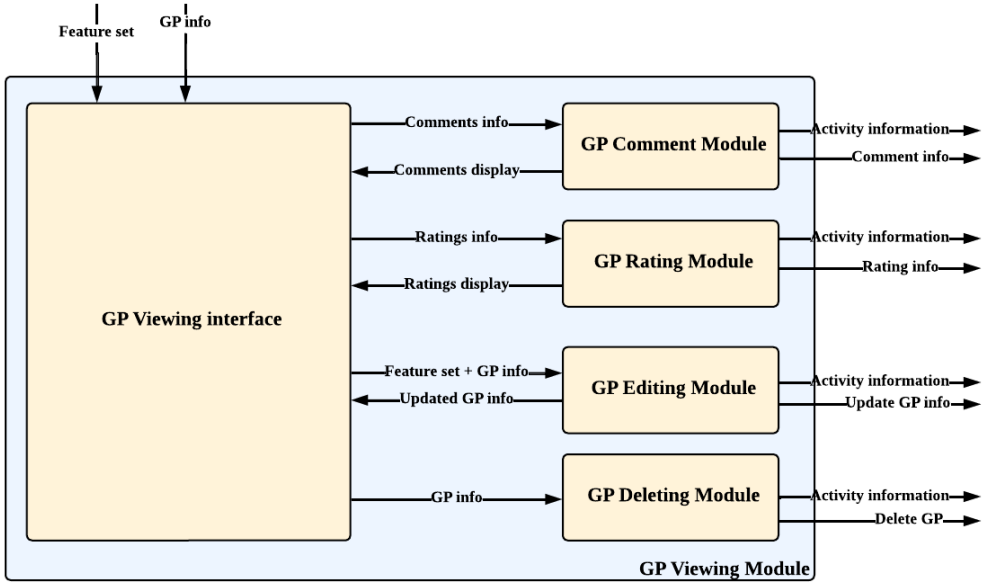


Figure 31: FAM of the GP viewing module

Domain Populating module

Allows developers to populate domains using excel files and lists constructed in openBest code. This feature is not model-driven, so functions should be adapted following domain configurations.

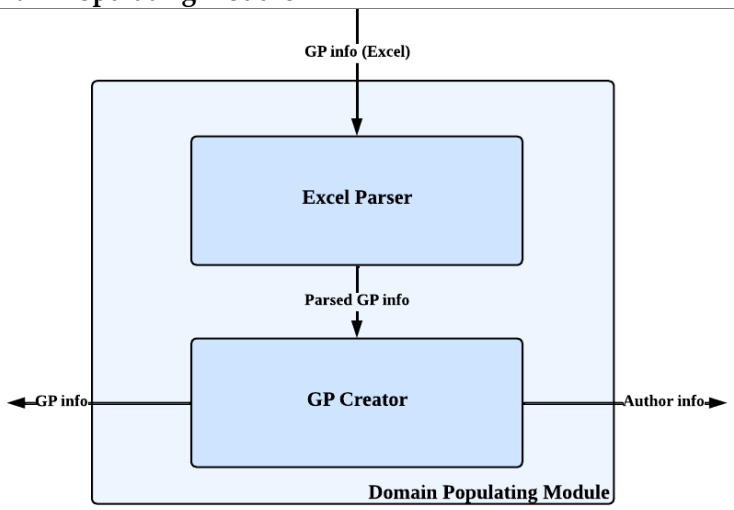


Figure 32: FAM of Domain Populating Module

User management module

Allows domain administrators and developers/ researchers to manage the members of domains. The module allows for the creation of authors and users.

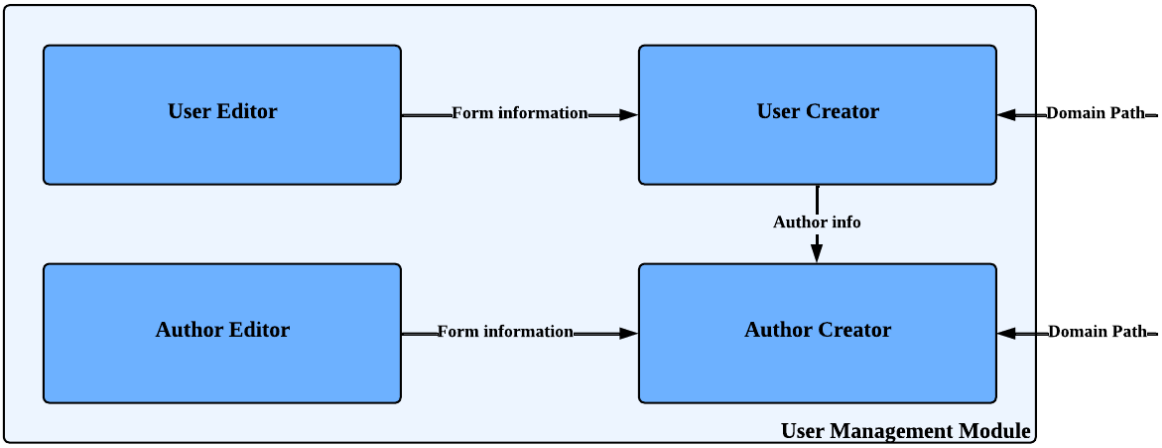


Figure 33: FAM of the User Management Module

6.1.2.2 Stakeholder Description

The stakeholders of openBest are employees of organizations in a domain and us as researchers and developers. Among these groups, three stakeholder groups use openBest. These stakeholders are users, domain administrators, and researchers/developers. Below in Table 30, we describe them.

Table 30: Stakeholders in openBest v2.0

Stakeholder	Description
User	A user can be any person within a domain that uses openBest to store and find good practices. A user is always part of an organization. They want to find good practices to improve their own organization's ESE performance and help other organizations by sharing good practices from their organization. They also want to create improvement plans that detail the objectives of their organization, how they plan to achieve them, and what good practices they will apply. They want to evaluate these improvement plans and the use of good practices. A related group of users is the authors. Authors are users who have created a GP or are planning to create one. Authors and users are linked by email addresses. The reason for separating these two is that it could occur that a user has created no GPs on the one hand and that, on the other hand, GPs are entered into the domain while the user itself is not part of the domain.
Domain administrator	A domain administrator is a special type of user that determines the GP structure for the domain. The domain administrator ensures that the repository's functionality adapts well to the domain in question by prescribing this structure in a model. The repository uses this model to determine what information is required from regular users when they want to store a good practice. In addition to this, domain administrators manage the users of their domain. A domain administrator is always a user, but a user is not always a domain administrator.
Researcher/ Developer	Two additional stakeholders are external to the organizations: the researcher and the developer. A researcher is a person who investigates openBest as a treatment, and the developer develops features for openBest. A researcher can be a developer, but a developer does not have to be a researcher. While the motives for the two stakeholder groups are different, their roles in openBest related to the functionality are similar and, therefore, described as one group. A researcher or developer is a special type of stakeholder that determines the functionality of openBest. The researcher/ developer may test functionalities and showcase domains to further the exposure in this capacity. For this, they can rapidly deploy and populate domains. In the researcher's case, the user may also be interested in activity data. The Researcher/ developer can be regarded as the platform administrator and perform all actions a user and a domain administrator can perform. This role should only be filled by knowledgeable people who want to continue the development of openBest or perform further research. The role is assigned in the code of openBest.

6.1.2.3 Interaction Description

OpenBest v2.0 allows for more interactions than openBest v1.0. Besides this, openBest v2.0 recognizes the researcher/developer stakeholder group. The interactions per stakeholder group include:

Table 31: Interaction per role in openBest v2.0

Role	Action
User	The user stores a good practice using the GP entry form.
	The user edits a good practice using the editing functionality on the GP's page.
	The user removes good practice by using the removal functionality contained on the GP's page.
	The user searches for a GP using filtering and sorting functions.
	The user opens a good practice and reads its contents.
	The user comments on a good practice they have found. Either by engaging in discussion or by commenting on the GP.
	The user rates a good practice based on a factor defined by the GP author. For the time being, default ratings (5 stars on the overall dimension) are used to reduce the effort of creating a GP.
Domain administrator	The domain administrator creates a new domain by opening the model editor. The administrator uses the form-based modeler to provide information on the good-practice structure. After the model has been saved, the domain will be instantiated.
	The domain administrator updates the domain by opening the model editor and making the necessary changes. After the model has been saved, the good-practice structure and corresponding features are updated for any new good practices.
	The domain administrator adds a user and possibly an author to the domain by filling and submitting the user form.
	The domain administrator adds an author to the domain by filling in and submitting the author form.
	The domain administrator manages the quality of the domain by editing and removing good practices using the corresponding functionalities.
Researcher/ Developer	The researcher/developer populates the domain using an Excel file.
	The researcher/developer tests all actions described for the domain administrator and the user.

6.2 Enabling measuring knowledge sharing behavior

This section discusses how the theoretical knowledge-sharing behavior evaluation framework can be implemented into openBest. For this, we first determine the knowledge sharing behavior framework of openBest, and then using that framework, we implement features for measuring the activities.

6.2.1 Designing the knowledge sharing framework for openBest

In this section, we design the knowledge sharing behavior framework for openBest. For this, we use our previously defined knowledge-sharing behavior framework design method.

Step 1: Identify tool-supported actions

The first step involves the identification of the tool-supported actions. The activities in this step are elaborated upon below in Table 32.

Table 32: Activities of the identify tool-supported actions step

<table>
<tr><th>Activity</th><th>Implementation</th></tr>
<tr><td>A1. Identify system stakeholders</td><td>Following the theoretical approach, the first step is identifying the stakeholders in the GPR. For openBest, we identified and described stakeholders and low-level interactions in Section 6.1.2.2. In this exercise, we only consider the user and administrator stakeholders, as they form the user group of the system. In contrast, the developer and the scientist stakeholders are not the system's users.</td></tr>
<tr><td>A2. Per stakeholder identify system-supported interactions</td><td>Following the theoretical approach, the first step is identifying stakeholders' interactions. For openBest, we already identified and described the stakeholders and low-level interactions in Section 6.1.2.3.</td></tr>
<tr><td>A3. Per interaction, identify system supported activities</td><td>Per interaction, the associated tool-supported actions are to be identified. For openBest, this yields the following:
Table 33: Interactions and associated actions in openBest v2.0
<table>
<tr><th>Role</th><th>Interaction</th><th>Action</th></tr>
<tr><td>User</td><td>The user stores a good practice using the GP entry form</td><td>• Create a good practice.</td></tr>
<tr><td></td><td>The user edits a good practice using the editing functionality on the GP’s page.</td><td>• Edit a good practice</td></tr>
<tr><td></td><td>The user removes a good practice by using the removal functionality contained on the GP page.</td><td>• Remove a good practice</td></tr>
</table></td></tr>
</table>

Activity		Implementation	
		The user opens a good practice and reads its contents.	• Open a good practice. via the GP table or the URL
			• Close a good practice (either by closing the modal or leaving or closing the page).

		The user comments on a good practice they have found. Either by engaging in discussion or by commenting on the GP.	• Make a comment on a good practice.
			  ○ Either a top comment (e.g., thread header); or
			  ○ A sub-comment (e.g., reaction to another comment).

			• Edit a comment (if the user is the comment's author).
			• Remove a comment (if the user is the comment's author).
		The user rates a good practice based on a factor defined by the GP author. For the time being, default ratings (5 stars on the overall dimension) are used to make the creation of GPs lower effort.	• Make a rating.
			• Edit a rating (if the user is the author of the rating).
			• Remove a rating (if the user is the author of the rating).
	Domain administrator	The domain administrator manages the quality of the domain by editing and removing good practices using the corresponding functionalities.	• All the actions of the user.
		The domain administrator adds a user and potentially an author to the domain by filling and submitting the user form.	• Add a user to the domain.

Activity	Implementation	
	The domain administrator adds an author to the domain by filling in and submitting the author form.	• Add an author to the domain.
	The domain administrator creates a new domain by opening the model editor. The administrator uses the form-based modeler to provide information on good-practice structure. After the model has been saved, the domain will be instantiated.	• Create a domain
	The domain administrator updates the domain by opening the model editor and making the necessary changes. After the model has been saved, the good-practice structure and corresponding features are updated for any new good practices.	• Edit the domain model
A4. Identify supporting actions of the system	As said before, supporting actions like opening a page or a good practice can also be mapped depending on the good practice platform. For openBest, these are:	

Table 34: Supporting actions of openBest

Supporting action	Description
Log in	The activity where the user logs in to openBest
Log out	The activity where the user logs out of openBest
Open Page	The activity where the user opens a page in openBest

Furthermore, we would like to measure filtering, organizing, pagination, and other activities related to 'The user searches for a GP using filtering and sorting functionalities' interactions. However, this is not achievable with the resources at hand. This happens because the table is constructed using external functions

Activity	Implementation
	from Datatables, making logging interactions more challenging. As a result, these interactions are left out of consideration.
A5. Assess if the identified actions can be recorded	Next, we must determine if the identified actions can be recorded within the GPR. In our case, the action of logging into openBest can not be recorded because this action occurs before we know the domain of a user. As a result, it is unclear at that point where the log is to be saved. Also, the setup, unfortunately, does not allow us to keep track of domain-related actions like setting up a domain or editing one because we are required to have a domain infrastructure to store the activity data. Next to this, the editing of a rating can also not be directly logged because in openBest, it is not a distinct action as editing a rating in openBest is done by creating a new rating for a GP that replaces the old GP. Hence it is logged as create rating instead of an edit rating. Consequentially we can record the following activities:

Table 35: Recordable actions in openBest

Role	Action	Source	Recordable openBest Action
User/ Administrator	• Create a good practice.	Stakeholder interaction	create best practice
	• Edit a good practice (if the user is one of the authors of the good practice).	Stakeholder interaction	edit best practice
		Stakeholder interaction	cancel edit best practice
	• Remove a good practice (if the user is one of the authors of the good practice).	Stakeholder interaction	remove best practice
	• Open a good practice. via the GP table or the URL	Stakeholder interaction	open best practice
		Stakeholder interaction	open by URL
	• Close a good practice (either by closing the modal or leaving or closing the page).	Stakeholder interaction	close best practice
	• Make a comment on a good practice. o Either a top comment (e.g., thread	Stakeholder interaction	make top comment
		Stakeholder interaction	make sub comment

Activity	Implementation		
		header); or ○ A sub-comment (e.g., reaction to another comment).	
	• Edit a comment (if the user is the comment's author).	Stakeholder interaction	edit comment
	• Remove a comment (if the user is the comment's author).	Stakeholder interaction	remove comment
	• Make a rating.	Stakeholder interaction	make rating
	• Remove a rating (if the user is the author of the rating).	Stakeholder interaction	remove rating
	• Logout of openBest	Supporting action	logout
	• Open a page in openBest	Supporting action	open page
Administrator	• Add a user to the domain.	Stakeholder interaction	add author
	• Add an author to the domain.	Stakeholder interaction	add user

Step 2: Identify knowledge-sharing processes

The next step involves mapping the KS processes that the knowledge sharing tool enables. The single activity of this step is discussed below.

Table 36: Activity of the identify knowledge sharing processes step

Activity	Implementation
A6. Identify knowledge processes of interest	In openBest, numerous knowledge-sharing processes can be of interest. Selecting a subset of the processes named in the literature remains arbitrary due to the varying names for similar processes, various available levels of granularity, and overlapping terminology. In openBest, in our opinion, we are mainly concerned with **knowledge donation** in terms of creating and managing good practices and **knowledge collection** in the form of looking up and opening good practices of others. These processes also nicely align with the earlier described dynamics with a knowledge provider who donates knowledge and the knowledge receiver who collects knowledge. Arguably, other KS processes like **knowledge application** are also present in openBest in the form of comments and ratings as knowledge holders apply their knowledge of a situation to the GP. Finally, we observe actions related to **(modifying) the characteristics of the (KS) network** by adding users and authors.

Step 3: Map the knowledge-sharing processes to the identified activities

Once we have constructed lists of activities and KS processes, it is time to link the activities to KS the processes we identified to be of interest in the previous activity. The activities of the KS processes and activity mapping step are elaborated upon below.

Table 37: Activities of KS processes and activity mapping step

<table>
<tr><th>Activity</th><th>Implementation</th></tr>
<tr><td>A7. Map the knowledge-sharing processes to the identified activities</td><td>For each activity, the most relevant KS process is to be selected. For openBest, we used knowledge donation, knowledge collection, knowledge application, and Modifying characteristics of the network.

Table 38: Recordable actions per role and their associated KS process in openBest v2.0

<table>
<tr><th>Role</th><th>Action</th><th>Recordable openBest Action</th><th>Associated KS process</th></tr>
<tr><td rowspan="10">User/ Administrator</td><td rowspan="2">• Create a good practice.</td><td>create best practice</td><td>knowledge donation</td></tr>
<tr><td>edit best practice</td><td>knowledge donation</td></tr>
<tr><td rowspan="2">• Edit a good practice (if the user is one of the authors of the good practice).</td><td>cancel edit best practice</td><td>None</td></tr>
<tr><td>• Remove a good practice (if the user is one of the authors of the good practice).</td><td>remove best practice</td><td>None</td></tr>
<tr><td rowspan="2">• Open a good practice. via the GP table or the URL</td><td>open best practice</td><td>knowledge collection</td></tr>
<tr><td>open by URL</td><td>knowledge collection</td></tr>
<tr><td>• Close a good practice (either by closing the modal or leaving or closing the page).</td><td>close best practice</td><td>None</td></tr>
<tr><td rowspan="2">• Make a comment on a good practice.
• Either a top comment (e.g., thread header); or
• A sub-comment (e.g., reaction to</td><td>make top comment</td><td>knowledge application</td></tr>
<tr><td>make sub comment</td><td>knowledge application</td></tr>
</table>
</td></tr>
</table>

		another comment).		
		• Edit a comment (if the user is the comment's author).	edit comment	knowledge application
		• Remove a comment (if the user is the comment's author).	remove comment	None
		• Make a rating.	make rating	knowledge donation
		• Remove a rating (if the user is the author of the rating).	remove rating	None
		• Logout of openBest	logout	None
		• Open a page in openBest	Open page	None
	Administrator	• Add a user to the domain.	add author	Modifying characteristics of the involved network
		• Add an author to the domain.	add user	Modifying characteristics of the involved network

Step 4: Identify variables

In this step, the variables of interest are further formulated. The implementation of this step's activities is described below in Table 39.

Table 39: Activities of the identify variables step

<table>
<tr><th>Activity</th><th>Implementation</th></tr>
<tr><td>A8. Formulate variables associated with the mapped activities</td><td>In openBest, we observe the same variables as in our theoretical SIR GPR. The main difference is not found in the variables themselves but rather in their values (e.g., both have different users, actions, and entities, but their variables are the same). Consequently, the data model is the same as the data model of SIR, as seen in Figure 17.</td></tr>
<tr><td>A9. Determine values for the variables associated with the mapped activities</td><td>Per variable, the possible values should be determined and documented. The values are based on the earlier identified stakeholders, actions, and entities.

Table 40: Recordable variables and values for openBest v2.0
<table><tr><th>Variable</th><th>Type</th><th>Values</th></tr><tr><td>User</td><td>String</td><td>User emails, account + '@gmail.com'</td></tr><tr><td>User role</td><td>Enumeration</td><td>{Administrator, User}</td></tr><tr><td>Action</td><td>Enumeration</td><td>{Open page, open good practice, open good practice by URL, close good practice, create good practice, edit good practice, cancel edit good practice, remove good practice, add user, add author, make top comment, make sub-comment, edit comment, remove comment, make rating, remove rating, logout</td></tr><tr><td>Entity type</td><td>Enumeration</td><td>{user, author, page, good practice}</td></tr><tr><td>Entity ID</td><td>String</td><td>ID of the entity to which the action applies.</td></tr><tr><td>Date</td><td>Datetime</td><td>Dates using the 'DD MMM YYYY hh:mm:ss time zone' DateTime notation</td></tr></table></td></tr>
</table>

6.2.2 Implementing the knowledge-sharing behavior framework

This section discusses how we implement the knowledge sharing behavior framework into a measurement instrument in openBest. For this, we follow the method as laid out in Section 0.

Step 1: Collect action data

In this step, the action data are collected by openBest and sent to the database. The action data collection is based on the data model with the variables and their values we identified earlier.

Table 41: Activities of the collect action data step

Activity	Implementation
A1. Collect action data	We designed a general function that records the performance of the activities with the variables we defined earlier. This function takes parameters for the user, user role, action, entity type, and entity ID. The function is called in the event handlers of the identified actions. When called, the function is provided with the parameters and determines the date-time based on the user's system time. The data collection process in openBest is illustrated in Figure 34.
A2. Send action data to the database	When the information is collected, the information is translated into a Firebase document structure and sent to the server. The document is then placed in the activity logs folder of the user domain. The operation ends with the system writing a textual representation of the log in the console.

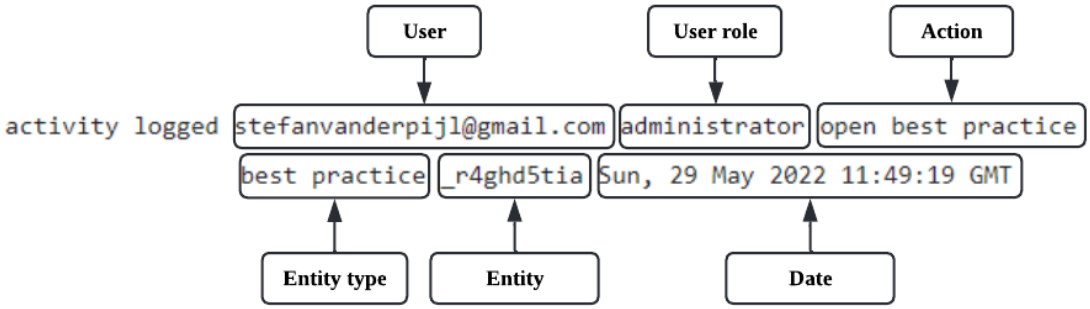


Figure 34: Activity log as present in openBest

Below the implementation of the action data collection step in openBest is schematically illustrated.

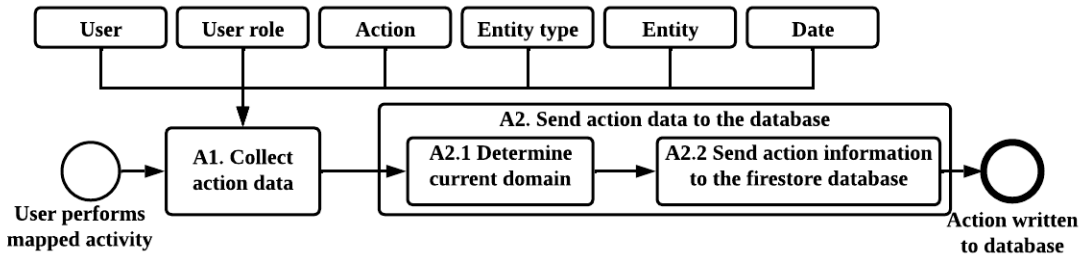


Figure 35: Implementation of the data collection step in openBest

Step 2: Retrieve action data

Once we have collected data on knowledge-sharing behavior activity, we want to retrieve and analyze the data. The collection of event logs can be downloaded as a CSV within openBest. Then this CSV contains all the actions performed by the users in that domain. The steps of the action data retrieval process are elaborated upon below in Table 42.

Table 42: Activities of the retrieval action data step.

Activity	Implementation
A3. Retrieve activity data from the database	The process starts with the researcher requesting the event logs by pressing the 'download usage logs' button in openBest. openBest then determines the domain in which the researcher is operating. This domain is then used to chart a path to the database location of the domain's event logs (e.g.,/*domainname*/domainstate/activitylogs). This path is then used by openBest to retrieve all event log documents contained in the 'activity logs' collection.
A4. Parse the data into a suitable format	Once all logs are retrieved, openBest extracts the contents of the individual documents and parses the body of activity logs into a CSV format.
A5. Download the parsed data to the user browser instance	Once this is done, the CSV file is automatically downloaded by the researcher's browser instance. After retrieving the activity data, the researcher has a CSV file containing all recorded actions of the domain. In Table 43, an excerpt of such a CSV, is shown.

Table 43: Example of the data collected

User	User role	Action	Entity type	Entity ID	Date
doe@gmail.com[6]	user	open page	page	/index.html	21 Mar 202 15:55:40
doe@gmail.com	user	open page	page	/bestpractices.html	21 Mar 202 15:55:58
doe@gmail.com	user	open good practice	good practice	OqZs1Dsl0	21 Mar 202 15:56:01
doe@gmail.com	user	make top comment	good practice	OqZs1Dsl0	21 Mar 202 15:56:27
doe@gmail.com	user	make rating	good practice	OqZs1Dsl0	21 Mar 202 15:56:33
doel@gmail.com	user	close good practice	good practice	OqZs1Dsl0	21 Mar 202 15:56:35

The activities in the table illustrate the typical process of logging in (opening /index.html) and navigating to the good practices (opening /bestpractices.html). Opening a good practice, rating and commenting on it, and closing the good practice.

[6] Note that in this report the user emails are anonymized. The email address is initially collected to be able to link the user's actions so that we know which activities are performed by the same user.

Below in Figure 36, the implementation of the action data retrieval process in openBest is illustrated.

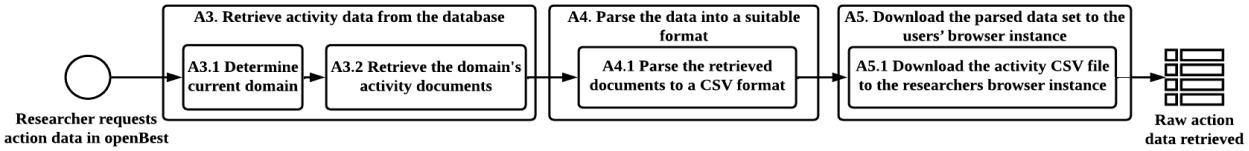


Figure 36: Overview of the action data retrieval process in openBest

Intermezzo: Implementing activity data collecting and retrieval functionality into openBest

The activity data collection and retrieval steps we have described so far have been implemented in openBest as part of the Activity logging module. The role of the activity log module in the overall system is illustrated in Figure 37. The elements related to the logging module are located within the dashed box.

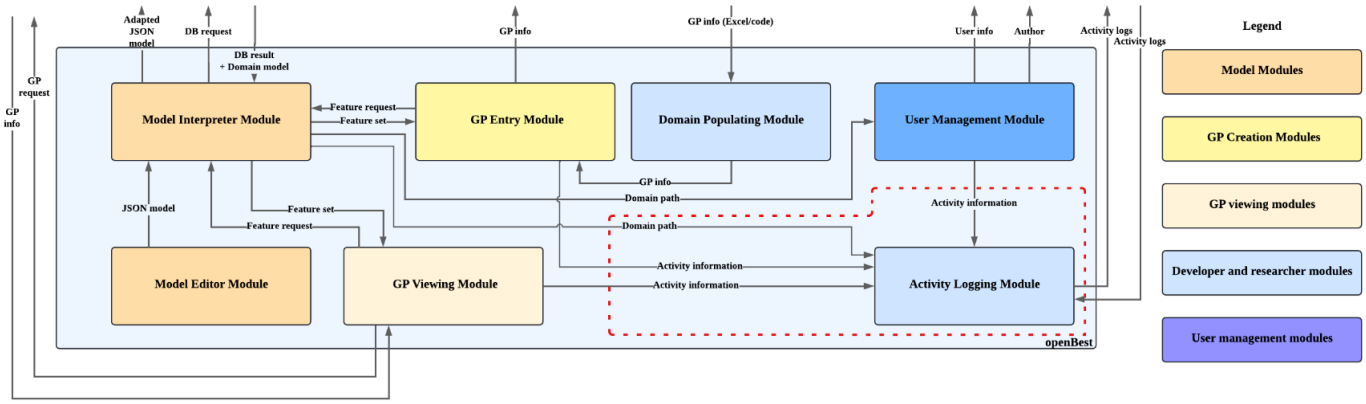


Figure 37: High-level FAM of openBest v2.0 with the logging module

Activity logging module

The activity logging module collects and stores data logs based on user activities, and the module is fed activity information by the other modules. The module also features an Excel parser to parse the data into a suitable format and download all activity logs of the domain. The user interface of the activity logging module includes buttons for downloading the activity logs and additional GP information. This part of the module is only accessible to the researcher and developer role.

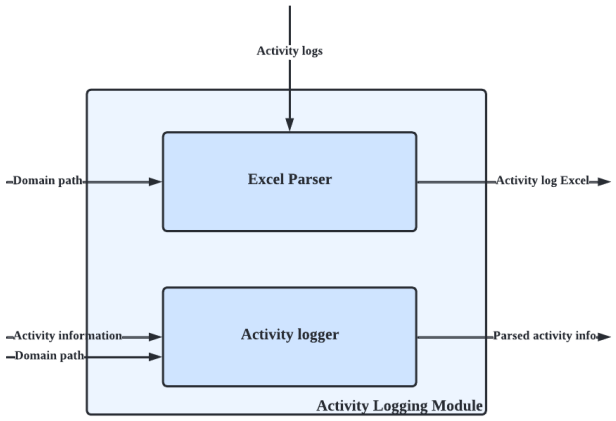


Figure 38: FAM of Activity Logging Module

Step 3: Process action data

In this section, we discuss the formatting of the data set. This involves all the steps to obtain an actionable processed activity log dataset from the raw activity logs. These steps are elaborated upon below in Table 44.

Table 44: Applied processing steps

Activity	Implementation	Rationale
A6. Filter the data set	Filter the 'User' column to exclude actions of internal stakeholders (Researchers, Supervisors, etc.).	The reason for this exclusion is that the actions of these users are not relevant to the analysis because both are insider actors and not participants in any tests.
	Filtering the column 'Action' to exclude the actions required for setting research domains. This involves adding users and authors by researchers and supervisors.	The reason for excluding these actions is that they are part of the setup and not the execution of any empirical test.
	The 'Date' column is filtered only to include dates within the span of any empirical test.	This is done to scope the event logs only to contain activities executed in the correct timeframe.
A7. Anonymize the data set	The 'User' column should be anonymized. This can be done by constructing a secured translation table, only accessible by researchers, and replacing the username with the identifier in the translation table. After the anonymization has occurred, the translation table can be deleted. Alternatively, more advanced methods can be used.	Anonymization is required because openBest users never give permission for their names to be used in any analysis, documentation, or report. They give permission that anonymized logs of their activity may be used for scientific purposes. For more information on permissions, please see Appendix K: Informed consent in openBest.
A8. Order the data set	The collected data set has been ordered into two levels. The first level is the user in alphabetical order, and the second level is based on the date in ascending order. This provides the following structure:	The data set is ordered at these two levels so that the resulting list chronologically shows the activities recorded per case (participant).

Table 45: Example of ordered data

User	Date	…
Participant A	13-4-2022 11:32	…
Participant A	14-4-2022 13:59	…
Participant B	12-4-2022 9:12	…
Participant B	13-4-2022 9:14	…

<table>
<tr><th>Activity</th><th>Implementation</th><th>Rationale</th></tr>
<tr><td rowspan="3">A9. Perform feature engineering on the data set</td><td>Annotate GP titles
The activity data can be enriched by filling in the GP titles next to the GP id. For this, the entity id is cross-referenced with the GP titles recorded in the GP data set.</td><td>This way, a more user-friendly label is presented to the researcher while analyzing the data set. Additionally, it allows one to distinguish between GPs present at the end of the empirical test and GPs that were removed and did not have a title. Next to this, the textual title of the GP is more understandable and readable by humans than the GUIDs.</td></tr>
<tr><td>Annotate KS processes
The data set can be enriched by annotating the KS process associated with the activities described in Table 38. This yields the following:
Table 46: Example of KS process annotation
<table><tr><th>Action</th><th>KS process</th><th>…</th></tr><tr><td>Create good practice</td><td>Knowledge donation</td><td>…</td></tr><tr><td>Create good practice</td><td>Knowledge donation</td><td>…</td></tr><tr><td>Create comment</td><td>Knowledge application</td><td>…</td></tr><tr><td>Open good practice</td><td>knowledge collection</td><td>…</td></tr><tr><td>…</td><td>…</td><td>…</td></tr></table>This can be done by making a relational translation table (e.g., Creating good practice (knowledge donation) or filling in the values as an extra column in the interaction data.</td><td>Later, we can perform an analysis based on the identified processes by annotating the associated KS process in the data set. This way, we can examine the knowledge donation and knowledge collection processes as a whole.</td></tr>
<tr><td>Annotate sessions
As said before, the activity data can be enriched by annotation sessions. In the case of openBest, we used the most common method of determining breaks based on common sense. This involves a break of 15 minutes for all subsequent tasks except for creating a good practice that we break at 60 minutes. We expect the 15-minute break to be shorter; the same is true for the good practice break. However, we believe that for now, this capture breaks reliably enough. In later works, this could be further refined.</td><td>Annotating sessions distinguish between active and passive time and allow for more reliable time analyses. Next to this, it allows for analysis on a session basis. This way, users can have several sets of activities instead of one large set. The reason for the sizeable 60-minute break time is that we do not know if users have a good practice in mind beforehand or perform the entire creative process in the form directly (i.e., are the users filling in a good practice based on a source file or are they creating one at the spot).</td></tr>
</table>

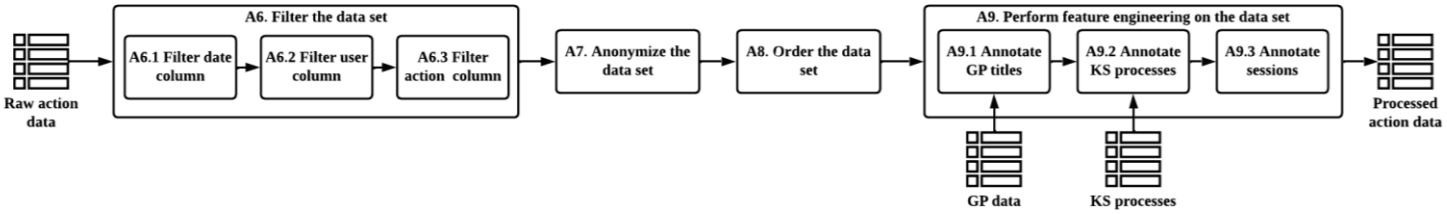


Figure 39: Overview of the data processing performed on the openBest data

The resulting data model is an adapted version of the conceptual data model highlighted in the theoretical design. The main difference is that our data model has an entity title. This is required in openBest because the entity recorded does not necessarily have a title but rather an ID. For insights during analyses, we think that having the title is better. This could be different in other knowledge repositories and depends on its architecture and the content of the entity data.

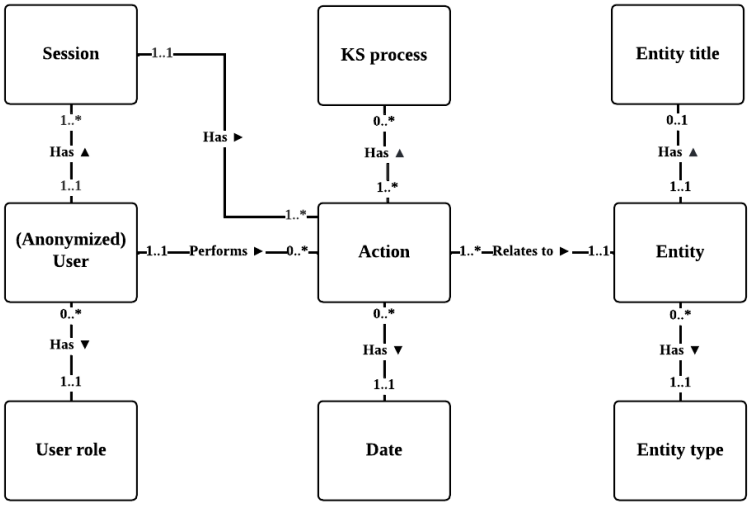


Figure 40: openBest activity data model after the processing steps

Note that the feature engineering involving cross-referencing IDs and GP titles can compromise the anonymization we applied earlier. This is because the title of a GP enables us to trace the authors and other activities. For example, if we have user X who created GP with ID '123' and later cross-reference the ID with the GP titles, we know the title. We then know that user X created GP 'Reducing wastewater'. If any users of the domain of user X then search for that GP title they see in this report, they may see the true identity of user X. This is not troublesome for now because no reports are written on active domains (e.g., user X and his peers cannot access the domain anymore). Therefore, no one can backtrack on the user's true identity. If a situation exists where we analyze or report on active domains in the future, we should take care when relating good-practice titles.

Step 4: Analyze processed action data

This section discusses how the data can be analyzed to draw conclusions about the quantitative KS behavior in the GPR.

A10. Perform analyses

At this point, we have clean processed activity logs, and it is time to perform some analysis. For this, we look at the perspectives we defined earlier, and the analysis design sub-activities are elaborated upon in the table below.

Table 47: Analyses design sub-activities

Activity	Implementation
Identify perspectives of interest	Looking at openBest, we see three central elements: users, GPs, and domains. To this, we add the perspective of the knowledge sharing processes.
Map activities to the perspectives	For the users, we can consider the activities they undertook. For example, how many good practices the user created. Next, we can investigate how many of the created good practices are removed. Other user actions we can investigate are the number of edits he made on his good practices, the number of comments he made, and the number of ratings he made. For the last two activities, we can also investigate the number of unique GPs the user rated and commented on. These are all activities that we think relate to knowledge donation. For knowledge collection, we can consider activities such as how the user viewed many good practices, and the number of GPs opened in general. These measures can be considered on an individual basis, but there could also be distributions (e.g., who viewed most GPs and the average number of comments of the users). When considering the GP as the central element, we can investigate the number of unique viewing users and the total number of views, comments, and ratings. Next, we could investigate how the GP is accessed via direct URL or the GP table. Again, these measures can be considered on an individual basis, but there could also be distributions (e.g., which GP is most often viewed). When considering the domain as the central element, we could consider aggregates of the measures from the user and GP perspectives—for example, the total number of GP views or the total number of comments. Next, we could investigate domain-specific actions, such as adding users and authors, which are of interest because they indicate active network growth. Finally, the number of KS actions per user, GP, and domain can be investigated when considering the knowledge sharing processes.

Identify the variables per action.

Once we have identified the activities per perspective, the variables of interest should be determined. These variables could be used as the basis for visualizations and analysis. For openBest, the following variables are of interest.

Table 48: Variables per action

Perspective	Action	Variable
User	Creating a good practice	• Number of created good practices.
	Removing a good practice	• Number of deleted good practices.
	Editing a good practice	• Number of edits by the user • Number of unique GPs the user edited
	Making a comment	• Number of comments from the user • Number of unique GPs the user commented on
	Making a rating	• Number of ratings by the user • Number of unique GPs the user rated
	Open a good practice	• Number of GP viewed by the user • Number of unique GPs viewed by the user
Good practice	Making a comment	• Number of comments • Number of unique users commenting
	Making a rating	• Number of ratings • Number of unique users rating

	Open a good practice	• Number of views
		  ○ Number of views through URL
		  ○ Number of views via table
		• Number of unique viewing users

Domain	Creating a good practice	• Number of created GPs
	Removing a good practice	• Number of removed GPs
	Editing a good practice	• Number of edits on GPs
	Making a comment	• Number of comments on GPs
	Making a rating	• Number of ratings on GPs
	Open a good practice	• Number views of GPs
	Adding a user	• Number of added users

Activity	Implementation		
		Adding an author	• Number of added authors
	Knowledge processes	Dependent on the mapping	• Number of occurrences of actions per process in total • Number of occurrences of actions per user • Number of occurrences of actions per GP

Using these variables of interest and their aggregation, we can perform an analysis per perspective of interest. For example, we can investigate the number of good practices created in a domain with time. This provides insight into the **frequency** of actions associated with the KS process performed in openBest over time. Next, process mining can be performed on the activity data. As described above, this provides insight into the **order** and **time** of the associated actions of the KS process.

A11. Interpret findings

In this activity, we will interpret the previous activity's findings regarding the measures we identified. For this, we can look at the earlier described features like frequency of actions, the order of activities, and the time required for the activities.

A12. Draw conclusions

After the interpretation, we can draw a conclusion on the KS behavior as seen in openBest.

6.2.3 Practical challenges of the knowledge sharing evaluation framework

We observe a few practical challenges with the implemented knowledge sharing evaluation framework. The first challenge is that we cannot log all activities in the GPR. For instance, all interactions involving the external DataTables with the good practices are challenging to record and are therefore not included. This happens because we cannot access the source code and can only construct code on top of it and attempt to connect it. This was not feasible, given the resources we have. We mitigated this data loss by recording the event when the page with the table is opened and the event when a GP is opened. In this way, we still get an indication of the duration of the interaction with the table. The second challenge is anonymization. As part of current research efforts, we were required to know who performed an action by name. This is because the measured activities are compared with the observed activities. As such, we needed to know the email addresses. The observed and measured activities have been subject to the same translation table, making the IDs correspond. This translation scheme could not be applied to the running time of the event log, which means that the events are not anonymized in the database. In future efforts, logging the user's ID would also suffice when comparisons between connected data must be made. This would eliminate the need for anonymization during or after runtime. The only challenge that then occurs is that linking the user's ID to other tables like the author collection is challenging because within openBest, the user's Google account is used as the unique identifier instead of the openBest generated user ID. Currently, the logs stored in the database still feature real email addresses. These are securely stored in an environment only accessible by authorized members of this project. These logs can also be anonymized at the source with some programming efforts. The third challenge is that the logging functions can malfunction if an error occurs in the code of openBest. For example, an error could occur if a user submits a faulty good practice by including characters that openBest currently cannot process. This error could block further code execution, such as activity log functions. It should be noted that the said errors do not have to constitute a tool-breaking error and that openBest can still be perceived as functioning for the user. An example could be an error when loading an image. In that case, the image cannot be loaded, which causes an error. This error is not shown to the user but could theoretically block the execution of the logging functions. This risk is minimized by reducing the number of potential errors by extensive testing of scenarios where users interact with openBest. With all this in mind, we think the implemented framework instruments are adequate for collecting data for analyzing frequencies, duration, and order of activities.

7 | Testing the proof of concept

This chapter describes how we test the proof-of-concept of the knowledge behavior evaluation framework implemented in openBest in a laboratory setting involving surrogate end users. The test investigates whether the knowledge sharing behavior framework can be applied in a real-world setting. For this, we collect data using the implemented behavior framework and observe participants' progress through tasks. Furthermore, participants report on their experiences. Using these data, we evaluate whether the implemented framework functions well, whether we can perform the analyses, and the extent of KS.

7.1 Design of the test

7.1.1 Motivation and context

In the previous chapters, we have designed and implemented a proof-of-concept of a knowledge sharing behavior evaluation framework. To investigate how this framework functions, we apply the framework to action by performing a test in a laboratory environment. To this end, we designed a test in which participants interact with a good practice repository. The measurement instrument based on the knowledge behavior framework is implemented in this repository of good practices. During the test, we collect activity data using the measurement instruments in the GPR. This way, we can determine how the implemented knowledge sharing behavior evaluation framework enables the measurement and analysis of knowledge sharing behavior in a good practice repository.

As participants, we selected students from the 2022 edition of the OICT (Organizations and ICT) course. The course is taught as part of the Informatiekunde Bachelor curriculum, but students from other programs can also follow the course. The course is taught by this project's supervisor. OICT is about understanding and analyzing an organizational context where an ICT solution is to be implemented. For this purpose, OICT identifies the problems, demands, and wishes of stakeholders. During the course's practical assignments, the students form groups of 2 to 4 persons. These groups design a good practice for an organization of their choosing. Because of this, students are familiar with concepts related to good practices and use good practices to document improvement steps for sustainable development topics. In the 2022 edition of the OICT course, 92 active students formed 31 project groups. There were three groups with two members, 27 groups with three members, and one group with four members.

As mentioned above, students develop good practice during the course. This good practice is documented as a slide in PowerPoint and then exported to an a5 pdf. For this empirical test, students are asked to fill their good practice into a good practice repository. They are then asked to perform other tasks in the good-practice repository. These tasks are not part of the regular course curriculum, and students receive an extra point for the GP creation workshop that is part of the curriculum upon completing the tasks. Consequently, this empirical test is subject to convenience sampling because the students were available. Moreover, there was some leverage to get students to participate because of the additional point for the practical assignment.

Although there was some convenience sampling, this was not the main reason for involving the students. The participation of the students has two main reasons: first, the students were available and extrinsically motivated to participate because of the additional point. Second, the students are familiar with the context and concepts of good practices and sustainability. This, in our opinion, makes the students suitable surrogates for the intended end user group of responsible organizations.

We know that this test is a simulation and does not occur under real conditions of practice, so we will not be able to generalize the findings properly. However, we think we can pilot the framework and draw some expectations for the practice environment.

7.1.2 Goals and variables

With the empirical test, we pursue two distinct but related goals. First, we want to test in a simulation setting the extent to which the proof of concept of the knowledge sharing behavior framework is operational and could be later used in real-world settings. For this, several variables are of interest. First, we want to know if the measurement instrument is accurate (i.e., does the collected data represent real-life situations). We examine collected activity logs based on **order** (e.g., no viewing of a GP before it is created) and **completeness** (e.g., no missing events). The reason for investigating these variables is that completeness and order could be negatively influenced because we rely on the Internet to provide communication and the other challenges outlined in the theoretical and practical design. Next, we manually monitor the activity by observing the activities and comparing this with the recorded activities. We then examine if the two fit. This way, we know that the collected data resembles real-life behavior. The fit is expressed in the **number of observed discrepancies** (e.g., monitored activity states 20 created good practices, but observed data suggest 21 groups). We regard the observed data as a benchmark for the truth in such cases.

Second, we also investigate to what extent KS behavior is observed within the good practice repository. For this, we look at the action-related variables we outlined earlier. We performed the analyses we designed earlier and interpreted the results.

Effectively, the first goal is to determine whether we can collect reliable, accurate data using the framework. The second goal concerns whether we can use the data in analyses and the analysis's outcome, i.e., how much knowledge-sharing activities are measured.

7.1.3 Protocol and instruments

The test protocol involves a set of research tasks and a set of participant tasks. The researcher's tasks consist of preparing the good practice repository for the test by setting up and populating a fitting domain. The researcher then prepared all aspects of the participants by sending out a call for action and registering the participants in openBest. The participants then perform tasks in openBest. During this activity, the measurement instruments of the implemented framework collect measured KS behavior data, and the researcher collects observed KS behavior data by monitoring the domain. After the tasks' performance, the participants report on their experiences. This results in participant perceptions. After the participant tasks, the researcher evaluates the empirical test using the measured and observed KS behavior data and evaluates any data on openBest. The latter is discussed in chapter eight. This setup is illustrated in Figure 41.

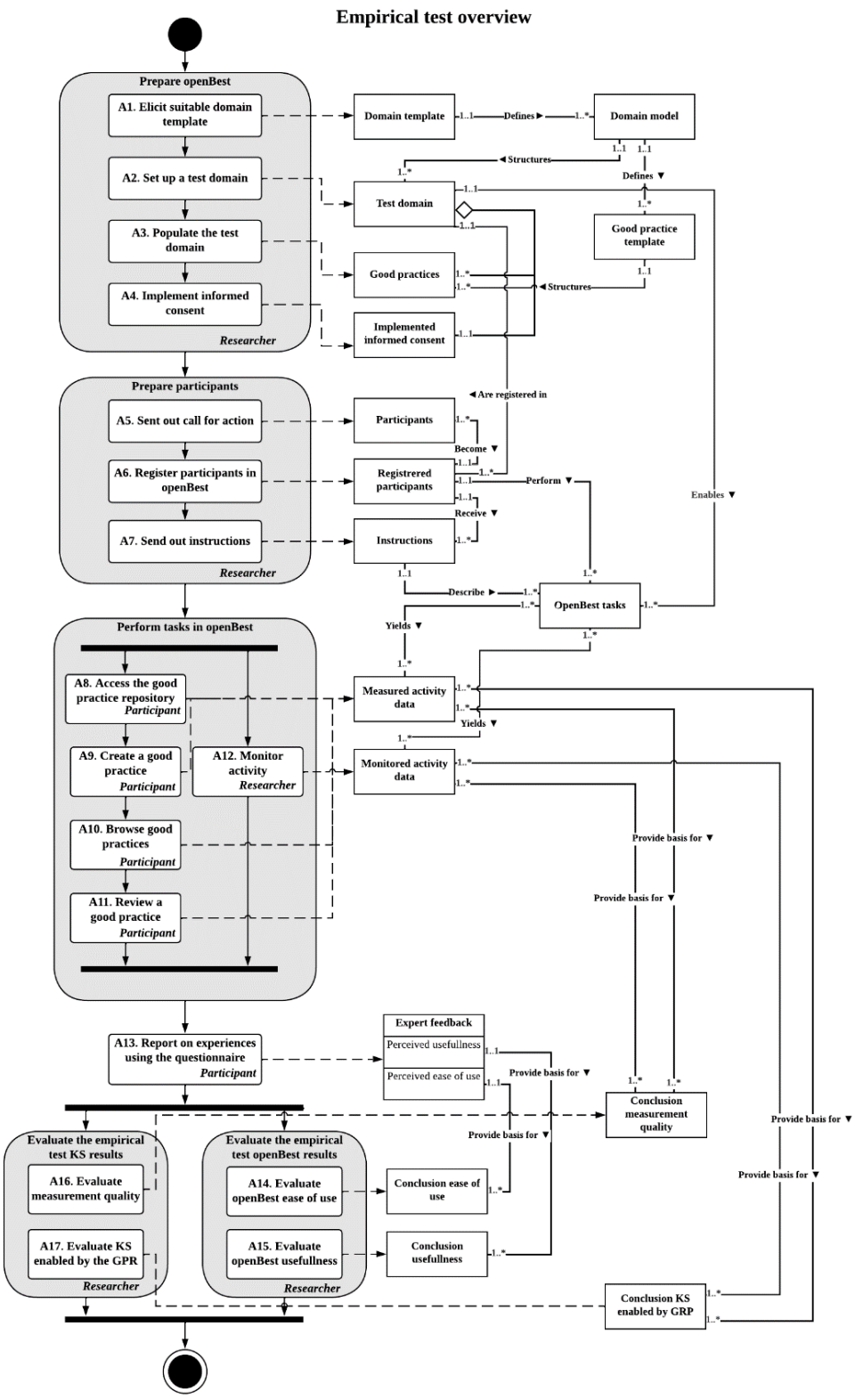


Figure 41: Empirical test setup PDD

Preparing openBest

Setting up and populating the empirical test domain

The first step in the (preparation) of the test is setting up the good practice repository for the empirical test. This involves setting up and populating an OICT domain in openBest. Most elements present in a typical OICT good practice are contained in this domain. The domain fields as part of the domain model were extracted by the author of this project in cooperation with the supervisor of this project (A1). The resulting domain model can be found in Appendix L: OICT domain model. The elements present in a good practice following the domain model are illustrated below in Table 49.

Table 49: Contents of a typical OICT good practice

Field name	Type	Content
Title	Short text	The title of the good practice.
Major dimension	Short text	The major sustainability dimension (category) of the good practice.
Sub dimension	Short text	The sub sustainability dimension (subcategory) of the good practice.
Front image	Image	An illustrative image placed on the front side of an OICT good practice card.
Front image license	Short text	The license under which the front image is used.
Date	Date	The date on which the good practice is created.
Author	List of short texts	The list of authors of the good practice.
Question	Short text	An intriguing question inviting the reader to read the good practice.
Quote	Short text	A quote associated with the good practice content.
Text	Long text	The textual content of an OICT good practice. The text is placed in a single field for simplicity.
Figure one	Image	An optional first illustrative figure.
Figure one caption	Short text	The caption of the first figure.
Figure two	Image	An optional second illustrative figure.
Figure two caption	Short text	The caption of the second figure.

In Appendix M: OICT good practice example, an example of a good practice following the OICT template is displayed.

Using the elicited domain model, a domain is created for this empirical test (A2). Upon instantiation, the domain is populated with six adapted good practices collected during earlier iterations of the OICT course (A3). The rationale for populating the repository is that the first groups interacting with openBest would already be able to see some good practices. In addition to this, the presence of some good practices may encourage exploration. The presence of some

good practices at the start of the empirical test is also thought to mimic real-life situations where domains are already somewhat active.

Implementing informed consent

The participants' activities and personal data (e.g., email addresses) are recorded during the test. Due to this, the participant should be informed about the test setup and all details regarding data collection. This is done using the informed consent letter (A4) included in Appendix J: Information letter. Furthermore, when entering and logging into openBest for the first time, the participant is greeted with a screen detailing the setup of openBest and its role in ongoing research. There is also a link to the informed consent letter on the page. The user is then asked to accept or deny being part of the research and, consequently, being monitored. If the user accepts, he gains access to the rest of openBest. If the user chooses to deny taking part, he is logged out. After this, the user can return and still accept to participate. If the user has accepted participating, there is still a reminder on the homepage that he is being monitored and a link to the informed consent letter. The application of informed consent in openBest is illustrated in Appendix K: Informed consent in openBest.

Preparing the participants

The next step is the participant preparation step. In this step, a call to action (A5) is sent out, and students can apply to participate in the empirical test using a Qualtrics form. Only one student was required to apply for each project group to qualify for the extra point. In the Qualtrics form, the setup of the research is outlined. There was also a link to the information letter seen in Appendix J: Information letter in the form's introduction. In the Qualtrics form, students are asked to agree with the content of the information letter. This means that they should agree that we collect data on their interactions with openBest. When they agree to these terms, they are asked to provide their group number, name, surname, and Google account. The name and surname fields were used for administrative purposes for the additional point. The Google account and group number were used in openBest to create accounts for the project groups.

After the application window has passed, openBest accounts are set up for participants so that they can enter openBest (A6). In addition, instructions for the test activities are sent to the participants (A7). The full instructions can be found in Appendix N: OICT student instructions.

Participant tasks

During the action step, the participants perform the activities indicated in the instructions. The participants' activities consisted of five sets of tasks: four within openBest and one outside of openBest. The four tasks within openBest involve accessing openBest (A8), creating a good practice (A9), browsing good practices (A10), and reviewing a good practice (A11). These tasks and their subactivities cover most of the activities a user can perform in openBest and resemble activities in other GPRs.

Tasks in openBest

The tasks the participants had to perform within openBest are elaborated upon below in Table 50.

Table 50: openBest interaction tasks

Task	Description	Outcome
Accessing the good-practice repository	Participants log into openBest using the Google account previously provided and check if they are indeed part of the OICT practicum environment.	After this set of small tasks, the participant must be logged in and be part of the correct domain. After this, he continues to the next task.
Creating a good practice	This activity involves the participant entering their good practice into openBest. Participants were allowed to copy elements directly from their OICT good practice for this.	After completing these tasks, the participant should have created his own good practice.
Browsing good practices	This set of tasks involved the participant browsing the repository to find their own good practice. They were asked to edit the good practice if it was not entirely to their liking.	After completing these tasks, the participant found and viewed his own good practice, and possibly edited their good practice, if needed.
Reviewing a good practice	This set of tasks involved navigating to an earlier specified good practice. The good practice was titled 'Teaming up for transportation.' This good practice was chosen on purpose because, by default, the good practice table is arranged in sets of 10. Because of this, only the first ten good practices, alphabetically ordered, are shown at first sight. This means that if a group performs the activity as the fifth group onward, there is a high probability that the good practice is hidden on page 2 or higher of the paginated table. This means some creativity is needed to find the good practice. Once the good practice is found and opened, the participant is asked to create a comment containing the dimension of the good practice, their group number, and if the good practice applies to the organization the participants have examined during the OICT course. The participant is then asked to rate the good practice. After completing these tasks, the participants browsed the good practice repository and provided community-based feedback on a good practice.	After completing these tasks, the participant navigated to a specific good practice and reviewed it using the commenting and rating features.

During these tasks, the researcher collects observational KS data (A12). For this, periodically, the researcher monitors the state of the empirical test domain in terms of present good practices and task progression.

Reporting on experiences

The one task outside of openBest is to complete another Qualtrics form in which participants can provide feedback and share their experiences with openBest (A13). In the second Qualtrics form, participants are asked to fill in their group number and Google account. This information is used again for administrative purposes. The participant is then asked the following questions:

Table 51: Reporting on experiences questions

Question	Description
Q1. What did you like about openBest? (Tops)	Is used to obtain expert feedback from participants on the good aspects of openBest. The answers to this question could indicate usability aspects that are adequately addressed in the current setup of openBest.
Q2. What could be improved in openBest? (Tips)	Is used to elicit expert feedback regarding potential improvement aspects of openBest. The answers to these questions could indicate directions for further improvement.
Q3. How many good practices have you viewed?	Is used to investigate how purely extrinsically motivated individuals engage in knowledge sharing using openBest. While viewing good practices is just one indication of activity, it could point us towards participants we could further investigate. Using the answers to this question, we can investigate activity that provides information on the extent to which networks of organizations could engage in knowledge sharing in openBest.
Q4. Do you have any further comments?	Is used to provide the participants with room to write any further commentary illustrating earlier questions or anything else that came to their mind during the interactions with openBest.

The results of the experiences questionnaire are not relevant to the framework evaluation but could later illustrate the usability and usefulness of openBest. The results of the form are discussed in chapter eight.

Evaluating the empirical test KS results

After the conclusion of the action step, the collected activity logs are retrieved and evaluated. Using these data and observed data, we evaluate the quality of the knowledge sharing behavior framework (A16) and the degree to which KS occurs within the GPR (A17).

Evaluate the empirical test openBest results

Next, we can evaluate the test results related to openBest itself. This involves evaluating the ease of use of openBest (A14) and the usefulness of openBest (A15) exhibited in the expert opinion contained in the experience reports. The findings of these exercises are reported in chapter eight.

7.1.4 Researcher's role

The researcher (the author of this project) plays three roles during the empirical test. First, the researcher has the role of a researcher. This role encompasses periodically monitoring activity in openBest and periodically examining activity logs to ensure that they resemble observed activities. Second, the researcher posed as a workshop assistant for OICT. In this role, the researcher monitored the completion of the participants' tasks to determine eligibility for the additional workshop point. Third, the researcher posed as the domain administrator. In this role, the researcher monitored the domain and, if necessary, hid the clutter. An example of clutter is a GP where the wrong author is selected. This is required because participants cannot change or remove a GP if they select the wrong author. This activity is justified because a domain administrator is also expected to act as an administrator by keeping the domain in shape and removing clutter in the intended context.

7.1.5 Expectations

To draw up expectations regarding the knowledge sharing we expect in the OICT domain, we look at the earlier defined framework of situational factors. Here, we apply the framework to the OICT setting. The situational profile of the OICT case is displayed below.

Table 52: OICT situational profile.

Category	Situational factor	Value	Explanation
KS interaction	Interaction level	interorganizational	We assumed all groups to be organizations engaged in interorganizational KS. In principle, the activities are meant to be performed by one group member but in cooperation with the rest.
	Modality	Online	An online platform enables KS interactions.
	Tool support	OpenBest	During the interactions, openBest is used as infrastructure.
	KS tool user efficacy	High	We think that the participants, being computer science and information science bachelor students, will have high efficacy with the tool as they are familiar with many of the conventions in web tools. We know that because the tool is new to them, efficacy may be lower at the start, but nearing the end of the tasks, we expect some learning to have taken place, increasing the efficacy.

Category	Situational factor	Value	Explanation
	Time	A time frame of about two weeks.	The instructions were sent on 4-4-2022, and the deadline for completing the exercises was set for 15-4-2022 at 23:59
	Shared mental model	Yes	There is common ground among the groups in that all the participants are aware of the concepts of good practices and their use in planning improvements as part of the OICT curriculum.
Motivation	Motivation for acting as a knowledge provider (linked to the interaction level)	Limited extrinsic	Participants are extrinsically motivated by the potential additional point for one workshop grade. We should note that this only constitutes little extrinsic motivation because, in the final OICT grade, this additional point has little impact. We expect to see little motivation for engaging in KS in both roles beyond the requirements for the additional point.
	Motivation for acting as a knowledge recipient (linked to the interaction level)	Limited extrinsic	
	Incentives	An additional point for one workshop grade	Participants receive an additional point for one workshop grade after completing the activities. There are no strict quality constraints on the performance of the activities. This means that participants who show effort to perform a specific task but fail can still qualify for the reward.
Knowledge being shared	Type of knowledge that is being shared	Explicit (embedded)	The knowledge being shared consists of explicit knowledge embedded in a situational application (e.g., good practice on reducing water usage in heavy industry)

Category	Situational factor	Value	Explanation
	Topic of the knowledge being shared	The topic of knowledge can be anything expressed in a GP. Typically, this could be knowledge of experiences or insights into processes. Moreover, the GP can also voice ideas for further research.	The topic and contents of the knowledge can be diverse, whereas normally, this would be relevant as organizations are not necessarily willing to share ideas for further development (as we have seen in the literature). This may not be problematic as the groups are not real organizations, and no real advantage is lost by sharing information that would otherwise be withheld.
Personal characteristics	Age	Mostly age groups between 18-24	We did not ask the participants, but because the course students are mostly bachelor students, we expect this age group. There may be some exceptions, but the majority will fall into that range.
	Sex	Unknown	We did not ask the participants and had no information to determine realistic estimations.
	Education	Majority: Undergraduate students following the course as part of their bachelor's program Minority: Pre-master students	Because the OICT course is taught as part of the bachelor curriculum of Informatiekunde and sometimes as part of a premaster, we think that most are undergraduate students. A minority have a bachelor's degree and follow the course as part of the premaster.
Organizational characteristics	Organization size	2 to 4 members	Most groups had 3 members, but some had 2 or 4 members.
	Branch	Various	We regard the student groups as organizations, and as such, their researched organization can be used to determine the branch they would represent if they were an organization. We expect to see various branches because there are no known restrictions for the groups when choosing an organization of interest.

Category	Situational factor	Value	Explanation
	Organizational structure	Informal (Horizontal)	The groups in this context can be seen as an abstraction of an organization with an informal organizational structure because there are no clear hierarchical roles.
Knowledge network characteristics	Network size	23 groups	23 groups responded to the call to action and are registered in openBest.
	Network goals	A shared goal, but not a common goal	The groups together do not pursue a common goal (e.g., they do not need each other for that goal). They pursue a common goal, as they all want to get the additional goal.
	Network coupling	Low	The network coupling is low. Although there may be some acquaintances between the groups, little expected cooperation or coordinated efforts are expected.
	Network geographical proximity	High	The groups corresponding to the organizations all follow the OICT course at Utrecht University, meaning that they all relate to the same geographical place, and therefore their proximity is high
	Network organizational proximity	High	All the groups have the same goals and assignments and are made up of students; therefore, the organizational proximity is high.
	Trust in the network	High	The groups have no (known) reason to distrust each other.

Based on this characterization, we expect the participants to perform the instructions' activities but not engage in any additional activities. The main reason for this is the limited motivation and incentive. Due to this, we expect minimal exploration, discussion, and the creation of good practices beyond mandatory activities. Additionally, the low network coupling and lack of shared goals suggest that there may also be limited KS happening among the groups regarding comments, ratings, and viewing each other's good practices. We expect to see no instances of activities related to modifying the characteristics of the network because actions related to that process, i.e., adding a user, or adding an author, are restricted to the administrator role. During the test, we ourselves act as the administrator, so there is no possibility of the users engaging in changing the characteristics of the network. Quantitatively we expect to see per user:

Table 53: Expectations for quantitative variables per user

Associated KS process	Variable	Value	Rationale
Knowledge donation	Sound created GPs	1	We expect that the users will only create the single GP they are required for the task. We make a distinction here between creating GP actions and sound Created GPs. The first is the sum of the actions, and the second is the product in terms of sound GPs (i.e.., good content, images linked to some extent).
Knowledge collection	Distinct viewed GPs of other users	~2	We expect that some users will only view the GP required for completing the exercise, which is 'Teaming up for transportation'. Some other users may be tempted to view one or two GPs of others out of curiosity and perhaps to seek an example of how the GP could look. Overall we expect this to average out to about 2 distinct GPs of other users viewed per user.
Knowledge application	Number of created comments	1	We expect that the users will only create the comment they are required for the task.
	Number of created ratings	1	We expect that the users will only create the rating they are required for the task.

For the other actions like editing or removing a GP, it is challenging to estimate as this is dependent on the user's efficacy with openBest, and it is also dependent on whether the users need to edit or remove the GP. This is not mandatory in the tasks.

7.2 Execution of the test

The test execution began with a call to the students to participate. This call was sent through multiple channels. First, the call was made during the practical sessions of OICT. Then there was also an announcement on the courses' Blackboard page. As part of the call to participate, a link to the Qualtrics application form and the information letter was provided. During the application phase, 23 of the 31 groups (~71%) applied to participate. After the application deadline, 23 groups were added to the OICT domain in openBest using their Google account and group number. At the same time, students received instructions for the activities in openBest via email. The students had not yet created a good practice as part of the OICT workshops. As a result, initially, there was little recorded activity. A little while later, when the students had to hand in a draft of their good practice activity, it started picking up and increasing until the deadline of 15-3-2022 at 23:59. As domain administrators, we had to act on several (7) occasions during the test. In such cases, groups had submitted faulty GPs by not selecting the correct author. This happened a total of 7 times. In such cases, we hid the GP from the domain. This means that we did not delete the

document but made it invisible to avoid cluttering the domain. At the deadline's passing, 20 groups performed most activities with varying success. Two groups did not attempt to perform any activities, and one group dropped out of the test after completing about half of the activities.

7.3 Test results

The results of the empirical test comprise two parts. First, there is the observed progress. These are the data collected by manually monitoring the progress of the groups in openBest. These data illustrate the participant's progress through the tasks. Second, there are the measured data. These data are collected by automated logging using the data collection instruments implemented as part of the framework. Using these data, we want to address the two main goals: evaluating the measurement instrument and investigating the extent of KS within the good-practice repository. Here, we first discuss both data sets.

7.3.1 Observed progress

Observed progress data

As we have seen before, the students were given a set of tasks. During and after the tasks were performed, progress was manually monitored. We did this by monitoring the domain in openBest. The raw data collected through this effort are recorded in Appendix X. OICT observed progress data. In Table 54, the aggregated progress of the groups of participants is recorded.

Table 54: Observed progress of the OICT groups

	Accessing openBest	Creating a good practice	Images linked	Browsing good practices	Evaluating good practices
Successful	21	20	12	20	18
Failed	0	0	5	1	0
Succeeded partly	0	1	4	0	2
Did not attempt	2	2	2	2	3

In appendix X: OICT observed progress data, we see that of all the groups of OICT, 23 groups applied to participate in the empirical test. For each of these groups, an openBest account has been set up so that they can participate. In Table 54, we see that 21 of the 23 groups that applied to participate accessed openBest. Note that while accessing openBest seems like not observable behavior, as there is no apparent output. We were able to observe this by keeping a column 'hasaccessed' in the user account in the database. This column's value is set to 'True' once a user has logged in and provided informed consent. Because of this, we know if a user has accessed openBest. All groups that participated (21) managed, to some extent, to create a good practice. Most groups created only one good practice, but 3 of the 21 groups created 2 GPs. This means that a total of 24 GPs were created. Of these 21 groups, 12 could link the images of the GPs correctly, and five could not. Four groups managed to link the images to some extent. In one of those cases, the images were linked incorrectly, but the group provided the URL to the Google Photos folder in their GP's comment section. In other cases, only some of the GP images were

correctly linked. When considering the linking of the images, it should be noted that there were some special circumstances. Some groups unknowingly provided temporary links to the images so they could only be seen for a limited time. These groups are counted as correctly linking the images because this was an external challenge in Google Photos and had no relation to openBest. In essence, they provided the correct link, but Google Photos offered an incompatible model for permanent links. We monitored the empirical test extensively to note the difference between incorrectly linking the image (cases where the images were missing from the start) and submissions with a temporary link to the image (cases where the images could be observed for a limited timeframe).

Of the 21 groups, only one group (P21) encountered difficulties that they could not solve themselves when creating their GP. An error would occur when the GP's text is pasted, making them unable to create a GP using their PowerPoint GP's text. Instead, the group provided an URL to their GP's text in the 'text' area of their GP card in OpenBest. Although this constitutes the creation of a GP, we think that the GP of this group is not fully qualified due to the lack of adequate text. It is unknown why the text was not later edited. After this, the group asked if their effort was sufficient and where to find the browsing overview. We then provided a detailed answer and suggested that they retry submitting their GP. After this, group P21 did not resume the tasks; the reason is unknown because attempts to contact them have failed.

Therefore, only 20 out of the 21 groups could complete the task of browsing good practices. Of these remaining 20 groups, 18 were able to complete the evaluation of good practices assignment. 2 groups of the remaining 20 only commented but did not give a rating. We are inclined to think that they forgot to perform the minor task because it was the last task, and perhaps they read over it. However, we cannot confirm this belief because efforts to contact the groups have been unsuccessful.

Observed progress conclusion

We conclude that most of the participating groups managed to complete most of the exercises. The main challenge identified from these data was the linking of the images. In addition, some groups did not make a rating, but the reasons for this are unknown. Finally, one group had problems finding the good-practice overview page; the reason for this is also unknown. This means that, judging by this dataset. openBest is usable by a knowledgeable participant group, but there are some challenges, of which the linking of images is the most evident.

7.3.2 Measured activity

7.3.2.1 Retrieving the data

Using the measurement instruments previously described, activity data was monitored. This activity data was contained in the folder 'activity logs' of the OICT domain. We also found a small number (n=4) of logs in a folder, 'activity logs' in the 'undefined' domain. These activity logs were incorrectly stored. The writing to the 'undefined' domain occurs when openBest could not retrieve the user's domain, which occurs when a loading error occurs on the user's side. We ensured that these logs belonged to the OICT domain by cross-referencing the events' User column containing the user email address with the OICT participants' email addresses. The activity logs from both sources were merged to form the raw data logs.

7.3.2.2 Processing the data

After retrieving and combining the data, we applied the processing steps we described earlier. This involved retrieving and filling in the GP titles and annotating the KS process associated with actions. For filling the GP titles, it was observed that some GPs did not have a title. This is because the GP was deleted at the time of data retrieval. In other words, no title was available for the recorded GP ID. This was the case for eight recorded activities. Moreover, there were logs where no entity ID (n=3) was recorded. This only occurred for 'Close GP' actions. This indicates that the GP may not have correctly loaded, thereby not having a GP ID and the user closing the faulty loaded GP. For both situations representing 11 recorded activities, we filled in 'No title' in the entity title column. Next, sessions were annotated using the earlier described session breaks. Furthermore, we applied anonymization using a translation table and applied the filtering we described earlier. Overall, the data processing went smoothly, and no challenges were identified. After the processing effort, the data set was ready for analysis. The resulting data set contains 597 recorded activities and forms the basis for analysis[7].

7.3.3 Evaluating the test results

As said before, the test had two distinct goals. Here we address them. We first evaluate the quality of the data collected using the knowledge sharing behavior evaluation framework. Then we investigate the extent to which we can use this data in analysis and the extent KS happens in openBest.

7.3.3.1 Evaluating the knowledge sharing behavior evaluation framework

Here, we evaluate the quality of the measurement instrument based on the KS behavior evaluation framework. We do this by first evaluating the quality of the collected action data by looking at the order and completeness of the collected activity data. We do this to see if the data itself are of good quality. Next, we compare the measured data to the observed data to see if the measured data provide a good reflection of reality (i.e., are the data accurate).

[7] If you are interested in the dataset, please reach out to s.w.vanderpijl@students.uu.nl and I would gladly share it.

Data quality analysis

In this section, we examine the quality of the data logs as they are after processing activities. We consider two quality aspects, namely proper **order,** and **completeness**. For the order, we consider whether the order of the activity logs makes sense and whether it could occur in a real-life scenario. For completeness, we consider the completeness of the logs. This means that we investigate whether, in our opinion, the activity logs we have constitute all the interactions a user has had. This is also assessed by looking at the observable behavior recorded in openBest.

Order

The order of the activity data was examined by looking at the individual participant's activities in the data. For this, we considered two variables as cases. First, we considered the participants (i.e., all activities performed by a single user) as cases. We reviewed all cases and assessed whether the activities following each other were allowed. For instance, opening the dashboard page and next viewing a good practice is not allowed as first the good practice overview page is to be opened. This valid order does not necessarily mean that the right activities were performed but that the order seems plausible and is allowed by the GPR. We found that all participants, except one, had valid order activities. The one participant who had a suspicious order was participant 4. This participant's event log started with the closing of a good practice. This is suspicious because the good practice in question was not created at the time. Moreover, closing a good practice can never be a user's first recorded action. This suspicious order in the activity data is illustrated in the excerpt in Table 55 below.

Table 55: Excerpt of the activity logs of participant 4

ID	Action	Entity type	Entity	Datetime
sVfw4gJQISS7vQVxiamn	close best practice	best practice	_5aeiiu27t	4/9/2022 21:13
….	…..	…..	…..	….
XX9ea5KuwfoGnWUZYIcG	open best practice	best practice	_5aeiiu27t	4/9/2022 21:14
CgXXHTHxQkeICObT2yMi	remove best practice	best practice	_5aeiiu27t	4/9/2022 21:14
….	…..	…..	…..	….
nDFjy3jlvVbn1jI8qQJR	create best practice	best practice	_5aeiiu27t	4/10/2022 3:19

Our initial hypothesis was that this had to do with connection issues either on the client-side or server-side at Firebase. The latter proved unlikely as Firebase did not report any incidents during April 2022[8]. Consequently, we thought the issue might be on the client's side. At first, the internet connection was considered the culprit. However, this was also unlikely because the other activities require a stable internet connection. Consequently, the cause was sought at the client side before the activity logs were sent out. The activity logger uses the user system's time. When an action is performed, the logger collects all information, including the timestamp, based on the

[8] https://status.firebase.google.com/products/6yDUaxmrjdHvC8tnGHRQ/history

user's system time. The datetime displayed in the table is the collected system time when sending the log to the database, not an automatically recorded sent or receive time. This setup was required to prevent delayed logs from having incorrect or malformed timestamps. This means that having a spotty Internet connection does not alter the recorded date and time. The flipside is that the activity logger depends on the user's system time. After extensive testing, we could reproduce the above logs by changing our system time during the actions. This, combined with the fact that the other activities are logged correctly and that our logs could not be manipulated by a limited Internet connection, makes us think that it is most likely that the participant (unknowingly) influenced the log order by changing his system time. This means that, while vulnerable to external influences, the measurement instrument did collect the correct information. Apart from this participant, no invalid orders of activities were identified.

Next, we evaluated the sessions we annotated as cases (i.e., the groups of activities per user per session). On that level, we did not encounter any orderings that should not be possible apart from the case we described above. Because of this, we think the recorded timestamp is accurate, yielding valid orderings.

Completeness

We examined the completeness of the event logs per user by checking the activities against observed behavior in openBest. For instance, if we consider a participant, we view his progress through the tasks and see if that matches our recorded logs. This showed that all progress data is reflected in the collected data. This analysis alone does not provide certainty of completeness as there could be non-observable behavior (i.e., data lacking in the observed data) that should be present in the measured data. To address this, we reviewed all activities and investigated if subsequent activities within a case were possible. This differs from checking the order in that reordering could make the activities sound again in the case of the wrong order. However, in the case of incomplete activity sets, subsequent activities could not occur, and there is no reordering that makes it sound. This is best illustrated using the following activity sets.

Activity set 1. Remove good practice → Create good practice → View good practice

Activity set 2. Create good practice → Remove good practice

Activity set one is a case of wrong ordering, as it can be addressed by moving the first activity to the last. In the second activity set, there is a series of activities that could not occur because deleting a good practice cannot be done without viewing it first, and no viewing activity is recorded.

While examining the data, we could not find any impossible sequences of events within the dataset. Because of this, we think that under ideal circumstances, like a stable internet connection. The measurement instrument provides complete event logs.

Comparison of observed and measured activity data

As we have seen in the previous subsections, the measured activity data seems to be of high quality. However, the main question that we still need to answer is to what extent the measured data capture the real actions we could observe. This is often called conformance checking (van der Aalst, 2012). For this, we compare manually collected data to the measured activity. We do this by comparing observable behavior (e.g., creating a GP, making a comment) to the measured data. Note that the observable behavior is limited to the contents present at the end of the test. This means that GPs that were once created but later deleted by a user cannot be observed manually. The structure of the comparison is as follows. First, we compare the observed behavior related to task completion to the collected activity logs using process mining. Second, we investigate if the measured action data provides a correct impression of the state of the domain. For example, how many comments should a user have at the current moment based on measured activities, and how many comments are observed? We do this from the user and the good practice perspectives because these are the two main elements.

First, we compare the collected task completion data to the case coverage of the recorded activities as displayed by the Disco process miner. In this exercise, we consider all activities performed by one participant, regardless of sessions, as one case. Below in Figure 42, the mined process model is shown.

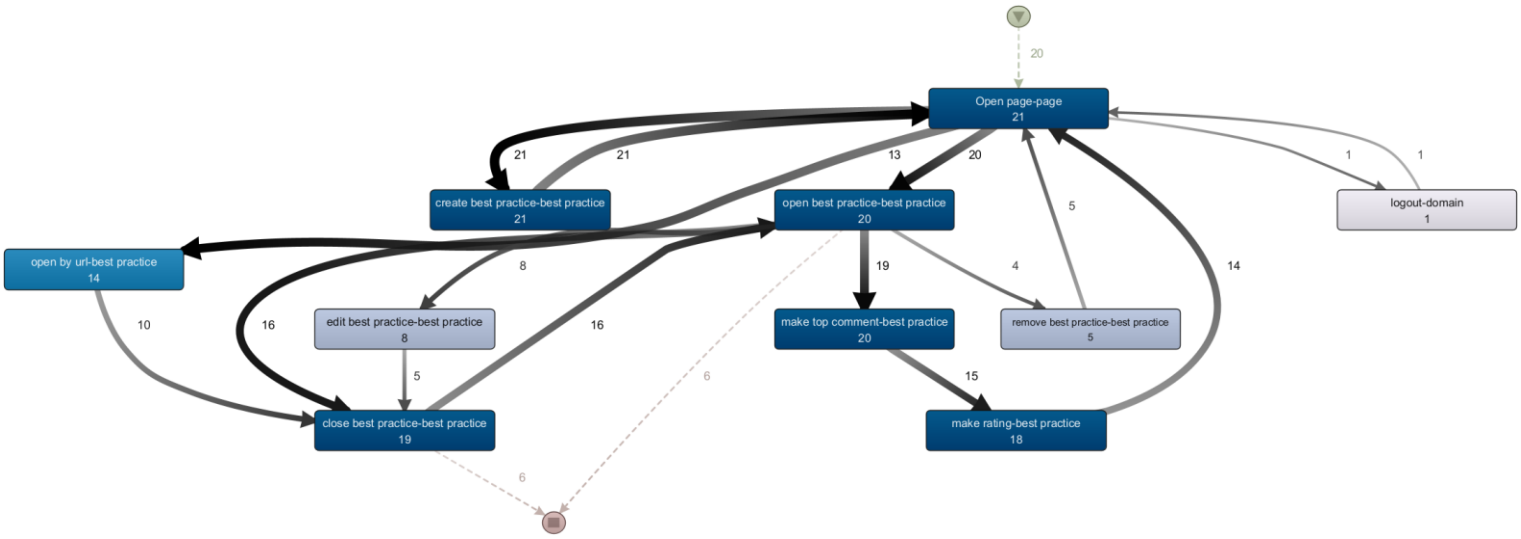


Figure 42: Process model displaying the case coverage with participants mapped to the case (with 100% activities and 0% paths)

The image illustrates the case coverage of activities based on activity logs. The parameters of the schematic overview are: show 100% activities and 0% paths. This configuration shows all activities, but only the most frequent paths are illustrated for simplicity.

If we now consider the activities that the participants had to perform (Accessing openBest, Creating a good practice, Browsing good practices, and Evaluating good practices). We can investigate if the collected data mirrors the progress data.

Accessing openBest – this task involved the participant logging into openBest. According to the monitored information, 21 groups were successful in accessing openBest. This is reflected in the Open page – page activity in the mined process as 21 cases opened a page in openBest. This activity is only logged if a person is logged in and assigned to a domain, indicating that 21 groups accessed openBest.

Creating a good practice – this task involved the participant creating a good practice by filling in the good practice form accessed via the dashboard screen. According to the monitored data, 21 groups attempted to perform this action, and 20 groups were successful. Looking at the mined process, we can see that 21 groups performed the create best-practice action. We also see that we cannot determine the operation's success by looking at the activity logs. The reason for this is that success is subjective. In fact, the group in question was partly successful in creating a good practice. The reason was that some contents were filled in wrong. As far as openBest is concerned, this, of course, constitutes creating a good practice but the success factor we refer to is more subjective (i.e., can not be logically captured by the activity logs)

Browsing good practices – This task involved participants interacting with the GP table, inspecting, and, if necessary, editing their own GP. We learned from the observed activity that 20 groups successfully performed these actions and that 1 group failed to perform this activity. Evidence of this is that 1 group reached out, stating they could not find the GP overview table. This situation is reflected in the collected activity logs. There, we can see that only 20 groups opened a good practice. Another part of this exercise was to edit the good practice if necessary. This behavior could not be observed because changes could be minimal; hence unfeasible to track by manually monitoring alone. The collected data logs indicate that eight groups performed editing activities and 0 groups canceled their editing efforts.

Evaluating good practices – This task involved participants in searching for a specific GP, making a rating, and commenting. From the observed behavior, we learn that 18 groups were successful, and two partly succeeded. Remember, these groups only commented and did not make a rating, and three groups did not attempt. Again, this is reflected in the collected activity logs. We can see that 20 groups commented, and 18 groups made a rating. From the schematic process overview, we cannot determine that these 20 commenting groups and 18 rating groups performed the activities on the correct GP (Teaming up for transportation). For this, Appendix P: OICT measured activity logs pivot tables can be used. Alternatively, the process miner can show the cases of the 2 participating groups.

From this, we observe that the measured activity data reflect and fit the monitored activity data regarding the case coverage. Because of this, we conclude that the measurement framework effectively captures the coverage of activities per case (user).

Second we compare monitored data with the measured activity data from the user perspective. For this, we consider observable behavior (e.g., behavior that can be observed directly in openBest) at the end of the test. For instance, we look at the number of GPs created by the user and the number of comments and ratings.

Good practices

First, we compare the observed number of GPs made by the users to the measured number of GPs made. Note that this measured number of GPs made is constructed by subtracting the number of 'remove GP' actions from 'create GP' actions per user. The aggregation of this is shown below. Please see Tables 31 and 36 in the Appendix for the full tables.

Table 56: Amount of measured and observed created GPs

Observed number of GPs made	Measured number of GPs made	Difference
24	31	7

From this, we can see a difference of 7 GPs between the observed and measured number of GPs in the domain. Although this difference may seem significant, this is exactly the number of GPs we hid in our role as domain administrators. Moreover, the 7 cases identified align with the hidden GPs. This confirms that these 7 GPs indeed cause the difference. The reason for hiding these GPs was that they were all faulty in one way or another and that the users could not repair this fault either because they (accidentally) selected the wrong GP author or because of other issues. Due to this, both measures are right. There are indeed 24 observable GPs in openBest and 31 GPs in the domain in the database. Of these 31, only 24 are made visible. In this sense, the measurement instrument performs well. Under normal circumstances, the domain administrator would have performed seven removal activities instead of hiding the GPs in the database. This would align 31 to 24 as 31-7 = 24. The rationale for hiding the GP during this test instead of removing it was documentation. We, or future researchers, can also investigate why the GPs were faulty without cluttering the domain.

Comments

Next, we can compare the observed and measured comments. When looking at the user level, we see that the number of comments we observe in the domain is identical to the measured number of comments. This means that the measurement instrument accurately captured these actions. Below, the aggregated version of this is displayed. For the full tables, please see Tables Table 74 and Table 82 in the Appendix.

Table 57: Amount of measured and created comments

Observed number of comments made	Measured number of comments made	Difference
22	22	0

In the current use case, no user engaged in deleting his comment or responding to another user's comment. If this were the case aggregating the number of created top comments could be different from the observer comment counts. In such cases, the comment count per user should be calculated by:

$$Measured\ amt\ of\ comments = (|Top\ comments\ created| - |Top\ comments\ removed|) + (|Sub\ comments\ created| - |sub\ comments\ created|)$$

Ratings

Next, we can compare the observed and measured ratings. When looking at the user level, we see that the number of ratings we observe in the domain is almost identical to the measured number of ratings. There is a difference of 1 rating. Upon inspection, we discovered that one participant created two ratings for the GP 'Teaming up for transportation'. Making a second rating replaces the first one, so the number of observable ratings remains the same. As such, the measurement instrument captures the situation correctly, but when analyzing the data to determine the total ratings at a given time, the calculation should be based on the ratings made per user per GP, considering the removal actions and the fact that creating a rating, if a user already has a rating for that GP does not increase the total amount of ratings. The measurement instrument accurately captured these actions, but the analysis should be aware of the nuance. For the full tables, see Table 73 and Table 81. Below, the aggregated version is displayed.

Table 58: Number of measured and created ratings

Observed number of ratings made	Measured number of ratings made	Difference
21	22	1

Third, we compare monitored data to the measured activity data from the good practice perspective. For this, we consider observable behavior at the end of the test, which means that we look at the number of comments and ratings per GP.

Comments

Next, we can compare the observed and measured comments. When looking at the good-practice level, we see that the number of comments we observe in the domain is identical to the measured number of comments. This means that the measurement instrument accurately captured these actions. For the full tables, see Table 75 and. Below, the aggregated version of this is displayed.

Table 59: Number of measured and created comments

Observed number of comments made	Measured number of comments made	Difference
22	22	0

Ratings

Next, we can compare the observed and measured ratings. The GP level shows that the number of ratings we observe in the domain is almost identical to the measured number of ratings. This is also due to the same challenge identified at the user level. For the full tables, see Table 75 and. For the full tables, please see. Below, the aggregated version is displayed.

Table 60: Number of measured and created ratings

Observed number of ratings made	Measured number of ratings made	Difference
21	22	1

Comparison conclusion

This section compared the data collected using the measurement instrument to the data collected by manually monitoring the domain. We first examine the coverage. Herein we looked at the manually monitored progress regarding the test's tasks and the process mined in Disco using the recorded activity data. The comparison showed that the mined process reflected most manually collected progress information. Next, we compared the measured activity data to the observable data from the user and the good practice perspectives. Here, we found that the collected data accurately represent reality, but some nuances should be considered when performing analysis. An example is that taking the sum of the create rating activities and subtracting the sum of the remove rating activities does not directly translate to the real number of ratings at a given time. The same is observed in the number of GPs. Overall, we conclude that the framework's measurement instruments accurately record the activities, but the named nuances need to be considered for accurate analysis.

7.3.3.2 Evaluating the extent to which the GPR enabled KS

Now that we know that the data we have collected using the knowledge sharing behavior evaluation framework reflects reality as far as we can observe, it is time to see if we can use the data in the analysis. For this, we performed several activities related to the analysis we mapped earlier. More precisely, we pick up the evaluation framework from the fourth step, 'Analyze processed action data.' We have already performed the design of activity A10, wherein we described the possible variables of interest and their aggregations. Now we will investigate them. For this, several pivot tables are constructed for the perspectives we determined: Users, Good practices, Domains, and KS processes. The tables are placed in Appendix P: OICT measured activity logs pivot tables. Next to this, visualizations containing the variables of the recordable KS-related actions in openBest are created in Microsoft Power BI[9].

Overall activity

First, we look at the overall activity as recorded in the domain. The activity distribution over the dates shows that some activity was recorded at the announcement of the exercise. Then for three days, no action was recorded. After this, some limited activity was recorded. After this one day, no activity was recorded. Then nearing the deadline, the activity started to pick up with April 14th recording limited activity of only one participant. On April 15th, the recorded activity peaked with 229 recorded actions. This is illustrated below in Figure 43.

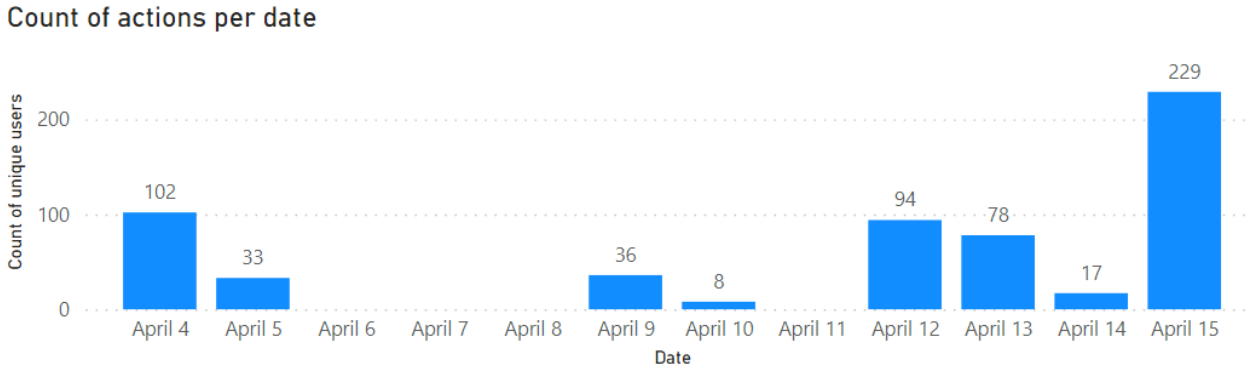


Figure 43: Time series of the total counts of actions within the OICT domain

This activity trend is also reflected in the number of (unique) active users per day, as seen in the figure below.

[9] The powerBI visualizations can also be viewed here as part of a simple dashboard https://app.powerbi.com/links/ZkLrXI1CkN?ctid=d72758a0-a446-4e0f-a0aa-4bf95a4a10e7&pbi_source=linkShare

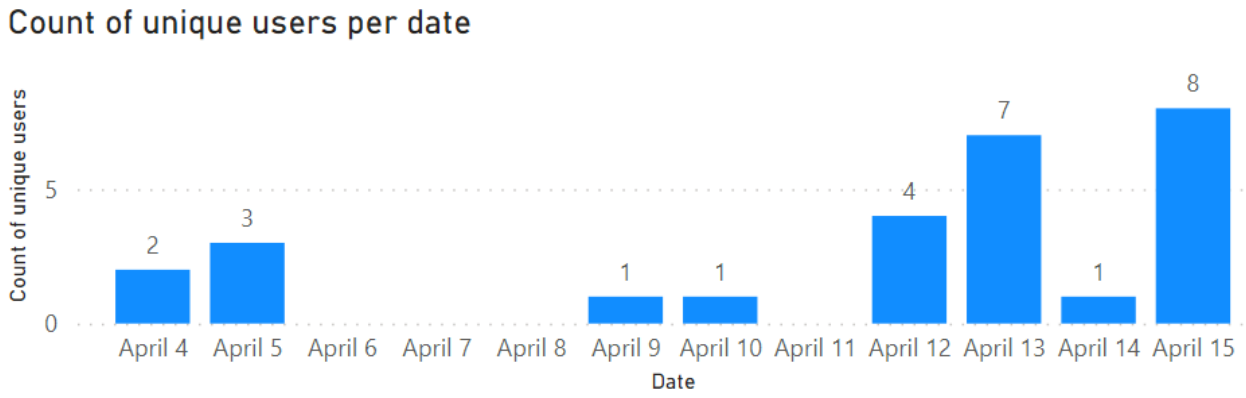


Figure 44: Time series of the count of unique users per day in the OICT domain

Good practice management actions

In the tables, we see that 39 'create good practice' actions were performed in the domain to create the end product of 24 sound GPs. This means that in ~61% of the cases, the good practice created was of sufficient quality or could be made adequate by editing. This editing was done 12 times. Of the 39 good practices created, eight were deleted by users, and the domain administrator hid the remaining 7. In these latter cases, the wrong author was selected as the GP's author. Due to this, openBest did not recognize the participants as the GP author, and the participant could not change or edit the GP. This meant that the domain administrator had to act. This is reflected in Figure 45, where we can see that some users had to remove their good practice, and some groups like p2, p4, p11, and p5, required multiple attempts to create their GP.

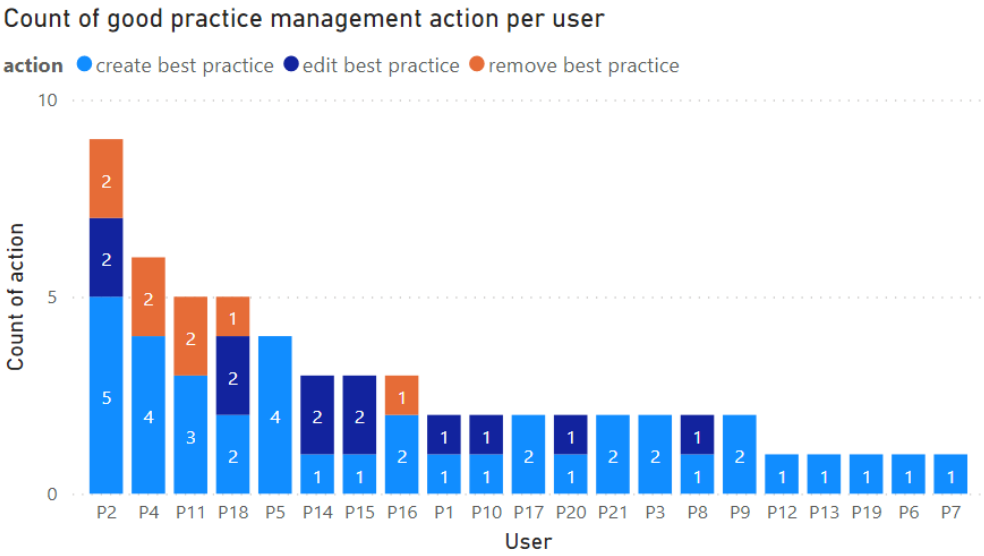


Figure 45: Count of good practice management actions per user

As we could expect, based on the time series of the activities in the domain, the activities related to good practice management (e.g., create good practice, edit good practice, remove good practice) are also placed in 3 bursts. We first have two sets of limited activity on the 4th and 5th and 9th and 10th of April, with activity picking up nearing the deadline on the 15th of April. This is illustrated in Figure 46 below.

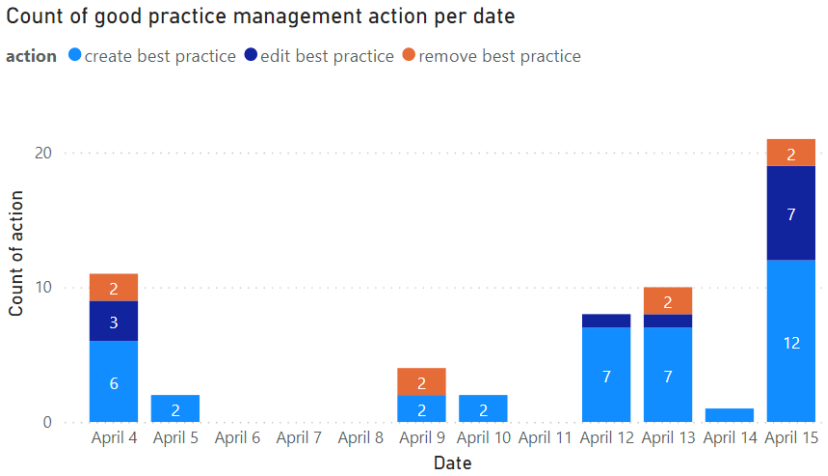


Figure 46: Time series of the counts of good practice management actions

Viewing good practices

From the data in the tables in the appendix relating to the opening of a good practice, either from the GPtable or URL, we can see that one group did not open any good practices. This is the group we discussed earlier that had problems finding the good practice overview table. Considering all groups that participated, on average, they viewed 3.6 distinct good practices and opened 5.6 good practices overall. The general distribution of the different good practices observed is illustrated in 47.

Figure 47: Distribution of the number of good practices viewed (based on Table 78)

Note that this count does include looking at one's own GP but does not include viewing deleted GPs (e.g., an older version of one's own GP). The data indicates that every group looked at his own GP. Because, on average, each group that participated created ~1.14 (24/21) sound GPs (24/21), we can subtract this from the distinct good practices viewed for the groups that had viewed at least one good practice to illustrate the number of GPs by other groups a group has viewed. This shows that each group viewed ~2.5 distinct GPs from others on average.

From the perspective of the GPs, taking into account the GPs still present at the end of the test, we can see that, on average, the GPs were viewed ~3.97 times by ~1.13 distinct users. The most visited GP is the GP 'Teaming up for transportation'. This GP was featured as part of the assignment and was opened 41 times by 20 different users. There is also a GP that has not been viewed by any users. This GP is the GP created by the group that had problems finding the navigation page. This GP was added last; therefore, no other groups viewed it. The entire distribution of unique viewers and views per GP is shown below in Figure 48.

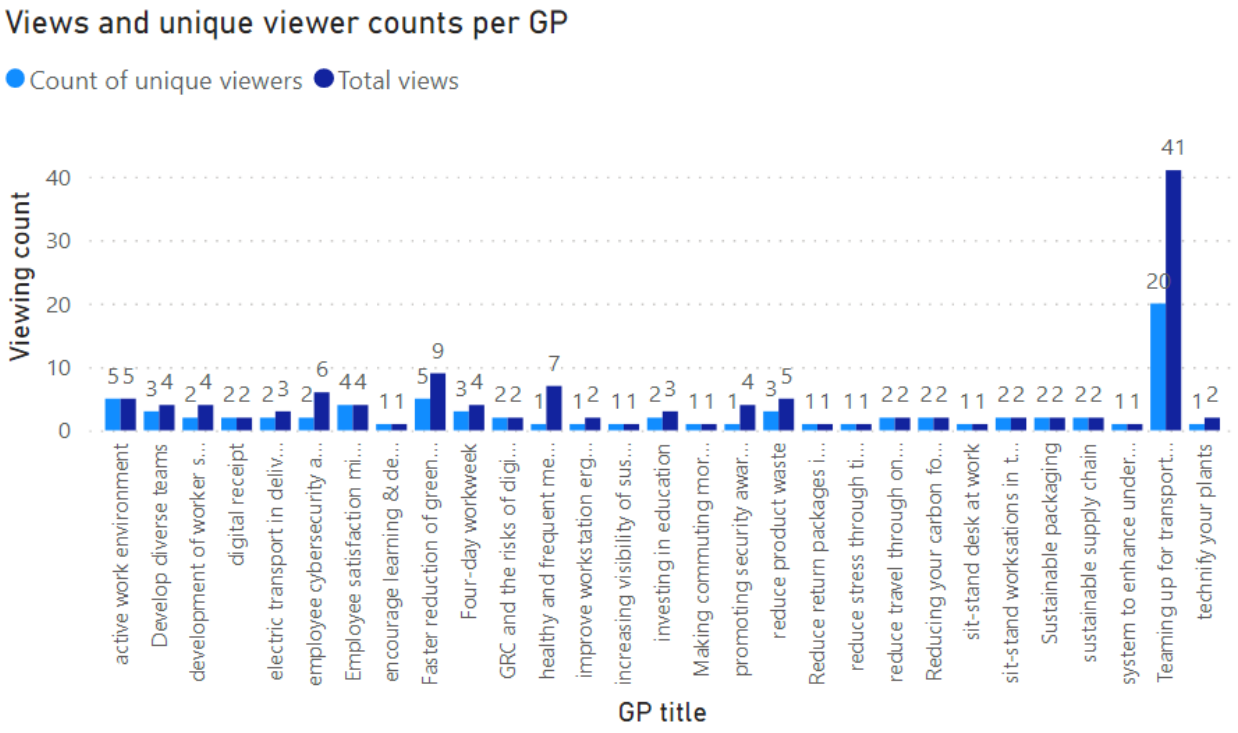


Figure 48: View counts per GP

From the domain perspective, we can see that the viewing frequency follows the same distribution as the overall activity distribution with three bursts. With the latter picking up as the deadline neared. This is illustrated below in Figure 49.

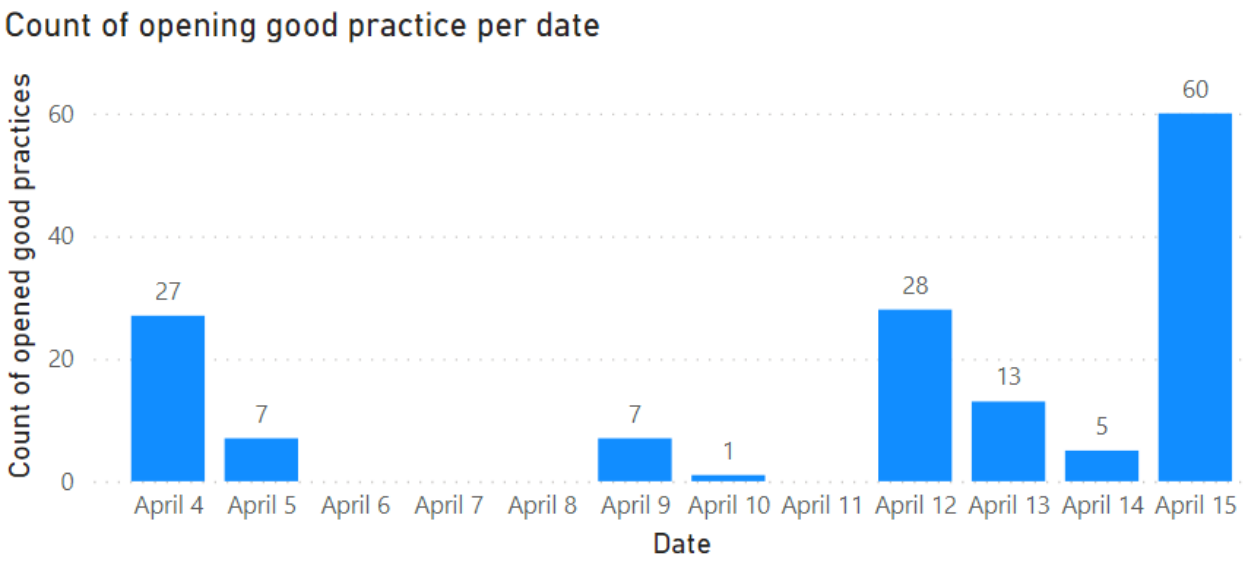


Figure 49: Time series of the counts of opening good practice actions

The counts of unique opened good practices show a similar distribution to the total number of opened good practices. This indicated that the GP viewing behavior is diverse. On the contrary, if GP viewing behavior had been monotone, the total counts of views could increase while the amount of unique viewed GPs would stay the same. The counts of unique opened good practices per date are displayed below in Figure 50.

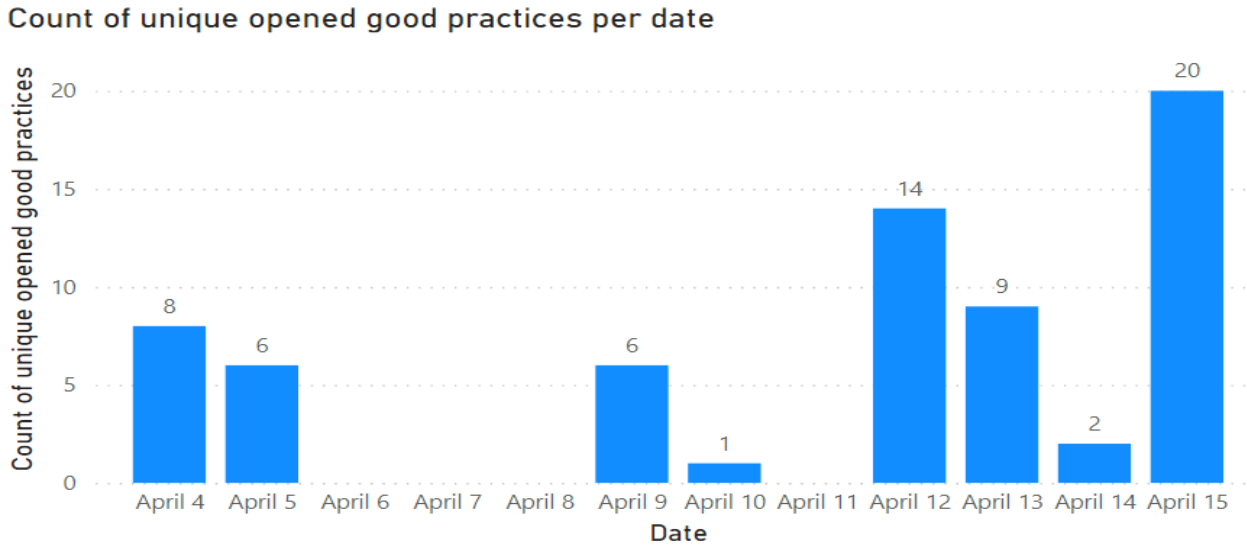


Figure 50: Timeseries of the count of unique opened good practices per date

Community-based feedback

Regarding community-based feedback features, the activity frequencies also follow the trend with the other activities. Their usage is minimal initially and starts picking up near the deadline, which is illustrated below in Figure 51.

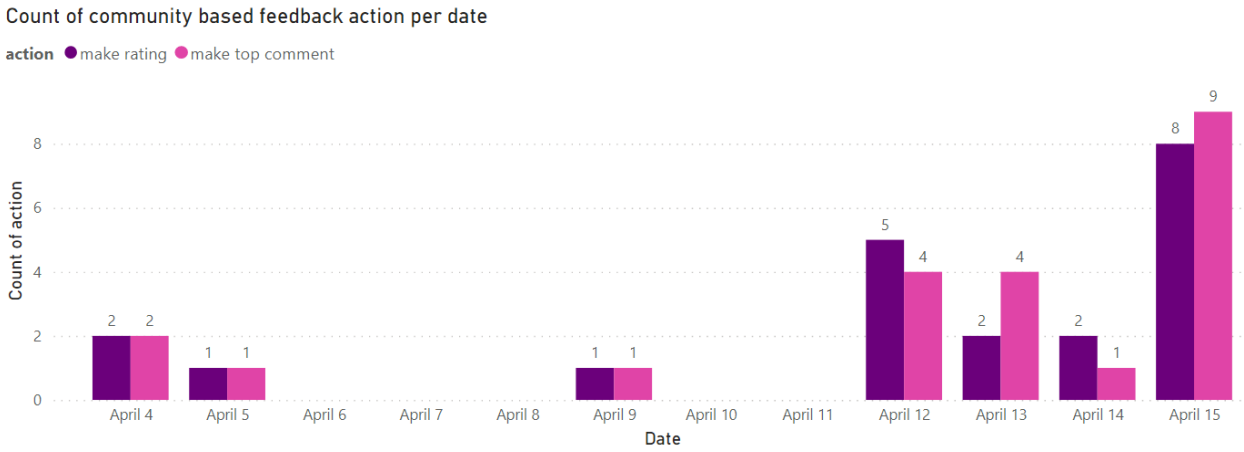


Figure 51: Time series of the counts of community-based feedback-associated actions

From the turntables, we learn that the two groups made more comments than required by the tasks. One group commented on their own GP with a comment describing where the images of the GP could be found, and the other group made a generic comment on their own GP. For the rating feature, similar results were observed. Most of the groups created the ratings required for the assignment, and only two groups created other additional ratings. Both groups rated their own GP. One group (P13) made two ratings for the same GP, thereby replacing the old one. This is reflected in the figure below.

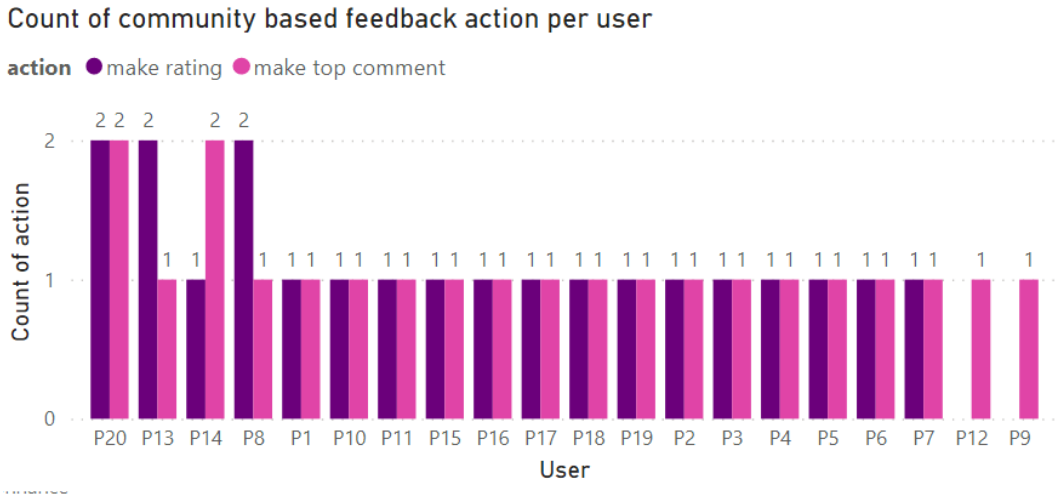


Figure 52: Counts of community-based feedback actions per user

Measured knowledge sharing behavior

Next, we can consider the knowledge sharing behavior perspective. As seen in chapter 6, we identified and mapped KS processes to the activities we can record within openBest. These activities can then be plotted in a time series. Below in Figure 53, such a time series is illustrated.

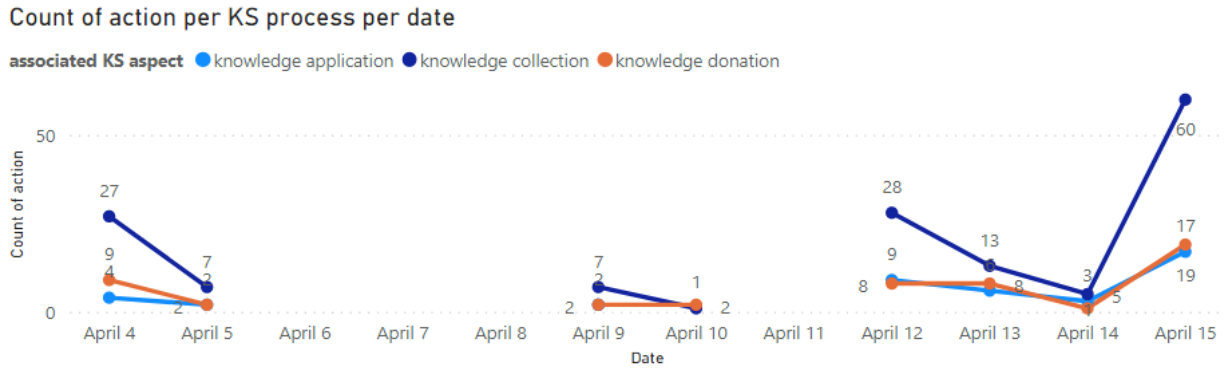


Figure 53: Time series of the counts of actions grouped by KS process

In the figure, we again see the three bursts we described earlier, with some activity after the announcement of the extra task, some limited activity in between, and increasing KS process-related activity nearing the deadline. What is interesting to see in this figure is that the three processes seem to have a relation, i.e., when one decreases, the other also decreases, and vice versa. Of course, in our empirical test, that was to be expected as each participant received the same instructions. If they followed them, each would have similar knowledge application, collection, and donation outputs. However, this latter statement is not true as participants have some differences regarding their KS process-associated activities.

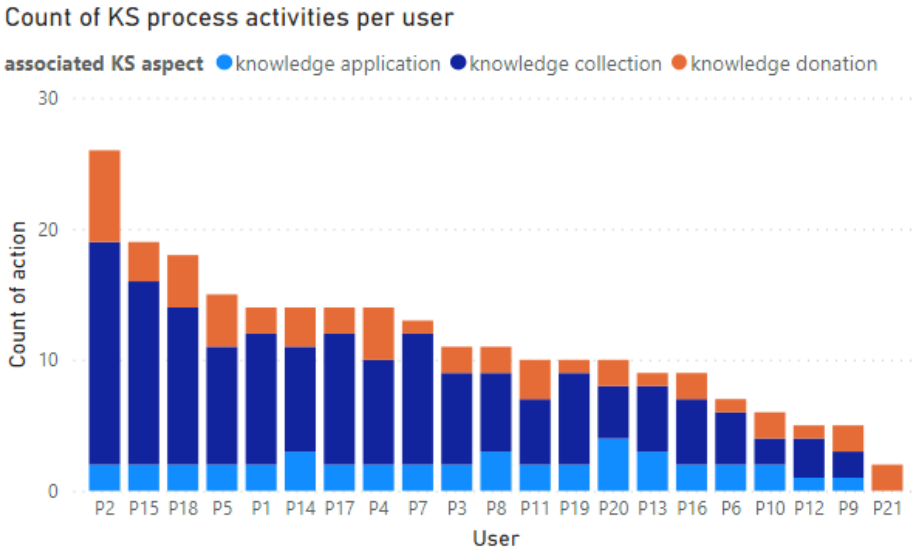


Figure 54: Count of KS process activities per user

In the above illustration, we see all the participants who conducted all activities successfully, but there is quite some difference among them regarding knowledge collection and knowledge donation. For instance, compare p2, p15, and p18 to p6, p10, and p12. We see big differences in terms of knowledge collection, i.e., opening a good practice. This means that some groups explored more than others. Moreover, there are some differences in knowledge donation, but this could also mean that some groups

If we examine the KS process activities per good practice, we see some differences between the good practices. For this, consider the illustration in Figure 55. First, the alphabetically ordered earlier good practices seem to have attracted more attention than those lower in alphabetical order. Moreover, we can see that many good practices did not feature knowledge application activities except the few we already described earlier. It is also clear that the good practice featured as part of the exercise had the most KS process-related activity. Note that there are also good practices without knowledge creation activities. These GPs were created by us and put into the domain using a script; hence, no create GP action was recorded for those.

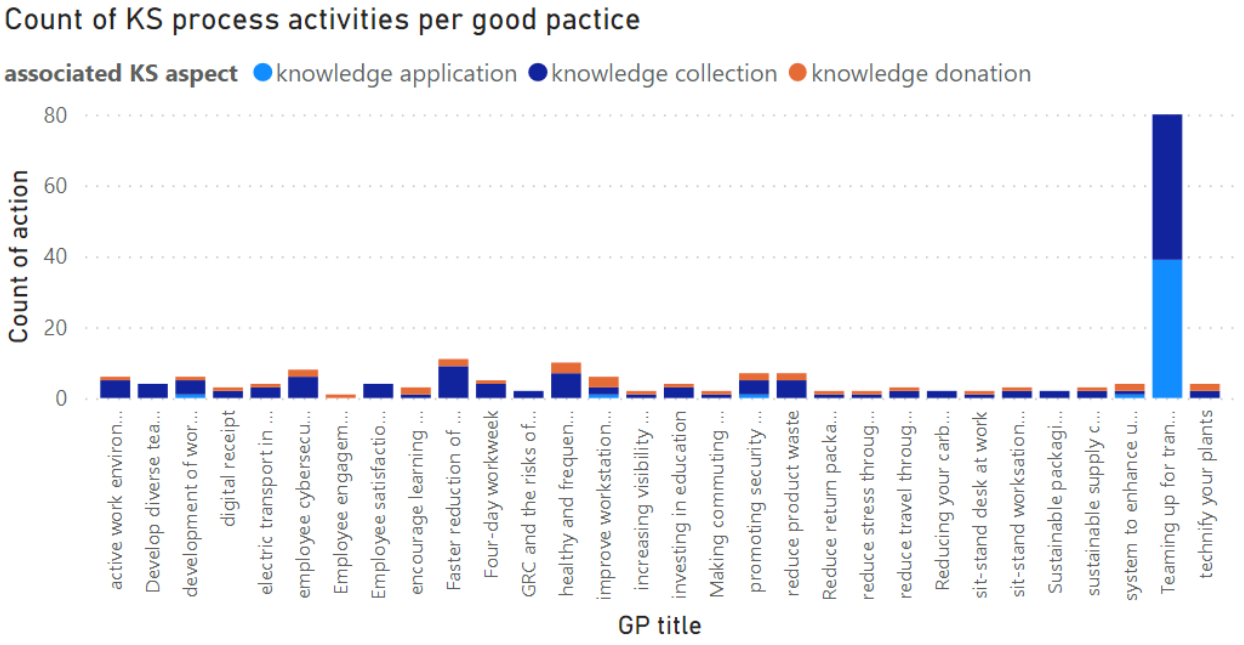


Figure 55: Count of KS process activities per good practice

Conclusion frequency analysis

We can see that during the test, there were three bursts of activity, those that started the tasks soon after receiving the instructions, some limited activity in between, and then activity picking up near the deadline. Regarding the knowledge sharing recorded in openBest, we can conclude that openBest invites users to explore. We calculated that users had viewed ~2.5 distinct GPs of other authors on average. To complete the assignment, this would only have to be 1. The viewing behavior also proved to be diverse. This is reflected in the fact that 50% of the GPs were viewed

by more than two distinct users. Besides exploring, we observed that participants engaged in more GP creation than required, as some groups created more than one GP. We have disappointing results for the community-based feedback features because beyond the assignment-mandated ratings and comments for the specified GP. There were no meaningful ratings or comments on GPs. There were some generic comments and ratings, but users made them for their own GP, which does not constitute community feedback. There were differences in observed KS behavior between the users and the GPs. Some users seem to have explored openBest, while others just performed the tasks. Among the GPs, the same differences are observed. Some GPs are more often viewed than others, with the most popular GP being the Teaming up for transportation GP that was featured as part of the tasks.

Applying process mining

Next, the activity logs are put into the process miner Disco. As said before, Disco allows for frequency and performance metrics analysis. Using the statistical analyses we applied, we think the frequency metrics are redundant. Therefore, we look at the performance metric related to the duration of activities. Below in Figure 56, a screenshot of the process model of the data in Disco is displayed.

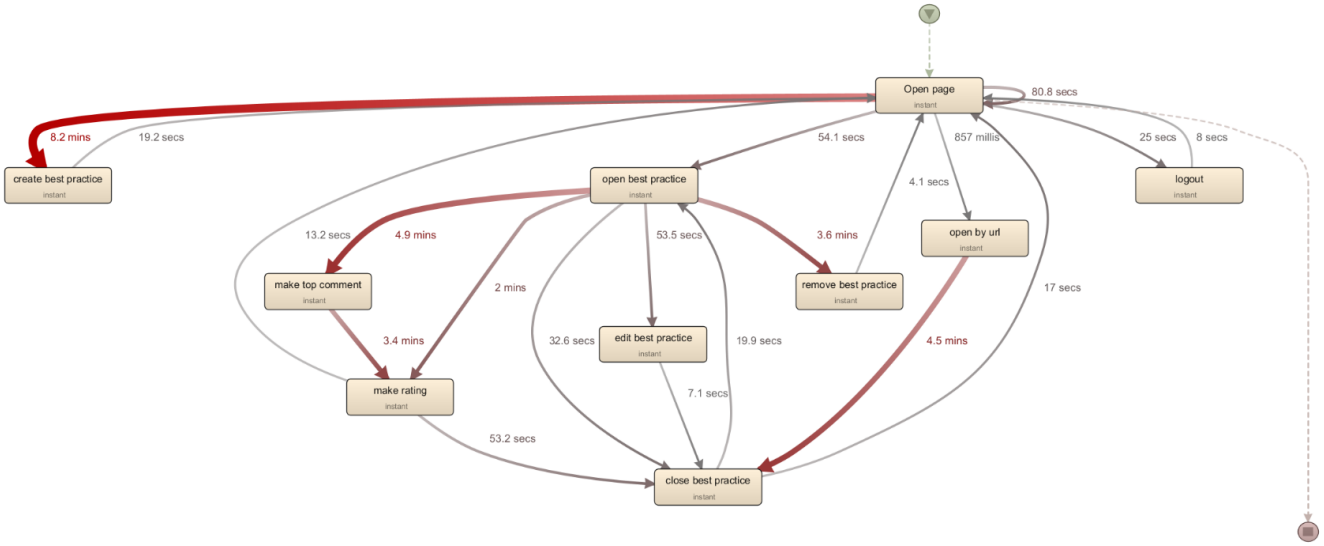


Figure 56: Process model displaying the activity mean time and sessions being the case (with 100% activities and 30% paths)

Looking at this model, we learn that we can conveniently see the performance of some activities. For instance, we can see that creating a good practice (shown on the left) takes, on average, 8.2 minutes. Additionally, we can see that, on average, opening a good practice from the table takes on average 54.1 seconds. Unfortunately, for the other activities related to a good practice, it is challenging to assess the amount of time spent on the activity. For instance, on average, there are 4.9 minutes between opening a good practice and creating a top comment. From this information, we cannot ascertain the amount of time spent reading the GP and the time needed to write the comment. The same is true for making a rating. This is unfortunate because the time spent reading a GP could indicate the quality of the knowledge collection. Regarding the editing of a good practice, this is less relevant because the person editing the GP is the author, so it is not necessarily of interest to know how long the author spends reading his GP.

Next, the process mining activity yielded an estimated median case duration of 22.6 minutes. The mean case duration was 23.6 minutes, with the longest case being around 1 hour and 30 minutes. This indicates that the case break system can be enhanced as it is unlikely that a participant spent 1 hour and 30 minutes in 1 go to complete the tasks.

All in all, the process mining activity showed that the duration of activities could be examined using process mining. In our case, it highlighted the need for more fine-grained activity recording regarding the reading of GPs.

7.4 Discussion

Evaluating the knowledge sharing behavior framework

Using the empirical test, our objective was to evaluate how the implemented knowledge sharing behavior evaluation framework allows the assessment of KS behavior in a good practice repository. For this, we performed the test and collected two types of information. First, there was the data collected by periodically monitoring the domain in openBest. Second, there are the measured data. The measured data were evaluated and proofed to reflect the findings of the observed data. In addition, the measured data quality was quite high because there were no unaccountable sequences of events or other apparent flaws. Consequently, the knowledge sharing behavior evaluation framework is found to collect high-quality data that reflect the reality as observed in the monitored data. Next, we performed the proposed analyzes as part of the theoretical approach. The data collected proved to be usable in these efforts and provided information on KS interactions from the perspectives of good practice, domain, KS processes, and users. We could do this in terms of frequencies of the activities using time dimensions. We could analyze the frequencies of activities over time in different ways. We could analyze activity frequencies per GP, User, Domain, and even KS process. In addition, the data proved to be fitting for process mining efforts. This yielded insight into the time qualities of the activities but also highlighted the need for more fine-grained activity recording to assess knowledge sharing enabled by a GPR. This does not mean that the framework cannot be improved. For example, it would also be good to have more direct measures to indicate the reading times of good practices. Now we cannot reliably assess that. Next, we have seen that our reliance on user system time may not be the best option. Because of this, an alternative method that involves online time should be attempted. An additionally identified drawback is the lack of qualitative information in the action data. For example, when a create GP action is recorded, we do not know if the GP is sound with proper contents. Because of this, we also had to consult the data we observed by monitoring the domain containing qualitative information. This was also required to determine the few nuances needed to explain the differences between observed and measured data. Because of this, the framework allows for good quantitative evaluation of KS, but for qualitative assessment, there should also be data in the form of monitored data or perhaps some notion of self-reporting by the user.

Evaluating the extent to which the GPR enables KS

Next to evaluating the knowledge sharing behavior evaluation framework, we also investigated the KS activities of the network of extrinsically motivated participants. From this investigation (using the visualizations and process mining we described earlier), we note that some KS appears to have occurred. The main reason is that the data suggest that participants viewed more GPs than was required to complete the assignment; we believe that these additional viewing activities indicate that openBest invites some extent of exploration. Next to knowledge collection, we noticed more knowledge donations than we initially expected. This is because the observed

progress and monitored activity indicate that three groups created two GPs. This is interesting because they were only asked to create 1. This means that some additional voluntary knowledge donations took place. The results in terms of knowledge application using community-based feedback were less notable. This is because very few feedback activities were recorded that were not part of the mandatory tasks. The table below shows the expected and observed values for some quantitative variables per user.

Table 61: Expectations and observed values for quantitative variables per user

KS process	Variable	Expected value	Observed value
Knowledge donation	Sound created GPs	1	1.14
Knowledge collection	Distinct viewed GPs of other users	~2	2.5
Knowledge application	Number of created comments	1	1.04 (22/21)
	Number of created ratings	1	0.95 (20/21)

We see that a little more knowledge donation occurred than we expected. The same is true for collections. The knowledge application is about equal but is a bit skewed because one of the groups could not find the features and apply them. Altogether, there was more KS behavior measured than we expected to see before the test. The main difference is found in the created three voluntary additional GPs and the higher GP viewing behavior than we expected.

8 | What we have learned about openBest

In this research, the main contribution is the knowledge sharing behavior framework, its implementation, and the validation effort we discussed. However, applying the framework meant applying openBest. Because of this, we have made efforts to mature openBest and incorporated many openBest elements throughout this project. This has yielded new insights into openBest. This chapter discusses what we have learned about openBest v2.0. For this, we look at the OICT expert feedback collected as a collateral product of the empirical test. Next, we discuss our interactions with organizations that expressed interest in openBest but did not use openBest during this project's timeframe.

8.1 OICT Expert feedback

In this section, we discuss the expert feedback provided by the OICT students. This feedback was collected using the questionnaire distributed to the OICT students during the empirical test we discussed in Chapter 7. The raw and processed feedback per question can be found in Appendix Q: OICT expert feedback. Here we analyze the feedback by putting the answers to the question 'what did you like about openBest?' next to the answers to the question 'what can be improved in openBest?' This way, we have a good overview of the two sentiments per openBest aspect. Next, we discuss the answer to the 'do you have any further comments?' question. We end the section by drawing a conclusion on the expert feedback.

What did you like about openBest? VS What could be improved in openBest?

Overall

In general, expert opinion advocates that openBest is easy to use (P1; P4; P9; P15; P19) with a clear interface (P20), making interactions feel natural and quick (P1; P7). This makes it so that participants are automatically navigated to their destination on the site (P14). The participants attest that the site is not too complicated (P4; P17), with few excessive distracting functions (P7) and an easily understandable UI (P6), making openBest easy to use and easy to learn (P9). However, the participants also advocate for accessibility improvements, such as more feedback by openBest, when creating a good practice card (P1; P2) and indicating the cause of the problem when an error occurs (P5). Another aspect of the affordance named by the participants is that the buttons are not always recognizable as buttons, and it is unclear if the buttons are active (P16).

Takeaway Overall

This indicates that overall, openBest is usable but could be improved by:

- Implementing more feedback
    - When performing actions.
    - When errors occur.
- Making elements more recognizable
    - Toggling buttons

General layout

The expert opinion states that openBest is stylish (P4) with a nice (P4), a clean layout (P7; P17), and UI (P6). This made openBest attractive (P9; P20) and pleasant to look at (P3). However, there were also some concerns about readability. The groups stated that some elements of openBest were difficult to read. First, the white text on light background colors should be changed (P18), and second, elements from the good-practice cards themselves were hard to read (P8).

Takeaway general layout

From this, we conclude that, in general, openBests' layout is generally perceived to be nice, clean, and understandable. However, some groups report that the readability of text in openBest could be improved. Therefore, the layout could be further improved by the following:

- Make elements more readable by adapting text size and color to create more contrast.

Creating a good practice

Regarding the creation of good practice, the groups said that it was clear which fields needed to be filled in (P3), making it easy to fill in the text (P10) and other data (P6) while not having to care about layout or outline (P12). Furthermore, participants reported that in openBest, it was easier to create a good practice than in PowerPoint. The main reason was that the layout in openBest is already determined (P8; P11)—this removed the efforts required to style the GP (P1). However, there were also two main points of critique. The first relates to the size of the text input boxes. The participants noted that the text box was too small and suggested making the box larger (P7; P9). The other often-named point of critique was that external image hosting was more difficult than expected (P2; P11), annoying (P3; P10), 'finicky' (P5), and, in general, not well-received (P12). There were also some minor critiques regarding various aspects of the feature. One group found that the button to create a good practice is less recognizable (P3). Furthermore, some groups noticed that they missed a preview function (P7; P8). In their view, such a function could alleviate the inconvenience of having to alter the GP after creation.

Takeaway creating a good practice

From this, we conclude that there is some mixed sentiment regarding the creation of good practices. Some groups attest to it being easy (P3) and clear (P10), while others reported having problems. These issues mainly relate to the text input and the images' hosting. Participants suggest a preview functionality to alleviate this. This means that to improve the creation of GP feature further; we should:

- Consider hosting images in openBest to reduce the participants' effort in hosting the images themselves.
- Enlarge the default size of the text areas.
- Enforce the click-me aesthetic of the create bp button.
- Provide a preview functionality for the content of the GP so that the form's content mirrors the end product.

Browsing good practices

Regarding the browsing of good practices, which is done on the Good Practices Overview page, the participants remarked that it is easy (P2; P5; P17) and very fun (P16). The page provides a clear overview of the GPs (P2) and is well-received (P17). Some comments contained concrete improvements. Regarding the table of good practices, the groups remarked that it could be more attractively styled (P3). Additionally, the table is perceived to be a little messy (P3). Another group states that the column 'text' that contains the first 100 words of the main GP text is too small. Furthermore, they state that the column 'text' has no purpose in being present because 'the content is irrelevant and only read when you open the GP' (P1). Another group notes that it may be beneficial to add the front-page images of the GPs to the table view. This, according to them, could spark the interest of the readers. This suggestion is made because no GP from the list currently jumps out (P14). Regarding the search mechanisms implemented on the GP overview page, the participants said that it is nice that there is a search function to search for a specific GP card or topic (P7). Regarding the simple search bar that applies to all columns, a group noted that it should be widened and placed on the left side above the table because 'this would be the most intuitive way to search for a specific good practice card' (P18). The custom search builder, which allows filtering based on individual columns, is found to be useful (P7), extensive (P18), nicely styled, and well-functioning (P18). On the contrary, the conditions of the custom search builder were also reported to be unclear (P4) and seem a little out of place (P14; P18). Furthermore, a group attested that the custom search builder was a bit overwhelming (P18). On the contrary, the same groups say the feature has promise and could be useful if placed under an 'advanced settings' button with appropriate explanations (P14; P18). Regarding the toggling of the columns feature present above the table, a group said that it was not apparent that the columns could be toggled (P14). The group called this feature unintuitive (P14). This is again in line with the potential for affordance improvements identified earlier. Regarding the filtering possibilities, the groups said they missed a way to retrieve their own good practice (P15; P17). One group suggests a view that contains a so-called personal library that contains all the good practices created by the group (P17). On the table sorting functionality, participants say that sorting good practices is also useful (P16).

Takeaway browsing good practices

From the above feedback, we conclude that while easy and fun to browse the good practices, the layout, contents, and setup of the table and the setup of the searching mechanisms could be improved. This can be done by:

- Redesigning the table contents to include the front image to make individual bps jump out.
- Redesign the table contents to include only elements that will be read (e.g., long texts will not be read according to P1).
- Situating the general search bar on the left-hand side and expanding the length.
- Placing the custom search builder behind an 'advanced' searching button.

- Providing some additional explanation on the searching mechanisms.
- Making the toggling of columns more recognizable.
- Enabling filtering on authors to easily find one's own good practices.

Viewing a good practice

Regarding the viewing of good practices, the participants said it was painless and easy (P6) and that the good practice card is well organized (P14) and designed with a nice layout (P7; P15; P18). However, there was also a group that disliked the layout (P17). Additionally, the images present in the good practices were said to be too large (P7).

Takeaway viewing good practices

From this, we conclude that viewing good practices is generally painless and easy. The layout is generally well-received, but there are exceptions. The GP viewing could be improved by:

- Reducing the size of the images.

Editing a good practice

Regarding the editing functionality, groups reported that it was initially confusing because it was unclear whether the editing mode was enabled or not (P16). The groups also stated that they had missed the possibility of editing the link to the images. Due to this, they had to remove and resubmit a GP if the image link was incorrect (P11; P16; P18; P20). On the contrary, a group also reported liking the editing functionality (P2).

Takeaway viewing good practices

From this, we conclude that editing good practices is generally received as confusing and limited. The main problem was that the image links could not be edited. Given this feedback, the editing feature could be improved by:

- Allowing more elements, like images, to be edited.
- Providing feedback on whether editing mode is enabled.

Community-based feedback

Community-based feedback features are well received because they allow better judgment of practices (P16). Some groups stated that it was unclear how they should make their own top comment (P2). This made it so that some groups had to search for where they could make their comments (P2; P3). Consequently, they note that the feature is not a user-centered design (P3). Other groups saw room for improvement by adding categorization for comments. This categorization could then be based on the element of the GP a comment related to (P6; P7). Regarding the rating feature, a group suggests that it is better to have the rating being made immediately represented in the average ratings. Currently, reloading the page is required for this, but this is received as cumbersome (P13).

Takeaway community-based feedback

While groups like the idea behind the features, we conclude that the design lacks user-friendliness. This means that this feature should be improved by:

- Improving the user-friendliness of the commenting feature.
- Implementing categorization for comments.
- Immediately represent ratings in the average ratings without having to reload the page.

Reliability

In general, there was also some feedback on the reliability of openBest. Many of these pertain to the submission of good practices. One group had the problem that the information they filled in was not saved (P5). Furthermore, they could not change faulty submissions using false information (P5). Another group stated that the submit button did not react for some time (P17). Next, a group could not submit the GP with its copy-pasted information (P19).

Takeaway reliability

From this, we conclude that the reliability could be improved. Although we could address this by communicating errors to the user, it is better to prevent these errors. We suspect all these errors are caused by incompatible content being pasted into the input fields of the bp creation form. The rationale for this suspicion is that all reported reliability issues are related to the bp creation form. Therefore, we think the reliability can be improved by:

- Applying input filters where applicable to prevent faulty submissions

Miscellaneous

The final suggestion was to add a favicon to the website to make it more distinguishable from the other webpage tabs (P7).

Takeaway miscellaneous

We think that this addition would indeed make openBest more distinguishable, so consequently, we think that openBest can be improved by:

- Adding a favicon to openBest.

How many good practices have you viewed?

The participants report that, on average, they have viewed 3 GPs. This means that including their own GPs, which, as we established, is approximately 1.14 GPs, they viewed 3 GPs. This means that, on average, the participants report having viewed approximately 1 GP more than they were asked to. This indicates that some exploration has occurred.

Do you have any further comments?

The general sentiment is that openBest could be a good and useful application to create and manage good practices in the future (P5; P13; P17). Participants also note that openBest could be improved by adding some functionalities and reinforcing the application to always work correctly (P5; P13; P17). An example is added feedback throughout the application. One participant stated that he would be interested in the tool and that if he worked for an organization, he would be interested in exploring openBest (P16). Another participant noted that filling in a good practice is easier in openBest than creating the PowerPoint slide but that the layout of the PowerPoint slide is better (P11). Another group just notes that the design of openBest looks great (P18).

Expert feedback conclusion

Overall, the expert feedback contains a mixed but mostly positive sentiment. Many groups attest to openBest being nicely styled and easy to use. Moreover, groups state that openBest is easy to learn and makes it easy to create a GP, even more so than creating a PowerPoint GP card. Some groups formulated improvement points regarding various aspects such as feedback in openBest, reliability, and overall improvements, which we feel are justified. These points are bundled in Appendix R: OICT elicited improvement points, and in Appendix S: OICT implemented improvement points, we describe how we implemented a set of them. The expert opinion provided clear-cut improvement points to improve openBest further and reinforced the idea that a knowledgeable user base could work with openBest.

8.2 Contacting organizations

During this project, we reached out to several organizations responsible for the project. This contact was initially made to assess the willingness of responsible organizations to adopt openBest so that we could have data on the application of openBest in practice. Of the organizations contacted, a small number responded with interest in openBest. More elaborate contact has been established with these organizations (n = 4). This contact, conducted using MS Teams, most times involved a showcase of openBest. A showcase domain was set up for these organizations and populated with illustrative good practices. In 2 of these cases, the organizations had templates of good practices that we could use to structure the domain. These templates could be easily translated into openBest models. The resulting showcase domains were shown in meetings for 3 of these organizations; for one, it was shared as screenshots via email. Two of these four organizations have shown continued interest in using openBest after the showcase, and the other two proved unresponsive (at least during this project). Unfortunately, the interested organizations could not implement openBest during this project's time frame, but we had some meetings discussing openBest and showcasing it. During these discussions, we learned that there is indeed interest in a good practice repository on good practices. One of the organizations highlighted the need for openBest by stating that they were just looking for a tool like openBest. They were involved in a project where university-related organizations exchanged good practices on various topics. This exchange was performed over email by sending a filled-in word form. The

organization representative stated that openBest would be the perfect tool to replace the word form and the emails. The representative of the other organization that voiced interest in openBest recognized the potential of a good practice repository for exchanging good practices where organizations help each other become more sustainable. The organizational representatives also voiced some challenges. First, the organizations voiced concerns about how the continued use of openBest can be ensured. That is, how can organizations be motivated to engage in KS in openBest? For this, we believe the best answer is to use openBest organizations should instate incentives either at the organizational or interorganizational level. Moreover, we think users should be somewhat motivated by the willingness to contribute to the common good. This is not something openBest can achieve. Second, organizations were unsure if the cost of applying openBest in terms of effort for adoption and usage would be less than the associated gain expressed in contributing to the common good. We think the monetary costs for adopting openBest are minimal, especially if a whole network contributes. There is limited effort required for adoption as setting up a domain and populating can be done very rapidly with our support. The only remaining challenge is that the organizations should have employees willing to learn how to work with the system. We have already seen that students were quite able to work with it on their first try, so given the employees are given some time and instructions, we expect them to be able to work with openBest. Third, while promising, the organizations found openBest to be minimal for actual usage. They all suggest additional features to implement to make openBest more mature. We think that with some more effort, openBest constitutes a complete MVP of what a model-driven GPR is meant to be. After the adoption of the tool and the collection of resources, any lacking functionalities could be implemented.

8.3 Discussion findings openBest

We can draw several conclusions from the data collected during the empirical test and the findings based on our contact with the organizations.

Usability

Looking at the observed and monitored data, we can conclude that most groups could complete all tasks in openBest. There are some nuances; While most groups managed to create a GP, linking the images proved challenging. Next, some groups appeared to have forgotten to perform some minor tasks. However, the 21 groups managed to create 24 sound GPs. Most of these had correctly linked images and looked good. In addition, the expert opinion supports the usability aspects and highlights the style of openBest. This does not mean that usability cannot be improved. This is because only 61% of the created GPs remain in the domain. This means that the rest was removed or hidden due to GP flaws. There were two reasons for this. First, the images were often wrongly linked in the initial submissions of the groups. This is reflected in the expert feedback and the monitored activity. Second, there were ample (n = 7) cases where the wrong author was selected. This prevented participants from adjusting these false GPs. Therefore, our conclusion should be that while openBest is perceived as usable, stylish, and straightforward, it can be

further improved in terms of usability. For this, we have elicited a list of improvement points from the expert opinion that should help us in this effort.

Intention to use

We have spoken to several organizations throughout the project. In these discussions, it became evident there is an apparent need for a tool like openBest, and the idea of having a shared repository is being recognized as a possible treatment for lacking guidance on achieving a sustainability goal. Nevertheless, we could not attract organizations to adopt openBest, reducing the strength of the 'intention to use' claim. Regardless, we feel that there is indeed a group interested in tools like openBest. We have shaken the tree in the landscape of responsible organizations and hope that the generated exposure may lead to the adoption of openBest or its successor in the future.

Flexibility

Even though no organization used openBest, in the end, we have gotten ample experience in setting up and populating domains for the organizations. From this experience, we learned that openBest could still be improved in terms of flexibility. For instance, the organizational GP templates, like the OICT domain, required models that did not conform to the core model as laid out by Plomp. Consequently, the models had to be configured as text outside of openBest and then be instantiated as part of code in openBest. This means that the required models could not be formulated within openBest itself. This is only a minor inconvenience and could be easily addressed by making the core model elements editable. Once instantiated, the models, even those using a different core model, worked well, so openBest performs very well in that aspect. It should be noted that changing the core model also affected the functionality of the GP table as it was designed to display only the common core model elements (i.e.., title, date, and description). This could be extended to more elements, possibly by putting something in the model editor whereby one can determine if the feature is to be shown in the GP table. Moreover, populating a domain using an Excel file required some effort each time because the script had to be changed to fit the GP template of the domain and tie it to the Excel file contents. However, once established, we could rapidly set up and populate a domain. Using that approach, there was also no difference between instantiating a domain with one or 100 good practices as it was all a script. All in all, this experience taught us that while the model editor can be slightly improved, the overall structure of openBest can address the organizations' needs when it comes to varying good practice templates. We can rapidly design and deploy a model.

9 | Discussion

9.1 Implications

This research has studied the contribution of a knowledge-sharing behavior evaluation framework applied to a GPR in the IP4ESET domain. The problem statement involved a lack of instrumentation to assess knowledge-sharing behavior enabled by knowledge-sharing tools like good practice repositories. Because of this, we proposed and implemented a knowledge-sharing behavior evaluation framework. This framework is designed to enable future researchers to monitor the knowledge sharing enabled by good practice repositories in general and openBest specifically. Our validation efforts, including comparisons between monitored and observed behavior, indicate that the implemented evaluation instrument accurately records events and interactions in the GPR. The data collected allows analyses of KS-related activities, confirming that the framework yields valuable information. Therefore, we are confident that the implemented evaluation framework can allow future researchers to assess the knowledge sharing that occurs within openBest.

Next to this, we think that the overall method for identifying and evaluating tool enabled knowledge sharing can be used in other knowledge sharing tools. The reason for this is that the method is tool independent but the implementation method, i.e., how the system is decomposed, is dependent on the system. This means that while we used a GPR related method for decomposing the system the decomposing step is tool independent. Consequently the method may also be usable for other KS tools.

Moreover, we contribute to the growing body of knowledge around the SBEIC. We have expanded tool support and implemented measurement instruments as part of the knowledge sharing behavior evaluation framework for the IP4ESET phase. This tool support and other tools of the Software for organizational responsibility research line for other phases created at Utrecht University can soon aid organizations in becoming more responsible.

9.2 Limitations

This research has several limitations that we need to address. First, there are some development-induced limitations. These limitations can be classified as implemented knowledge sharing behavior evaluation framework and openBest related. The limitations of the implemented framework have already been addressed in chapters 5 and 6. The primary limitations identified were related to the dependence on the Internet as a communication facilitator and the dependence on the users' system times for logging timestamps. Overall, this meant that there were some irreducible limitations that we had to accept due to too limited resources and lack of influence on some parts like Internet communication. This makes the implemented measurement instruments as part of the KS behavior framework functional, but it could be improved by further addressing the limitations.

The development limitations related to openBest are exhibited in the fact that much effort was put into openBest to make it usable by organizations. For this, some tailoring had to be done. Due to limited resources, this has mostly been done on a case-based pattern. This means that not all functionality is model-driven.

The validation of this research suffers from some limitations as well. First, we could only make validation efforts of the framework in a controlled laboratory environment using surrogate end users. This was due to limited resources and participation of the organizations, limiting the opportunities for validation in practice and generalizations of the findings to the practical context. We would have made more validation efforts to address this if we had more resources.

9.3 Future work

Knowledge sharing behavior evaluation framework

Future work on the theoretical evaluation framework should focus on further enhancing the steps and methods for executing the activities. For this, recommendations can be added based on the findings of this project. For instance, a suggestion to record the timestamp using the server time before sending the action data to the server could be added for the action data collection step. These suggestions would provide more guidance to an implementing party. In addition, interviews with GPR owners can further refine the framework to assess whether they think it is feasible for evaluating KS. In such research, primary attention should be paid to whether the KS behavior framework yields a representative set of activities and additional variables to characterize the KS activities in the GPR. Now we have seen it for the theoretical SIR and openBest repositories. However, the fit of the framework for openBest, and SIR does not constitute validation in practice.

The implemented framework in openBest should be improved by including more fine-grained activity information. This involves overcoming current limitations by recording the search and filtering actions in the GP table. The activities related to the reading of the GPs should also be recorded more fine-grained. This would allow us to add qualitative data to our quantitative information, i.e. GP 'Teaming up for transportation' has been viewed 10 times where the reader spent less than 5 minutes reading and 5 times the reader spent more than 5 minutes reading, as opposed to our current simple frequency logging. Next, the time intervals for annotating the sessions could be fine-tuned. Currently, these rely on assumptions, but after more data is collected, we may be able to see where a logical break can be made. This would then yield a more accurate session grouping of the event data. Next, the timestamp logging must be redesigned to take the user's system time out of consideration. Moreover, the implemented framework should be complemented with a system for assessing qualitative quality aspects of GPs. We have seen that we could not assess the real amount of sound GPs using the evaluation framework. This is because the recorded action creating GP does not provide insight into the quality of the created GP. We now had to assess the amount of sound GPs by going over the domain. For proper analysis, we think it should be assessed. Then finally a function should be added to enable or

disable the measuring features per individual user to also accommodate users who do not want to be involved in the research. The more mature framework should then be validated by applying it in the context of networks of responsible organizations.

openBest

openBest should mature further by implementing other requirements stipulated by previous projects. This also involves consolidating the current code and making an effort to stabilize openBest further. Next and most importantly, openBest should be applied in the context of networks of responsible organizations. This way, it can be investigated whether the treatment meets the original goals and adequately addresses the lack of infrastructure for KS in the IP4ESET phase. Central in these activities would be collecting data using the measurement instruments as part of the implemented framework developed in this project and analyzing the collected data following the methods we described. Next, the intention to adopt, usability, and perceived usefulness of openBest can be explored using MEM questionnaires with responsible organizations.

Moreover, an effort could be made to connect openBest to other tools in the Software for Organizational Responsibility research line. A condition for this is that the other tools are mature enough and ideally operate on compatible platforms. This synergy of tools could then be validated in future projects.

10 | Conclusion

This research aims to develop a framework for evaluating KS behavior enabled by a model-driven GPR that stores GPs that contain improvement steps on ESE topics. This has sparked the design and implementation of a knowledge sharing behavior evaluation framework and suggestions for further processing and analysis. This implemented framework as part of a GPR has been employed in an empirical test to evaluate the extent to which it works. Next, we also improved the model-driven GPR by implementing more of the functionalities in the other projects in the Software for organizational research line. We did all this by answering the research questions.

As part of the problem investigation phase, we answered RQ1: What relevant factors influence interorganizational knowledge sharing among members of a network of responsible organizations? We did this by conducting an SLR on knowledge sharing and factors that influence KS's effectiveness at the various KS levels. We found an overview of factors grouped into individual, organizational, interorganizational, technological, and nature of knowledge factors. The most important factors were found to be motivation and trust. Other relevant factors included the time available for engaging in KS, the mode of KS interactions, tool support, the type of knowledge being shared, and the geographical, technological, and organizational proximity of the organizations involved. For each of these factors, we determined if they could be assessed as part of a research project and which situational factors could be determined. These situational factors combined formed the situational profile that can be used to characterize inter-organizational KS situations.

Then, as part of the treatment design phase, we answered RQ2: How can knowledge sharing behavior enabled by a good practice repository be assessed? We did this by investigating how knowledge-sharing behavior can be shared. This showed that there are no frameworks for assessing KS behavior in a GPR. Investigation in other contexts showed that methods often focus on recording KS-related activity frequencies, self-reporting, or a mix of them. We chose to follow the school of thought related to the frequencies as this does not require any additional effort from the users and does not interfere with their KS processes. Based on this, we designed a knowledge sharing behavior framework for identifying actions and variables related to KS for a GPR. This method decomposes GPR into a set of supported user interactions. Per user interaction, recordable user actions are identified. Next to these actions, the relevant KS processes are identified, and the two are mapped, resulting in a table with actions and their associated KS process. For the activities, it is determined which other variables can be recorded in the GPR. For this we considered the entity subject of the activity, its type, the user performing the action, his role, and the timestamp of the activity. We then designed a framework for evaluating these actions. This framework involves steps for recording the activity data, retrieving the activity data, processing the data, and analyzing the data. We implemented features based on this framework into openBest, which enables it to record all identified relevant recordable actions and allows us to retrieve the data.

Finally, as part of the validation phase of treatment, we answered RQ3: To what extent does the implemented knowledge sharing behavior evaluation framework allow for assessing knowledge sharing behavior enabled by a good practice repository? This question is posed to test the evaluation framework. We perform an empirical test in which participants interact with openBest by performing pre-determined tasks. During the empirical test, monitored and measured activity data is collected. This data is compared to assess the quality of the measurement instrument. Next, we test whether our described analyses can be performed. We found that the instrument performs well as there were no unexplainable discrepancies between the recorded and observed data. Nevertheless, there were some incidents of faulty logs and suspicious log orders. These incidents of faulty logs were not inherent to the framework but rather to challenges in openBest. The suspicious log order incident was investigated and shown to most likely have been caused by an external factor to openBest. As such, we think the recorded data is of high quality. Next, we have shown that the recorded action data was suitable for quantitative knowledge-sharing behavior analysis. We were able to create illustrations showing the frequencies of the KS-related activities. As a result, we think that the implemented knowledge-sharing behavior evaluation framework allows for assessing quantitative knowledge-sharing behavior in a GPR.

References

Adèr, M. (2020) The state of the art and practice in sustainable improvement planning for ethics, social and environmental topics. Master's thesis, Utrecht University. Not published.

Al-Busaidi, K. A., & Olfman, L. (2017). Knowledge sharing through inter-organizational knowledge sharing systems. VINE Journal of Information and Knowledge Management Systems.

Al-Ashaab, A., Flores, M., Hernando Anta, P., & Varro, B. (2013). A framework of industrial sustainability good practices.

Aljuwaiber, A. (2016). Communities of practice as an initiative for Knowledge sharing in business organisations: a literature review. Journal of Knowledge Management.

Cabrera, A., Collins, W. C., & Salgado, J. F. (2006). Determinants of individual engagement in knowledge sharing. The International Journal of Human Resource Management, 17(2), 245-264.

Cabrera, E. F., & Cabrera, A. (2005). Fostering Knowledge sharing through people management practices. The international journal of human resource management, 16(5), 720-735.

Charband, Y., & Navimipour, N. J. (2016). Online knowledge sharing mechanisms: a systematic review of the state of the art literature and recommendations for future research. Information Systems Frontiers, 18(6), 1131-1151.

Chen, Y. H., Lin, T. P., & Yen, D. C. (2014). How to facilitate inter-organizational knowledge sharing: The impact of trust. Information & management, 51(5), 568-578.

Chen, I. Y., Chen, N. S., & Kinshuk. (2009). Examining the factors influencing participants' knowledge sharing behavior in virtual learning communities. Journal of Educational Technology & Society, 12(1), 134-148.

Coenen, Z. (2020). An informational analysis of Good Practice Repositories for Responsible Enterprises. Bachelor's thesis, Utrecht University. Not published.

Ghadirian, H., Ayub, A. F. M., Silong, A. D., Bakar, K. B. A., & Zadeh, A. M. H. (2014). Knowledge sharing behaviour among students in learning environments: A review of literature. Asian Social Science, 10(4), 38.

Ganguly, A., Mostashari, A., & Mansouri, M. (2011). Measuring knowledge management/knowledge sharing (KM/KS) efficiency and effectiveness in enterprise networks. International Journal of Knowledge Management (IJKM), 7(4), 37-54.

Economy for the Common Good. (n.d.). ECG in a Nutshell. Retrieved December 17, 2021, from https://www.ecogood.org/what-is-ecg/ecg-in-a-nutshell/

España, S. & Brinkkemper S. (2016). Responsible software: A research agenda to help enterprises become more sustainable, ICT for Sustainability 2016.

Firebase. (2022a, February 12). Cloud Firestore Data model | Firebase Documentation. Retrieved March 15, 2022, from https://firebase.google.com/docs/firestore/data-model

Firebase. (2022b, February 21). Supported data types | Firebase Documentation. Retrieved March 13, 2022, from https://firebase.google.com/docs/firestore/manage-data/data-types

Gagné, M. (2009). A model of knowledge-sharing motivation. Human Resource Management: Published in Cooperation with the School of Business Administration, The University of Michigan and in alliance with the Society of Human Resources Management, 48(4), 571-589.

He, D., & Göker, A. (2000, April). Detecting session boundaries from web user logs. In Proceedings of the BCS-IRSG 22nd annual colloquium on information retrieval research, 57-66.

Ho, L. A., & Kuo, T. H. (2013). How system quality and incentive affect knowledge sharing. Industrial Management & Data Systems.

Holzer, A., Kocher, B., Bendahan, S., Vonèche Cardia, I., Mazuze, J., & Gillet, D. (2020). Gamifying knowledge sharing in humanitarian organisations: a design science journey. European Journal of Information Systems, 29(2), 153-171.

Ipe, M. (2003). Knowledge sharing in organizations: A conceptual framework. Human resource development review, 2(4), 337-359.

Jacobs, A. (2021). Designing a universal attribute filter for good practice repositories. Bachelor's thesis, Utrecht University. Not published.

Jilani, M. M. A. K., Fan, L., Islam, M. T., & Uddin, M. (2020). The influence of Knowledge sharing on sustainable performance: A moderated mediation study. Sustainability, 12(3), 908.

Kuhlman, T., & Farrington, J. (2010). What is sustainability?. Sustainability, 2(11), 3436-3448.

Kuo, F. Y., & Young, M. L. (2008). A study of the intention–action gap in knowledge sharing practices. Journal of the American Society for Information Science and Technology, 59(8), 1224-1237.

Latapí Agudelo, M. A., Jóhannsdóttir, L., & Davídsdóttir, B. (2019). A literature review of the history and evolution of corporate social responsibility. International Journal of Corporate Social Responsibility, 4(1), 1-23.

Laudon, K., & Laudon, J. (2020). Management Information Systems: Managing the Digital Firm (16th edition). Pearson.

Lauring, J., & Selmer, J. (2012). Knowledge sharing in diverse organisations. Human Resource Management Journal, 22(1), 89-105.

Lee, A. R. (2021). Investigating Moderators of the Influence of Enablers on Participation in Knowledge Sharing in Virtual Communities. Sustainability, 13(17), 9883.

Lin, H. F. (2007). Knowledge sharing and firm innovation capability: an empirical study. International Journal of manpower.

Lindgreen, A., & Swaen, V. (2010). Corporate social responsibility. International journal of management reviews, 12(1), 1-7.

Lee, L. L. (2000). Knowledge sharing metrics for large organizations. Knowledge management: Classic and contemporary works, 403-419.

Ma, W. W., & Yuen, A. H. (2011). Understanding online knowledge sharing: An interpersonal relationship perspective. Computers & Education, 56(1), 210-219.

Majchrzak, A., Faraj, S., Kane, G. C., & Azad, B. (2013). The contradictory influence of social media affordances on online communal knowledge sharing. Journal of Computer-Mediated Communication, 19(1), 38-55.

Martins, V. W. B., Rampasso, I. S., Anholon, R., Quelhas, O. L. G., & Leal Filho, W. (2019). Knowledge management in the context of sustainability: Literature review and opportunities for future research. Journal of cleaner production, 229, 489-500.

Mehrzadi, D., & Feitelson, D. G. (2012, June). On extracting session data from activity logs. In Proceedings of the 5th annual international systems and storage conference, 1-7.

Mentzas, G., Apostolou, D., Kafentzis, K., & Georgolios, P. (2006). Inter-organizational networks for knowledge sharing and trading. Information Technology and Management, 7(4), 259-276.

Nodari, F., Oliveira, M., & Maçada, A. C. G. (2016). Organizational performance through the donation and collection of interorganizational knowledge. VINE Journal of Information and Knowledge Management Systems.

Nooshinfard, F., & Nemati-Anaraki, L. (2014). Success factors of inter-organizational knowledge sharing: a proposed framework. The Electronic Library.

Okoli, C. (2015) "A guide to conducting a standalone systematic literature review," Communications of the Association for Information Systems, vol. 37, nr. 1, pp. 879-910, 1 11.

Pang, S., Bao, P., Hao, W., Kim, J., & Gu, W. (2020). Knowledge sharing platforms: An empirical study of the factors affecting continued use intention. Sustainability, 12(6), 2341.

Panteli, N., & Sockalingam, S. (2005). Trust and conflict within virtual inter-organizational alliances: a framework for facilitating knowledge sharing. Decision support systems, 39(4), 599-617.

Plomp, M. (2020a). Creating a Method for Defining a Family of Validations for Model-Driven Development Systems , Utrecht University. Not published.

Plomp, M. (2020b). Designing a model-driven repository for good practices on ethical, social, and environmental topics. Master's thesis, Utrecht University. Not published.

Quigley, N. R., Tesluk, P. E., Locke, E. A., & Bartol, K. M. (2007). A multilevel investigation of the motivational mechanisms underlying knowledge sharing and performance. Organization science, 18(1), 71-88.

Rathi, D., Given, L. M., & Forcier, E. (2014). Interorganisational partnerships and knowledge sharing: the perspective of non-profit organisations (NPOs). Journal of Knowledge Management.

Razmerita, L., Kirchner, K., & Nielsen, P. (2016). What factors influence Knowledge sharing in organizations? A social dilemma perspective of social media communication. Journal of knowledge Management.

Sensuse, D. I., Lestari, P. I., & Al Hakim, S. (2021). Exploring Factors Influencing Knowledge Sharing Mechanisms and Technology to Support the Collaboration Ecosystem: A Review. DESIDOC Journal of Library & Information Technology, 41(3).

Shannak, R. O. (2009). Measuring knowledge management performance. European Journal of Scientific Research, 35(2), 242-253.

Soekijad, M., & Andriessen, E. (2003). Conditions for knowledge sharing in competitive alliances. European management journal, 21(5), 578-587.

Tohidinia, Z., & Mosakhani, M. (2010). Knowledge sharing behaviour and its predictors. Industrial Management & Data Systems.

UNESCO. (2015, August 20). Sustainable Development. Retrieved December 13, 2021, from https://en.unesco.org/themes/education-sustainable-development/what-is-esd/sd

United Nations General Assembly (1987). Report of the World Commission on Environment and Development: Our Common Future Towards Sustainable Development

Usoro, A., Sharratt, M. W., Tsui, E., & Shekhar, S. (2007). Trust as an antecedent to Knowledge sharing in virtual communities of practice. Knowledge Management Research & Practice, 5(3), 199-212.

Van de Weerd, I., & Brinkkemper, S. (2009). Meta-modeling for situational analysis and design methods. In Handbook of research on modern systems analysis and design technologies and applications (pp. 35-54). IGI Global.

Van Der Aalst, W. (2012). Process mining: Overview and opportunities. ACM Transactions on Management Information Systems (TMIS), 3(2), 1-17.

Van der Pijl, S. (2020). Designing discussion and rating mechanisms to foster community based feedback for a repository of sustainability good practices. Bachelor's thesis, Utrecht University. Not published.

Wang, N., Yin, J., Ma, Z., & Liao, M. (2021). The influence mechanism of rewards on knowledge sharing behaviors in virtual communities. Journal of Knowledge Management.

Wang, S., & Noe, R. A. (2010). Knowledge sharing: A review and directions for future research. Human resource management review, 20(2), 115-131.

Wieringa, R. J. (2014). Design science methodology for information systems and software engineering. Springer.

Wohlin, C., Runeson, P., Höst, M., Ohlsson, M. C., Regnell, B., & Wesslén, A. (2012). Experimentation in software engineering. Springer Science & Business Media.

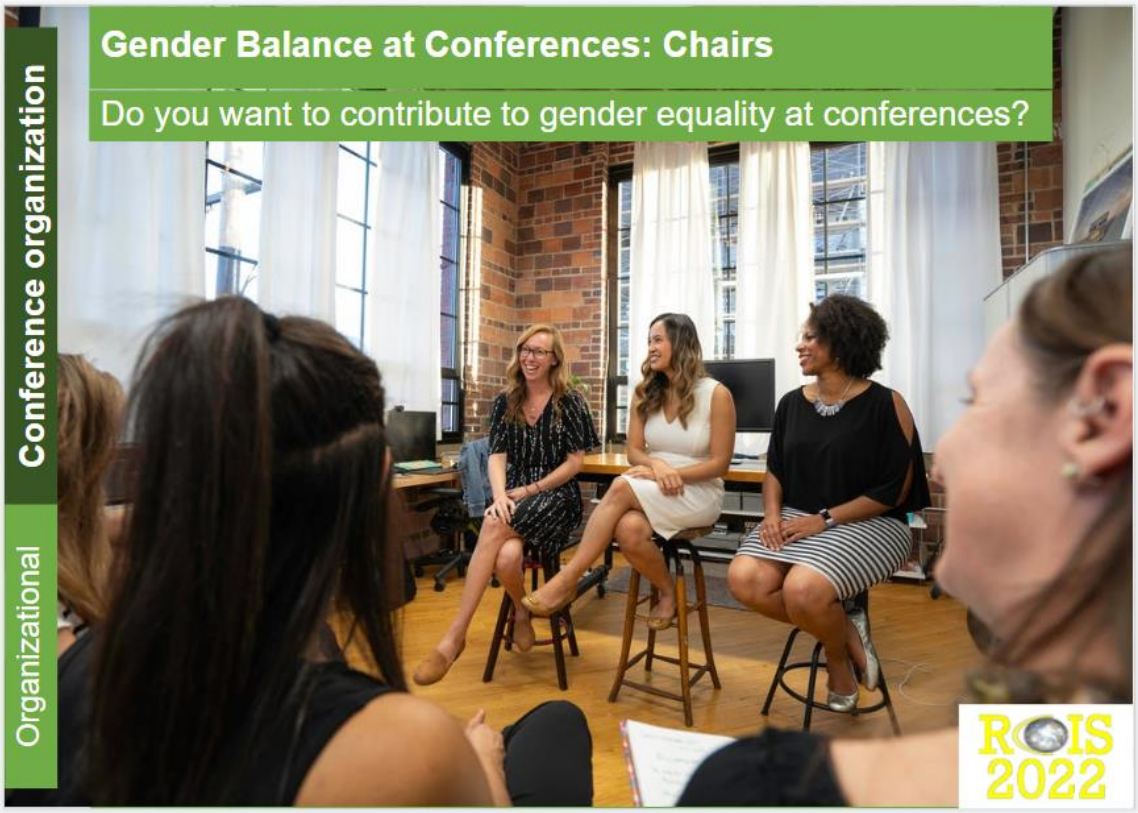
Yang, H. L., & Wu, T. C. (2008). Knowledge sharing in an organization. Technological Forecasting and Social Change, 75(8), 1128-1156.

Yi, J. (2009). A measure of knowledge sharing behavior: scale development and validation. Knowledge Management Research & Practice, 7(1), 65-81.

Zakay, N., & Feitelson, D. G. (2012, May). On identifying user session boundaries in parallel workload logs. In Workshop on Job Scheduling Strategies for Parallel Processing (pp. 216-234). Springer, Berlin, Heidelberg.

Zheng, T. (2017). A literature review on knowledge sharing. Open Journal of Social Sciences, 5(03), 51.

Appendix A: Example of a good practice



Gender Balance at Conferences: Chairs

Although there are initiatives and efforts to close the gender gap in academia, advancements toward gender equality are still slow. Naturally, researchers of all genders are an integral part of the world of academia. Women, men, non-binary people, agendered people, bigendered people, gender fluid people, and people with other gender identities should be given equal opportunities. Besides it being fair, research has also shown that a diverse team produces more successful outcomes.

A possibility to achieve more gender balance in academia could be to strive for an equal distribution of genders among General and Programme chairs.

To address this, conferences could instate quotas for chairing positions. Another option could be to ensure that the gender distribution of General and Programme chairs is equal. For instance, if the gender distribution of the Programme chair is 1:2:1 (meaning, for every woman there are two men and one differently gendered person) the General chair should have a similar distribution. The later option accounts for areas where women (and differently gendered people) are underrepresented. Given that it is more difficult to achieve gender balance in such areas.

Alternatively, the gender distribution of the conference attendees can be used as a benchmark for the chair compositions.

Fig 1. Gender distribution of the General chair

Fig 2. Gender distribution of the Programme chair

Conference organization

Organizational

Appendix B: SLR Protocol

SLR method

For the SLR method, we look at the method defined by Okoli (2015). This method is chosen because it is a rigorous, standardized methodology that spans the entire SLR process.

The SLR method involves eight phases.
The phases are:

1. Identify the purpose
2. Draft protocol
3. Apply practical screen
4. Search for literature
5. Extract data
6. Appraise quality
7. Synthesize studies
8. Write the review

Below, the purpose, practical screen, and literature search are briefly described. The rest of the phases are implicitly implemented in this project.

Purpose

The SLR should provide some conceptual information on the context of knowledge sharing between responsible organizations. This conceptual information is partly used for the conceptual framework as part of the background knowledge and partly for the further problem investigation phase involving the influence factors.

Practical screen

The practical screen dictates conditions for including or excluding sources from further examination.

In this project, a source is eligible to be included if:

- The source is freely available.
    - The source is freely accessible; or
    - Freely accessible via the UU library.
- The source is available in English.
- The source's title contains a mention of any of the search strings.
- The sources summary (visible on scholar. Google) contains the same terms as the title.
- The source is academic.
    - Newspapers, online forums, and others are automatically excluded.
- The source is reasonable recently published.
    - There is no hard line on when a source is excluded. This is because varying concepts might be receptive to change, whereas others are not.

    - To address this, newer sources are preferred over older sources.

To be included, a source does not have to be fully dedicated to knowledge sharing in the context of responsible organizations. A mention of some relevant concepts is enough to be eligible for further examination.

Search for literature

The literature search is conducted on Google Scholar

Search strings

- s1.1 digital knowledge sharing AND (influence factors OR influence OR sustainability OR "responsible enterprises" OR "responsible organizations" OR "good practice")
- s1.2 digital interorganizational sustainability knowledge sharing factors of influence
- s1.3 interorganizational knowledge sharing factors of influence
- s1.4 knowledge sharing
- s1.5 knowledge sharing between organizations

References and Search strings

Table 62: Search strings and their associated retrieved literature

Reference	Search string	Able to access	Selected for Inclusion	Reason for exclusion	Included in SLR
Razmerita, L., Kirchner, K., & Nielsen, P. (2016). What factors influence Knowledge sharing in organizations? A social dilemma perspective of social media communication. Journal of knowledge Management.	s1.1	Yes 11/24/2021	Yes		Yes
Majchrzak, A., Faraj, S., Kane, G. C., & Azad, B. (2013). The contradictory influence of social media affordances on online communal knowledge sharing. Journal of Computer-Mediated Communication, 19(1), 38-55.	s1.1	Yes 11/24/2021	Yes		Yes
Lin, H. F. (2007). Knowledge sharing and firm innovation capability: an empirical study. International Journal of manpower.	s1.1	Yes 11/24/2021	Yes		Yes
Wang, N., Yin, J., Ma, Z., & Liao, M. (2021). The influence mechanism of rewards on knowledge sharing behaviors in virtual communities. Journal of Knowledge Management.	s1.1	Yes 11/24/2021	Yes		Yes
Chen, I. Y., Chen, N. S., & Kinshuk. (2009). Examining the factors influencing participants' knowledge sharing behavior in virtual learning communities. Journal of Educational Technology & Society, 12(1), 134-148.	s1.1	Yes 11/24/2021	No	This source is concerned with virtual learning communities in the context of education and does not provide findings generalizable to our context.	
Sensuse, D. I., Lestari, P. I., & Al Hakim, S. (2021). Exploring Factors Influencing Knowledge Sharing Mechanisms and Technology to Support the Collaboration Ecosystem: A Review. DESIDOC Journal of Library & Information Technology, 41(3).	s1.1	Yes 11/24/2021	Yes		Yes

Reference	Search string	Able to access	Selected for Inclusion	Reason for exclusion	Included in SLR
Chen, Y. H., Lin, T. P., & Yen, D. C. (2014). How to facilitate inter-organizational knowledge sharing: The impact of trust. Information & management, 51(5), 568-578.	s1.1	Yes 11/24/2021	Yes		Yes
Jilani, M. M. A. K., Fan, L., Islam, M. T., & Uddin, M. (2020). The influence of Knowledge sharing on sustainable performance: A moderated mediation study. Sustainability, 12(3), 908.	s1.1	Yes 24/11/2021	Yes		Yes
Lee, A. R. (2021). Investigating Moderators of the Influence of Enablers on Participation in Knowledge Sharing in Virtual Communities. Sustainability, 13(17), 9883.	s1.1	Yes 24/11/2021	Yes		Yes
Quigley, N. R., Tesluk, P. E., Locke, E. A., & Bartol, K. M. (2007). A multilevel investigation of the motivational mechanisms underlying knowledge sharing and performance. Organization science, 18(1), 71-88.	s1.1	Yes 24/11/2021	Yes		Yes
Pang, S., Bao, P., Hao, W., Kim, J., & Gu, W. (2020). Knowledge sharing platforms: An empirical study of the factors affecting continued use intention. Sustainability, 12(6), 2341.	s1.1	Yes 24/11/2021	Yes		Yes
Hansen, M. T. (2002). Knowledge networks: Explaining effective Knowledge sharing in multiunit companies. Organization science, 13(3), 232-248.	s1.1	Yes 24/11/2021	No	This source only considers intra organizational knowledge sharing and its findings are not generalizable to our context.	No
Valk, R., & Planojevic, G. (2021). Addressing the knowledge divide: digital knowledge sharing and social learning of geographically dispersed employees during the COVID-19 pandemic. Journal of Global Mobility: The Home of Expatriate Management Research.	s1.1	No it was locked behind a paywall	No		NA

Reference	Search string	Able to access	Selected for Inclusion	Reason for exclusion	Included in SLR
Zheng, T. (2017). A literature review on knowledge sharing. Open Journal of Social Sciences, 5(03), 51.	s1.1	Yes 24/11/2021	Yes		Yes
Charband, Y., & Navimipour, N. J. (2016). Online knowledge sharing mechanisms: a systematic review of the state of the art literature and recommendations for future research. Information Systems Frontiers, 18(6), 1131-1151.	s1.2	Yes 1/12/2021	Yes		Yes
Panteli, N., & Sockalingam, S. (2005). Trust and conflict within virtual inter-organizational alliances: a framework for facilitating knowledge sharing. Decision support systems, 39(4), 599-617.	s1.2	Yes 1/12/2021	Yes		Yes
Nooshinfard, F., & Nemati-Anaraki, L. (2014). Success factors of inter-organizational knowledge sharing: a proposed framework. The Electronic Library.	s1.3	Yes 7/12/2021	Yes		Yes
Al-Busaidi, K. A., & Olfman, L. (2017). Knowledge sharing through inter-organizational knowledge sharing systems. VINE Journal of Information and Knowledge Management Systems.	s1.3	Yes 7/12/2021	Yes		Yes
Mentzas, G., Apostolou, D., Kafentzis, K., & Georgolios, P. (2006). Inter-organizational networks for knowledge sharing and trading. Information Technology and Management, 7(4), 259-276.	s1.3	Yes 7/12/2021	Yes		Yes
Ipe, M. (2003). Knowledge sharing in organizations: A conceptual framework. Human resource development review, 2(4), 337-359.	s1.4	Yes 7/12/2021	Yes		Yes
Wang, S., & Noe, R. A. (2010). Knowledge sharing: A review and directions for future research. Human resource management review, 20(2), 115-131.	s1.4	Yes 7/12/2021	Yes		Yes

Reference	Search string	Able to access	Selected for Inclusion	Reason for exclusion	Included in SLR
Cabrera, E. F., & Cabrera, A. (2005). Fostering Knowledge sharing through people management practices. The international journal of human resource management, 16(5), 720-735.	s1.4	Yes 10/12/2021	Yes		Yes
Gagné, M. (2009). A model of knowledge-sharing motivation. Human Resource Management: Published in Cooperation with the School of Business Administration, The University of Michigan and in alliance with the Society of Human Resources Management, 48(4), 571-589.	s1.4	Yes 10/12/2021	Yes		Yes
Yang, H. L., & Wu, T. C. (2008). Knowledge sharing in an organization. Technological Forecasting and Social Change, 75(8), 1128-1156.	s1.4	Yes 10/12/2021	Yes		Yes
Cabrera, A., Collins, W. C., & Salgado, J. F. (2006). Determinants of individual engagement in knowledge sharing. The International Journal of Human Resource Management, 17(2), 245-264.	s1.4	Yes 10/12/2021	Yes		Yes
Tohidinia, Z., & Mosakhani, M. (2010). Knowledge sharing behaviour and its predictors. Industrial Management & Data Systems.	s1.4	Yes 11/12/2021	Yes		Yes
Soekijad, M., & Andriessen, E. (2003). Conditions for knowledge sharing in competitive alliances. European management journal, 21(5), 578-587.	s1.5	Yes 11/12/2021	Yes		Yes
Lauring, J., & Selmer, J. (2012). Knowledge sharing in diverse organisations. Human Resource Management Journal, 22(1), 89-105.	s1.5	Yes 11/12/2021	Yes		Yes
Rathi, D., Given, L. M., & Forcier, E. (2014). Interorganisational partnerships and knowledge sharing: the perspective of non-profit organisations (NPOs). Journal of Knowledge Management.	s1.5	Yes 11/12/2021	Yes		Yes

Reference	Search string	Able to access	Selected for Inclusion	Reason for exclusion	Included in SLR
Aljuwaiber, A. (2016). Communities of practice as an initiative for Knowledge sharing in business organisations: a literature review. Journal of Knowledge Management.	s1.5	Yes 12/12/2021	Yes		Yes
Whiddett, D., Tretiakov, A., & Hunter, I. (2012). The use of information technologies for knowledge sharing by secondary healthcare organisations in New Zealand. International journal of medical informatics, 81(7), 500-506.	s1.5	Yes 12/12/2021	No	This paper is geared specifically at the use of KS technologies in New Zealand and does not provide generalizable findings.	NA
Usoro, A., Sharratt, M. W., Tsui, E., & Shekhar, S. (2007). Trust as an antecedent to Knowledge sharing in virtual communities of practice. Knowledge Management Research & Practice, 5(3), 199-212.	s1.5	Yes 21/12/2021	Yes		Yes
Holzer, A., Kocher, B., Bendahan, S., Vonèche Cardia, I., Mazuze, J., & Gillet, D. (2020). Gamifying knowledge sharing in humanitarian organisations: a design science journey. European Journal of Information Systems, 29(2), 153-171.	s1.5	Yes 21/12/2021	Yes		Yes

Appendix C: Knowledge sharing dimensions

Table 63: Dimensions named in the literature

Dimension	References	Amount
Individual factors	Gagné, 2009; Nooshinfard & Nemati-Anaraki, 2014; Razmerita et al., 2016; Lin, 2007; Zheng, 2017; Yang & Wu, 2008; Al Busaidi & Olfman, 2017; Wang & Noe, 2010;	8
Organizational factors	Gagné, 2009; Nooshinfard & Nemati-Anaraki, 2014; Razmerita et al., 2016; Lin, 2007; Zheng, 2017; Yang & Wu, 2008; Cabrera et al., 2006; Al Busaidi & Olfman, 2017; Soekijad & Andriessen, 2003; Aljuwaiber 2016; Wang & Noe, 2010	11
Technological factors	Gagné, 2009; Nooshinfard & Nemati-Anaraki, 2014; Razmerita et al., 2016; Lin, 2007; Zheng, 2017[10]; Cabrera et al., 2006; Al Busaidi & Olfman, 2017	7
Nature of knowledge factors	Gagné, 2009; Yang & Wu, 2008; Soekijad & Andriessen, 2003	3
Demographics	Razmerita et al., 2016	1
Team factors	Zheng, 2017	1
Socio Psychological factors	Cabrera & Cabrera, 2005; Cabrera et al., 2006	2
Peer factors	Al Busaidi & Olfman, 2017	1
Sector factors	Al Busaidi & Olfman, 2017	1
Relationship between the organisations involved factors	Soekijad & Andriessen, 2003	1
The source of knowledge (The knowledge-providing organization)	Mentzas et al., 2006	1
The recipient of knowledge (The knowledge-acquiring organization)	Mentzas et al., 2006	1
Electronic media	Mentzas et al., 2006	1
Interorganisational factors	Panteli & Sockalingam, 2005; Chen et al., 2014	2
Interpersonal and team factors	Wang & Noe, 2010	1
Motivational factors	Wang & Noe, 2010	1

As we can see, some dimensions' content seems to overlap. As an example, consider electronic media and technological factors. To reduce dimensions, we choose to merge these overlapping or similar dimensions. See Figure 57 below for a mapping from the dimensions found in the literature to the merged dimensions.

[10] Technology in this source is discussed as a factor of the organizational dimension but compared to other papers it is closer to its own dimension.

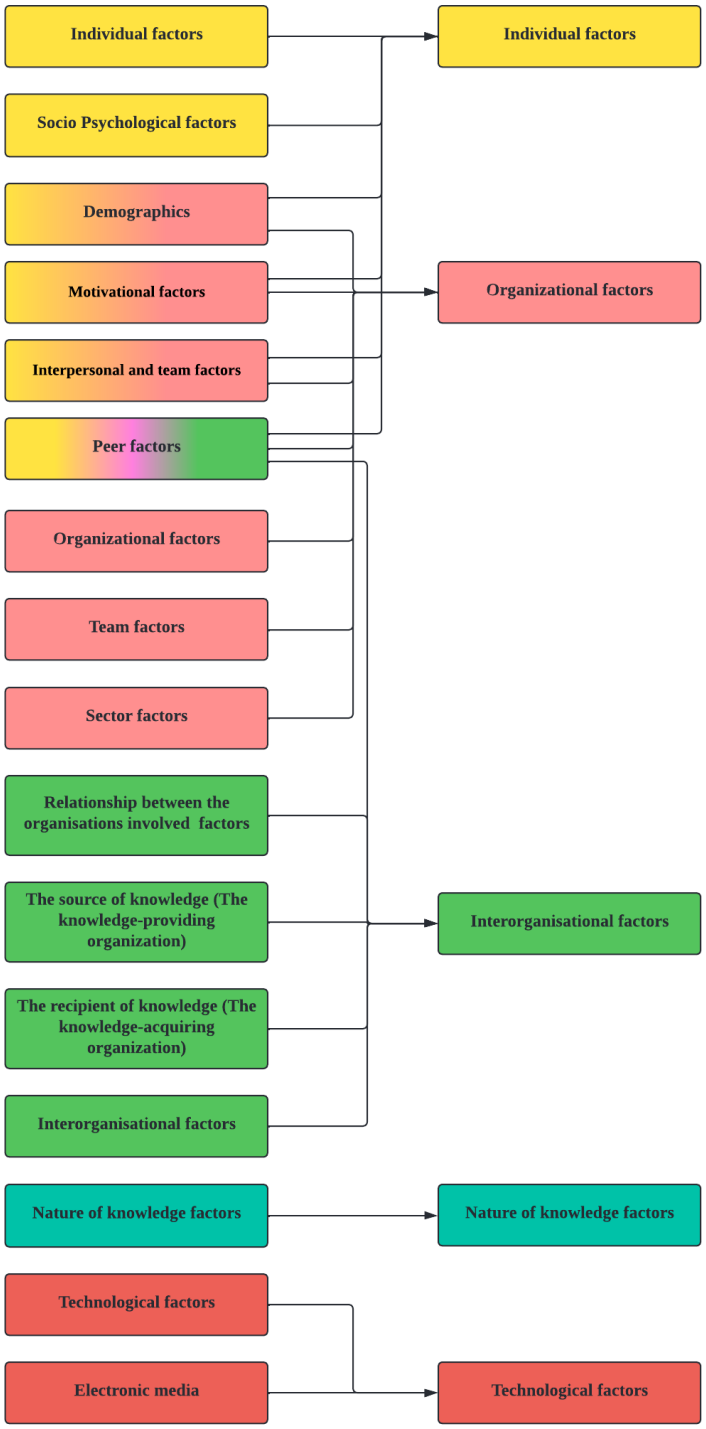


Figure 57: Mapping of literature dimensions to dimensions used in this report

In Figure 57 above, we see mapping the dimensions found in the literature to the dimensions we refer to in this report. Merging is done based on commonalities between factors in dimensions described by varying authors. For instance, the Socio-Psychological factors include trust and self-efficacy; other authors refer to these as individual factors. That is why the dimension Socio-Psychological factors are merged into individual factors. The same principle is applied to the other dimensions. Other dimensions like 'peer factors' are referenced in multiple dimensions because factors contained in the peer dimension are also referenced in the dimensions. This means the factors from the peer dimension are distributed over the other dimension.

Table 64: Merged dimensions named in the literature

Merged Dimension	References	Amount
Individual factors	Gagné, 2009; Nooshinfard & Nemati-Anaraki, 2014; Razmerita et al., 2016; Lin, 2007; Zheng, 2017; Yang & Wu, 2008; Cabrera & Cabrera, 2005; Cabrera et al., 2006; Al Busaidi & Olfman, 2017; Wang & Noe, 2010	10
Organizational factors	Gagné, 2009; Nooshinfard & Nemati-Anaraki, 2014; Razmerita et al., 2016; Lin, 2007; Zheng, 2017; Yang & Wu, 2008; Cabrera et al., 2006; Al Busaidi & Olfman, 2017; Soekijad & Andriessen, 2003; Aljuwaiber 2016; Wang & Noe, 2010	11
Technological factors	Gagné, 2009; Nooshinfard & Nemati-Anaraki, 2014; Razmerita et al., 2016; Lin, 2007; Zheng, 2017; Cabrera et al., 2006; Al Busaidi & Olfman, 2017; Mentzas et al., 2006	8
Nature of knowledge factors	Gagné, 2009; Yang & Wu, 2008; Soekijad & Andriessen, 2003	3
Interorganisational factors	Soekijad & Andriessen, 2003; Mentzas et al., 2006; Panteli & Sockalingam, 2005; Chen et al., 2014	4

Appendix D: Knowledge-sharing factors of influence references

This appendix displays the matrix of the sources and the factors they name. The matrix is displayed in Table 65 below.

Table 65: Knowledge sharing factors per source

Category	Factor	References																						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Individual factors	Intention to share (motivation)	✓	✓	✓	✓	✓	✓	✓	✓															✓
	Personal characteristics		✓		✓	✓		✓		✓														✓
	Time					✓					✓													
	Trust (and relationship)		✓		✓	✓		✓			✓	✓	✓											✓
	Fear		✓			✓		✓						✓										
Organizational	National culture					✓																		✓
	Organizational culture					✓		✓				✓			✓									✓
	Organizational strategy					✓						✓												
	Organizational structure		✓			✓										✓								✓
	Management leadership		✓				✓										✓							✓
	Organizational KM mechanisms	✓		✓																				✓
	Rewards		✓		✓	✓	✓										✓	✓						✓
	Shared mental model			✓				✓																
	Diversity					✓		✓											✓					
Technological	Richness of communication		✓			✓		✓		✓						✓								

Category	Factor	References																						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	Lowering barriers		✓					✓					✓											
Nature of knowledge	Structure of knowledge			✓																✓				
	Content of knowledge																			✓				
Inter-organizational	Trust (and relationship)		✓										✓							✓	✓	✓	✓	
	Proximity to other organizations		✓																					

Reference number	
1. Gagné, 2009	13. Yang & Wu, 2008
2. Nooshinfard & Nemati-Anaraki, 2014	14. Jilani et al., 2021
3. Ipe, 2003	15. Cabrera & Cabrera, 2005
4. Quigley et al., 2007	16. Cabrera et al., 2006
5. Razmerita et al., 2016	17. Al-Busaidi & Olfman, 2017
6. Lin, 2007	18. Lauring & Selmer, 2012
7. Zheng, 2017	19 Soekijad & Andriessen, 2003
8. Holzer et al., 2020	20. Mentzas et al., 2006
9. Tohidinia & Mosakhani, 2010	21. Panteli & Sockalingam, 2005
10. Charband & Navimipour, 2016	22. Chen et al., 2014
11.Sensuse et al., 2021	23. Wang & Noe, 2010
12. Usoro et al., 2007	

Note that these references describe the factors listed above. References used in subsection introductions that do not support individual factors explicitly are left out of this list.

Appendix E: Requirements from related projects

This appendix contains the requirements from the related projects by Coenen (2020) and Plomp (2020).

Coenen (2020)

The table below illustrates the requirements for the optimal GPR described in Coenen (2020).

Table 66: Optimal GPR requirements and their implementation in openBest v1.0 (name and description adapted from Coenen, 2020)

ID	Name	Description	openBest v1.0 implementation
C-RF1	Store	The GPR needs to be able to store all Good Practices gathered in the GPR.	openBest allows for creating and storing GPs in a domain in a Firebase database.
C-RF2	Display	The GPR must show Good Practices in their complete form, including tables and models if needed.	openBest allows for displaying the elements determined in the model. This displaying is currently very basic and not pleasantly styled, which is reflected in the absence of styling of the individual GP elements. In addition, openBest does not allow for tables, models, or other images to be displayed.
C-RF3	Alter	The GPR must allow users to change, add, and remove GPs in the repository.	openBest does not facilitate editing and removing good practices in the openBest tool itself. It is possible to do this directly in the database as a domain administrator
C-RF4	Search	The GPR must allow search requests and find the correct GP(s) related to that request.	openBest supports limited search functionalities, there is a search bar on top of the list of good practices, and they can be ordered according to the tables' column variables. While some efforts have been made to expand these features, unfortunately, the accompanying code does not function properly as of now.
C-RF5	Categorize	The GPR needs to have some categorization to structure and combine GPs accordingly.	openBest supports the categorization of GPs, which can be done using the core model categorization elements or custom elements determined in the model.
C-RF6	User management	The GPR needs to allow roles to be implemented, giving different roles a different level of management access to the GPR. This feature is only needed when the repository has multiple management roles.	openBest features a login feature based on Google accounts. Next, openBest accommodates multiple roles like a user and the domain administrator.
C-RF7	Link	The GPR needs to allow patterns to link to each other	openBest allows for documents to be linked to GPs, this also goes for GPs themselves, but this is not configured in the models as of now.
C-RF8	Submit	To submit a document into the GPR. This submission would only be added once reviewed by someone responsible.	It is currently possible to submit a good practice into the GPR (see Store). The constraint of having it approved beforehand is not explicitly enforced. This is because the document is not locally stored or forwarded to someone responsible. However, when creating a GP, it is required to state who has proofread it.
C-RF9	List of Good Practices	The repository must contain a list of Good Practices.	openBest features a table view of all good practices present in the repository. The columns currently present are title, date, and description. This may be a bit limited for more advanced filtering and searching (RF4)

Plomp (2020)

This appendix contains the requirements as found in Plomp (2020b).

Table 67: Requirements by Plomp (derived from 'future work', Plomp, 2020b)

ID	Description
P-RF1	The functionality of openBest should be extended by including functionality for creating improvement plans. These plans can be constructed as the Theory of Change (ToC) linked to the work by Adèr and Plomp (2020b).
P-RF2	Information in improvement plans that include GPs should be used to define contextual information for GPs, allowing active recommendation of relevant GPs to organizations.
P-RF3	Other options for contextual information may also be researched, such as the inclusion and specification of organizational models (e.g., organizational charts or process models) in openBest.
P-RF4	Current functionality should be further developed to improve its usefulness.
P-RF5	The model editor requires further ability to adapt core model elements and easier specification of relationships.
P-RF6	openBest currently relies on completely textual GPs. In future work, functionality should be implemented that allows users to specify GPs using images, models, and external files.
P-RF7	The functionality for finding GPs should be extended with more filtering options.
P-RF8	openBest should be connected to other tools in the BECIC software ecosystem.
P-RF9	openBest should allow users to search through repository instances of other domains to promote knowledge sharing across domains. This functionality needs to consider privacy-related issues; some organizations may not want to share knowledge with organizations outside their domain.

Appendix F: Requirements from other sources

Validation requirements

This appendix contains the requirements constructed following needs for the validation activities. This list does not include requirements regarding measuring knowledge sharing, as these requirements are described in the treatment validation section of this report.

Table 68: Requirements for the validation activities

ID	Description
V-RF1	openBest should allow multiple domains to be active simultaneously, with users accessing their domain based on their account instead of a local model.
V-RF2	openBest should allow domain administrators to add users to their domain.
V-RF3	openBest should allow domain administrators to add authors to their domain.

Development requirements

This appendix contains the requirements that are found by other serendipitous means.

Table 69: Other requirements

ID	Description
O-RF1	openBest should allow populating the domain with good practices from an Excel or other cell-based file.

Appendix G: Requirement assessment

Table 70: Requirement Assessment

ID	Complexity	Concreteness	Time required	Relevance	Explanation
FR1	Moderate	Moderate	Moderate	High	Lacking images and models makes the GPs very plain looking and void of illustrations supporting the GP's story. This makes the feature relevant. Implementing it may be complex because of the tool's model-driven nature, so many changes must be made for a minor change. For example, the viewing module needs to be significantly changed. Next, the term 'models' is ambiguous, making the requirement less concrete.
FR2	Low	High	Low	Low	Featuring files currently seems not relevant for making openBest validation ready. This is because, currently, openBest supports files to be made in openBest. This means that if it is needed, external files can be added through means of text.
FR3	High	High	High	High	Currently, the GPs are not editable in openBest, which means that this is impossible if users make a typo or wish to change a detail in the GP based on new insights. Like many other features, the implementation of this feature is made more complicated by the model-driven nature.
FR4	Low	High	Low	High	Removing a GP is currently not an option, making it impossible for authors to remove outdated or incorrect GPs. Consequently, this feature is relevant for the correct functionality of the tool for validation.
FR5	Moderate	High	Moderate	High	Filtering and searching are instrumental to finding the correct and fitting GP. Some effort has been put into expanding these features, but these constructed features are not usable. However, the findings of said efforts are very concrete and can serve as the blueprint for implementing this requirement. The implementation of this feature is made more complicated by the model-driven nature because this influences the potential variables for filtering.
FR6	Low	High	Moderate	High	A more elaborate table can work in tandem with the more advanced filtering mechanisms because the more information displayed in the table, the more filter possibilities. The implementation of this feature is made more complicated by the model-driven nature because this influences present potential variables for filtering.

ID	Complexity	Concreteness	Time required	Relevance	Explanation
FR7	High	Moderate	High	Low	While implementing ToC into openBest is essential for more advanced improvement planning, we think this may be too ambitious for now because we still must validate openBest as a treatment for knowledge sharing using GPs. ToC could, in a later stage extent, openBest with more enhanced improvement planning.
FR8	Moderate	Moderate	High	Low	We think that this requirement depends on the implementation of FR 7, and it could be achieved using frequent pattern mining in combination with similarity metrics between similar good practices.
FR9	Moderate	Moderate	Moderate	Low	We think that this requirement is dependent on the implementation of FR 7.
FR10	High	Low	High	High	While not concrete, we feel that the usability of openBest could and must be further improved. The implementation of this feature is made more complicated by the model-driven nature. For instance, this determines the order in which items are shown and loaded into the client-side. Examples include the order of the GP fields and the order of the GP table columns.
FR11	Moderate	Low	Moderate	Low	This requirement is unclear because it is unspecified what elements must be adapted more easily. In addition to this, we do not think editing the core model should become more accessible. This is because we chose the model to have certain mandatory elements because of the earlier research by Coenen and Plomp specifying what constitutes a good GP. Next, the model used in the validation will be tailored for the organization, making it irrelevant for this project how useful the model editor is on that point.
FR12	Very High	Moderate	Very High	Low	Implementing openBest into the suit of SBEIC ecosystem tools would be beneficial. This is because findings from other SBEIC phases can be used as input for openBest. However, we think this is time-consuming and of low relevance for this project. This is because openBest still needs to be validated. This means that even if openBest is tied to the other tools, this will not be used during validation. In addition, factors of those other tools could influence the validation outcome of openBest, which is a validity threat we would mitigate by not coupling the tool at this point.

ID	Complexity	Concreteness	Time required	Relevance	Explanation
FR13	High	High	High	Low	We think allowing organizations to see GPs of other organizations (domains) is useful. However, this requires extensive reengineering because, at the core, openBest only allows users to access at most one domain, even if they are admitted members of more domains. We consider the relevance of this requirement for the project to be low because we are validating openBest in the context of one network of organizations. For that purpose admitting all members to a single domain suffices.
FR14	High	Moderate	Very High	High	Allowing multiple domains to be active simultaneously is a requirement that should have primary priority. This is because having a model-driven tool that still caters to one domain at a given time does not fully foster the model-driven architecture's opportunities. Next to this, for maintenance, it is undesirable if switching between domains is managed in the source code. This way, an engineer needs to edit code and deploy a new version whenever a different domain needs to be accessed. Finally, it is essential because it is not unthinkable that multiple organizations using different templates want to use openBest concurrently during validation or later deployment. This is not possible in the current setup. The implementation is perceived as having high complexity and relevance while also being concrete and time-consuming. This is because this alteration is meant to change the whole setup of openBest and requires changed routines for starting up the website. Additionally, all other functions now rely on the local model, which will be removed, which can yield numerous complications.
FR15	Moderate	High	Moderate	High	Implementing this requirement can provide the organizations potentially involved in future validation activities with the ability to manage their domain users autonomously. This is required because it removes the need for a scientist to manage users.
FR16	Moderate	High	Moderate	High	Implementing this requirement can provide the organizations potentially involved in future validation activities with the ability to manage their domain users autonomously. This is required because it removes the need for a scientist to manage users.

ID	Complexity	Concreteness	Time required	Relevance	Explanation
FR17	High	Moderate	High	High	During the development and showcasing of openBest, populated domains should be made frequently. For this reason, it is required to have some setup that allows for rapid setup and a population of domains. This requirement is highly relevant because we potentially need to rapidly develop and deploy several domains for the validation activities.

Appendix H: Requirements and rationale for inclusion

Table 71: Requirements and rationale for inclusion

ID	Included	Rationale
FR1	Yes	Lacking images and models makes the GPs very plain looking and void of illustrations supporting the GP's story. Implementing them can make openBest more attractive to potential users.
FR2	No	Featuring files currently seems not relevant for making openBest validation ready. This is because, currently, openBest supports files to be made in openBest. This means that if it is needed, external files can be added through means of text. In addition to this, adding files into a Firebase database is a challenge for which the cost in time outweighs the perceived benefits for now. The reason for this is that we currently use a text-only database.
FR3	Yes	Editing the GPs is essential for giving users control over the contents of the GPs.
FR4	Yes	Removing GPs is essential for quality control, and it can allow users or administrators to remove clutter, wrong, or redundant GPS.
FR5	Yes	Filtering and searching are instrumental to finding the correct and fitting GP. Some effort has gone into expanding these features, but these constructed features are not usable for now. The findings of said efforts are very concrete and can serve as the blueprint for the implementation of this requirement. The implementation of this feature is made more complicated by the model-driven nature because this influences potential present variables for filtering.
FR6	Yes	A more elaborate table can work in tandem with the more advanced filtering mechanisms because the more information displayed in the table, the more filter possibilities. The implementation of this feature is more complicated by the model-driven nature because this influences potential present variables for filtering.
FR7	No	While implementing ToC into openBest is essential for more advanced improvement planning, we think this may be too ambitious for now because we still must validate openBest as a treatment for knowledge sharing using GPs. This ToC would then extend it with more enhanced improvement planning.
FR8	No	We think this requirement depends on the implementation of FR 7, which we perceive to be unfeasible for now.
FR9	No	We think that this requirement is dependent on the implementation of FR 7.
FR10	Yes	While not concrete, we feel that the usability of openBest could and must be further improved. The implementation of this feature is made more complicated by the model-driven nature. For instance, this determines the order in which items are shown and loaded into the client-side. Examples include the order of the GP fields and the order of the GP table columns.
FR11	No	This requirement is a bit unclear. In addition to this, we do not think editing the core model should become more accessible. This is because we chose the model to have certain mandatory

ID	Included	Rationale
		elements because of the earlier research by Coenen and Plomp specifying what constitutes a good GP. Next, the model used in the validation will be tailored for the organization, making it irrelevant for this project how useful the model editor is on that point.
FR12	No	Implementing openBest into the suit of SBEIC ecosystem tools would be beneficial. This is because findings from other SBEIC phases can be used as input to openBest. However, we think this is time-consuming and of low relevance for this project. This is because openBest still needs to be validated, which means that even if openBest is coupled with the other tools, this will not be used during validation. In addition, factors of those other tools could influence the validation outcome of openBest, which is a validity threat we would mitigate by not coupling the tool at this point.
FR13	No	This feature requires extensive reengineering of openBest. We consider the relevance of this requirement for the project to be low because we are validating openBest in the context of one network of organizations. For that purpose admitting all members to a single domain suffices. Additionally, it is expected that having users part of multiple domains is troublesome. This is because the domain determines the model that is referenced, and this model, in turn, determines all functionalities of openBest. We can, therefore, currently not have multiple domains accessible at once by a single user. As an example, consider the challenge of having to show lists of 2 different types of GPs in a single table overview. It can simply not be done because document items can be disjointed. Therefore only limited labels, like title and description, can be shown in the GP table, and issues can occur when viewing GPs with different templates.
FR14	Yes	Allowing multiple domains to be active simultaneously is a requirement that should have primary priority. This is because having a model-driven tool that still caters to one domain at a given time does not fully foster the model-driven architecture's opportunities. Next to this, for maintenance, it is undesirable if switching between domains is managed in the source code. This way, an engineer needs to edit code and deploy a new version whenever a different domain needs to be accessed. Finally, it is essential because it is not unthinkable that multiple organizations using different templates want to use openBest concurrently during validation activities or later deployment. This is not possible in the current setup.
FR15	Yes	Implementing this requirement can provide the organizations potentially involved in future validation activities with the ability to manage their domain users autonomously. This is required because it removes the need for a scientist to manage users.
FR16	Yes	Implementing this requirement can provide the organizations potentially involved in future validation activities with the ability to manage their domain users autonomously. This is required because it removes the need for a scientist to manage users.
FR17	Yes	During the development and showcasing of openBest, populated domains should be made frequently. For this reason, it is required to have some setup that allows for rapid setup and a population of domains. This requirement is highly relevant because we potentially need to rapidly develop and deploy several domains for the validation activities.

Appendix I: Requirement implementation

Below, the implementation of the selected requirements for implementation is illustrated. The implementation constitutes the maturing of openBest from version 1.0 to 2.0.

FR1: openBest must allow GPs to feature images and models.

openBest v2.0 allows GPs to feature images using an external URL. This URL can be filled in during the creation of a good practice. For the image, the decision was made to use the URL approach (external hosting of images) over uploading a file approach (internal hosting of images) for two reasons. First, the Firestore database that we use for the back-end of openBest does not allow an image format to be saved. This means that uploading an image would involve engineering elements on the Firebase storage module and making a connection between that and our Firestore database. Second, we have chosen the URL approach because a URL is a string that is more affordable in terms of storage. We know that the external hosting approach may require more effort from the users, but considering the current limitations, this is the only feasible approach for now. Because of this, the URL approach was chosen as the best fitting temporary solution. Should time and monetary resources become more available, the rationale applied here could become invalid, and internal hosting could be considered for these usability reasons. The second part of this requirement is that the GPs should also feature models. This was a bit ambiguous because the model could also be displayed as an image. Therefore, we think that this is implemented. A caveat is that the models should be reachable online, by external hosting, because of the URL method, but that is because of the earlier tradeoff.

An example of an image in a GP can be seen below in Figure 58.

Figure 58: A GP image in openBest

FR3: openBest must allow GPs to be edited by the GP creator or a domain administrator in openBest.

openBest now allows GPs to be edited in the same window in which a GP is viewed. This can only be done by the GP's author, the domain administrator or an openBest developer. In openBest, the GP's content can be edited by pressing the 'Edit GP' button, editing the GP's contents where required, and pressing 'Confirm edit.' The user can press the 'Cancel edit' button if an edit is not required. When that button is pressed, the GP's content is reverted to its original contents. In Figure 59, the editing functionality of openBest is illustrated.

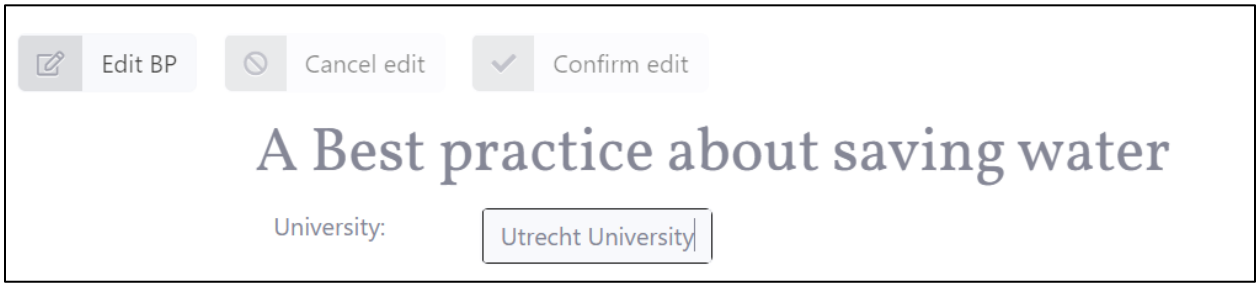


Figure 59: Editing in openBest

Currently, the editing functionality does not allow all fields to be edited. Some fields, like 'author,' are stored in different documents in the database. These related documents are documents saved in different collections, such as the 'authors' collection. These documents are linked to a GP using references. This means that editing an author would entail a much more complicated procedure because the reference of both the GP and author documents should be edited. This would be a challenge because Firebase does not facilitate relational data like this. As a result, such a routine would require looking up the author's documents and the corresponding author fields in the GP document. This is considered too elaborate for now, and the resources were needed for the other requirements. Additionally, we thought that the investment return for allowing authors to be edited was too low compared to the earlier-named efforts. Consequently, authors and other related document contents cannot be changed when editing a good practice. The same is true for the images.

FR4 openBest must allow GPs to be removed by the GP creator or a domain administrator in openBest.

openBest now allows the removal of GPs by the GP author or domain administrator. This can be done on the good practice viewing screen by pressing the 'Remove GP' button. Next, the user is asked to confirm that he wants to remove the good practice. This is illustrated below in Figure 60.

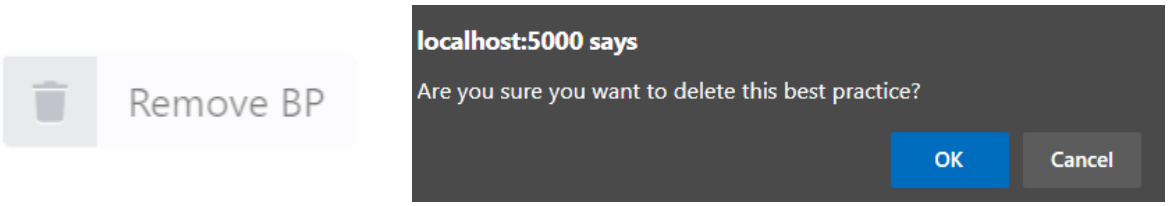


Figure 60: Removing GP in openBest

FR5 openBest must allow advanced searching and filtering functionality

openBest now features filtering based on all elements of a GP, which do not consist of 'related documents' on every criterion that fits the column data type (e.g., before a given date if the element is a date type or dropdown if the element is categorical). By having these explicit column-type dependent filtering mechanisms, we think to satisfy Jacobs' (2021) requirements. This implementation of the filter features is influenced by the fact that an external source is used to structure the table with good practices. This external source, Datatables[11] , steers and restricts the possibilities for filtering. Consequently, we had to design the solution within the DataTables framework. The result of this is the implementation of two filter mechanisms. First, there is the generic filter functionality. This generic filter, best described as a search bar, allows textual queries to be made. This query is then applied to all columns of the good practice table. This basic filter functionality is illustrated below in Figure 61.

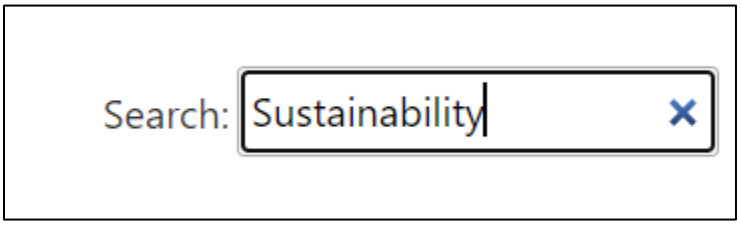


Figure 61: Generic filtering in openBest

Since this filtering mechanism is a bit limited and does not provide explicit filtering suggestions, we implemented a second filtering mechanism. This more extensive filtering mechanism allows for complex queries on the column level. The conditions can be structured using logic such as 'And' and 'Or' statements. The extensive filtering functionality is illustrated below in Figure 62.

[11] https://www.datatables.net/

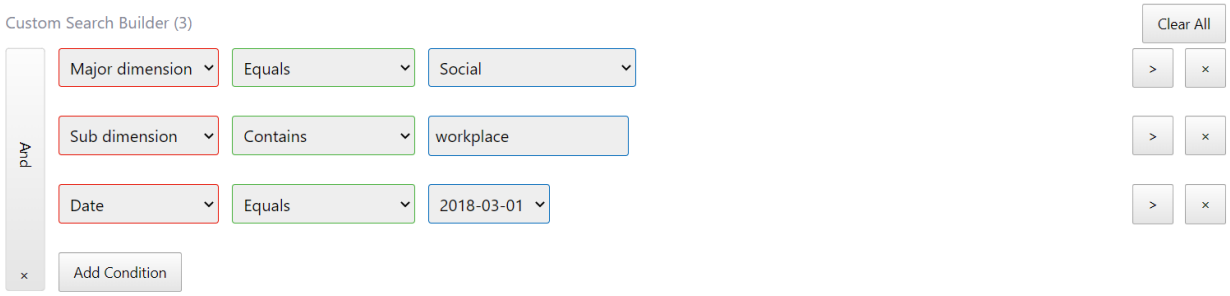


Figure 62: Filtering in openBest

This more extensive filtering mechanism satisfies Jacobs's requirements but may prove a bit too extensive for a simple search. That is why the simple filtering mechanism is also retained.

FR6 openBest should have a more detailed table view with more columns to enable more advanced filtering.

openBest 2.0 allows all elements of the GP which do not consist of 'related documents' to be shown in columns of the GP table. All columns can be toggled by pressing the associated column name on the toggle buttons so that the user can view the information he wants. The toggling buttons of columns are illustrated in Figure 63.

Figure 63: Column toggles in openBest

Currently, this is implemented as a case-based system. This means that for each domain, the table's columns need to be specified in the code. In a later stage, this can be included in the model editor.

FR10 Current functionality should be further developed to improve its usefulness.

This was a general, arguably, non-functional requirement. An attempt to implement it was made by styling the elements to be more familiar (e.g., all buttons as buttons), improving affordance. Moreover, the plain-looking style of openBest 1.0 GPs was adapted to conform to the layout seen in Plomp (2020b). The overall layout is illustrated below in Figure 64 and Figure 65.

Figure 64: Example of viewing a good practice in openBest (part 1)

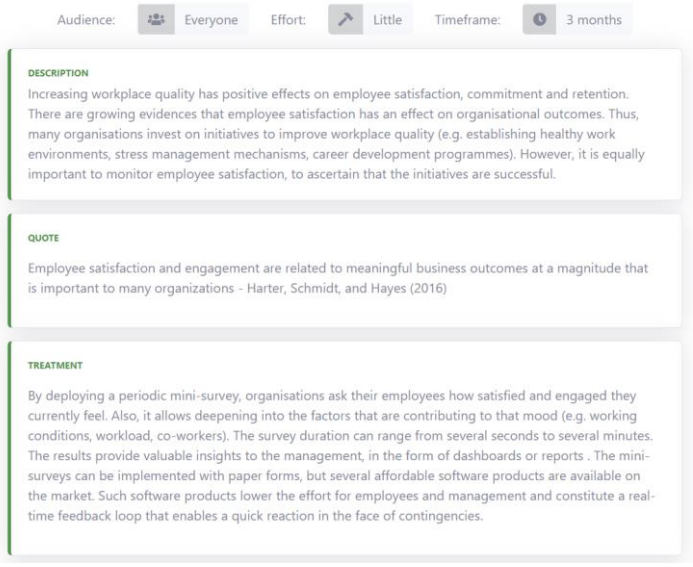


Figure 65: Example of viewing a good practice in openBest (part 2)

How the elements are displayed is determined by the viewing module. In openBest v2.0, this is done case-based. Consequently, new domains featuring elements like ‘audience’ should have those elements named exactly ‘audience’; otherwise, they are displayed like other elements like 'description', 'treatment'. In future versions, this could also be translated into the domain model by annotating the viewing type per label. Currently, the case-based system is used to keep development simple.

FR14 openBest should allow multiple domains to be active simultaneously, with users accessing their domain based on their account instead of a local model.

openBest now allows multiple domains to be active concurrently. This means that a user of ‘Domain A’ can now access that domain while a user of ‘Domain B’ accesses his domain. This is achieved by writing the model of a domain to the database as a string and retrieving it once it has been established that a user is part of the said domain. Based on this retrieved domain model string, the function paths are defined. This is similar to the earlier approach with the local model. The only difference is that there is no locally saved model to construct function paths on now. Instead, the retrieved domain model is used to construct these paths. The flow now determines to which domain a user belongs when the user logs in. If the user belongs to a domain, the fitting model is retrieved. This model is then used to construct the required paths for all functions. As a result, there is no longer a need for a locally stored domain model. This new process is illustrated below in Figure 66.

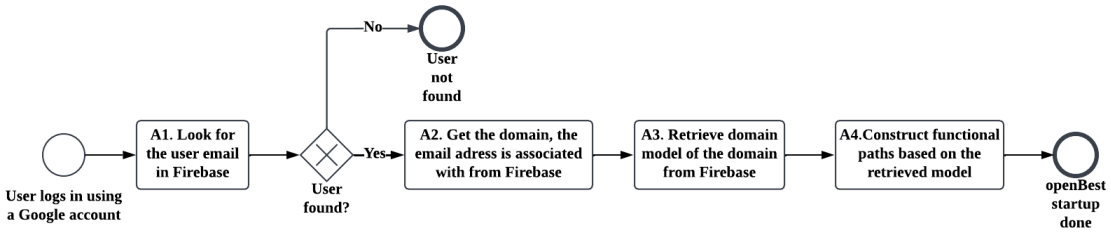


Figure 66: Illustration of the startup process of openBest v2.0

A restriction is that a user can be a member of only one domain. This is because only the first instance is returned when looking for the user email in Firebase. In a later version, this could be expanded to return multiple domain names. Then it would be required to implement a switch in openBest to allow users to switch between the domains of which they are members. This is because a user can be a member of at most one domain as this domain determines the model, which defines what is shown to the user.

FR15 openBest should allow domain administrators to add users

openBest now allows domain administrators to add users. This can be done using the button 'Add user' in the user management card. The user management card is shown below in Figure 67.

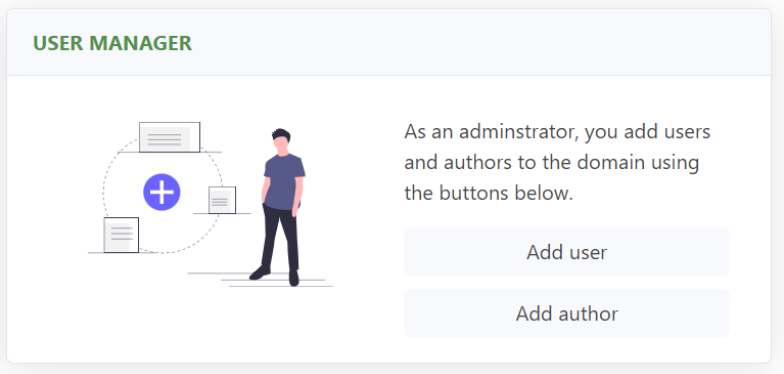


Figure 67: User management card

Pressing the buttons opens modals where a user or the author can be added. When creating a user, it is possible to indicate the user's role and immediately create an author account for the user. When the form is submitted, openBest checks if the email is unique and the user/ author is already present in the database. This way, duplicates can be prevented. The user management form is illustrated below in Figure 68.

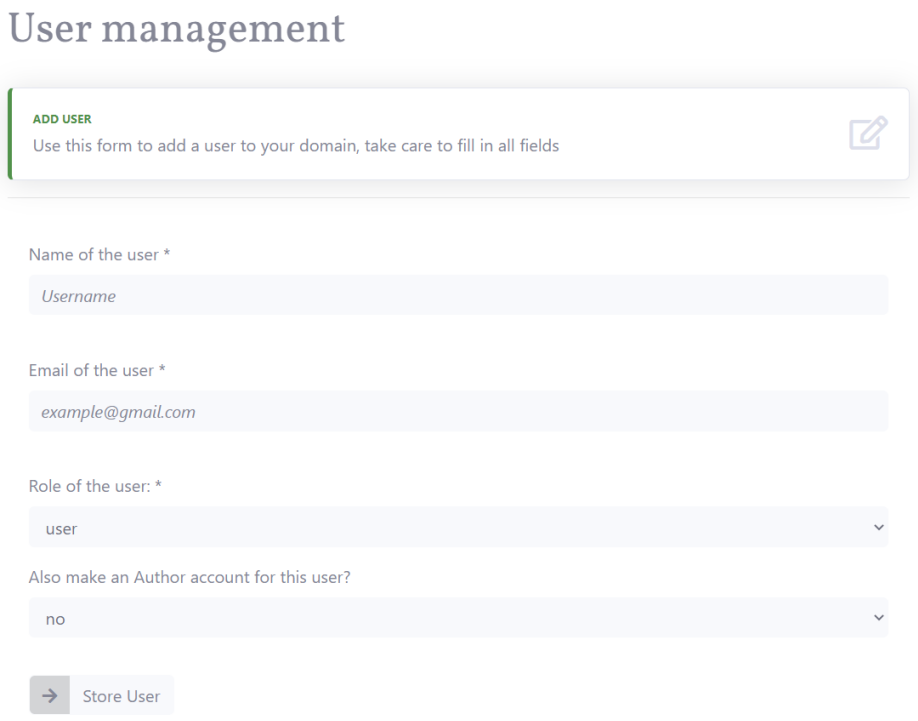


Figure 68: User management in openBest

FR16 openBest should allow domain administrators to add authors.

Next, as discussed before, the functionality for adding an Author is required to link users to good practices. This functionality is used if an existing user also wishes to create good practices under his name. To add an author, the domain administrator should navigate to the user management card and press the 'add author' button. Then a form opens that allows the domain administrator to add an author. The add author form is shown below in Figure 69.

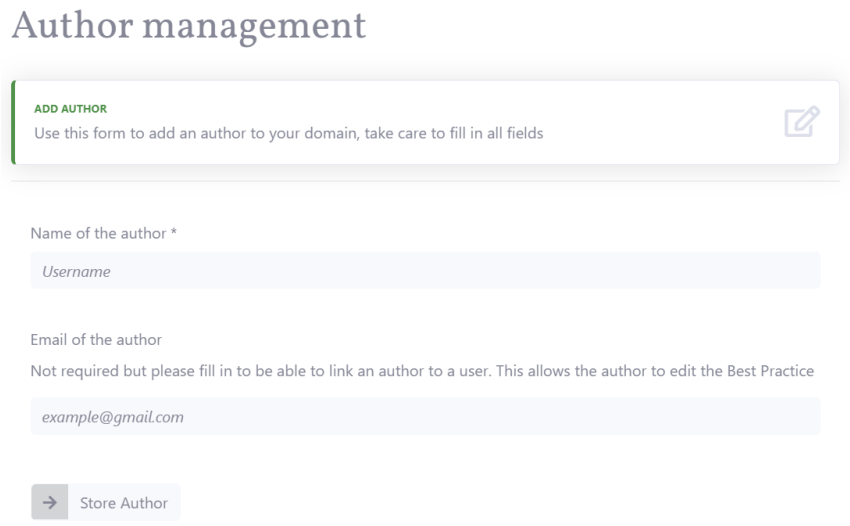


Figure 69: Author management in openBest

FR17 openBest should allow populating the domain with good practices from an Excel or other source file.

openBest now features developer tools. These tools are contained in 'dev tools domain.js' and allow the developer to populate the database associated with a domain. This can be done using local lists incorporated into the code or selecting an Excel file. This Excel file can then be used to populate the repository with good practices. Note that this depends on the domain model and may require reengineering for other situations. The 'dev tools domain.js' file can be a starting point for further development in further projects. In openBest, the development tools are only visible to users whose email is included in the 'developers' list in 'auth.js'. The development tools currently included in openBest are illustrated in Figure 70.

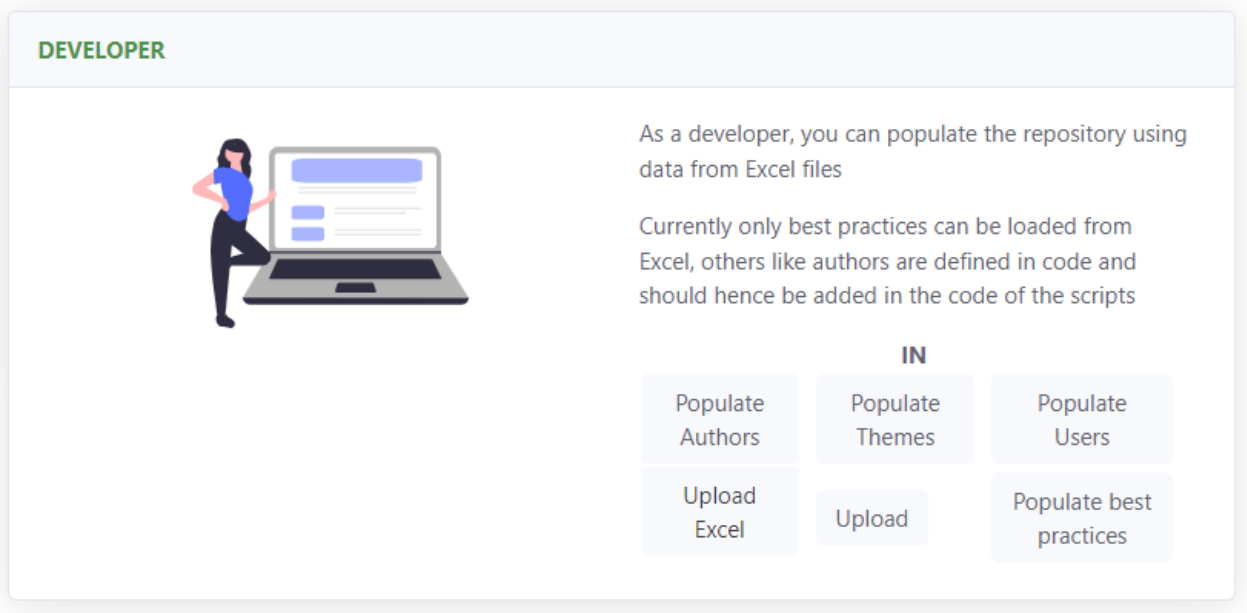


Figure 70: Developer tools in openBest

Appendix J: Information letter

RESEARCH PARTICIPANT INFORMATION SHEET

Validating a Model-Driven Repository for Best Practices on Ethical, Social, and Environmental Topics

Stefan van der Pijl
Utrecht University
Software for Organizational Responsibility line

Version date: 24-3-2022

What is the purpose of this study?

We intend to investigate the extent to which a best practice sharing repository, like OpenBest, can enhance knowledge sharing by facilitating creation, storing, and viewing of best practices containing steps of improvement to reach sustainability goals. For this we deploy OpenBest to be used by you! During the interactions with OpenBest your activity is monitored.

What will I do if I choose to be in this study?

You will interact with OpenBest, by looking at, creating, editing, commenting on, and exchanging best practices.

If you are an OICT student, you will follow the procedure outlined in the email you received.

How long will I be in the study?

The study period lasts from the 10-3-2022 to at least 2-7-2022. After this period this study is concluded but OpenBest may remain usable depending on the situation on that time. This will be communicated timely. It is not required for you to stay engaged during the entire period, but it is encouraged. This means that by this single visit you are already contributing but we would like to see you more often during the study period.

What are the possible risks or discomforts?

During the interactions with OpenBest information about your usage is collected. This can be intimidating and perhaps felt as intrusive. By agreeing to the terms in this document you agree that we can collect said information. If later, you feel unsure about this be sure to contact us and we will remove the data. There are no other risks or discomforts known.

Are there any benefits?

By sharing your experience and opinion, you are contributing to the body of knowledge. If you want, we will share the results with you.

As a student from the OICT course you can also get 1 extra point in the grade of workshop assignment A5.

What information about me and my participation is collected?

The information that we collect consists of logs of activities. This means that when you perform a specific activity this is collected as information. Such a log typically contains the following

information, the email you used to login to OpenBest, the action you performed (e.g., open a best practice or make a rating), the date and time you did this. While we initially collect the email address this is later anonymized in the research. After this anonymization it is not possible to request removal of your data because we cannot determine which data relates to you.

Will information about me and my participation be kept confidential?

Your interactions will be kept strictly confidential, and digital data will be stored in secure computer files. In the publications based on this research we will report on the results in a way that they are not traceable to you or your organisation. We will thank the participants in the acknowledgements section using a generic sentence and not their names. The project's research records may be reviewed by departments at Utrecht University responsible for regulatory and research oversight.

What are my rights if I take part in this study?

Your participation in this study is voluntary. You will not be paid for your participation. You may choose not to participate or, if you agree to participate, you can withdraw your participation at any time without being penalised. If you wish to have your information removed, please reach out to the researcher. Please note that removing information is only possible before anonymization is applied.

Who can I contact if I have questions about the study?

If you have questions, comments, or concerns about this research project, you can talk to one of the researchers. Please contact:

- Main researcher: Stefan van der Pijl <s.w.vanderpijl@students.uu.nl>
- Supervisor: Sergio España <s.espana@uu.nl>
- Daily supervisor: Vijanti Ramautar < v.d.ramautar@uu.nl>

If you have questions about your rights while taking part in the study or have concerns about the treatment of research participants, please contact Sergio España <s.espana@uu.nl>, also at this number +31 30 253 7088

Appendix K: Informed consent in openBest

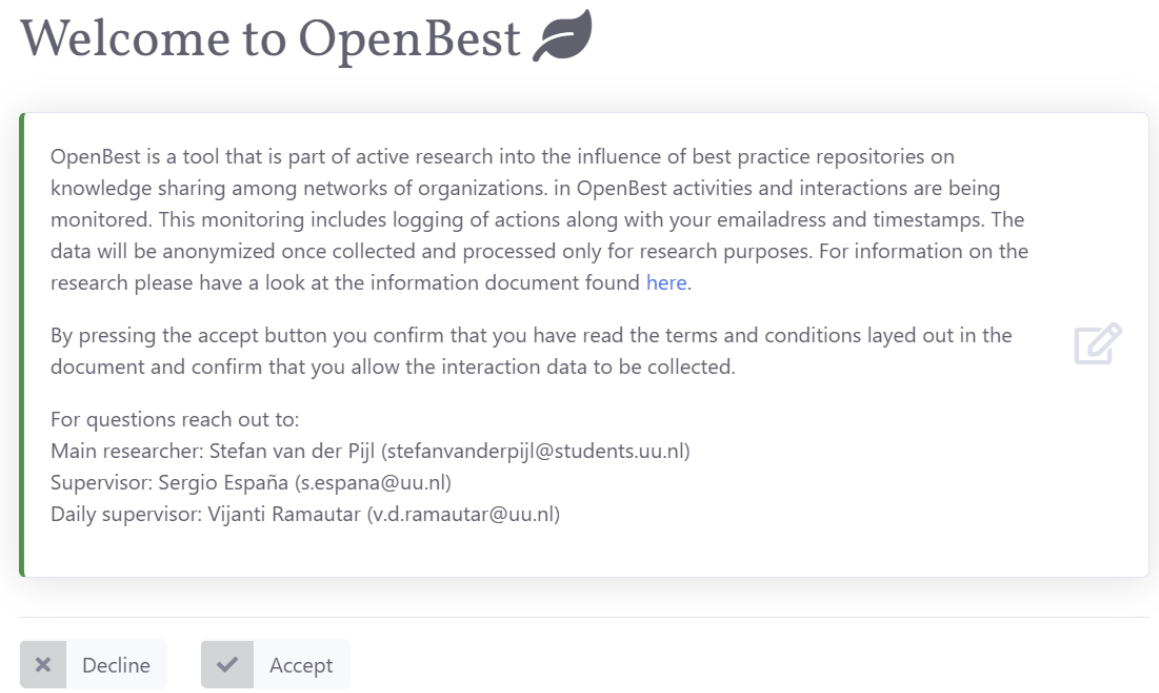


Figure 71: Welcome message asking for consent

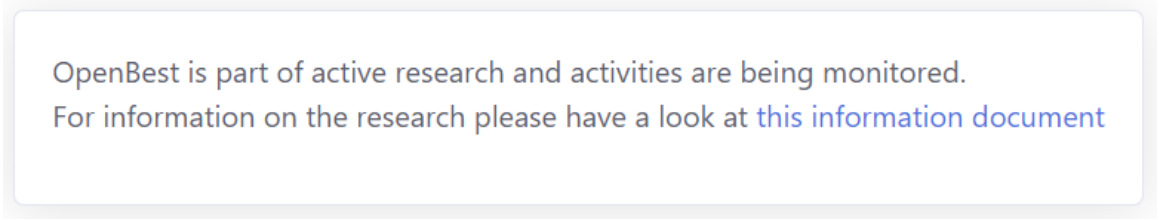


Figure 72: Reminder with link to the information letter

Appendix L: OICT domain model


```
"OICT": {
        "domainstate": {
                "displayfeature": false,
                "model": "string",
                "name": "OICT (practicum environment)",
                "administrator": "stefanvanderpijl@gmail.com",
                "bestpractices": {
                        "bpdocument": {
                                "01grouptitle": "Best practice",
                                "02groupdesc": "Introduce the good practice briefly. Also describe
                                what the solution is.",
                                "1displayfeature": true,
                                "10title": "string",
                                "11question": "string",
                                "12quote": "string",
                                "13major dimension": "string",
                                "14sub dimension": "string",
                                "15date": "string",
                                "16front image": "string",
                                "17front image licence": "string",
                                "18author": [{
                                        "name": "Written by",
                                        "self": "document reference",
                                        "related": "document reference"
                                }],

                                "19text": "text",
                                "20figure one": "string",
                                "21figure one caption": "string",
                                "22figure two": "string",
                                "23figure two caption": "string",
                                "comments": {
                                        "commentdocument": {
                                                "displayfeature": false,
                                                "author": "string",
                                                "date": "string",
                                                "email": "string",
                                                "img": "string",
                                                "level": "int",
                                                "parent": "string",
                                                "text": "string"
                                                }
                                        },
                                "ratings": {
                                        "ratingdocument": {
                                                "01grouptitle": "Ratings",
                                                "02groupdesc": "Describe the dimension (category)
                                                on which the good practice can be rated",
```

```
                                "2ratingtype": ["stars"],
                                "3dimension": ["Overall"],
                                "4dimension description": ["Overall quality"],
                                "5scale": [5],
                                "6stepsize": [1]
                                }
                        },

                }
        },
        "users": {
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                        "2email": "string",
                        "3name": "string",
                        "4role": "string",
                        "5hasaccesed":"string"
                        }
                },
        "authors": {
                "authordocument": {
                        "1displayfeature": false,
                        "2contactinfo": "string",
                        "3internal": "boolean",
                        "4name": "string"
                        }
                },
        "activitylogs": {
                "activitylog": {
                        "1displayfeature": false,
                        "2user": "string",
                        "3userrole": "string",
                        "4action": "string",
                        "5entitytype": "string",
                        "6entityid": "string",
                        "7date": "string"
                        }
                },
        }
}
```

Appendix M: OICT good practice example

Develop diverse teams

are you ready for inclusivity?

Major dimension: Social

Sub dimension: Workplace diversity

Written by: Gioser Añasep

Date: 2018-03-01

Licence: Public domain image issued under a CC0-No Rights Reserved license

QUOTE

There's a pure and simple business case for diversity: companies that are more diverse are more successful. – Mindy Grossman (2011)

TEXT

The group of people that enter the labour market is becoming more and more diverse. Not only because of globalisation, which leads to communities reaching further than ever before, but also due to the increasing financial independence of woman and participation of the disabled. Unfortunately, workplace discrimination is still the order of the day. As discrimination affects the psychological well-being of persons, businesses must take action to prevent it. By creating a diverse team, privileged persons will expose their own implicit biases and this will eventually decrease overall discrimination. Aside from this ethical consideration, a diverse team has more to offer. Research indicates that a diverse team is more likely to be creative and profitable, provided that they are managed well. Apart from that, gains are processed due to increased satisfaction. In case adequate management lacks, diversity could have negative impacts, such as communication problems, personal conflicts and misunderstandings, but still the upsides prevail over the downsides. In order to establish diverse teams, it is important that the recruitment processes are not homogenizing, so that the share of minorities in the organisation increases.

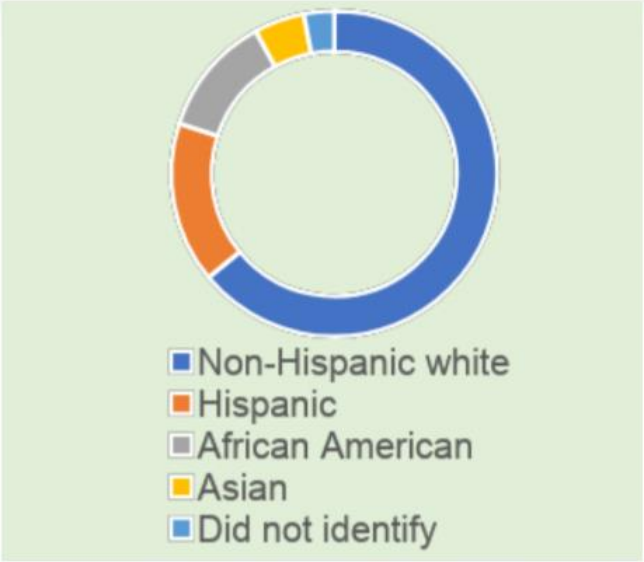


Fig 1. Ethnicity of the American workforce. [Burns et al., 2012]

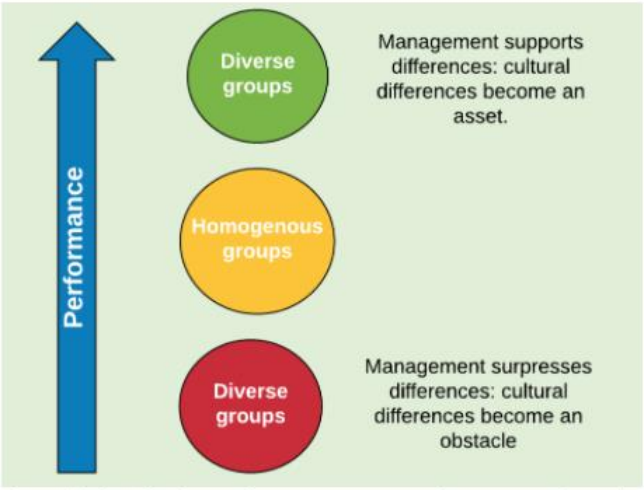


Fig 2. The implications of managers supporting/surpressing cultural differences for the business performance. [Lane & Maznevski, 2014]

Appendix N: OICT student instructions

Instructions extra task OICT Workshop A5

Introduction

As we announced, we are analysing the possibility to use a knowledge management tool called openBest in future editions of the Organisations and ICT course. If you are here, you have voiced your interest in carrying out a small additional task. By completing this task, you will be given 1 extra point in the grade of workshop assignment A5. Remember, only one member per group needs to complete the activity. The whole group will receive the extra points upon completing the additional task.

During the activities, the actions you take in openBest (only in this tool) are monitored and logged, so we can make an informed decision about using the tool in future editions of the course. For the moment, you can find more details in the information letter found at: https://drive.google.com/file/d/1UY0LL2qJKyM2CsUtfmX4jBhohYQflcLS/view

Please note that OpenBest is an early version of a proof of concept. The site has been developed and tested using Google Chrome and Microsoft Edge. If you use another browser and encounter difficulties, please consider using either Chrome or Edge for this exercise. Also please consider disabling any ad-blockers during your visit to openBest. Adblockers have been found to interfere with the functionality of openBest and leaving them active could prove troublesome when viewing elements where images should be shown. Next, please perform the activities on a laptop or similar device. While the openBest has been designed to be responsive we cannot ensure it to function completely on mobile devices for now.

In this document, we provide instructions for the tasks. If at any point you have questions regarding this form or the data collection activities, please contact Sergio España at s.espana@uu.nl or Stefan van der Pijl at s.w.vanderpijl@students.uu.nl

Instructions

Please follow the order of the instructions as outlined below. Exploration is allowed and encouraged, but the general order of tasks should be adhered to. Exploration is best left for after completing the assignments. Also, please consider completing the tasks within openBest in one session. For instance, you will be asked to fill in your best practice. This activity cannot be resumed later and should be performed in one go.

Accessing openBest

1. Go to the openBest website at https://green-repo.web.app/login.html
2. Log in with the Google account that your group provided in the earlier form.
3. You are greeted with a notice outlining the purpose of openBest. This is the same information you have received earlier. Press 'accept' to continue.
4. Check if you are indeed assigned to the correct domain. It should say 'OICT (practicum environment)' in the top left of the screen.
    a. If the domain name is incorrect, please refresh the page and try again.
    b. If the issue persists, please make sure that you are indeed using the **same** Google account that was provided to us.

Creating a best practice

5. Press the button for creating a best practice.

6. Fill in the form with your best practices' information. Feel free to copy paste from your PowerPoint document. Make sure that every piece of text is copied or pasted into the right field
7. For the images, please host them externally. For this you could host the image on https://photos.google.com/ and fill in the link to that image using the image address which can be quite long and is gotten by pressing right click on the image in Google Photos and selecting 'copy image adress'.
    a. The URL should lead to the image being displayed like so: https://bit.ly/3tOc9gH.
    b. The URL should lead directly to the image itself not the page the image is embedded in.
8. Make sure to select your group name as the best practices' author.
9. Save the best practice by pressing the button on the bottom of the form.

Browsing best practices

10. Navigate to the page with an overview of the best practices.
11. Look for your best practice (the one you just created) and see if it is present.
    a. If it is not present, please consider re-entering the best practice. If the problem persists, then reach out to us.
12. When you find your best practice in the overview, open it.
    a. Edit the best practice contents if needed.
        i. Note that editing author information and image sources is currently not possible. If the information for those fields is incorrectly displayed, please consider removing the best practice and resubmitting a better version.
13. When done, return to the best practice overview.

Evaluating best practices

14. Look for a best practice with the title 'Teaming up for transportation' and open it.
    a. You can navigate to it through any means you see fit.
15. Navigate to the comment section of that best practice and write a comment containing the best practices subdimension, your group name (e.g., Group 01), and if the best practice applies to the organization you have investigated during the course.
16. Navigate to the rating section of the 'Teaming up for transportation' best practice and make a rating with an additional line of text with the rationale for that rating. Again, the rationale can be just one or two sentences.

At this point, you have completed all tasks required within openBest. You are invited to explore the tool further, but this is not required for the extra point on A5.

Small Questionnaire

Please fill in the questionnaire found here: https://survey.uu.nl/jfe/form/SV_do0JJjpA4Yu4rHg .In this questionnaire, we ask a few questions where you can reflect on your experience in openBest. This information can serve as an expert opinion in our further validation efforts. Upon completion of the questionnaire, the additional task is completed.

Next steps

We thank you for participating in the journey towards documenting best practices on sustainability topics. The TAs will assign those that followed the steps and fill in the small questionnaire with the extra point for assignment A5.

If you are interested in the research findings, please reach out to us, and we would be happy to share insights and developments.

Appendix O: OICT observed data

Table 72: OICT observed progress data

Participant	Accessing openBest	Creating a best practice	Images linked	Browsing best practices	AMT of BPs made	Evaluating best practices
P1	Successful	Successful	Failed	Successful	1	Successful
P2	Successful	Successful	Failed	Successful	1	Successful
P3	Successful	Successful	Successful	Successful	2	Successful
P4	Successful	Successful	Successful	Successful	2	Successful
P5	Successful	Successful	Successful	Successful	2	Successful
P6	Successful	Successful	Failed	Successful	1	Successful
P7	Successful	Successful	Succeeded partly	Successful	1	Successful
P8	Successful	Successful	Successful	Successful	1	Successful
P9	Successful	Successful	Succeeded partly	Successful	1	Succeeded partly
P10	Successful	Successful	Successful	Successful	1	Successful
P11	Successful	Successful	Successful	Successful	1	Successful
P12	Successful	Successful	Successful	Successful	1	Succeeded partly
P13	Successful	Successful	Succeeded partly	Successful	1	Successful
P14	Successful	Successful	Successful	Successful	1	Successful
P15	Successful	Successful	Successful	Successful	1	Successful
P16	Successful	Successful	Successful	Successful	1	Successful
P17	Successful	Successful	Successful	Successful	1	Successful
P18	Successful	Successful	Successful	Successful	1	Successful
P19	Successful	Successful	Failed	Successful	1	Successful
P20	Successful	Successful	Succeeded partly	Successful	1	Successful
P21	Successful	Succeeded partly	Failed	Failed	1	Did not attempt
Not participating group 1	Did not attempt	Did not attempt	Did not attempt	Did not attempt	0	Did not attempt
Not participating group 2	Did not attempt	Did not attempt	Did not attempt	Did not attempt	0	Did not attempt

Table 73: OICT observed ratings made per participant

GP title / Participant	development of worker safety	promoting security awareness	Teaming up for transportation	Total
P1	0	0	1	**1**
P2	0	0	1	**1**
P3	0	0	1	**1**
P4	0	0	1	**1**
P5	0	0	1	**1**
P6	0	0	1	**1**
P7	0	0	1	**1**
P8	0	1	1	**2**
P10	0	0	1	**1**
P11	0	0	1	**1**
P13	0	0	1	**2**
P14	0	0	1	**1**
P15	0	0	1	**1**
P16	0	0	1	**1**
P17	0	0	1	**1**
P18	0	0	1	**1**
P19	0	0	1	**1**
P20	1	0	1	**2**
Total	**1**	**1**	**18**	**20**

Table 74: Observed comments made per participant

GP title / Participant	improve workstation ergonomics	system to enhance understanding norms and values	Teaming up for transportation	Total
P1	0	0	1	**1**
P2	0	0	1	**1**
P3	0	0	1	**1**
P4	0	0	1	**1**
P5	0	0	1	**1**
P6	0	0	1	**1**
P7	0	0	1	**1**
P8	0	0	1	**1**
P9	0	0	1	**1**
P10	0	0	1	**1**
P11	0	0	1	**1**
P12	0	0	1	**1**
P13	0	0	1	**1**
P14	1	0	1	**2**
P15	0	0	1	**1**
P16	0	0	1	**1**
P17	0	0	1	**1**
P18	0	0	1	**1**
P19	0	0	1	**1**
P20	0	1	1	**2**
Total	**1**	**1**	**20**	**22**

Table 75: Observed comments and rating activities per GP

GP title	Ratings	Comments	
		Top comment	Sub comment
development of worker safety	1	0	0
improve workstation ergonomics	0	1	0
promoting security awareness	1	0	0
system to enhance understanding norms and values	0	1	0
Teaming up for transportion	18	20	0
Total	20	22	0

Appendix P: OICT measured activity logs pivot tables

Table 76: Measured number of actions per participant

Participant	Open page	Open best practice	Close best practice	Create best practice	Make top comment	Make rating	Open by URL	Edit best practice	Remove best practice	Logout	Total
P1	11	9	7	1	1	1	1	1	0	0	**32**
P2	31	16	11	5	1	1	1	2	2	0	**70**
P3	17	7	2	2	1	1	0	0	0	0	**30**
P4	26	7	2	4	1	1	1	0	2	0	**44**
P5	16	9	9	4	1	1	0	0	0	0	**40**
P6	5	3	1	1	1	1	1	0	0	0	**13**
P7	3	9	8	1	1	1	1	0	0	0	**24**
P8	11	5	5	1	1	2	1	1	0	1	**28**
P9	8	2	1	2	1	0	0	0	0	0	**14**
P10	8	2	0	1	1	1	0	1	0	0	**14**
P11	13	4	1	3	1	1	1	0	2	0	**26**
P12	8	3	1	1	1	0	0	0	0	0	**14**
P13	8	4	1	1	1	2	1	0	0	0	**18**
P14	7	7	7	1	2	1	1	2	0	0	**28**
P15	11	14	12	1	1	1	0	2	0	0	**42**
P16	6	4	3	2	1	1	1	0	1	0	**19**
P17	12	8	7	2	1	1	2	0	0	0	**33**
P18	21	11	5	2	1	1	1	2	1	0	**45**
P19	29	6	2	1	1	1	1	0	0	0	**41**
P20	5	3	3	1	2	2	1	1	0	0	**18**
P21	2	0	0	2	0	0	0	0	0	0	**4**
Total	**258**	**133**	**88**	**39**	**22**	**21**	**15**	**12**	**8**	**1**	**597**

Table 77: Measured number of GPs made

Participant	Measured number of GPs made
P1	1
P2	3
P3	2
P4	2
P5	4
P6	1
P7	1
P8	1
P9	2
P10	1
P11	1
P12	1
P13	1
P14	1
P15	1
P16	1
P17	2
P18	1
P19	1
P20	2
P21	1
Total	31

This amount is calculated by subtracting the number of GP removal activities from the GP creation activities per user

Table 78: Measured viewed GPs per participant

Participant GP title	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	Total
active work environment					1		1										1	1	1		**5**
Develop diverse teams	2						1										1				**4**
development of worker safety																			3	1	**4**

Participant GP title	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	Total
digital receipt											1								1		**2**
electric transport in delivery companies													2	1							**3**
employee cybersecurity awareness												1					3				**4**
Employee satisfaction mini-surveys			1				1							1	1						**4**
encourage learning & development										1											**1**
Faster reduction of greenhouse gases in the value chain	1	2	1				1							1							**6**
Four-day workweek			1												2	1					**4**
GRC and the risks of digital security														1	1						**2**
healthy and frequent meals at work															7						**7**
improve workstation ergonomics														2							**2**

Participant GP title	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	Total
increasing visibility of sustainable products																1					**1**
investing in education						2		1													**3**
Making commuting more sustainable			1																		**1**
promoting security awareness								4													**4**
reduce product waste	3	1					1														**5**
Reduce return packages in you e-buisness									1												**1**
reduce stress through time-flexible work policies												1									**1**
reduce travel through online meetings				1			1														**2**
Reducing your carbon footprint				1														1			**2**
sit-stand desk at work							1														**1**
sit-stand worksations in the workplace				1			1														**2**

Participant GP title	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	Total
Sustainable packaging	1		1																		**2**
sustainable supply chain					1										1						**2**
system to enhance understanding norms and values																				1	**1**
Teaming up for transportation	3	3	2	2	1	2	2	1	1	1	2	1	3	2	2	2	3	4	2	2	**41**
technify your plants																		2			**2**
Total	**10**	**6**	**7**	**5**	**3**	**4**	**10**	**6**	**2**	**2**	**3**	**3**	**5**	**8**	**14**	**4**	**8**	**8**	**7**	**4**	**119**

Table 79: Amount of viewed GPs and the amount of viewed distinct GPs per participant

Participant	Number viewed GPs	Number of distinct viewed GPs
P1	10	5
P2	6	3
P3	7	6
P4	5	4
P5	3	3
P6	4	2
P7	10	9
P8	6	3
P9	2	2
P10	2	2
P11	3	2
P12	3	3
P13	5	2
P14	8	6
P15	14	6
P16	4	3
P17	8	4
P18	8	4

P19	7	4
P20	4	3
P21	0	0
average	5.7	3.6
total	119	76

Table 80: Measured views per GP

GP title	Total view count	Unique viewers
active work environment	5	5
Develop diverse teams	4	3
development of worker safety	4	2
digital receipt	2	2
electric transport in delivery companies	3	2
employee cybersecurity awareness	4	2
employee engagement	0	0
Employee satisfaction mini-surveys	4	1
encourage learning & developmentâ€‹	1	1
Faster reduction of greenhouse gases in the value chain	6	1
Four-day workweek	4	1
GRC and the risks of digital security	2	1
healthy and frequent meals at work	7	1
improve workstation ergonomics	2	1
increasing visibility of sustainable products	1	1
investing in education	3	1
Making commuting more sustainable	1	1
promoting security awareness	4	1
reduce product waste	5	1
Reduce return packages in you e-buisness	1	1
reduce stress through time-flexible work policies	1	1
reduce travel through online meetings	2	1
Reducing your carbon footprint	2	1
sit-stand desk at work	1	1
sit-stand worksations in the workplace	2	1
Sustainable packaging	2	1
sustainable supply chain	2	1
system to enhance understanding norms and values	1	1
Teaming up for transportation	41	1
technify your plants	2	1
Average	3.97	1.3
Total	119	39

Table 81: Measured ratings made per participant

GP title / Participant	development of worker safety	promoting security awareness	Teaming up for transportation	Total
P1	0	0	1	**1**
P2	0	0	1	**1**
P3	0	0	1	**1**
P4	0	0	1	**1**
P5	0	0	1	**1**
P6	0	0	1	**1**
P7	0	0	1	**1**
P8	0	1	1	**2**
P10	0	0	1	**1**
P11	0	0	1	**1**
P13	0	0	2	**2**
P14	0	0	1	**1**
P15	0	0	1	**1**
P16	0	0	1	**1**
P17	0	0	1	**1**
P18	0	0	1	**1**
P19	0	0	1	**1**
P20	1	0	1	**2**
Total	**1**	**1**	**19**	**21**

Table 82: Measured comments made per participant

GP title / Participant	improve workstation ergonomics	system to enhance understanding norms and values	Teaming up for transportation	Total
P1	0	0	1	**1**
P2	0	0	1	**1**
P3	0	0	1	**1**
P4	0	0	1	**1**
P5	0	0	1	**1**
P6	0	0	1	**1**
P7	0	0	1	**1**
P8	0	0	1	**1**
P9	0	0	1	**1**
P10	0	0	1	**1**
P11	0	0	1	**1**
P12	0	0	1	**1**
P13	0	0	1	**1**
P14	1	0	1	**2**
P15	0	0	1	**1**
P16	0	0	1	**1**
P17	0	0	1	**1**
P18	0	0	1	**1**
P19	0	0	1	**1**
P20	0	1	1	**2**
Total	**1**	**1**	**20**	**22**

Table 83: Measured comments and rating activites per GP

GP title	make rating	make top comment	remove comment
development of worker safety	1	0	0
Faster reduction of greenhouse gases in the value chain	0	1	1
improve workstation ergonomics	0	1	0
promoting security awareness	1	0	0
system to enhance understanding norms and values	0	1	0
Teaming up for transportation	19	20	0
Total	21	23	1

Appendix Q: OICT expert feedback

Raw expert feedback

Table 84: Feedback from the OICT students

Participant	What did you like about OpenBest? (Tops)	What could be improved in OpenBest? (Tips)	Number of best practices viewed	Do you have any further comments?
P1	Ease of use and speed. Oversight of all the different best practices. Automatic creation of the best practice card, no hassle with layout.	Feedback on best practice card submission, atleast a popup. I don't think there was one. Text box on the best practice filling thing is very small, you can increase it but maybe automatically make it big. In the practices hub, the "Text" is small and I would even say has no purpose being there. You won't read it anyway unless you click on it.	4	Maybe emphasize capitalization when filling the form. It is required but there is no explanation when filling it in. Might be useful.
P2	Editing the best practice card. Navigating to the best practice cards was easy.	The form for the best practice card should be more clear. Using quotation marks was not possible. Linking the images from the host was more difficult than stated in the instructions. Creating a comment on someones else best practice card was not clear. I first replied to someones elses comment, because I could not find the textbox to make my own.	3	
P3	I like the dashboard page. Looks nice. Also it was very clear which fields I needed to fill in.	Many things - The Create BP button should get an other color I think because now you don't really see it. It doesn't say click me. And if it was green that was more clear. - The Google Foto's uploading thing is annoying. Should be easier. - The table with the practices also isn't very nice. It doesn't look nice. And it is hard to find where you need to click to open one. It's a little bit messy. - If you open a card is quite alright. But the comment writing isn't very user experience designed as well. I really had to search where I could write a comment.	3	No
P4	Nice layout easy to use and not to complex.	the conditions in the custom search builder were unclear.3	4	no

Participant	What did you like about OpenBest? (Tops)	What could be improved in OpenBest? (Tips)	Number of best practices viewed	Do you have any further comments?
P5	There is a clear overview, and it is easy to see other people's best practices. Stylish website.	There is little to no feedback. We did something wrong when we wanted to store our best practices and could not submit the best practice. We did not know what went wrong however. Another problem we came across was that the information we filled in was not saved. We went back to the homepage and then everything we filled in was gone. We were also unable to change a submission we did to test what went wrong.	Around 5.	We think OpenBest could be a good application to use in the future, but right now it misses some functionalities and does not work properly.
P6	The UI is very nice and easily understandable, it was easy to get our data into openBest and upload the best practice. The viewing of other best practices was easy and pain free.	The uploading of images is a little finnicky with needing direct links to these images that need to be gathered from google photos. The way of being able to select a part of the best practice to comment on that is present in feedbackfruits would be a great addition to openBest.	3	Not at this time.
P7	- Very clean design, we also really like how the best practice cards look - Interaction with the site feels natural - No excessive functions that distract from the main focus on the website - Nice that there is a search function to look for a specific best practice card or topic - Also the option to filter on specific metrics like date can be quite useful we think	- When adding a best practice card â†’ make the input box for 'Text' a bit larger because now you can only see 2 lines at a time - Also another option we would like to see is some sort of 'preview' function before subtmitting a best practice card - Very minor thing but add a favicon for the website so you can more easily distinguish between tabs - It would be great if there was, just like in Feedbackfruits, to comment on a specific part of a best practice card - Images on the best practice cards are quite large, maybe make them smaller and clickable to enlarge?	3	
P8	I liked the fact that the layout could not get messed up, as the information was filled in a form and not a Powerpoint.	I did not like the fact that I could only see the end product after submitting and that I could not see the main written text well. Uploading the photos to Google was also a hassle.	3	No

Participant	What did you like about OpenBest? (Tops)	What could be improved in OpenBest? (Tips)	Number of best practices viewed	Do you have any further comments?
P9	I think OpenBest has a pretty nice interface that is clear and attractive. Furthermore, it's quite easy to learn and use.	I think the texts bar sizes should be increased vertically in order to give a clearer overview of what a user is typing. right now it can be hard to read a whole paragagraf and remember what it said 3 sentences back.	3	
P10	I liked the fact that it was easy to fill in the text.	It was annoying to upload the images to Google Photos first.	2	No
P11	It is easy to fill out all the information. I found that in powerpoint it was a struggle sometimes to get all the information implemented in the right way, but with OpenBest I did not encounter these difficulties.	The implementation of the figures is not very easy. I had to look online for ways to host the figures and this took a couple of tries. This also resulted in me having to delete the whole best practice a couple of times instead of just being able to edit the link.	3	I think OpenBest is easier for filling in all the information but the best practice card looks better in powerpoint.
P12	It was easy to add text and it makes the outline for you	adding images	3 cards	no i dont have any further comments
P13	It really make the creation process of the best practice way easy. It was way faster than the powerpoint used in the main part of the exersize.	When I submitted the rating, I had the reaload the page, reselect the best practise and move back to the rating i posted. This is a bit difficult. I recommend the ratings effect should be seen directly.	2, the ones I was supposted to vieuw for this exersize.	Overall, seems very handy for making the best practises. The revieuw aspect could use some inprovement.

Participant	What did you like about OpenBest? (Tops)	What could be improved in OpenBest? (Tips)	Number of best practices viewed	Do you have any further comments?
P14	openBest is very well designed and pleasant to look at. Almost always I automatically navigated to the destination I intended to go to. Also, the way a Best practice card is shown is well organized.	In the best practices overview it wasn't obvious that the different columns could be toggled. It does say "Toggle column", but since the words below don't appear clickable this was not intuitive. Furthermore, the "Custom Search Builder" seemed a bit out of place. There is no explanation given to how it can be used, so it must be expected that the user is already familiar. To me it was not, perhaps it could be hidden under an "advanced settings" dropdown. Lastly (and most importantly), in the overview, the frontpage pictures are not visible. These were the way to peak the interest of readers and get them to study the whole card. In this overview I can see the titles, but because there are so many listed none jump out. This would be different if I could see the frontpage (+ title).	+/- 4	
P15	Ease of use, the best practice card had a nice layout	It would be nice to see the card which you created yourself in your account more easily, instead of having to go to section where all the cards are listed and having to search for it	5	
P16	Browsing through practices is very fun. Being able to sort them helps to find the practice I'm looking for. Being able to add comments and ratings is very good, this way you can better judge the practice.	Of some buttons it is not visible that they are active. Editing a best practice was also very confusing, at first it wasn't clear to me that I was in editing mode. It would also be nice if while editing a practice I could change the links of the images that I entered, now I had to redo entering the practice.	3	I think this is a very interesting tool/concept and I think that if I worked in an organization, I would want to explore this tool.
P17	The database of the other best practices. It is easy to search for specific best practices. The site is not complicated and looks clean.	There is a bug with submitting the best practice. The button did not react for some time. I would have liked a personal library for every best practice i have submitted. The layout of the published best practice is rather ugly compared to the best practice template PowerPoint.	3	The site needs some improving but it has promise as a usable program.

Participant	What did you like about OpenBest? (Tops)	What could be improved in OpenBest? (Tips)	Number of best practices viewed	Do you have any further comments?
P18	The way the input data from the best practice card was formatted and presented. Also the button that minizes the sidebar. The functionality of the Custom Search Builder is extensive and works really well, and i like colour coordination within it.	The image link could not be changed after the fact, but that was already mentioned in the instructions. While the SQL like search function looks great and functions very well, it feels a little out of place. There are too many conditions and refinements available for such a small data set, which can feel a bit overwhelming. Also, the search bar should be on the left side or more centered and widened since i feel like that would be the most intuitive way to search for a specific best practice card, and the Custom Search Builder could appear when a button called "Advanced" or "Tools" is pressed. Maybe the white text or the light background colour could be changed for readability purposes. I do like the custom search builder and i can imagine it being used to group best practice cards from specific categories or those that contain specific keywords.	3	The design looks great!
P19	It was easy to use.	When I copy pasted the main text a little box appeared (probably a texture it couldn't load) in front of well-being. I couldn't send the bp without deleting it. No clue what the box was originally.	2	
P20	Good looking, easy to use interface.	Being able to change to images after you have created the Best Practice.	2	

Expert feedback per question

Here the feedback is structured following the elements present in openBest and the groups of tasks present in the empirical test's instructions.

What did you like about openBest? (tops)

Category	Feedback
General usability	In general, the expert opinion of the participant advocates that openBest is easy to use (P1; P4; P9; P15; P19) with a clear interface (P20), making interactions feel natural and quick (P1; P7). This makes it so that participants were automatically navigated to their destination on the site (P14). The participants report that openBest is not too complicated (P4; P17), with few excessive functions (P7) and an easily understandable UI (P6). This made openBest easy to use and, according to some participants, easy to learn (P9).
General Layout	The participants report that openBest is stylish (P4) with a nice layout (P4), a clean layout (P7; P17), and UI (P6). This made openBest attractive (P9; P20) and pleasant to look at (P3). Most groups made this claim in general, but some groups said this about specific elements such as the dashboard page (P3) and the minimizing of the sidebar (menu) (P18).
Creating a good practice	The participants report that it is clear which fields are to be filled in (P3), making it easy to fill in the text (P10) and other data (P6) while not having to tend to any layout or outline (P12). As said before, the participants had to make a good practice during the OICT course. This good practice was formatted as a PowerPoint slide. Therefore, some participants compared the creation of such a slide and the creation of a good practice in openBest in their feedback. On that note, the participants reported that in openBest, it was easier to create a good practice than in PowerPoint. The main reason was that the layout in openBest was already determined (P8; P11). This eliminated the need to style the GP (P1). Next, creating a good practice in openBest was faster than creating one in PowerPoint (P13). About the layout of the good practice cards, the participants said that they like the look of the cards (P7) and that the formatting and presentation are nice (P18).
Browsing good practices	Participants remarked that browsing is easy (P2; P5) and very fun (P16). The page provides a clear overview of the GPs (P2) and is well-received (P17). Regarding the search mechanisms implemented on the GP overview page, participants like that there is a search function to look for a specific GP card or topic (P7). The custom search builder, which allows filtering based on individual columns, is useful (P7), extensive, nicely styled, and well-functioning (P18). Next, the participants say that sorting the good practices is also useful (P16). Overall, the participants report that searching for specific good practices in openBest is easy (P17).
Viewing a good practice	Regarding viewing good practices, the participants said it was easy and painless (P6). The good practice card is reportedly well organized (P14) and designed with a nice layout (P15).
Editing a good practice	Editing the good-practice card is well-received (P2).
Community-based feedback	Community-based feedback features are well received because they allow better judgment of practices (P16).

What could be improved in openBest? (tips)

Category	Feedback
General usability	The participants advocate an improvement in the affordance of openBest. For example, they would like more feedback from openBest, such as confirming that a good practice card is submitted (P1) and indicating the cause of the problem when an error occurs (P5). The groups would like to see elements like the form for the good practice card entry be clearer using this feedback by informing on input constraints (P2). Another aspect of the affordance named by the participants is that the buttons are not always recognizable as buttons, and it is unclear if the buttons are active (P16).
General Layout	There were some concerns about readability. Two groups stated that some elements of openBest were difficult to read. First, the white text on light background colors should be changed (P18), and second, elements from the good-practice cards themselves were hard to read (P8).
Creating a good practice	There were two main points of criticism regarding the creation of good practices. The first relates to the input text boxes for creating multiline texts. The participants noted that the text box was too small (P1). They suggested making the box a bit larger to make more lines visible at a time (P7; P9. The second point of critique was that external image hosting was cumbersome. The groups said that it was more difficult than expected (P2; P11), annoying (P3; P10), 'finicky' (P5), and overall, it was not well-received (P12). In addition to these two main critiques, there were some more minor critiques regarding various aspects of the feature. A group found that the button for creating a good practice was little recognizable because it did not have the 'click me' esthetic (P3). This is in line with the above-named potential improvement points. Additionally, some groups noted that they missed a preview function (P7; P8). In their view, such a function could alleviate the inconvenience of having to alter the GP after creation.

What could be improved in openBest? (tips)

Category	Feedback
Browsing good practices	Regarding the good practice overview page, some comments contained concrete improvement points. Regarding the table of good practices, the groups remarked that it does not look very nice and that it is hard to find where to click to open a given good practice (P3). In addition, the table is perceived to be a little messy (P3). Another group states that the column 'text' that contains the first 100 words of the main GP text is too small. Furthermore, they state that the column 'text' has no purpose in being present because 'the content is irrelevant and only read when you open the GP' (P1). Another group notes that it may be beneficial to add the front-page images of the GPs to the table view. This, according to them, could spark the interest of the readers. This suggestion is made because currently, no GP from the list jumps out (P14). Regarding the search functions above the table, the groups note that the conditions in the custom search builder are unclear (P4) and seem a bit out of place (P14; P18). Another group attested that the custom search builder was overwhelming (P18). In contrast, the same groups say that the feature has promise and could be useful if placed under an 'advanced settings' button with appropriate explanations (P14; P18). Regarding the simple search bar that applies filters to all columns, a group noted that it should be widened and placed on the left side above the table as 'this would be the most intuitive way to search for a specific good practice card' (P18). Regarding the toggling of the columns feature present above the table, a group said it was not evident that columns could be toggled (P14). The group called this feature unintuitive (P14). This again is in line with the potential for affordance improvements previously identified. Regarding the filtering possibilities, the groups said they missed a way to retrieve their own good practice (P15; P17). One group suggests a view that contains a personal library containing all the good practices created by the group (P17).
Viewing a good practice	Regarding the layout, a group stated that the GP, as shown in openBest, is rather ugly than the PowerPoint card they created (P17). Another group suggests that the images on the GP cards are a bit big; they suggest making them smaller and clickable to enlarge (P7).
Editing a good practice	Regarding editing functionality, groups said that it was confusing initially because it was unclear if editing mode was enabled or not (P16). Groups also stated that they did not have the ability to edit the link to the images. Due to this, they had to remove and resubmit a GP if the image link was incorrect (P11; P16; P18; P20).
Community-based feedback	Regarding comment functionality, groups stated that it was unclear how to make their own top comment (P2). This made it so that some groups had to search where they could make their comments (P2; P3). Consequently, they note that the feature is not very user experience-centered (P3). Other groups saw room for improvement by adding categorization for comments. This categorization could then be based on the element of the GP to which a comment is related. For this, they suggest that we imitate the approach of Feedbackfruits (P6; P7). Regarding the rating feature, a group suggests that it is better to have the rating that is being made immediately represented in the average ratings. Currently, reloading the page is required for this, but this is received as cumbersome (P13).

What could be improved in openBest? (tips)	
Category	**Feedback**
Reliability	In general, there was also some feedback on the reliability of openBest. Many of these pertain to the submission of good practices. One group had the problem that the information they filled in was not saved (P5). Furthermore, they could not change faulty submissions made using false information (P5). Another group stated that the submit button did not react for some time (P17). Next, a group could not submit the GP with their copy-pasted information (P19).
Miscellaneous	The final suggestion was to add a favicon to the website to make it more distinguishable from the other tabs of the website (P7).

How many good practices have you viewed?
Regarding how many good practices were viewed, most of the groups reported having viewed three good practices. About an equal number of groups (4 to 5) reported having viewed less than three good practices and more than three good practices, respectively. On average, students reported having viewed ~ 3 good practices. This distribution is illustrated in Figure 73.

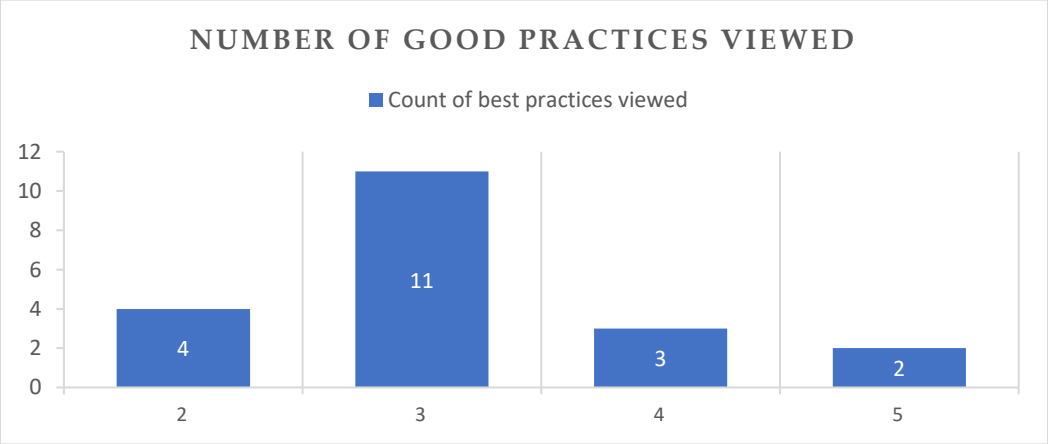


Figure 73: Distribution of the reported number of good practices viewed

Do you have any further comments?

Category	Feedback
Overall	The general feeling of the participants who responded to the topic is that openBest could be a good and useful application to create and manage good practices in the future (P5; P13; P17).
Room for improvement	Participants also note that openBest could be improved by adding some functionalities and strengthening the application to always work properly (P5; P13; P17). An example of such an improvement is that there should be more feedback throughout the application. For instance, capitalization should be emphasized when filling in the good-practice form because it is the norm. openBest currently lacks an explanation for such aspects (P1).
Creating interest	One participant even says that he would be interested in the tool and that if he worked in an organization, he would be interested in exploring openBest (P16).
Comparison to GP cards in PowerPoint	A participant noted that filling in a good practice is easier in openBest than creating the PowerPoint slide but that the layout of the PowerPoint slide is better (P11). Another group just notes that the design of openBest looks great (P18).

Appendix R: OICT elicited improvement points

By examining the expert feedback, we have found the following improvement points:

Table 85: Expert opinion improvement points

Category	Improvement points

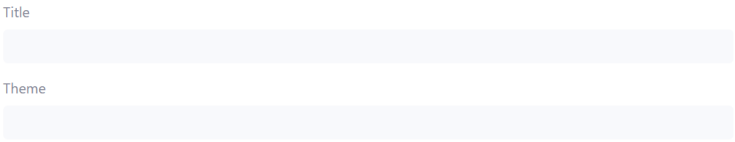
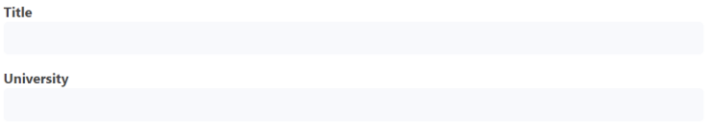
Overall	• Implementing more feedback
	  ○ When performing actions.
	  ○ When errors occur.
	• Making elements more recognizable
	  ○ Toggling buttons.

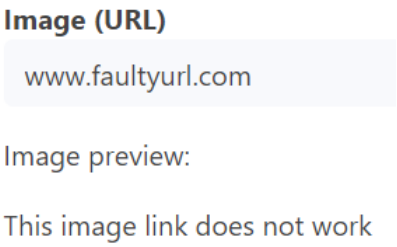
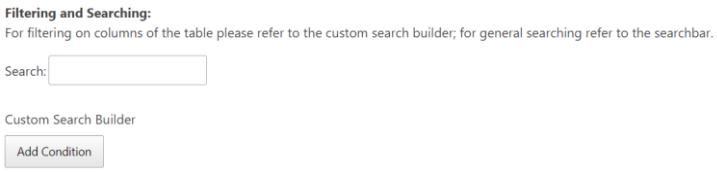
General layout	• Making the elements more readable by adapting text size and color to create more contrast.
Creating a good practice	• Consider hosting images in openBest to reduce the participants' effort in hosting the images themselves. • Enlarge the default size of text areas. • Enforce the click me aesthetic of the create bp button. • Provide a preview functionality for the contents of the GP so that it becomes more what you see is what you get.
Browsing good practices	• Redesigning the table contents to include the front image to make individual GPs jump out. • Redesigning the table contents to include only elements that will be read (e.g., long texts will not be read according to P1). • Situating the general search bar on the left-hand side and expanding the length. • Placing the custom search builder behind an 'advanced' searching button. • Providing some additional explanation on the searching mechanisms. • Making the toggling of columns more recognizable. • Enabling filtering on authors to easily find one's own good practices.
Viewing a good practice	• Reducing the size of the images.
Editing a good practice	• Allowing more elements, like the images, to be edited. • Providing feedback on whether editing mode is enabled.
Community-based feedback	• Improving the user-friendliness of the commenting feature. • Implementing categorization for the comments. • Immediately represent ratings in the average ratings without having to reload the page.
Reliability	• Applying input filters where applicable to prevent faulty submissions
Miscellaneous	• Adding a favicon to openBest.

Appendix S: OICT implemented improvement points

In our venture to provide an ever-better version of openBest, the following improvement points elicited from expert feedback have been implemented. We were unable to implement all the improvement points elicited due to limited resources. As a result, a selection was made on the perceived complexity of the implementation and the potential gain.

Table 86: Implemented improvement points

Category	Improvement point	Implementation
Overall	• Implementing more feedback	We addressed this by implementing more feedback throughout openBest. This has been done using textual explanations in addition to elements and more feedback when performing actions. For example, there is now feedback if an image link provided is faulty.
	• Making elements more recognizable	We addressed this by making some elements more recognizable. For instance, the main critique was that toggleable buttons, such as edit GP, did not show whether it was enabled. This has been addressed by color-coding active buttons.  *Figure 75: Not activated button*  *Figure 74: Activated button*
General layout	• Making the elements more readable by adapting text size and color to create more contrast.	We addressed this by making the text a bit darker. This made the text contrast more with the background. In situations where this was not an option, for example, the menu bar with white text, we made the text bold and slightly larger. This seemed to have improved the readability. This has been confirmed by the browser's built-in contrast checker, which reported a strong enough contrast between elements on the page. In areas where making the text darker did not suffice, the text was made bold. An example of this is found in the create bp form.  *Figure 76: Earlier form layout*  *Figure 77: Current form layout*
Creating a good practice	• Enlarge the default size of text areas.	We addressed this by setting the default size from 2 lines to 5 text lines.

Category	Improvement point	Implementation
	• Provide a preview functionality for the contents of the GP so that the form's content mirrors the end product.	We addressed this by implementing a preview of the images. This is because the images were reportedly the most significant challenge before. Now the user can see if the image turns out right in real time and before finalizing the creation of the bp.  *Figure 78: Create GP, Image preview functionality when an image is found*  *Figure 79: Create GP, Image preview functionality when an image is not found.*
Browsing good practices	• Situating the general search bar on the left side and expanding the length. • Placing the custom search builder behind an 'advanced' searching button. • Providing an additional explanation on the search mechanisms.	We addressed these improvement points by restructuring the tools above the GP table. The general search bar is now presented as the default search functionality and is placed on the left-hand side above the custom search builder. Because of this, the custom search builder is the second searching mechanism in line, indicating that it is a more advanced searching mechanism. Above the two features, and accompanying text is placed explaining which mechanism should be used in what situation.  *Figure 80: Good-practice browsing tool setup*
	• Making the toggling of columns more recognizable.	Toggling columns has been emphasized with proper cursor gestures applied. This should make the toggling buttons more recognizable.  *Figure 81: Good practice table toggling buttons*

Category	Improvement point	Implementation
Viewing a good practice	• Reducing the size of the images.	The image width has been reduced by 20%, and the image height has retained the auto-set height.
Editing a good practice	• Allowing more elements, like the images, to be edited.	We addressed this improvement point by making it possible to edit the image URL when editing a bp.  Topimage URL: https://upload.wikimedia.org/wikipedia/commons/thumb/4/4e/Hedgehog_germany0908.j *Figure 82: Edit GP editing an image (Image extracted from Wikipedia[12])*
Reliability	• Applying input filters where applicable to prevent faulty submissions	We addressed this by, where possible, applying masks on the input fields. This should be expanded in later versions, but for now it seems, considering some limitations like excluding quotation marks, that openBest is much more reliable.
Miscellaneous	• Adding a favicon to openBest.	We addressed this by implementing a favicon based on the current openBest logo. *Figure 83: Unofficial minimal openBest logo*

[12] https://commons.wikimedia.org/wiki/File:Hedgehog_germany0908.jpg (Creative Commons Attribution-Share Alike 3.0 Unported license)