Engineering the concept of ELSI and RRI

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**Abstract**

The concept of Responsible Research and Innovation (RRI) remains a pivotal element of the EU's Science and Technology Policy, and is expected to continue through the Horizon Europe framework until at least 2027. Nevertheless, despite its significance, the concept of RRI is not clearly defined, with differing interpretations leading to inconsistent understandings. The relationship between RRI and the Ethical, Legal, and Social Issues (ELSI) approach is a topic of ongoing debate. While some view them as distinct activities, others perceive a degree of overlap. This paper examines the conceptual ambiguity surrounding RRI and proposes the "Conceptual Engineering" approach as a means of refining and clarifying the concept. This paper examines the evolution of the concept of RRI within the EU context and its relationship to ELSI. It proposes a framework that reconstructs RRI as "the activities that address 'ELSI as Issues' around specific targets in a way that involves specific attitudes". This conceptual design aims to enhance the practical application and evaluation of RRI, contributing to a clearer understanding of its diverse practices globally.

Keywords: ELSI; ELSA; RRI; Conceptual Engineering

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# 1. Introduction

One of the fundamental concepts of Horizon 2020, the European Union (EU) 's 8th Framework Programme launched in 2014, is Responsible Research and Innovation (RRI). Ten years later, in 2024, the concept of RRI remains an important aspect of the EU's science and technology policy, embedded in the fundamental underlying principles. It is likely to remain important at least until 2027, when the 9th Framework Programme, "Horizon Europe", will end (cf. von Schomberg and Hankins 2019). This movement is not limited to the EU; it is also gaining ground in the Americas, Africa, Asia, Australia and even in international organisations such as the WEF (World Economic Forum) and OECD (Organisation for Economic Co-operation and Development) (cf. Owen et al. 2021; Wakunuma et al. 2021; Enomoto et al. 2024a).

Conversely, despite its significance, the concept of RRI has been addressed in a somewhat ambiguous manner. The concept of RRI is referenced on several occasions, including in the "Rome Declaration," which is also mentioned in Section 3. The most influential of these references is the following one by von Schomberg.

Responsible Research and Innovation is a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view on 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 ed. 2011, p.9)

As will be discussed subsequently, there have been a number of attempts to provide a concise and precise interpretation of this fundamental yet ambiguous characterisation. For instance, it is sometimes described in terms of four elements, at other times in terms of five, six or even nine elements. The inconsistencies in these different characterisations, when taken together literally, often give rise to conflicts and present a challenge to interpretation. Furthermore, RRI is frequently situated as "post-ELSI" (cf. Nydal et al., 2015; Balmer et al., 2016). However, there is also some criticism that ELSI and RRI are, in fact, the same two activities with only a slightly different focus. This has led to confusion about how RRI should be understood in light of its relationship with ELSI (cf. Zwalt et al. 2014).

From the perspective of the theorist who places emphasis on practice, a debate over the question "What is RRI?" may appear to be a mere theoretical discussion. A common criticism is that the question of what RRI actually does is more important than the question of what the label means. This criticism is valid in that the question of what RRI means is not a useful one in itself, and indeed, if the meaning of the label cannot be interpreted consistently, this is not a problem as long as the label is used in an operational way. Indeed, in light of the multifaceted introduction of RRI into policy and the disparate characterisations thereof, as discussed in Section 3, assumptions such as the existence of a singular, correct view of RRI and the possibility of deriving a reasonable view of RRI through appropriate analysis may be unproductive in the pursuit of realistic problem-solving.

Nevertheless, it is feasible to address the question of "What is RRI?" through a conceptual design that will be beneficial for the following objective: "We aim to rethink what we do in the practice of RRI and how we evaluate its results." Furthermore, such a conceptual design is beneficial for reflecting on the past ten years' attempts and for establishing connections between them and the future practice of RRI. Accordingly, the position taken in this paper is that of "Conceptual Engineering," which represents an ongoing conceptual design and revision of the concept of RRI (cf. Todayama 2019). The objective of conceptual engineering is to develop RRI concepts that are conducive to real-world RRI practice, in a manner analogous to engineering's aim of designing artefacts that serve a specific purpose.

The following is a description of the structure of this paper. Firstly, in order to examine the concept of RRI, it is essential to have a clear understanding of the concept of ELSI. This is because ELSI plays a similarly important role in the EU's science and technology policy as RRI. In order to facilitate an effective discussion, Section 2 presents the concept of ELSI in three distinct forms. Subsequently, Section 3 delineates the concept of RRI within the context of the EU, with particular emphasis on its historical evolution. Nevertheless, there are still some cases that cannot be encompassed by the framework that has been established here. Consequently, Section 4 presents a more comprehensive conceptualisation of RRI, derived from the findings of Section 3. In essence, the concept of RRI can be defined as "the activities that address 'ELSI as Issues' around specific targets in a way that involves specific attitudes". It is therefore the intention of this discussion to provide a framework that will facilitate a proper understanding and evaluation of the diversity of RRI practices around the world.

# 2. Interpreting the concept of ELSI in three ways

Section 2 is concerned with the organisation of the concept of 'Ethical, Legal and Social Issues (ELSI)'[[1]](#footnote-1), which is frequently referenced in the science and technology policies of a number of countries, specially in Japan. This is because the concept of ELSI is open to at least three different and misleading interpretations, the details of which are presented in this paper. It is therefore essential to organise the concept of ELSI in order to facilitate understanding of the concept of RRI. It should be noted that the concept of ELSI can be broadly divided into two categories: 'ELSI as Issues' (2-1) and 'ELSI as Activities'. The latter can be further divided into two subcategories: one that is not historically banded (2-2) and one that is historically banded (2-3).

## 2-1. ELSI as Issues

One possible interpretation is to disregard the historical context and take the expression 'ELSI' at face value. In other words, the term ELSI is used to refer to ethical, legal and social 'issues', and thus excludes technical aspects (cf. Osaka University 2020). To illustrate, the term ELSI is defined in Japan's '6th Basic Plan for Science, Technology and Innovation' as follows:

In particular, in the transition to Society 5.0, in order to deal with the ELSI that will arise when new technologies are used in society, it is necessary to take a bird's-eye view of things, and the construction of a system that can utilise 'comprehensive knowledge' including not only the natural sciences but also the humanities and social sciences is required. (Cabinet Office 2021, p.13, underlined quotes)

In this interpretation, ELSI is simply an 'issue' pertaining to a specific aspect, thereby allowing for a variety of stances to be taken with regard to how this issue is addressed. Rather, the original meaning is just this. To illustrate, an issue may be "identified," "analyzed," "considered," "handled," "solved," or "overcome," among other possibilities. These verbs can be applied to describe the various ways in which an issue may be approached. In other words, the term 'ELSI' does not provide the user with a clear indication of the manner in which the issue is to be addressed.

It is sometimes, or even often claimed by those specialising in traditional ethics, law and sociology that ELSI is merely a new term for issues that have been the subject of debate for a considerable period of time. The veracity of this viewpoint is irrelevant; it represents the prevailing understanding of ELSI as "ELSI as Issues." As ELSI is defined as issues involving ethical, legal, and social aspects, it is possible to reconstruct the history of ELSI from this perspective and to build a history of ELSI.

## 2-2. ELSI as Activities (1): not historically banded type

On the other hand, it may not be sufficient to take ELSI as an 'issue' in the literal sense. For example, the use of expressions such as "ELSI is carried out" or "ELSI is required" is not meaningful when interpreted in a naive manner as "ELSI as Issues" (cf. Yoshizawa 2021; Kyushu University 2023). However, this is by no means a misuse of the term. In this context, ELSI is regarded as an activity that comprehensively examines the subject of 'ELSI as Issues'. In order to accurately capture this situation, several commentators have described ELSI as follows:

Today, the concept of ELSI is used to refer broadly to the ethical, legal and social issues themselves and the research and activities related to them. (CRDS [Center for Research and Development Strategy] 2021a, p.1, underlined quotes)

The acronym ELSI (in the U.S.) or ELSA (in Europe) refers to research activities that anticipate and address ethical, legal and social *implications* (ELSI) or *aspects* (ELSA) of emerging life sciences, notably genomics. (Chadwick and Zwalt 2013, underlined quotes)

The underlined passages in the quote appear to be the verbalisation of the noun 'ELSI'. In other words, the term 'ELSI' may be used to refer to the entire activity of 'analysing various issues at an early stage, sharing and discussing issues, and appropriately positioning its impact on society', or a part of it. In this paper, the term ‘ELSI as Activities’ will be used to refer to activities related to the aforementioned subject.

As will be discussed in further detail in section 4-2, it is assumed that at least "ELSI as Issues" exists when "ELSI as Activities" is valid. Although issues and activities are distinct categories that cannot be expressed in a simple inclusion relationship, for the sake of convenience in this paper they will be represented as illustrated in Figure 1. It should be noted that the polka-dot background is not intended to be a set.



Figure 1. The relationship between 'ELSI as Issues' and 'ELSI as Activities' to address them

## 2-3. ELSI as Activities (2): historically banded type

The 'ELSI as Activities' described in 2-2 represents a contemporary conceptualisation of ELSI that eschews historical precedent. For the sake of convenience, this will henceforth be referred to as 'ELSI as Activities (1)'. In contrast, some projects classified under the usage of 'ELSI as Activities' may refer specifically to a specific period of time. CRDS provides the following explanation in the same context as the aforementioned quote.

Originally, 'ELSI ' was a motto for funding research and development on the ethical, legal and social issues of emerging technologies, and was introduced as a funding mechanism into the funding system. It is well known that the genesis of the ELSI was the US/Human Genome Project, which began in 1990. In Europe, [...] introduced under the name ELSA, funding for relevant research and practice began from the 4th Framework Programme for Research and Innovation (1994-1998) onwards. (CRDS 2021a, p.1)

From the 1990s to the 2000s, research on 'ELSI as Issues' was conducted in Europe and the USA under the guidance of research funding agencies, which provided top-down policy guidance. The RRI, which will be discussed in greater detail in Section 3, is often described as 'post-ELSI' (cf. Nydal et al. 2015; Balmer et al. 2016; Shineha 2020). However, the use of ELSI (or ELSA) as 'pre-RRI', so to speak, refers to such research projects conducted in Europe and the US during a specific period. This will be referred to as ‘ELSI as Activities (2)’ in this paper (Figure 2). The curious phenomenon of the term 'ELSI as Issues' being labelled as 'outdated', despite its apparent continued relevance across different periods[[2]](#footnote-2), can be attributed to the interpretation of ELSI as 'ELSI as Activities' within a specific time frame.



Figure 2. 'ELSI as Activities (2)', which is part of 'ELSI as Activities'

In light of the aforementioned considerations, the concept of ELSI can be elucidated through three distinct interpretative lenses as illustrated in Figure 3: 'ELSI as Issues', 'ELSI as Activities (1)' and 'ELSI as Activities (2)'. The concept of RRI, which is the primary focus of this paper, is founded upon the concept of ELSI. By establishing the concept of ELSI in this manner in advance, the concept of RRI can be comprehended in a coherent manner, without the various applications becoming confused.



Figure 3. Relationship diagram of the concept of ELSI

# 3. Tracing the history of the development of the concept of RRI

Section 3 presents a historical analysis of the characterisation of the concept of RRI, with particular consideration of its introduction within the policy context. Firstly, the paper provides a summary of the ways in which the concepts of ELSI and RRI have been discussed within the context of the EU (3-1). It then goes on to highlight that the characterisation of the concept of RRI has occurred along two distinct lines: 'RRI as the key' (3-2) and 'RRI as the dimension' (3-3). In conclusion, a provisional concept of RRI is put forward, based on a coherent interpretation of the aforementioned elements.

## 3-1. A brief history of EU policy

The concept of RRI has a history of being promoted within a top-down policy framework in the EU, particularly since the 2010s. Consequently, an examination of the concept of RRI must consider its relationship to science and technology policy within the EU. This section presents a review of the EU Framework Programmes (FPs) and the programmes established within the FPs, with particular attention to their relevance to the concepts of ELSI and RRI (Figure 4).



Figure 4. Simplified EU policy timeline on ELSI and RRI

The explicit introduction of 'ELSA (Ethical, Legal and Social Aspects)' can be traced back to the 4th Framework Programme 'FP4' (1994-1998) (Zwalt et al. 2014), where it was first introduced as a concept that corresponds to the broader concept of ELSI in EU science and technology policy. This is purported to have constituted a top-down policy directive based on a distinct conceptualisation of particular research methodologies, with the objective of transcending the preceding ELSI research in the USA. In the present era, the term is occasionally employed in a manner that aligns with the interpretation of 'ELSI as Issues'[[3]](#footnote-3). However, it can be assumed that in the majority of cases when 'ELSA' is referred to in the EU, it is used as 'ELSI as Activities (2)'. In other words, 'ELSA' is a specific historically contextualised expression that was introduced as a policy inducement, particularly during this period. It is therefore important to note that the term 'ELSA' can be readily associated with the methodological attitudes and research methods that were prevalent during this period. In the present era, these may be perceived as having already been superseded by the advent of RRI.

Following this, there were no significant developments in ELSI-related matters within FP for a period of time. However, the programme 'Science and Society (SaS)' was established as part of the 6th Framework Programme 'FP6' (2002-2006), and ELSI-related initiatives were funded as part of this programme. In consequence of this, awareness of the issues was conveyed to the subsequent programmes from FP7 onwards, on the basis of the SaS.

The 7th Framework Programme (FP7) (2007-2013) is regarded as a pivotal point in the evolution of ELSI and RRI. ELSI-related initiatives were subsumed by a follow-up programme to SaS, Science in Society (SiS), but behind the scenes, there was criticism of ELSI (ELSA) and a campaign to convert it to RRI. In 2009, the publication of the 'Lisbon Treaty' (EU 2007), which called for a shift to governance based on values such as openness, inclusiveness and accountability, prompted the exploration of an alternative approach to ELSA. The first WS on the subject of RRI, 'Responsible Research and Innovation', was organised by the European Commission in May 2011[[4]](#footnote-4). Moreover, in November 2011, the seminal reference point for RRI, "Towards RRI", edited by von Schomberg, was published, marking 2011 as the inaugural year of RRI (von Schomberg, 2011). In the following year, 2012, a presentation was made at a conference organised by the European Commission, in which the inclusion of RRI as a central concept of FP8 was called for, and it was noted that the ELSA approach was insufficient (Geoghegan-Quinn, 2012).

Consequently, RRI was incorporated as a pivotal concept within the 8th Framework Programme, otherwise known as Horizon 2020 (2014-2020) and the subsequent programme of SiS, 'Science with and for Society (SwafS)', which commenced the funding of RRI-related initiatives. In addition, it is noteworthy that the 'Rome Declaration' (EC 2014a) was released in 2014, advocating for the comprehensive integration of RRI within EU Member States.

The 9th Framework Programme, 'Horizon Europe' (2021-2027), represents a continuation of the SwafS initiative, with a particular focus on the promotion of Research & Innovation (R&I). Although RRI is not explicitly identified as a direct grant objective, as was the case with SwafS, the concept of RRI remains at the core of the programme. This is evidenced by the policy shift towards promoting RRI across the entire R&I domain[[5]](#footnote-5).

In light of the aforementioned historical context, it can be posited that RRI was introduced as an alternative to ELSA, designated as "ELSI as Activities (2)". However, it is notable that the characterisation of RRI itself does not employ the expressions "ELSI" or "ELSA". This leads to the question of the relationship between ELSI (or ELSA) and RRI.

## 3-2. RRI as the key

In order to consider the characterisation of RRI and the relationship between ELSI and RRI, it is useful to adopt an approach that understands RRI in terms of the 'key' derived from the policy history identified in Section 3.1. As previously stated in Section 1, numerous attempts have been made to interpret von Schomberg's characterisation. To reiterate, the aforementioned argument follows.

Responsible Research and Innovation is a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view on 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 ed. 2011, p.9)



Figure 5. Six keys for RRI (prepared by the author based on RRI Tools 2014)

One notable example of this is the five-factor characterisation of 'gender', 'science education', 'engagement', 'open access' and 'ethics', and the six-factor characterisation that adds 'governance' to this (Figure 5) (cf. RRI Tools 2014; Stahl et al. 2021; Okamura 2021). The aforementioned elements were established with the objective of evaluating the characterisation proposed by von Schomberg as a reference point, specifically in terms of its actionability and measurability (Owen et al., 2021).

In the wake of the 2011 WS, which was also referenced in 3-1, the European Commission released a leaflet in January 2012. entitled "Responsible Research and Innovation: The European Competence to Meet Societal Challenges," which outlined the "six keys" for RRI (EC 2012). Specifically, the aforementioned "gender," "science education," "engagement," "open access," "ethics," and "governance" are of note. Owen et al. (2021) have highlighted that the six keys, which were abruptly employed to define RRI, were in fact a direct reflection of the SiS action line (EC, 2008) within the then FP7 (2012-2013). In other words, the items related to ELSI/ELSA that were used prior to the positioning of RRI within the policy were succinctly summarised and incorporated. The presentation, delivered in April 2012, positioned RRI as a central concept within the context of Horizon 2020. The characterisation of RRI presented in this context was based on the aforementioned six keys.

Subsequently, as FP transitions to Horizon 2020, the six core principles of RRI are formally articulated in the 'Rome Declaration' of November 2014. However, the Rome Declaration describes the six keys as 'six dimensions'. This makes it challenging to ascertain the continuity of the aforementioned 'European Competence', which was revised in September 2014. The revised version of the competence, which is cited in the Rome Declaration, employs the same six elements, which have been changed to the notation 'dimensions' (EC 2014b). As this is the sole occasion on which the dimension notation is employed, this event is organised in this paper as being related to the key.

ubsequently, in order to facilitate a comprehensive assessment of specific RRI initiatives, the European Commission (EC, 2015) proposed the establishment of a set of indicators for the evaluation of RRI[[6]](#footnote-6). In order to guarantee the continuity of the project between the FP7 programme SiS and the Horizon 2020 programme SwafS, the keys for RRI reflecting the SiS action lines were also adopted as the evaluation criteria for RRI practices within SwafS. It can thus be stated that the same items pertaining to ELSI/ELSA will continue to be adopted in Horizon 2020. It is important to note, however, that at this juncture the keys for RRI have been reduced to five, with the exclusion of 'governance', namely 'gender', 'science education', 'engagement', 'open access' and 'ethics'. This was due to the following circumstances. Although the six elements of the SiS action lines were directly reflected in the key as previously described, it was highlighted by the working group on indicators for evaluation that 'governance' was challenging to establish as a distinct work programme. Consequently, it was necessary to position 'governance' and the other elements at different levels (EC 2013; Owen et al. 2021). In this way, RRI as the five keys was established, namely RRI as an activity in which commitment to these five elements is particularly valued.

As previously stated, the transition to Horizon Europe has resulted in a structural change that aims to promote RRI throughout the entire R&I, which is the successor programme to SwafS. It is important to note, however, that the five keys are still incorporated into one of the items in R&I, 'Deepening the ERA' (cf. CRDS 2021b, p. 47), despite the fact that, in contrast to SwafS, they are not explicitly stated in R&I.



Figure 6. Four dimensions for RRI (prepared by the author based on EC 2012)

## 3-3. RRI as the dimension

The next step is to identify another perspective that characterises RRI, namely the 'dimensions'. Using the one proposed by von Schomberg in 2011 as a reference point, Stilgoe et al. characterised RRI in terms of four dimensions in 2013. These are 'anticipation', 'reflexivity', 'inclusion' and 'responsiveness' (see Figure 6) (Stilgoe et al. 2013)[[7]](#footnote-7). This differs from the 'key', which sought to encapsulate RRI as a tangible, actionable and measurable concept. As Jakobsen et al. (2019) describe it, the 'key' is "a framework for coherently capturing the ethos of RRI". If the 'key' represents the target of RRI practice, then this 'dimension' represents the attitude and orientation towards the process when practising RRI.

Subsequent attempts at characterisation around dimensions have been made, albeit with some controversy. To illustrate, in 2014 the RRI Tools project, which was funded by Horizon 2020, organised RRI under the name 'process dimensions' with four elements:

'Diverse & inclusive,' 'Anticipative & reflective,' 'Open & transparent,' and 'Responsive & adaptive to change' (RRI Tools 2014). In a different context, in 2019, the Engineering and Physical Sciences Research Council (EPSRC) in the UK developed the AREA Framework, which is based on four elements: 'Anticipate,' 'Reflect,' Engage' and 'Act' (EPSRC 2019). The specific content of these four elements varies depending on the entity in question. Nevertheless, provided that their meanings remain largely consistent and they are making claims about attitudes to RRI practice, they can be regarded as belonging to the same genealogy.

It should be noted that, in contrast to the approach presented in this paper, some positions do not view 'keys' and 'dimensions' as distinct perspectives for capturing the same concept of RRI. For example, Wittrock et al. (2021) posit that a total of nine elements – comprising five keys and four dimensions – are the targets of RRI practice. They further suggest that keys and dimensions are overlapping elements within the same level. However, previous research has overlooked several issues. Specifically, the two perspectives, 'keys' and 'dimensions', have been developed independently, with von Schomberg as the reference point. These perspectives are intended to be targets and attitudes, respectively, and are at different levels of discussion.

It is noteworthy that the 2014 revision of the European Competence (EC 2014b) and the Rome Declaration (EC 2014a), which cites it, treat keys in a particular manner. As previously stated, the key equivalents are indicated by the 'dimension' notation exclusively in these two instances. The rationale behind the provisional alteration to the notation remains opaque; however, the assessment of continuity must be based on the interconnectivity of the substantive content, rather than on the labels themselves.

To reiterate the discussion thus far, it is consistent to regard the two different perspectives characterising RRI as the 'key' as the main target of RRI practice and the 'dimension' as the attitude of RRI practice. Furthermore, the five keys, which are the primary objectives of RRI, were a form of "ELSI as Issues," [[8]](#footnote-8) as previously discussed in Section 2. Their purpose was to provide a tangible, implementable, and measurable framework for understanding RRI. In light of the aforementioned considerations, the concept of RRI, at least as currently conceived within the EU, can be described as follows.

RRI is the practice of addressing 'ELSI as Issues' around targets such as 'gender', 'science education', 'engagement', 'open access' and 'ethics' in a way that is accompanied by attitudes that are 'anticipation', 'reflexivity', 'inclusion' and 'responsiveness'.

As discussed in Section 2, the work on 'ELSI as Issues' aligns with the 'ELSI as Activities (1)' framework. It can thus be concluded that RRI represents a specific instance of 'ELSI as Activities (1)'.

# 4. Converging the diverging concepts of RRI

Section 4 introduces a distinct variant of RRI, diverging from the prevailing conceptualisation within the EU. It proposes that the preliminary iteration of the concept of RRI requires a successful revision (4-1). In response, we put forward a revised concept of RRI that we believe will be more widely applicable, based on the findings of the preceding discussions (4-2).

## 4-1. Variant RRI that are regionally and culturally dependent

It is frequently observed that the concept of RRI in the EU is contingent upon regional and cultural factors, rather than being universally applicable across the globe. For example, de Hoop et al. posit that there are various impediments to RRI, including material limitations and constraints on stakeholder involvement (de Hoop et al. 2016). They contend that the circumstances under which RRI practices in the EU are feasible and the regions in which they are applicable warrant serious consideration. Furthermore, she and others posit that the value of striving to simultaneously address environmental conservation and socioeconomic needs is a distinctive feature of the EU and may not be universally applicable. In light of the aforementioned considerations, the "ethical acceptability" and "social desirability" ascribed to von Schomberg's approach (whether intended by von Schomberg himself or not) are subject to regional and cultural relativity. Moreover, the five elements selected for targeting were contingent upon the practical circumstances prevailing in the EU. This then gives rise to the following question. The aforementioned concept of RRI is historically contingent, as evidenced by the "ELSI as Activities (2)" designation. Could it be argued that this represents the EU iteration of the local concept of RRI? Or, even if the EU version of RRI could be considered the "standard RRI," could we also define a "variant RRI," so to speak, that differs slightly from the standard one?

Indeed, the concept of RRI has been the subject of debate in a variety of regions and contexts, including North America, South America, Africa, South Asia, East Asia and Australia (cf. Chatfield et al. 2017; Doezema et al. 2019; Gao et al. 2019). To illustrate, Wakunuma et al. (2021) highlight that RRI is required (and in fact practised) in various ways in developed economies, developing economies and emerging economies. They respectively refer to these as "capital-oriented RRI", "livelihood-oriented RRI" and "hybrid RRI". In developed economies, such as the Netherlands, "capital-oriented RRI" is a prevalent practice. This is promoted by private and public funds with the objective of promoting innovation in science and technology, and is characterised by procedural, formal, and top-down strategies. Despite the incorporation of multi-stakeholder considerations, it has been observed that these activities may inadvertently exclude certain communities, such as those residing in rural areas. This can be considered to be consistent with the so-called ‘standard RRI’. In developing economies, such as Malawi, "Livelihood-Oriented RRI" is a prevalent approach. This comprises grassroots activities with minimal reliance on government policy guidance, with the objective of co-creating innovation in science and technology. It is characterised by individual contextual, informal, and bottom-up strategies. In contrast to capital-oriented RRIs, the agenda is often tailored to the specific needs of marginalised communities, such as those in rural areas. Lastly, in emerging economies, exemplified by Brazil, a form of "hybrid RRI" can be observed, which combines capital-oriented RRI with livelihood-oriented RRI. While government policies and their implementation processes exhibit similarities to capital-oriented RRI, they also display parallels to livelihood-oriented RRI, frequently addressing the necessities of livelihoods in non-urban regions.

If we consider that the RRI in the EU is standard and that the evaluation criteria for RRI are the degree of formal and top-down governance and economic aspects, we might conclude that hybrid RRI is relatively lacking in this regard and that livelihood-oriented RRI cannot be classified as RRI at all. Nevertheless, as Enomoto et al. posit, the crucial aspect of addressing "ELSI as Issues" is the cyclical process of analysing the present situation and reassessing issues (Enomoto et al. 2024b). From this perspective, the process of determining and acting on "ELSI as Issues" that should be addressed now, according to the culture and available resources unique to the area, can be considered a form of "ELSI as Activities (1)" with a specific attitude and objective. This approach can be evaluated as a representative example of RRI.

## 4-2. Reconstituted RRI

In light of the aforementioned examples, it appears prudent to generalise the "standard RRI" introduced in 3-3, specifically in terms of attitude and target. Here, for the purpose of generalization, "attitude such that it satisfies $ n\_{i}$" is expressed as $A(n\_{i})$, and "target such as $m\_{k}$" is expressed as $T(m\_{k})$ (where $i $and$ k$ are an integer greater than or equal to 1). Also, for convenience, we adopt the notation of $ A\left(n\_{1}, n\_{2}, …,n\_{i}\right)$ as an abbreviation of $A\left(n\_{1}\right)∧A\left(n\_{2}\right)∧…∧A\left(n\_{i}\right)$, and $T\left(m\_{1}, m\_{2}, …,m\_{k}\right)$ as an abbreviation of $T\left(m\_{1}\right)∨T\left(m\_{2}\right)∨…∨T\left(m\_{k}\right)$. Then, the concept of RRI can be reworded as follows.

RRI is an activity that addresses "ELSI as Issues"
with a focus on $T\left(m\_{1}, m\_{2}, …,m\_{k}\right)$

in a way that is accompanied by $A\left(n\_{1}, n\_{2}, …,n\_{i}\right)$.

This general reformulation allows for a broader view of the regionally and culturally relative concept of RRI, and also highlights the characteristics of RRI practice in the EU. For example, RRI as adopted by the EU can be expressed under this formulation as follows[[9]](#footnote-9).

RRI (in the EU) is an activity that addresses "ELSI as Issues"
with a focus on $T\left(gender, science education,engagement, open access, ethics\right)$

in a way that is accompanied by $A\left(anticipation, reflecxivity, inclusion,responsiveness\right)$.

Note that if nothing is assigned to $n\_{i}$, the phrase "in a manner that involves $A\left(n\_{1}, n\_{2}, …,n\_{i}\right)$" may be ignored as not specifying the attitude in working on "ELSI as Issues". Similarly, if nothing is assigned to $m\_{k}$, the phrase "with a focus on $T\left(m\_{1}, m\_{2}, …,m\_{k}\right)$" may be ignored as not specifying the priority issues in "ELSI as Issues.

Many commentators have pointed out that the RRI in the EU is more focused on economic aspects than the 'ELSI as Activities (2)', and MacKay, for example, criticises the RRI as a typical capitalist approach (MacKay 2022). However, this is due to the necessity of focusing on the economic aspect when considering the overall manner of designation regarding attitudes (cf. Zwalt et al. 2014; de Hoop 2016; Jakobsen et al. 2019). Thus, it is not so much the framing of RRI itself that is criticised, but rather the attitudes that are attributed to it as a component of RRI.

In conclusion, Figure 7 can be derived. Firstly, "ELSI as Issues" is the premise for the others, and it is assumed to exist at the very least when working on it as activities. Subsequently, "ELSI as Activities (1)," which addresses "ELSI as Issues," can be regarded as a set that is established to the extent that "ELSI as Issues" exists. Next, the 'reconstituted RRI', which requires specifications regarding attitudes and targets for 'ELSI as Activities (1)', can be regarded as a subset of 'ELSI as Activities (1)', and is consistent with 'ELSI as Activities (1)' only when there are no specifications regarding attitudes and targets. Moreover, the "ELSI as Activities (2)" and its successor project, the EU version of the RRI, are the ones historically banded as specific. Consequently, they constitute the proper subset of the "reconstituted RRI," as they are the ones that are actually specified with respect to specific attitudes and targets. Although there is some overlap between the two, they are regarded as distinct sets due to their disparate interests and foci.



Figure 7. New understanding of the concept of RRI using the concept of ELSI

In previous studies, it was commonly held that RRI, which is post-ELSI, has a more expansive and comprehensive perspective than ELSI. However, as a result of the reconstruction presented in this paper, it can be posited that RRI is rather narrower in scope than "ELSI as Activities (1)," which does not specify attitudes, and that RRI addresses "ELSI as Issues" in a narrower focus to satisfy more specific interests, similar to "ELSI as Activities (2)."[[10]](#footnote-10) In light of these considerations, it is reasonable to conclude that the conceptualisation of ELSI and RRI presented in this paper necessitates a re-evaluation and adaptation of the conventional understanding of these concepts.

## 4-3. Questions and Answers

In order to provide further clarification regarding the discussion presented in this paper, we will address some potential questions in advance. The following section will proceed in the format of a question-and-answer session.

*Question 1*:

Why is "governance" not included among the targets, despite its status as a significant concern within the field of RRI?

*Answer 1*:

This point seems reasonable and warrants further consideration. This is because, although removed from the keys of the RRI, governance is still employed as an evaluation criterion at a different level than the keys. Nevertheless, an analysis of the evaluation criteria reveals that the assessment of "governance" is heavily influenced by the level of commitment to the five keys. Good governance is achieved by addressing the keys in a anticipatory and sustainable way. Given that governance is predominantly discussed in the context of the five keys, a decision has been taken to exclude it from the targets. This does not, however, imply that governance is a non-essential element.

*Question 2*:

According to the author, the scope of RRI is more limited than that of ELSI. Nevertheless, given that RRI encompasses the entirety of the research process, it could be argued that RRI is in fact more expansive in scope than ELSI, which focuses exclusively on the implications of research outputs.

*Answer 2*:

Perhaps there is some misunderstanding in three respects, which it would be beneficial to clarify. Firstly, the question implicitly assumes the concept of 'ELSI as Activities (2)'. In other words, the intention is to draw a comparison between RRI and 'ELSI', with the latter understood as the practices that were being undertaken during a specific historical period. The rationale behind my attempt to clarify the concept of ELSI in Section 2 is to prevent the emergence of such confusion. Secondly, when I posit that "RRI is narrower in scope than ELSI," I am suggesting that the concept of RRI, which is delineated by a specific set of attitudes and targets, is more sharply focused than the concept of ELSI as Activities (1), which lacks such specification. Although this may appear somewhat counterintuitive, it does not depend on the scale in practice, whether large or small. In theory, RRI is conceptually narrower. Thirdly, the assumption that ELSI examines the issues pertaining to the output of research is inaccurate, even when 'ELSI' is equated with 'ELSI as Activities (2)'. Indeed, depending on the specification of the attitude in question, the focus may have often been on the outputs of research. Nevertheless, as several authors have observed, the activities defined by "ELSI as Activities (2)" should not necessarily be constrained to those alone.

*Question 3*:

Although the practice of RRI encompasses research and development, could the scope of RRI efforts be limited to "ELSI as issues"? In other words, is it feasible to exclude technical issues (i.e. non-ELSI) from the scope of RRI?

*Answer 3*:

Based on what is discussed below, the answer is " we can exclude it". The term "responsible R&D" is predicated on the assumption that irresponsible R&D was previously undertaken (Sugawara 2024). In the present era, the prevailing view is that R&D should be conducted in a responsible manner, informed by the insights gained from past experiences. What is of significance here is the notion that aspects of ELSI should be integrated into the contemporary practice of R&D in a manner that is intrinsic to the process itself. In this context, the term 'ELSI as Issues' covers the practice of R&D. It may be the case that the dichotomy between ELSI and technical issues (non-ELSI) is becoming increasingly irrelevant.

*Question 4*:

Does "ELSI as Issues" exist externally (in the philosophical sense)?

*Answer 4*:

This question is challenging and the subject of considerable debate. From a practical standpoint, it is non-external or internal in that we humans lack omniscience, and thus are only able to consider issues that we are able to recognize. Conversely, the supposition that there are (or have been) issues that we are not cognizant of and are lacking does not appear to be an implausible assumption. Indeed, the RRI in the EU was instigated with the objective of addressing issues that had not been addressed in the ELSA project. It is external in the sense that we simply refer to it as "ELSI as Issues" for the issues that are already present and continue to exist even if they are not recognized. In order to circumvent the potential difficulties associated with this debate, this paper proposes the relatively modest premise that 'ELSI as Issues' exists, at least when 'ELSI as Activities' is a viable activity. It thus follows that both externalists and internalists can accept the arguments put forth in this paper.

# 5. Conclusion: Toward Application

We now briefly review the discussion in this paper. Firstly, we organized the concept of ELSI in Section 2. As a result, the concept can be interpreted in three ways: "ELSI as Issues," which is taken literally; "ELSI as Activities (1)," which is a general activity to address the issues; and "ELSI as Activities (2)," which refers to projects conducted during a specific period of time. Consequently, Section 3 summarizes how the concept of RRI has developed in the EU. As a result, it became clear that RRI has been characterized from two perspectives: "target," which is the main object to be tackled, and "attitude," which is required when tackling it. From this, the concept of RRI in the EU has been formulated at a glance. Finally, in Section 4, we attempted to reformulate the concept of RRI in such a way that it is independent of the EU-specific context. As a result, the concept of RRI was formulated more generally as "the activities that address 'ELSI as Issues' around specific targets in a way that involves specific attitudes". This is a broader view of RRI than the general view of RRI, and it forces a modification and revision of the traditional understanding of ELSI and RRI.

The new framework for RRI obtained in this paper is useful in that it will enable us to evaluate the efforts being made around the world from the perspective of RRI. For example, the "Quantum Technology Innovation Strategy" (Cabinet Office 2020a), a strategy document for quantum technology in Japan, does not mention ELSI or RRI seemingly at first glance. This differs from the "AI Strategy 2022" (Cabinet Office 2022) and "Bio Strategy 2020" (Cabinet Office 2020b), which are also positioned as important national technology strategies. In accordance with the conventional interpretation of RRI, this could be employed to assess Japan's quantum technology policy as being deficient in an RRI perspective. However, upon reexamination through the lens of the RRI framework presented in this paper, it becomes evident that the document is primarily oriented towards ELSI, with a specific approach to achieving the desired values. This suggests that it can be interpreted as a strategy document that incorporates the RRI viewpoint. In other words, it is possible to discuss the actions that should be taken and the manner in which they should be evaluated by including initiatives that were not previously considered in the evaluation process according to the conventional RRI perspective on the same playing field, without blindly following foreign standards. Similarly, the "livelihood-oriented RRI" described in section 4-1 can be considered an example of this phenomenon.

On the other hand, due to space limitations, this paper did not go as far as to specifically re-examine and evaluate such practices as RRI. The revision of concepts, including conceptual engineering, must be subjected to constant review from the standpoint of whether they are, in fact, beneficial as a consequence of their application to the aforementioned subjects. This is a topic that requires further investigation in the future.

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1. In some instances, the 'I' in ELSI is used to denote 'implications' rather than 'issues'. In some instances, it is also referred to as ELSA in relation to 'Aspects'. Although these terms originally have a historical and regional context, for the purposes of this paper they will be used without distinction. [↑](#footnote-ref-1)
2. For example, the US Defense Advanced Research Projects Agency (DARPA) has recently emphasised the importance of ELSI (Ethical, Legal, and Societal Implications) in its research activities, and in 2024, the agency began recruiting researchers whose work is focused on ELSI (DARPA 2024). It should be noted that the substantive content to which the expression 'ELSI' refers (i.e. any non-technical issue) is considered important regardless of the specific time period. The question of whether the expression itself is outdated is not under discussion. The question of whether the expression is outdated and the question of whether the substantive meaning of the expression is important are two distinct issues. [↑](#footnote-ref-2)
3. For example, the Dutch National Agenda for Quantum Technology describes 'social impact (ELSA)' in the usage of 'ELSI as Issues' (Quantum Delta NL 2024). [↑](#footnote-ref-3)
4. Information on this WS can be found in several references, including Owen and others, but it has now been removed from the EU/EC website and it is not possible to consult the proceedings or other documents. [↑](#footnote-ref-4)
5. n Horizon Europe, the RRI perspective is to be incorporated into the application process. The application format is accessible via the following link: <https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/temp-form/af/af_he-ria-ia_en.pdf> (last accessed 25 June 2024). [↑](#footnote-ref-5)
6. For a comprehensive analysis of the evaluation criteria pertaining to RRI, please refer to the works of Wickson and Carew or Shineha (Wickson and Carew, 2014; Shineha, 2020). [↑](#footnote-ref-6)
7. Earlier, in the report ‘Options for Strengthening RRI’, published in February 2013, four dimensions were identified as defining RRI (EC, 2013). It should be noted, however, that this was an interim stage report by an expert group of which Stilgoe was a member. The source of the information is given as 'Stilgoe et al. (2012)'. However, the bibliography indicates that the relevant document is marked as 'forthcoming' and that no paper with the same title has been published as of 2024. Given the resemblance between the title and content, it was surmised that the 2013 article under discussion here corresponds to the aforementioned literature. It is important to note that Stilgoe et al. introduce four dimensions as aspects of Responsible Innovation (RI), which have similar elements to RRI but are, according to the authors, broader in scope. However, we do not differentiate between RI and RRI on the grounds that the aforementioned 'Options for Strengthening RRI', in which Stilgoe is a member, cites the four dimensions as a definition of RRI (Stilgoe et al., 2013; EC, 2013). [↑](#footnote-ref-7)
8. The description in Figure 5 could also be interpreted as 'ELSI as Activities'. However, as the description itself already incorporates a specification on attitudes, it is interpreted here broadly as 'ELSI as Issues'. [↑](#footnote-ref-8)
9. Zwalt and Neil (2009) propose a classification of ELSA projects designated as "ELSI as Activities (2)" into four categories: proximity, anticipation, interactivity, and interdisciplinarity. By employing these as attitude designations, it is possible to interpret ELSA projects as a specific form of RRI. That is, it can be expressed as follows:

ELSA is an activity that addresses "ELSI as Issues"
with a focus on $T\left(gender, science education,engagement, open access, ethics\right)$

in a way that is accompanied by $A\left(proximity, anticipation, interactivity,interdisciplinarity\right)$. [↑](#footnote-ref-9)
10. This finding is consistent with the claims of some authors, such as Zwalt et al. and Ryan and Block, that ELSI (ELSA) and RRI are in fact very similar, just with a different focus (Zwalt et al. 2014; Ryan and Block 2023). [↑](#footnote-ref-10)