The Challenge of Organised Irresponsibility:

Dominant Responsibility Frameworks and The Dark Sides of Innovation

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Table of Contents

1. Introduction

As a process, science has been proven effective for straightforward forms of inquiry, but is increasingly being questioned as the dominant framework for addressing complex and dynamic challenges our civilization faces today and will continue to face in the future (Sarewitz, 2016). For example, through its outputs of research and innovation, science is considered a strong driving force of progress in society, but this progress is often achieved through the measurement and framings of economic growth and competition (Schot & Steinmeuller, 2018; Bozeman, 2020). However, the processes and aims of the economic framing are being increasingly questioned on if they are compatible with those of sustainable development and transitions, and are ultimately able to deliver on the needs of societies at large (Ehrenfeld, 2005; Schot & Steinmeuller, 2018; Bozeman, 2020).

One challenge in particular, is that the pursuit of economic growth is generating unknown or externalised consequences, which are distributed unevenly in the world. These negative effects of science, technology, research, and innovation have been examined in innovation literature (Giuliani, 2018), as well as in the academic literature of other disciplines for decades. For example, the famous German sociologist Ulrich Beck described 'manufactured risks' which were not caused only by a failure of progress but was also created by its very success (Beck, 2000):

> "First, there is the process of modernization, which is about progress. It is targeted at innovation and the production and distribution of *goods*. Second, there is the process of the production and the distribution of *bads*. Both processes unfold and push in opposite directions. Yet, they are interlocked. This interlinkage is not produced through the failure of the process of modernization or through crises but through its very success. The more successful it is, the more *bads* are produced" (Beck, 2015:78, italics my own).

These negative effects are thus products which are not only unintended consequences as often argued but are in fact *manufactured* side effects (Van Loon, 2002:23), where the very same system which has failed to manage negative effects is called upon to solve problems created by these effects, thereby producing even more *bads* and perpetuating a system (Beck, 2015).

In effect, I argue that this is in fact what underpins science as an 'endless frontier'. The endless frontier is in fact not a linear arrow as is typically described (Bozeman, 2020), extending forever in one direction on the eternal search for knowledge; but is rather an endless spiral in which each iteration builds higher upon existing knowledge but is simultaneously creating its

own new questions and challenges to solve in subsequent rings through the exercise of its very existence and pursuit.

This is evident in the need to solve the 'grand challenges' humanity faces, whereby resources are being poured into science and innovation, while neglecting the potential new problems that the pursuit of such solutions will generate (Ehrenfeld, 2005; de Saille, 2015). For example, the United Nations Sustainable Development Goals, which see research and innovation as a key part of development through Goal 9, which aims for "encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending" (UN, n.d.). Thus, even with noble aims, innovating for sustainability within the current system will continue to produce negative side effects, which like previous innovations, may be pushed to alternate spatial (e,g, geographic) and temporal arenas (e.g. future generations) (de Saille, 2015).

I argue that these negative manufactured side effects of modernisation are in fact, 'dark sides' of progress, science, and innovation, and they are perpetuated in the current system of manufacturing risks, due to what Ulrich Beck refers to as 'organised irresponsibility' (Beck, 2000; Stilgoe, Owen, and Macnaughten, 2013) meaning that while there are certainly those who are 'responsible' in the sense that they are involved in creating the problems, the system of ambiguous responsibility designation ensures that no one is specifically held accountable (Giddens, 1999). In recognition of this perpetuating challenge, there have been recent call for a new relationship or 'contract' between science and society: one in which science is responsive to society's needs and ensures the taking of responsibility for its negative effects and internalises rather than externalises them, and allowing for no one to be held accountable (Owen, Macnaughten & Stilgoe, 2012; de Saille, 2015; Biggi & Giuliani, 2020).

For this conceptual paper, I examine this call for a new relationship with the aim of providing insight into the exploratory research question: *How do dominant responsibility frameworks address the dark sides of innovation?* To answer this, I first illuminate some of the deeper elements involved in the concepts which underpin the 'dark sides" of innovation. I then explore three contemporary and dominant frameworks being used to designate responsibility: Corporate Social Responsibility, Public Values Science, and Responsible Research and Innovation. I then discuss how each of these frameworks designate responsibility to different elements of society and yet they are interlinked and overlapping. I conclude by questioning whether these frameworks really upend the system of organised responsibility or further solidify it.

2. Key concepts

In the previous section I introduce the notion of negative sides or dark side effects of innovation. However, this notion has several key concepts which underpin it that should not be taken for granted. This is because these concepts have different meanings and definitions in different academic disciplines. In this Section, I thus aim to explicate my understanding of the key concepts and demonstrate how they are relevant and indeed underpin the dark sides of innovation.

2.1. Hazard

In her presentation for the *Dark Sides of Innovation* course at the University of Oslo (Course code: TIK9022 in September 2020), Dr. Elisa Giuliani from the University of Pisa, Italy began with the question: *what is a harmful innovation?* She noted three central conditions for an innovation or technology: hazardous in use, hazardous in production, and hazardous due to wider (direct and indirect) societal effects. She then asked the questions: *how is a hazard defined, by whom, and why?* Dr. Giuliani answered this by noting that a hazard is often based on experience, including when it is defined based on scientific findings. She stated that it is ultimately determined by regulators, and is the result of addressing the (often conflicting) interests from NGOs, civil society, citizens/consumers, as well as industry and other organisations.

The concept of a hazard is thus argued to be related to the defining of the dark sides of innovation. This is because *how* a hazard is defined determines if an innovation has negative consequences (a dark side) or not, but that in contrast to this seemingly objective designation, that *who* and *why* indicated that there are in fact very subjective aspects. This becomes more clear when explicating the questions further: Who is defining a hazard (and by extension, if an innovation will have negative effects)? Which groups are involved in the entirety of the process, and with which levels of influence? Through which processes is this carried out, and does the process present an equal forum for all parties to discuss both empirical and non-empirical evidence and concerns? Ultimately, what is the motivation for a certain threshold or definition of hazardous as the selected one over other options, or where are the acceptable levels of hazards and no longer acceptable? In effect, what future is pushed forward as desirable based on this decision, and in doing so, whose values are preserved and whose are left behind in this designation?

Underneath its surface, a hazard is not as straightforward as it seems; and I argue that these lofty questions require perhaps a different understanding, in particular of the underlying elements involved. So while hazard may be used to designate a scientific or objective measurement or standard of safety, as Dr. Giuliani demonstrated in her presentation and in thinking about the aforementioned questions: a hazardous standard's measurements are in fact rarely based on scientific consensus in early stages, and are instead determined through experience and knowledge acquired over time. Furthermore, the thresholds for such standards can change over time- and this is not just due to increasing scientific knowledge, but in fact is also due to changes in social and political climates.

2.2. Risk

Given this, I would argue that the concept of a hazard may not necessarily be the best concept with which understand innovation and its harmful side effects; instead the concept of risk is. I argue that that this is due to the inherent uncertainties involved in the innovation process (Jalonen, 2012), which hazards cannot necessarily accurately or meaningfully capture since they are based on experience acquired over time. An example of this is the Fukushima Daiichi nuclear reactor meltdown that occurred in Japan in 2011. This occurred due to an earthquake which triggered a tsunami, and ultimately caused the subsequent radiation disaster that ensued (Walker, 2015). At the time, the government officials argued that these events were 'unimaginable' and they surpassed any scientific ability to have anticipated. There was thus "no merit in reflecting on it" (Walker, 2015:300).

As a hazard, perhaps yes, this statement could be correct. However, in terms of risk and uncertainty, perhaps not. Risk involves anticipating events of the future, where different uncertain futures and possibilities can be pursued through the calculation or reduction of these uncertainties and translation of them into information needed for decision making. Traditionally, a risk is a calculation based on probability of occurrence and impacts on effected values, and in this way, risk is not objective but is subjective and is furthermore related to socio-political and economic values: it is *social* (Garland, 2003; Arnoldi, 2009).

It can be argued that the concept of risk is often used as a mechanism to determine hazard and to mitigate impact. In this way risk has two sides: an objective view determined by more objective measurements, as well as a subjective view, which sets the delineations for those 'objective' measurements. These are not necessarily at odds but rather they are connected:

"What is deemed risky depends not only on objective risks but *also* on values" (Arnoldi, 2009:10). It is therefore a useful concept to unpack the dark sides of innovation because it presents a nuanced picture. I would argue that an even more nuanced understanding of risk is even more useful though, one which can also capture the insidious and perpetual elements of the dark sides: that of *manufactured risk.*

> "Manufactured risk is risk created by the very progression of human development, especially by the progression of science and technology. Manufactured risk refers to new risk environments for which history provides us with very little previous experience. We often don't really know what the risks are, let alone how to calculate them accurately in terms of probability tables. Manufactured risk is expanding in most dimensions of human life. It is associated with a side of science and technology which the early theorists of industrial society by and large did not foresee. Science and technology create as many uncertainties as they dispel- and these uncertainties cannot be 'solved' in any simple way by yet further scientific advance" (Giddens, 1999:4).

Hazard, which is built on experience, does little to help us in this circumstance. In addition, risk may be a more useful concept to assess innovation because it can more explicitly capture the changes in social and political climates as changes to risk appetites and socially acceptable levels of risk (Arnoldi, 2009); as well as the tensions between risk and reward, or positive risk and negative risk (Giddens, 1999). In this way, I assert that *risk* and more specifically *manufactured risk* underpins the concept of dark sides of innovation and helps us to understand it in a more comprehensive and subjective way than that of hazards.

A final important note is that of control, which is a concept which underpins risk (see Bernstein, 1998; Arnoldi, 2009), however due to constraints on the essay length I cannot dive into this aspect significantly. I will however briefly discuss one particular theory related to control. Collingridge's 'dilemma of control' is relevant to manufactured risks because it helps to explain one aspect of why they might occur (Genus & Stirling, 2018). Collingridge's dilemma articulates the challenge whereby early on in technological development, when change is easy and inexpensive, it is difficult to predict the future impacts which would warrant the change. Later in the process, when impacts become evident, it is too late: the technology has reached a lock-in in which it is too expensive or difficult to change direction (Genus & Stirling, 2018). In this way, even with the use of forecasting, or other objective measuring tools for risk, impacts on social values will still occur and create societal challenge, for which it may not be a simple matter of creating a new technology or innovation to fix.

2.3. Value

This touches on an important and subjective aspect in understanding an innovation's dark sides, namely that of a non-empirical element: that there are certain values underpinning decisions regarding innovation. When assessing what is of value, to whom, and to what degree, one frames the object of risk, such as which objects are at risk and from what, and then what subsequent actions should be taken (Beck, 2009a; Beck, 2009b; Arnoldi, 2009). Just as risk is subjective, values are also inherently subjective, as well as dynamic, insofar as they can change depending on context and are often generated from deeper moral and ethical philosophies of the culture.

In other words, risk and value go hand in hand, because value frames risk: for something to be at risk, it must be of value (Arnoldi, 2009). While this may sound straightforward, the challenge here lies in two elements of an interconnecting nature: values can conflict, and values can be plural. Given that values can conflict, this means that there are inevitable tensions and trade-offs involved in decision making, which may go unknown, undiscussed, or unrepresented. Furthermore, people themselves can hold multiple different types of value for different things, or plural values. For example, an economic or monetary value of an object is fundamentally different than an ethical or personal value for the same object, both of which can be held by the same person at the same time. Furthermore, values can be personally based or more widely based, such as for an entire group or society, or even universally (Borglund, De Geer, and Sweet, 2017).

When it comes to decision making, it is a challenge for how to weigh these different values against each other when making decisions, as acknowledging plural values has very practical challenges in our current regulatory and institutional contexts. For emerging technologies, where past experience is often lacking and even when one can draw from it, does not equate to certainty (Arnoldi, 2009), it is the subjective aspects of values that are instead pursued as a means of basis for decision making.

I thus argue that the dark sides of innovation are underpinned by the need assess risk to reduce negative effects on values. These are both subjective processes however, and are contextually dependent. There is however, one key aspect underpinning this notion that remains: when this is carried out, who will be held responsible for the dark sides of innovation and the noxious impacts and consequences? This leads to the final fundamental aspect of these side effects that I discuss in this essay: that of responsibility.

2.4. Responsibility

"The definition of responsibility depends on its context and is determined, defined and understood in relation to society at large" (Borglund, De Geer, and Sweet, 2017:60). Responsibility differs for different innovations in different cultural and regulatory contexts-despite global and interlinked impacts (Genus & Stirling, 2018). Furthermore, definitions are temporally contextual: what can be considered responsible or irresponsible is affected by societal norms, ideas, and changes over time.

When broken down, responsibility is contextual via four key elements. First, responsibility must be for or in regard to something (henceforth referred to as object) (Grunwald, 2019a). Second, there must an actor involved, who is furthermore capable, or has an ability to act or make decisions to affect the object (Gianni, 2019). Third, there needs to be rules or criteria for which to measure or hold accountability against (Grunwald, 2019a), as well as an actor with which to be the holder of the accountability (Genus & Stirling, 2018). In this way, "responsibility needs to be supported by, and embedded in, a social framework where institutions promote common objectives and make them possible" (Gianni, 2019:23). Finally, there needs to be knowledge about the risk, or the "impacts and consequences of the action or decision under consideration" (Grunwald, 2019a:37).

This may appear straightforward as the pre-conditions, but it is made challenging by causality. There are causal arguments which underpin responsibility, by cause and by effects. First, because of the pre-condition that there needs to be an actor involved, who "assumes or is made responsible" (Grunwald, 2019a:37), it must be determined *who* is the *cause*. This can be challenging especially in complex landscapes of numerous actors and influences. Second, the impacts or consequences of a decision, or the effect being *caused*. This effect can be challenging to determine because of the interconnectedness of societies and environments, through both a spatial (e.g. geographical) sense, as well as a temporal (e.g. future generations) sense.

Recent scholarship continues to examine alternative views of responsibility (see Reber, 2019). For example, in these understandings of responsibility, simpler definitions of responsibility are expanded on to include more complex and reflexive ones, which are more morally and philosophically demanding, such as by the pre-condition of freedom (Gianni, 2019). I cannot dive deeper into these discussions do to constraints of this essay, but I do aim to add meaningfully to the practical elements of responsibility, by assessing some of the dominant responsibility frameworks and gaining insight into their role in providing responsibility.

3. Case study

There are dozens of theories and perspectives across a variety of disciplines which aim to allocate responsibility for science, research, technologies, and/or innovations. Throughout history, numerous frameworks have been developed, and inlude; ethics, responsible innovation, public engagement or participation, corporate citizenship, citizen science, and ELSA (Ethics, Legal, and Social Aspects). For this essay, I have selected three contemporary frameworks based on their relevance to the course; Corporate Social Responsibility (CSR), which addresses responsibility through the corporation as the key actor; Public Values Science (PVS), which addresses responsibility through the governance of science and innovation policy; and Responsible Research and Innovation (RRI), which addresses responsibility primarily through the individual scientist, researcher, or innovator. In this Section, I explain the aim and function, and highlight some of the benefits and challenges of each of these three frameworks.

3.1. Corporate Social Responsibility

It is well acknowledged that business has a significant role in the production of negative impacts, which have traditionally been externalised to the company (Giuliani, 2018). An increasingly popular way to counter this is through Corporate Social Responsibility (CSR). CSR focuses on the responsibilities of firms, and in particular, it demonstrates a shift from the traditional role in the responsibilities of companies, which was traditionally solely to their shareholders. In recent decades however, this has shifted to include responsibilities to environment and society (Borglund, De Geer, and Sweet, 2017; Haski-Leventhal, 2018). CSR functions as a responsibility framework "because it sets a direction for business to behave in the interest of our global society and all stakeholders" (Haski-Leventhal, 2018:22). CSR can be especially interesting in contexts like emerging technologies, where regulations are often far behind technological developments (Stilgoe, Owen, and Macnaughten, 2013), or in the globalised business landscape, where regulations differ for different locations of operations.

"As our world, economy, and society rapidly change, CSR can offer a way for business to be responsible and ethical" (Haski-Leventhal, 2018:7) such as through dialogue with their stakeholders as well as shareholders. However, it is important to keep in mind the fact that for the vast majority of situations, companies "choose their responsibilities" (Borglund, De Geer, and Sweet, 2017:49) because the specific responsibilities are not dictated by an authority but rather defined by the company based on the desire to keep its social 'license to operate.'

CSR can thus function through a variety of different mechanisms. For example, there are internal mechanisms, such as codes of conduct or requirements that a company may set for its subsidiaries or supply chain. There are also external mechanisms, for example, in the event that a government policy dictates certain requirements for an industry. There are also formalised mechanisms, such as the International Organization for Standardization which carries out assessments of organisational activities according to their standards. Finally, there are also informal mechanisms such as through self-reporting (CSR/sustainability reporting), which can optionally be done in accordance with certain frameworks like the Global Reporting Initiative.

In addition to these numerous mechanisms for demonstrating that a firm is taking responsibility, firms also face challenges to the taking of responsibility itself. These include the profit-orientation of company culture and leadership (Haski-Leventhal, 2018), the normalisation of corporate wrong-doing (Giuliani, 2018), and the use of CSR only as a communication tool, which often results in the omissions of disclosures of negative impacts in an effort for firms to protect themselves and their brands (Haski-Leventhal, 2018).

Furthermore, in recent years, the term CSR is also becoming increasingly mixed with notions of corporate sustainability or sustainable business. This is primarily rooted in the idea that firms which take greater responsibility will also demonstrate greater sustainability (Haski-Leventhal, 2018). One challenge with this is the conflation of intentions to impacts. For example, even when a company has good intentions and is, for example, trying to create a socially beneficial innovation, this does not mean that the company is holistically taking responsibility or becoming sustainable, rather than simply working to be less harmful or less unsustainable (Ehrenfeld, 2005). Tidd & Bessant (2020) articulate these difference 'levels' for a sustainable business in Figure 1 below:
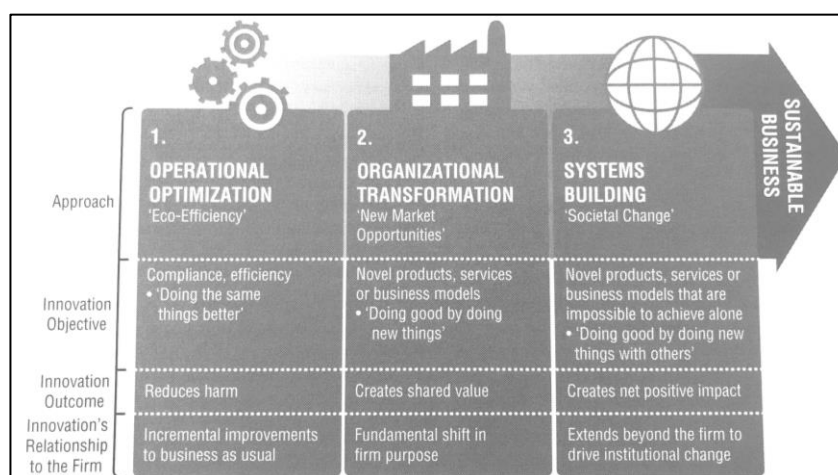

Figure 1: Stages of a Sustainable Business (Source: Tidd and Bessant, 2020)

In Level 1, 'operational optimization', the firm is working to reduce harm. In Level 2, they are working towards transformation by generating shared value, such as through generating financial value as well as producing social benefits. Finally, in Level 3 the organisation is taking responsibility for its wider impacts on society by helping to be a driver of systemic change.

This demonstrates that for CSR, there are different levels of how much responsibility an organisation takes on, and they demonstrate this responsibility through a variety of unregulated mechanisms. While CSR is a popular soft power framework, it is challenging to pinpoint the specific roles of responsibility that firms take. Insofar as it is a vague meaning of responsibility that is then taken, this leads to the potential need for stronger external mechanisms in the socio-political context of operation to instead designate responsibility, or an external force to ensure responsibility. This means that the stronger forms of responsibility for firms are ultimately that of a legal responsibility, as designated by regulations (Giddens, 1999).

3.2. Public Values Science

An alternative top-down approach to the legal regulations however, is by placing responsibility for impacts of science and innovations on the public institutions and governments. However, it is increasingly argued that this approach has not been sufficient at protecting societies from harmful impacts in the past. Thus instead of placing responsibility on social policies to address these social challenges created by science and technology, the second framework I discuss, Public Values Science (PVS) argues for a new approach to science and innovation policy.

PVS focuses on the responsibility of public institutions and the government through public funding of science. PVS argues that science and innovation policy has been regressive, with benefits being unevenly distributed, and the negative impacts of innovation directly and indirectly affecting wide parts of society and leading to greater inequalities (Bozeman, 2020). There is thus an imperative to rethink science and innovation policy, and to orient science and innovation toward considering the wider values of the public. In this way, the government takes responsibility by making adequate "investments in science and technology that can produce public value benefits that accrue to all citizens" (Bozeman, 2020:38).

Bozeman (2020) suggests five steps to ensuring PVS. First, to widen the knowledge of effects for those working in science and technology, such as by requiring more social sciences and ethics courses for students pursuing those topics. Second, to not only assess the promises of new innovations, but to evaluate the actual social impacts and consequences of them. Third

is the separation of basic research from PVS, as while this has value, research aimed at satisfying curiosity about the world need to be insulated from goal-driven innovations. Fourth, is to be radically more inclusive of those who are working in science and technology, such as by giving much greater opportunities for those from minority and low-income backgrounds. Finally, to revisit public involvement in science to ensure that participation is accessible and meaningful.

One apparent challenge for PVS is inherent in the name: public values, implying a standard set of values that are homogenous in a given society. Of course, this is rarely the case, as values are plural, and there are tensions amongst different groups in the society and the values they hold (Jasper and Steen, 2018). A second challenge is the resistance from scientists, many of whom hold the belief that public values will be achieved through un-directed science, or the free pursuit of knowledge. Bozeman (2020) challenges this by asking: "What if the scientific community were to take on the grand challenge of replacing Science, the Endless Frontier with a new vision of scientific research as a means not only of contributing to innovation and economic growth but also as part of the solution for addressing the growing and unsustainable degree of economic and social inequality that is tearing our society apart" (Bozeman, 2020:41)?

However, even if these two challenges were remedied, there remains a challenge of a more insidious nature. In PVS, responsibility is designated in a top-down manner whereby government influences science and innovation via science and innovation policy. This neglects a fundamental perspective though: that of the bottom-up, whereby science, research, and innovations also impact and inform policy.

3.3. Responsible Research and Innovation

There is thus evidently a potential need still for responsibility to be bottom-up, to lie at the individual level, whereby individual actions and impacts inform and reshape institutions. This brings us to the third framework, Responsible Research and Innovation (RRI). The most basic aims of RRI are that of "taking care of the future through collective stewardship of science and innovation in the present" (Stilgoe, Owen, and Macnaughten, 2013:1570), whereby science becomes "responsive to societal challenges, in the face of the inevitable uncertainties, ambiguities and questions that innovation creates" (Macnaughten et al. 2014:192).

RRI focuses on the creation of responsible innovations through "a transparent, interactive process by which societal actors and innovators become mutually responsive to each

other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)" (von Schomberg in Stilgoe, Owen, and Macnaughten, 2013:1570). It is thus culturally and contextually dependent.

As a reverse perspective to PVS, RRI can be seen as the "latest manifestation in a long line of policy-oriented debates concerned with providing space to consider and debate the interactions between the oft-separated worlds of 'science' and 'society; to ask questions about who shapes research agendas, to what ends research should be done and how best new knowledge and novel technologies might be governed" (Ribeiro, Smith, and Millar, 2017:84).

Owen et al. (2013) and Stilgoe, Owen, & Macnaughten (2013) identify four elements to achieve RRI (von Schomberg 2018). First is anticipation, which considers the possible impacts of research and innovation outcomes as well as processes. Second is reflexivity, which requires both individuals (scientists) and institutions (firm or organization) to make explicit their own assumptions and values. Third is inclusion, which encourages the "opening up" of science to citizens and diverse stakeholders' groups to participate in the process and decision-making. Finally, is responsiveness, which implies that research and innovation pathways can be changed if such are determined to be against the public good.

There are several challenges posed by placing responsibility primarily on the individual. First, the individual needs to have the capability to enact change and to act responsibility, but this is not always the contextual case of the researcher (Gianni, 2019). Furthermore, it is difficult to demonstrate a causal condition: there are many actors involved in any single innovation, which expand across a long causal chain of innovation process and eventual direct (and even indirect) societal impacts (van de Poel and Sand, 2018). There is also concern that RRI will not reconfigure the science-society relationship by challenging norms and making science responsive, instead boiling down to a vague set of boxes to be checked by the researcher, such as when they apply for funding for an innovation project (de Saille, 2015).

Finally, while RRI has gained significant traction in Europe, including being taken up by national government research bodies such as the United Kingdom and Norway, as well as being a cross-cutting component to the European Commission funding *Horizon 2020* (Owen, Macnaughten & Stilgoe, 2012), its uptake outside of Europe has faced challenges (Macnaughten et al. 2014) because while RRI purports to be culturally or contextually framed, it is still at risk of perpetuating European values to other regions like the Global South.

4. Discussion

In this Section, I discuss these different frameworks in an effort to explore my research question: *How do dominant responsibility frameworks address the dark sides of innovation?* I discuss how each of these frameworks designates responsibility to different elements of society and yet that they are also interlinked and overlapping. I conclude by placing the frameworks back into an overall context, by asking whether these frameworks indeed upend the system of organised responsibility or further solidify it.

4.1. Analysis

What is first interesting for the dark sides of innovation is how each of these frameworks holds different actors accountable and through different mechanisms. For CSR, the responsible actor is the firm, and whereby the firm is held accountable for its responsibility primarily through itself and through its CSR. For example, if a firm is disclosing impacts through sustainability reporting, it can omit certain negative impacts in order to reduce being held responsible, especially through some of its worst impacts whereby it could be held responsible or culpable in a legal sense (Giddens, 1999; Haski-Leventhal, 2018).

This means that so long as the firm does the minimum to maintain its social license to operate, where the consumers may indirectly hold a firm accountable, firms can choose the types and levels of responsibility they take on (Borglund, De Geer, and Sweet, 2017). While pressure is mounting to expand their responsibility, such as for firms to include the entirety of the value chain (upstream and downstream) (Borglund, De Geer, and Sweet, 2017; Haski-Leventhal, 2018), this remains a challenge in terms of responsibility, as many actors and events will challenge the ability to claim causality, thus limiting any external enforcing of responsibility and leaving the firm to assume it themselves.

For PVS, the responsible actor is not the firm but the government, which through public funding influences firms, and ultimately takes responsibility for the outcomes of science and innovation by influencing the types of projects that can be pursued and knowledge that can be created, towards those with greater social benefits and impacts. The government is held accountable for its responsibility primarily through itself and through its PVS policies. For example, a government will place funding into the areas where it expects to have the greatest impacts. According to the second step of PVS, the government will develop greater assessments for impacts, which assess what effects a technology or innovation that it has invested in actually

has in practice, rather than what it promises to do. However, this will be done after-the-fact, meaning the effects will already have occurred. Thus with a checks-and-balance within its own system, the government can politically prioritise certain impacts and effects over others, where the citizens will again only indirectly hold the government accountable.

For the CSR and PVS frameworks, responsibility is self-fulfilling, in that the responsibility is taken by the very actors holding the accountability. This is concerning, as it opens up for a lack of real responsibility, whereby the firm or government will work to take responsibility only for some aspects of impacts and prioritise specially profitable or political effects rather than target the truly negative and noxious impacts. It also calls into question if it will pre-empt dark sides, or simply try to change course or fix them after they have made impacts. For example, firms that operate in another location, or government funding which produces something with global impact. Neither of these frameworks seem sufficient to ensure responsibility for the impacts of science and innovation which are spatially or temporally displaced.

For RRI, the responsible actor is the individual, who carries out the research or innovation. It is not however, the individual who is holding themselves accountable. Who is holding them accountable though, is more difficult to say. Across readings of dozens of articles and book chapters, it was not immediately clear who is ultimately holding the individual accountable. I thus came to the conclusion, that it is the wider community, including the firms and organisations where the researchers work, and through the funding given by those firms and the governments, all ultiimately based in the norms, values and cultural contexts (Stilgoe, Owen, and Macnaughten, 2013) within which they are rooted. Of course these norms and values are not only dynamic over time, they also change from one location to another. There is thus a call for a *global* RRI, in which there is a global governance framework that debates and works towards ethical acceptability, sustainability, and socially desirability of research and innovation, each identified and held accountable through specific and relevant mechanisms (see Shroeder and Kaplan, 2019). What this would resemble in practice however, is unclear.

In lieu of a framework that ensures full responsibility for impacts, it is essential to look at how these various governance and responsibility frameworks are aligned (Stilgoe, Owen, and Macnaughten, 2013). For example, the first step in PVS is to delegate some degree (additional) of responsibility to the scientists and innovators by requiring further coursework in ethics and social sciences. Furthermore, while it is at its core, RRI has the individual innovator and researcher taking responsibility, RRI also recognises the institutional and systemic changes

that are necessary to occur in order for individuals to be empowered to carry this out. These include ensuring ethics, gender equality, science education, open access, public engagement, effective governance (Strand and Spaapen, 2015). This also overlaps with PVS, where, for example, one key aspect of the vision for RRI is to align innovation with public values, and to "shift from justification in solely macroeconomic terms of publicly funded research and innovation, towards a justification of the purpose and direction of innovation in terms of broadly shared public values" (von Schomberg, 2019:17).

Furthermore, there is also overlap between RRI and CSR (Lindner, R. et al., 2016). According to Pavie (2019), there are five levels of maturity for firms seeking to genuinely work towards responsible innovation, shown in Figure 2 below:
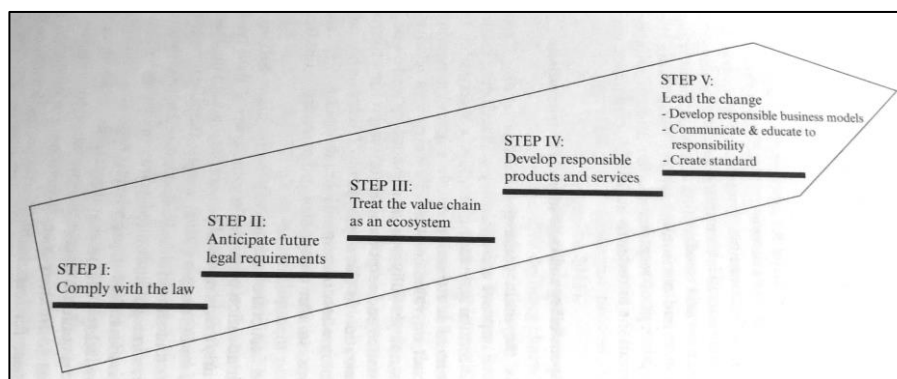

Figure 2: Steps of responsible innovation in organisations (Source: Pavie et al. in Pavie, 2019)

Interestingly, these five steps closely resemble the sustainable business steps in Figure 1. In addition, the compatibility of CSR and RRI is demonstrated in the words done by lIatridis and Schroeder (2015) in their assessment of several CSR tools and standards and the relevance to RRI. In this assessment, dozens of the key CSR tools, for standards to reporting frameworks, are analysed for their compatibility with RRI and for where RRI can contribute.

Furthermore, the elements of stakeholder engagement or public participation resonate as significant and essential components across all three frameworks (Blok, 2019). This is interesting, and it may demonstrate a turn towards a better understanding one of the important and underlying aspects of responsibility: that risk is not objective, but is related to what is valued. While none of the frameworks present a standard definition for value, they do promote the open and democratic discussions in which such values can be made explicit and debated. This turn towards subjective and deliberative values is built into the core of each of the frameworks, and means that the while it is not clear who is necessarily responsible and to what degree- that it is to the *people*, that they do ultimately owe the responsibility to.

4.2. Findings

On the one hand, the interlinkages and compatibilities of these frameworks may demonstrate a deeper and perhaps more 'balanced' or shared view of responsibility (Gianni, 2019; Reber, 2019). On the other hand, it could also lead to another situation, where "complex governance of modern science and technology involving many actors would lead to thinning responsibility" (Grunwald, 2019b:329). Especially regarding emerging and highly uncertain technologies, such as those that would be subject to Collingridge's dilemma, it could be meaningless to take on responsibility as no one could ultimately hold one to that responsibility (Haupten, 2019). In these cases, scholarship diverges and the tensions become evident. For example, the RRI notion of anticipation remains a strong element of still asserting responsibility in some literature (Schot and Steinmeuller, 2018; Giuliani, 2018), while in others, it is argued to focus more on present actions, and rely less on anticipating the future (Grunwald, 2019a; Grunwald, 2019b).

Furthermore, each framework places the key responsibility at different layers of society: CSR at the corporate level, PVS at the government level, and RRI at the individual level. It is thus difficult to definitively conclude if the overlap and interconnections of these responsibility frameworks represent a strengthened and robust way to forward responsibility of the negative impacts of innovations and technologies, or instead represents a complication of it. For example, which "further complicates the tensions between 'responsible' as liable and accountable, 'responsible' as a form of moral action best deployed through processes of mutual learning and deliberation, and 'responsible' as ensuring that public money allocated towards research does eventually create products and services which fill that society's needs, rather than merely creating new opportunities for purchase." (de Saille, 2015:162).

To address my research question: *How do dominant responsibility frameworks address the dark sides of innovation?* I do not find that enough conceptual evidence that these contemporary and dominant responsibility frameworks are sufficient to cut through Beck's organised irresponsibility. Nearly 20 years ago, this was described and questioned as the:

> "diversity of humanly created risks for which people and organisations are certainly 'responsible' in a sense that they are its authors but where no one is held specifically accountable. Various questions the come to the fore. Who is to determine how harmful products are, what side effects are produced by them, and what level of risk is acceptable? How can 'sufficient proof' be determined in a world full of contested knowledge claims and probabilities? If there are damages to be paid, or reparations made, who is to decide about compensation and appropriate forms for future control or regulation?" (Giddens, 1999:8)

I thus cannot argue that the contemporary dominant frameworks analysed in this essay have proven sufficient to answer these decade-old questions and ultimately provide responsibility. Particularly for emerging technologies, and the pursuit of research and innovation to achieve sustainability and sustainable transitions, it is not clear that the cycle of manufactured risks will not continue, and new dark sides of these innovations will not also be generated (de Saille, 2015). The aim for sustainability and the pursuit of the Sustainable Development Goals as a response to deal with the negative side effects from previous innovations, may thus perpetuate the system which continues to exhibit organised irresponsibility or at worse, even strengthens it- where the trade-offs and values that are left behind as this progress is pursued are left undeliberated and no one takes responsibility or is held responsible for the negative impacts.

4.3. Limitations and further research

That said, there are numerous additional responsibility frameworks that can also be assessed. In addition, other perspectives, such as that of the responsibility and roles of consumers or citizens, could also be examined. In addition, due to the relevance requirements and constraints of the essay, there are a number of key concepts that could still be explored further. I selected responsibility and risk as the most interesting ones which underpin the concepts of negative side effects of innovation and technology, but there are other aspects that intersect with these as well, such as control or precaution. Finally, the concepts described here could be further explored through their deeper philosophical and contextual meanings. Thus if different underpinning concepts were examined, and different frameworks were analysed, the discussion could lead to alternative conclusions about how to approach the dark and negative sides of science and innovation.

In terms of continuing this research, I argue that since responsibility is highly contextual, it follows that the next steps for advancing this research could be to examine case studies, for example of certain emerging technologies like that of CRISPR/Cas9 gene-editing, in a specific location or set of locations, and in regards to a particular use in that context. It would be interesting to then assesses which of the responsibility frameworks are applied at this contextual intersection, and to examine what elements of responsibility are designated to which parts of society and who will be the actors holding accountability to them. Through exercises such as scenario-planning or envisioning futures, it could then also be possible to see what possible manufactured risks could occur, and how responsibility would work in practice to deal with any negative and dark side effects.

5. Conclusion

While innovation and technology are often purport as the solution to the "grand challenges" our civilisation will face over the next century, an important alternative perspective is gaining traction: that it is not merely the lack or failure of innovation which hinder achieving sustainability and solving such challenges, but it is in fact also through the creation and success of innovations and technologies that hinder these aims. Increasing focus is thus being placed on the need to rethink the science-society relationship and to re-examine the products and processes of science to ensure they are responsive and responsible. It is thus essential to examine whether the emerging dominant frameworks are truly able to restructure this relationship, and to thus fracture a system of organised irresponsibility, in which the negative and dark side effects of innovation leave no one responsible and where new risks are continually manufactured by the very system which aims to mitigate old ones.

In this brief exploratory essay, I have asked: *How do dominant responsibility frameworks address the dark sides of innovation?* I first explored the foundational concepts which underpin the notion of an innovation having dark or negative sides to it. For this I argued that the concept of risk was effective because it captures the subjective elements of the values which designate something as negative. It is furthermore the manufactured risks, which are created through science and technology, that is of interest. I then expanded on the concept of responsibility and an important underlying element.

For the case study of this paper, I then assessed three contemporary responsibility frameworks based on their relevance to the course literature: Corporate Social Responsibility, Public Values Science, and Responsible Research and Innovation. I examined each of these frameworks through their purpose and functions, aims, and some of their benefits and challenges. Building on the concepts of risk and responsibility, I then discussed these frameworks together, finding that each of them designate responsibility to a different level of society: the firm, the government, and the individual researchers, respectively; and how CSR and PSV are held responsible through their own frameworks, while RRI likely is held accountable through the wider community. Finally, I discussed how they are furthermore interconnected and overlapping. Ultimately, I could not find conceptual evidence that these frameworks create a strong and robust system of responsibility, instead of simply creating tensions and confusions, and furthering the system of organised irresponsibility that perpetuates the manufacturing of further dark sides of innovation and technologies.

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