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Discussing Ethical Impacts in Research and Innovation:

The Ethics Canvas

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Abstract. Technologies are increasingly intertwined with people's daily lives. Consequently, there is an increasing need to consider the ethical impacts that research and innovation (R&I) processes, both in commercial and non-commercial contexts, bring about. However, current methods that offer tools for practicing ethics in R&I inadequately allow for non-ethicists such as engineers and computer scientists to practise ethics in a way that fits the character of their work. As a response, we propose a tool for identifying ethical impacts of R&I that is inspired by a method for the generation of business models, the Business Model Canvas. This tool, the Ethics Canvas, enables researchers to engage with the ethical impacts of their R&I activities in a collaborative manner by discussing different building blocks that together constitute a comprehensive ethical interpretation of a technology. To assess the perceived usefulness of the Ethics Canvas, a classroom experiment was conducted, followed-up by a questionnaire. The results suggest that the Ethics Canvas (1) is perceived as useful for identifying relevant stakeholders and potential ethical impacts and (2) potentially triggers reconsiderations of technology designs or business models.

Keywords: Ethics Canvas · Applied ethics · Responsible research and innovation · Practising ethics

1 Introduction

Due to the increasing pervasiveness of technologies in people's everyday lives (e.g. social media, artificial intelligence, genomics, communication and transportation technologies), it becomes increasingly important to reflect on the ethical impacts of research and innovation (R&I) processes and their outcomes. In academic R&I

settings, ethical considerations are typically mediated by professional codes of conduct and more or less bureaucratic “ethics clearance” procedures. In commercial R&I settings, ethical considerations are far less systemised and are often predominantly taken into account through legal requirements (e.g. in the general data protection regulation). Both in and outside academia R&I, practices show considerable shortcomings because they are usually reactive, not suitable for anticipating potential ethical impacts and not in accordance with the notion of ethics as a reflective activity. Consequently, there is a need for developing new methods and tools to guide the practice of ethics in R&I processes, which has led to a burgeoning literature on practising ethics in R&I.

This paper proposes a novel tool for discussing ethical impacts in the process of R&I. We conceptualise the R&I process as consisting of four distinct stages: (1) the formation of (scientific) knowledge and concepts that can be operationalized for technological applications, (2) the translation of this knowledge into a technology design, (3) the prototyping and testing of this design and (4) the introduction of the R&I outcomes into society [1]. Each of these stages of the R&I process can bring about distinct ethical impacts. However, existing methods that offer tools for practicing ethics in R&I do not adequately facilitate the discussion of these impacts amongst R&I practitioners¹. Below, we identify an important shortcoming in existing methods for practicing ethics in R&I. In order to improve the way ethics is currently dealt with in R&I processes we then propose a novel tool that enables R&I practitioners to engage with the ethical impacts of their R&I activities.

To achieve this, we searched for an extensively adopted tool that facilitates accessible and clear processes of discussion and reflection amongst non-experts. Consequently, we transformed a business-modelling tool that is widely used in business development practices, the Business Model Canvas (BMC) [2], into the “Ethics Canvas”. The Ethics Canvas is a collaborative brainstorming tool that has two distinct aims: (1) to have R&I practitioners come up with and discuss possible ethical impacts of the technologies they develop, and (2) to have R&I practitioners consider pivots in their technology design or business model to avoid or mitigate the negative ethical impacts. The overall aim of this tool is to foster ethically informed technology design by improving the engagement of R&I practitioners with the ethical impacts of their R&I activities. We assessed the perceived usefulness of the Ethics Canvas by putting it into practice in a classroom situation of business & IT students who were developing novel technological applications. A follow-up questionnaire that the students filled in provided some initial suggestions with regards to the usefulness of the Ethics Canvas for practising ethics in R&I.²

In what follows, we first shortly discuss existing methods that offer tools for practicing ethics in R&I and discuss an important shortcoming of these methods. Second, we discuss methods used to create business models that can offer tools for overcome this shortcoming. Third, we propose the design of the Ethics Canvas that is inspired by the Business Model Canvas approach in business modelling research.

¹ With “practicing ethics” we refer to any way of doing ethics R&I processes in the broadest sense.

² This study has been approved by the Trinity College Dublin Research Ethics Committee

Fourth, we explore the merits of the Ethics Canvas in a practical setting by evaluating the outcomes of a questionnaire that students filled in after having engaged in the Ethics Canvas exercise that related to a technological application they were working on.

2 Challenges for Practicing Ethics in R&I

In recent years, there has been a strong increase in discussions about responsible R&I [3], responsible technology design [4] and responsible approaches to instructional technology research [5]. This tendency is due to growing concerns about ethical impacts that technological innovations can have on our society, intensifying public debate and mounting concerns about unsustainable technological developments (pollution, climate change, etc.). Policy makers reinforce the move towards responsible R&I, for instance by incorporating ethics assessment practices in funding mechanisms, as is the case in the framework programmes of the European Union [3]. According to Stilgoe et al. [6], literature on responsible research and innovation generally focuses on four dimensions of the assessment of R&I practices: (1) the anticipation of future societal impacts of technology design, (2) reflection on the values that are implied in technology design, (3) inclusion of stakeholders in the design process and (4) responsiveness of technology design to societal changes. Ethical impacts of technologies form an important consideration in this context of responsible research and innovation, since all of these four dimensions consider aspects of human-technology interactions or relations that have a strong normative significance.

Resonating with at least the first three dimensions of responsible R&I, methods for practising ethics in R&I are (1) dealing with uncertainty of technological change, such as anticipatory technology ethics [7], (2) enabling, organising and ensuring ethical technology design, such as ethical impact assessment [8] (3) identifying, analysing and resolving ethical impacts, such as the ethical matrix [9] and (4) enabling, organising and ensuring appropriate stakeholder participation, such as value sensitive design [10, 11]. Not each method for practising ethics falls neatly into one of these categories of use, but these categories nonetheless provide a useful overview of the core aspects of practising ethics in R&I that should be taken into account. In this paper, we will restrict our investigations predominantly to the aspect of enabling, organising and ensuring technology design.

One critical shortcoming of current methods is that they insufficiently manage to offer tools to integrate ethics in the day-to-day work of R&I practitioners [11]. Many of the methods for practising ethics in R&I offer tools that are targeted at ethicists and that presuppose special ethics expertise, which causes difficulties for R&I practitioners in adopting those tools in their everyday activities. As a result, for instance, an R&I practitioner cannot simply engage in value sensitive design by following the proposed steps in the respective literature. Similarly, an ethical impact assessment needs the involvement of people that manage the assessment process and offers little grounds for R&I practitioners to assess their day-to-day work.

Yet, the engagement of R&I practitioners in practising ethics is crucial for achieving ethical technology design. In the overall process of practising ethics, Brey [12] distinguishes a disclosure level, at which ethical impacts are explored and identified, a theoretical level, at which theoretical frameworks are developed and employed to evaluate these impacts and the application level, at which moral deliberation takes place as the basis for overcoming the negative ethical impacts in the R&I process. According to Brey, the disclosure level is aimed at revealing, or rather identifying the potential ethical impacts of a technological application. He accentuates the role of R&I practitioners in dealing with ethics in R&I at this level, arguing that they play a vital role in disclosing ethical issues of emerging technologies and in making sure that technology design choices are informed by considerations of these ethical issues [12]. Brey argues that researchers, designers and innovators are important actors at the disclosure level, because they have an understanding of the technology that many ethicists and policy-makers lack. Hence, we have good reasons to look for a novel tool that overcomes the shortcomings of tools offered by existing methods and facilitates engagement of R&I practitioners with ethics in their day-to-day work³.

Resulting from the foregoing considerations, we propose two requirements that such a tool should satisfy. First, it should be accessible to non-ethicists, or people without a substantial background in ethics. This argument is reinforced by the Council for Big Data, Ethics and Society, which argues that ethics engagement should happen in “hybrid spaces” in which people with different roles in the R&I process collaborate [14]. Second, it should enable people with different roles and backgrounds to work together in identifying ethical impacts. The different interpretations people have of potential ethical impacts of technologies can be brought to the table by means of a collaborative process in which multiple people involved in an R&I process express their expectations of potential ethical impacts in the form of narratives (i.e. for this group of stakeholders, such-and-such feature of our technology can have such-and-such ethical implications). As we will see later, this requirement fits with theories in Science and Technology Studies (STS) that explain how our understanding of technologies results from an interaction between different interpretations of technologies for different people [15].

In line with these two requirements, we have to make sure that the threshold for using our tool should be low and that it should be possible to use it without thorough background knowledge of ethical theories or conceptual discussions of values. Additionally, the tool should facilitate an open-ended process of interpretation in a collaborative fashion to identify potential ethical impacts of an R&I process and its outcomes. At the moment, methods in the fields of applied ethics and ethics of technology offer no tools that adequately fulfil these two requirements. For this reason, we decided to look at fields that are unrelated to academic ethics, but that do focus on creating low-entry tools for collaborative processes of discussion and

³ For our current purposes and the scope of this paper it is not feasible to propose a full-fledged method. However, the Ethics Canvas tool fits with a newly developed method that introduces a narrative approach in ethics of technology [13].

interpretation; focusing on a specific use case. This brought us to the field of business development, and notably the field of business model development.

3 Turn to the Business Model Canvas

In the field of business model development, some discussions of responsible research and innovation have already emerged. For instance, Henriksen et al. discuss business models that promote sustainable ways of production, or “green business model innovation” [16]. In a similar vein, Bocken et al. explain how a re-definition of the notion of “value” in business models can help rendering businesses more sustainable, for instance by focusing on the entire supply-chain [17]. However, these approaches primarily focus on the design of the business case (in terms of resources, customers, etc.) and not on technologies that are developed in R&I processes. To change this focus, we will investigate how we can transform existing business model development approaches to align them with our aim of constructing a tool for disclosing the ethical impacts in R&I processes in which technologies play a crucial role.

Before we do so, however, we have to address the question of to what extent tools in business model development methods incorporate the two requirements we introduced in the previous section: (1) engaging non-ethicists with the disclosure of ethical impacts and (2) facilitating this as a collaborative process of interpretation. We can observe how business models are defined in the literature. As pointed out by Zott et al. [18], a business model can be understood as an “architecture”, a “heuristic logic”, a “concise representation” and also a collection of “stories”, aimed at describing and explaining how a particular enterprise functions or operates. A spectrum of business models can be identified, with on the one hand business models that are meant to offer a strict representation of both internal and external processes of an existing corporation, and on the other hand models that use stories to give an account of these processes – possibly of businesses that do not already exist (i.e. a model for a start-up). The latter type of business modelling approaches is particularly interesting for our purposes, since it appears to focus on an understanding of business processes in terms of narratives that are constructed through social interaction.

Lucassen et al. [19] use two indicators that capture the two aspects of the abovementioned spectrum (between models that are strictly representational and those that are the result of people’s interpretations) to review and compare different visual business modelling approaches. They use the notion of “capturing” to indicate to what extent a business modelling method accurately represents a business process, and the notion of “communicating” to indicate to what extent a business-modelling tool is accessible and generates understandable outcomes. They argue that the so-called Business Model Canvas (BMC) is most successful with regards to the indicator of “communicating”, compared to two other established models⁴ “because it effectively

⁴The two traditional business model approaches that the business model canvas was compared with are the “software ecosystem model” approach and the “board of innovation” approach [19].

models explicit information of both tangible and intangible aspects of a business and communicates this information in a highly accessible manner to parties unfamiliar with the modelling technique” [19]. As Kujala argues, the BMC can be classified as a “narrative business model” [20], because it enables “participant narratives” [21]. The BMC provides a visual-linguistic tool (see figure 1) that can be used in a collaborative process in which participants generate ideas by offering and discussing certain narratives that are related to the thematic boxes displayed on the canvas.

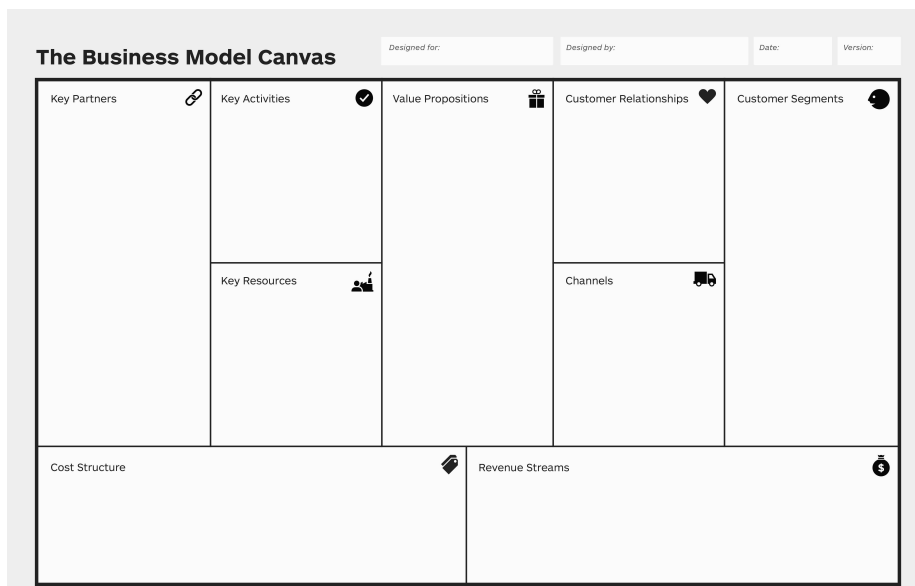


Fig. 1: The BMC [2].

Thus, we argue that of the existing business modelling approaches, the BMC fulfils the two requirements we formulated. First, as Lucassen et al. [19] argue, it is highly accessible and understandable to people without specific knowledge of the field. If the structure of the BMC can be incorporated in a tool for disclosing ethical issues, it would be an answer to Brey’s [12] concern regarding the disclosure level for it allows researchers to engage with ethical reflection in an accessible manner without them having to have thorough knowledge of the field of applied ethics. Second, since the BMC relies on the collaborative generation of participant narratives, it seems to satisfy the second demand to a large extent. It enables participants to engage in a collaborative process of interpreting and discussing business processes. Considering the foregoing arguments, turning towards the BMC to find a novel tool for disclosing ethical impacts in R&I processes is justified. However, we need to transform the BMC, which is clearly focused on discussing business processes and has little to do with ethics, into a tool that can be used in the context of practicing ethics in R&I.

4 Designing the Ethics Canvas

To explain the process of designing the Ethics Canvas, we first briefly describe the BMC and discuss its aims and the way in which it is used in a collaborative setting. The BMC was developed by business theorists Osterwalder and Pigneur [2] as a visual-textual plane that is divided up into nine “building blocks” through which a business model can be described in a holistic manner. It is argued that a business model can be defined as a model that “describes the rationale of how an organisation creates, delivers, and captures value” [2], and that this definition can be captured by participants discussing all the “building blocks” of a business model. By engaging in a collaborative discussion about the different building blocks of a business model, such as ‘key partners’, ‘channels’ and ‘revenue streams’, participants working with the BMC are able to arrive at a comprehensive understanding of the way in which their organisation is supposed to create, deliver and capture value.

In its original form, the BMC is printed on paper and used as the core instrument for a collaborative workshop. In addition to the canvas, Osterwalder and Pigneur provide for a handbook that provides guidance for the workshop participants in understanding the meaning of the different building blocks and presents use-cases of the canvas as well as techniques for designing better business models. The printed canvas is used as the focal point of a collaborative workshop, with participants discussing and writing down ideas for each of the building blocks. Next to the original BMC, online applications have been developed that offer digital versions⁵ of the canvas, through which teams of different sizes can create multiple business models and save them on their accounts. The BMC has experienced widespread adoption in the business modelling of start-ups. Its ease of use in capturing and communication a business model lends itself well to the identification and resolution of uncertainties typically facing teams developing a start business model. Blank [22] describes how BMC is widely used in the teaching of start-up business modelling to research and innovation across universities in the United States. In this capacity, the BMC is used as an easily updated ‘scorecard’ for documenting the development of pivots in a business model when following Blank’s own iterative, evidence-driven Customer Development methodology [23] combined with Reis’ agile approach to start-up development [24]. Osterwalder et al. [25] have elaborated how the value proposition and customer segments elements of the BMC can be further categorised in the detailed modelling and testing of product market fit. These developments indicate that the form of the BMC has proven adaptable both to integration into independently developed methodologies as well as for methodological elaboration in critical areas.

Taking the business model canvas as a starting point, we aimed to transform it in a way that would enable its users to discuss how a technology might bring about ethical impacts for different stakeholders instead of discussing a business model. To achieve this, we considered different building blocks that could amount to a holistic ethical analysis of a certain technological application. The building blocks were constructed in a two-way process: by considering literature in Science, Technology

⁵ See for instance <https://strategyzer.com/> and <https://canvanizer.com/new/business-model-canvas>

and Society studies (STS) and philosophy of technology, and simultaneously engaging in a trial-and-error exercise of using the Ethics Canvas to improve its user-friendliness. Each building block consists of a central term and a number of core questions that can guide the discussion concerning a term.

We consulted literature that provides accounts of different aspects of impacts of technologies on individuals, groups and society as a whole. We need to stress that this consultation was mostly aimed at pragmatically gathering different vantage points to consider ethical impacts of technology, and not at providing a coherent theoretical framework underpinning the Ethics Canvas. The STS literature offers useful accounts of the ways in which technologies are embedded in relationships between different “relevant social groups” [15], which can be types of individuals (e.g. producers, technology users, women, elderly) or institutional, collective actors (e.g. government, companies, labour unions). Akrich [26] discusses the Actor-Network Theory (ANT) approach and shows how technologies can have impacts on actors that are not directly connected to its design, production or use such as non-users but also non-humans (understood as e.g. the impact of a mobile phone on a supply chain for raw materials). She argues that technologies can politicise social and material relations, which can for instance be made explicit by considering how non-users of social media applications can become marginalised.

In order to subsequently understand how technologies impact relevant individuals or groups, we turn to writings in philosophy and technology. Ihde [27] and Verbeek [28] show how individuals can change their behaviour or relationships by engaging with technologies. For instance, Verbeek shows how the ultrasound technology has transformed the relationship between parents and their unborn child [28], and how technologies, such as traffic lights and speed bumps, mediate the behaviour of car drivers [28]. These scholars accentuate that “ethical impacts” are not simply consequences of technological change, but should be understood as impactful relations between human beings and technologies. Feenberg [29] goes beyond this focus on the technological mediation at the level of the individual, by arguing how technologies can impact relations between people and collectives, for instance between workers and their companies, between governments and labour unions. In line with this, he shows how technologies can impact the public sphere, in which “everyday communicative interactions” take place [29], in which ideologies are formed and social struggles arise. To consider ethical impacts that are more directly related to the material aspect of technologies, we consulted scholars discussing “constructive technology assessment”. These show that technology assessment should take impacts of technologies on the environment and production processes into account [30]. Finally, to provide a bridging step in the move from description (i.e. what are the ethical impacts?) to prescription (i.e. what should be done?), we turn once more to value sensitive design and included the notion of technical choices driven by value considerations [10] as the logical end-point of the Ethics Canvas. However, we broadened up the choices to be considered, asking participations to think beyond the technical by also considering organisational changes or changes in policies.

Although we did not provide a full-fledged and exhaustive review of literature dealing with the impacts of technologies on humans, groups, and society as a whole, our discussion does give us an adequate picture of what the building blocks of the Ethics Canvas could look like. To summarise, we can infer the following characterisations of technology impacts from the literature:

- Ethical impacts occur as relations between technologies and different types of actors, which can be types of individuals and types of collectives, or groups.
- Technologies can mediate the behaviour of individuals, but also the relations that people have with one-another.
- Technologies can mediate the worldviews of social groups and can bring about social conflicts between social groups.
- A technology impacts the material network in which it is designed, produced and used, including for instance the supply chain it constitutes and the natural resources it needs.

While taking the abovementioned characterisations of technology impacts as a guideline, we entered into a trial-and-error design process of the Ethics Canvas. This design process was aimed at making sure that the rationale of the Ethics Canvas design would not only be grounded in the relevant literature, but that it would also be user-friendly and intuitive. Based on the literature, we designed nine different versions of the Ethics Canvas, all with different building blocks and layouts. These designs were iterated through a series analysis exercises conducted by the Ethics Canvas design team, which consisted of the authors of this paper and other researchers who collectively possessed expertise in applied ethics, personalisation in digital applications, knowledge engineering, software engineering and innovation methodologies. In addition, versions of the Ethics Canvas were trialled in teaching and training settings with over 260 undergraduate and postgraduate students in computer science, engineering, business studies and working on groups on pre-assigned digital application designs. This provided a further source of design insight into improving the usability of the Ethics Canvas design. The criteria for success we used during these meetings were that participants (1) should be able to complete the entire canvas within a reasonable amount of time (a maximum of 1,5 hours) and (2) should be able to address each building block without having to consult any external source.

As a result of this trial-and-error exercise, some important changes were made concerning the wordings of each box, because some terms use in the consulted literature (e.g. actor, human-technology-world relations, ideology) were not intuitive for the users and needed to be translated into concepts that are more easily usable (e.g. group, behaviour, worldview). The table below (table 1) provides an overview of the conceptual framework of the Ethics Canvas, displaying sources in the academic literature and the corresponding approaches that each building block is based on and explicating what changes in terminology were applied to ensure the usability of the Ethics Canvas.

Table 1: Overview of (1) the central questions of the Ethics Canvas, (2) authors consulted to address these, (3) the approaches used by these authors, (4) the changes in wordings applied during the trial-and-error sessions and (5) the final boxes for the Ethics Canvas.











Central question	Literature consulted	Approach	Change in wording	Boxes
Who are affected?	Pinch and Bijker [15], Akrich [26]	Actor Network Theory	Relevant social group / actor / actant =>	1) Individuals affected
			individual / group	2) Groups affected
How are stakeholders affected?	Ihde [27], Verbeek [28]	Postphenomenology	“Human-technology-world” relation =>	3) Behaviour
			behaviour / relations	4) Relations
	Feenberg [29]	Critical Theory of Technology	Ideology =>	5) Worldviews
			worldviews Struggles => social conflicts	6) Social Conflicts
	Schot and Rip [30]	Constructive Technology Assessment	Risks of products and processes =>	7) Product or service failure
			product or service failure Environmental aspects => Problematic use of resources	8) Problematic use of resources
What can be done?	Friedman, Kahn, and Borning [10]	Value Sensitive Design	Technical choices driven by value-considerations => What can we do?	9) What can we do?

Eventually, the design process brought us to the current design of the Ethics Canvas (figure 2). The Ethics Canvas is organised according to nine thematic blocks that are grouped together according to four different stages of completing the canvas. The first stage (blocks 1 and 2) challenges the participants to consider which types of individuals and groups might be relevant stakeholders when considering a specific technology. The second stage (blocks 3 to 6) asks the participants to consider potential ethical impacts, considering the different stakeholders that were identified. The third stage (blocks 7 and 8) asks the participants to consider potential ethical impacts that are not stakeholder specific, pertaining to product or service failure or any problematic use of resources. The fourth stage (block 9) challenges participants to think beyond the potential ethical impacts they discussed and discuss some initial ideas for overcoming these ethical impacts. To complete the Ethics Canvas exercise in a physical space, participants can write down their ideas on a printed Ethics Canvas,

and consult the Ethics Canvas Manual [31] that provides guidance on how to conduct the exercise. An online version of the Ethics Canvas⁶ has also been developed. On this platform, people can collaborate to complete a particular Ethics Canvas online while being in different physical places.

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Ethics Canvas		Project Title:	Date:
Individuals affected Who use your product or service? Who are affected by its use? What is their gender, age, occupation, etc.?	Behaviour How might people's behaviour change because of your product or service? Their habits, time-schedules, choice of activities, etc.?	What can we do? What are the most important ethical impacts you discussed? How can you address these by changing your design, organisation, or by proposing policy changes?	Worldviews How might people's worldviews be affected by your product or service? Their ideas about consumption, religion, work, etc.?
 1	 3 Relations How might relations between people and groups change because of your product or service? Between friends, family members, co-workers, etc.?	 4	 5 Group Conflicts How might your product or service create or affect group conflicts? Could it discriminate people, put them out of work, etc.?
Product or Service Failure What are potential negative impact of your product or service if it fails to operate or to be used as intended? What happens with technical errors, security failures, etc.?	 7	Problematic Use of Resources What are potential negative impacts of the consumption of resources relating to your product or service? What happens with its use of energy, personal data, etc.?	 8
 2	 1	 4	 5

The Ethics Canvas is adapted from Alex Osterwalder's Business Model Canvas. The Business Model Canvas is designed by Business Model Foundry AG. This work is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license. To view a copy of this license, visit <https://creativecommons.org/licenses/by-sa/3.0/>. To view the original Business Model Canvas, visit <https://strategyzer.com/canvas/>.

Fig. 2: The Ethics Canvas, version 1.9.

5 Assessing the Usefulness of the Ethics Canvas

The BMC is a widely used tool for business model development and has been positively assessed [19]. We wanted to similarly assess the Ethics Canvas and its usefulness as a tool that supports practising ethics in R&I settings. Comparing the Ethics Canvas with other tools for practising ethics in R&I is not possible due to lack of similar tools that are used in day-to-day activities of R&I practitioners. Therefore, we assessed the Ethics Canvas through evaluating its perceived usefulness amongst its users and its anticipated effects related to follow-up activities.

We organised an Ethics Canvas pilot with students who were required to create a new ICT application as part of their coursework. The students attended a one-hour lecture at which the content of the Ethics Canvas Manual was presented. After this, the students were given the assignment to complete the Ethics Canvas in groups, using the online version for their particular R&I project in approximately one hour.

⁶ <https://ethicscanvas.org/index.html>

Students were free to meet up in a physical space or to hold a conference call for completing the exercise. A total of 109 students participated in the Ethics Canvas exercise, organised into groups, each comprising of 3 or 4 students. After the groups had completed their Ethics Canvasses, all participating students were asked to fill in a questionnaire that asked them about their perception of the usefulness of the Ethics Canvas to practise ethics in their respective R&I projects. Filling in the questionnaire was voluntary. The feedback questionnaire was filled in by 31 students, which represented 28% of the total number of students who worked on the Ethics Canvas exercise.

The questionnaire followed a 5-point Likert scale, with a 1-point assessment indicating strong disagreement and a 5-points assessment indicating strong agreement. Statements were formulated in the affirmative mode and as negations to be able to assess whether participants paid attention to the statements. The participants were asked about (1) the perceived usefulness of the Ethics Canvas (e.g. did the Ethics Canvas add to the overall understanding of ethical considerations?) and (2) the anticipated effect of the Ethics Canvas (e.g. did the exercise influence the business model and or technology design?). In what follows, these two aspects are discussed based on reflections on the questionnaire results.

The perceived usefulness of the Ethics Canvas was evaluated extensively in the questionnaire. Generally, 56% of the participants agreed and 28% strongly agreed that the exercise improved their understanding of the potential ethical impacts of their R&I projects. Participants were asked whether the Ethics Canvas exercise widened their understanding of different individuals or groups affected by their project, to which 44% of the participants replied that they agreed and 29% that they strongly agreed. On being asked whether the exercise helped them create a broad overview of potential ethical impacts of their project, 42% of the participants stated to agree and 35% to strongly agree. To further the scope of the assessment, the participants were asked whether the ethical impacts they discussed in the task sufficiently fitted the structure of the Ethics Canvas. 40% of the participants agreed that it sufficiently fitted and 21% strongly agreed. To assess the value of the Ethics Canvas in stimulating productive discussions, participants were asked whether they considered any ethical impacts that were not known to them or unclear beforehand. Only 21% of the participants disagreed or disagreed strongly with this question, indicating that the majority of the participants discussed ethical impacts that were new to them. This suggests that the Ethics Canvas can be a useful tool to guide participants into discussing ethical impacts that group members didn't know or didn't clearly think about beforehand.

The second theme of the survey focused on the assessing the anticipated effect the Ethics Canvas has the business model and technology design of the ICT application that the students are working on. First the participants were asked whether the exercise would have any impact on their project's technology design, resulting in 32% of the participants agreeing and 16% strongly agreeing. A similar question was asked in relation to the impact of the canvas on the business model. 52% of the participants agreed that the Ethics Canvas led them to reconsider their business models and 5% strongly agreed. Finally, the participants were asked whether the

exercise was useful in promoting the group's ethical behaviour. 35% of the participants agreed that the exercise promoted ethical behaviour and 40% even strongly agreed. Even though these outcomes do not directly indicate that follow-up actions have been taken or will be taken, they at least indicate an intention amongst the students to use the outcomes of the Ethics Canvas exercise to adjust their business models or technology designs.

Overall, the results suggest that it is reasonable to state that the Ethics Canvas is perceived as a useful tool to guide participants in discussing a broad range of ethical impacts as well as the identification of relevant stakeholders. Moreover, the results indicate that it is reasonable to assume that the Ethics Canvas can lead to the intention of participants to reconsider their business models or technology designs. Nevertheless, results also indicate that the structure of the Ethics Canvas will need to be improved to be more inclusive of potential ethical impacts. Moreover, our study is limited due to the limited participation rate (28% of all the students who worked on the Ethics Canvas exercise). This might possibly have led to biased results, because the cohort of students that voluntarily filled in the questionnaire could have coincided with the cohort of students that was most positively engaged during the Ethics Canvas exercise. Hence, even though these initial results positively suggest that the Ethics Canvas is a useful tool for practising ethics in R&I, further development of the Ethics Canvas and additional ways of assessing its usefulness will be needed for future studies.

6 Conclusion

In this paper, we presented a novel tool for the discussion of ethical impacts in R&I settings. The Ethics Canvas responds to shortcomings in the current methods that offer tools for practicing ethics in R&I, concerning the lack of ways in which R&I practitioners can engage in practicing ethics in their day-to-day work. We argued for two requirements for constructing a suitable tool for addressing the disclosure stage: that it should be accessible and clear to R&I practitioners and that it should facilitate a collaborative process in which people can discuss different interpretations of impacts of technologies. Since no existing tool in the field of ethics of technology seemed to address this need in an adequate way, we turned to the field of business model development instead. In this field, we assessed the BMC as a suitable tool because it is highly accessible to different types of people, and structures a collaborative effort to discuss issues surrounding a central goal. We designed the Ethics Canvas by redirecting the focus of the canvas format from business modelling to a comprehensive identification of ethical issues of an R&I process. Utilising established theories in philosophy of technology and STS that are aimed at understanding ways in which technologies can impact the behaviour and relations of individuals and collectives, and engaging in a trial-and-error design process, we formulated different building blocks of the Ethics Canvas. Finally, we put the Ethics Canvas to the test in a classroom setting, which resulted in initial positive results, which suggest that the Ethics Canvas is perceived as a useful tool for discussing relevant stakeholders and

potential ethical impacts in R&I projects and for triggering anticipations of pivots in business models or technology designs. However, more studies will need to be done to further develop the Ethics Canvas and assess its usefulness in multiple ways.

Finally, we should reflect on two limitations of the Ethics Canvas that could prompt future research. First, even though the exercise can provide R&I teams with a much better overview and understanding of ethical impacts of their R&I activities it does not yet provide a way to evaluate these impacts. That is, it does not provide a way to evaluate whether a certain ethical impact is to be considered positive or negative or whether it is to be considered severe or non-severe. Additional tools will thus have to be developed to enable this, which will probably have to draw strongly from theories in normative ethics (i.e. consequentialism, deontology, virtue ethics) that offer the best intellectual resources for shaping evaluation practices. Second, the Ethics Canvas draws from conceptual work in academic literature, but does not yet offer a way to translate engagement with the Canvas in practice to revisit its conceptual roots. Potentially, multiple Ethics Canvas exercises could for instance be used as empirical input for revisiting and refining the actor network theory. Future work could therefore focus on the translation of concrete and numerous outcomes of Ethics Canvas exercises into changes in the conceptual framework that guide our thinking about R&I activities.

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