I AM RRI

Webs of Innovation and Value Chains of Additive Manufacturing under Consideration of RRI

www.IAMRRI.eu

D2.2 Definitions and Conceptualisations

Abstract (3 Lines):

D2.2 is a collection of all definitions and conceptualisation used to describe the webs of innovation value chains in additive manufacturing by a conceptual as well as a numerical model

I AM RRI Identifier:	IAMRRI-D2_2_V1_Final
Author(s) and company:	Geerten van de Kaa, Vladimir C. M. Sobota, Martin Spring, Danny Soetanto, Miia Martinsuo, Toni Luomaranta, Antonia Bierwirth, Brigitte Kriszt, Nhien Nguyen, Izaskun Jimenez Iturriza
Work package:	WP2
Document status:	Final version_V2
Dissemination Level:	Internal
Keywords:	Definitions
Abstract:	This deliverable provides definitions of key concepts used in the IAMRRI project. Also, it provides a list of key factors for AM technology selection and their definitions
Version & date:	V9, 13-12-2019, revised version

This project has received funding from the European Union`s Horizon 2020 research and innovation programme under grant agreement No. 788361.

Contents

1. Introduction

This document creates a common vocabulary for the members of the IAMRRI project. The selection of concepts and definitions is based on the final version of deliverable D2.1 and the possible actors and stakeholders involved in AM, and the list was compiled by manually screening the document for concepts and definitions. Any concept that seemed noteworthy was included, whether it is defined in the deliverable or not. Most of the definitions are based on the literature, and some rely on definitions by project members. Table 1 concerns concepts mentioned in the literature. Table 2 defines the outcome of the project work, the antecedent factors of the three key performance indicators.

Some factors such as 'capability to overcome firms' path dependence and the dominant logic', 'Focus on business model rather than the product or technology', and 'Capability to develop and strengthen new competencies' have not been taken into account as they are not directly relevant to the modelling and they were aimed for firm's level of analysis.

2. Main concepts and definitions used within the entire research

Concept	Definition
Value	The term value can refer to both economic and societal/social/ethical value. Both terms are defined here. Value in the sense of a societal/social/ethical value can be considered as an individual's abstract beliefs about ideal modes of conduct and ideal terminal goals — i.e., as end-states that are or are not worth attaining (Rokeach, 1973). There is a need to distinguish between espoused values (those that are defined and communicated explicitly), values-in-use (those that are really adopted and reflected in behaviors and artifacts), and enacted values (espoused values that are implemented in practice) (Schein and Schein, 2017). Economic value refers to "the amount buyers are willing to pay for what a firm provides them" (Texas A&M University, 2019). According to Texas A&M University (2019) value "is measured by total revenue. … A firm is profitable if the value it commands exceeds the costs involved in creating the product".
European values	"The Union is founded on the values of respect for human dignity, freedom, democracy, equality, the rule of law and respect for human rights, including the rights of persons belonging to minorities. These values are common to the Member States in a society in which pluralism, non-discrimination, tolerance, justice, solidarity and equality between women and men prevail" Lisbon Treaty, article 1a, see also European aims, article 2) Based on the European values several aims are defined which also point to the RRI approach and are included in the I AM RRI consideration in the impact dimension (internal European market, sustainable smart growth. (
Product	A deliverable that can solve a specific customer need or problem; for example, an item that is manufactured additively. Products may sometimes be divided into "goods" (material products) and "services" (immaterial products), but here products purposely refer to manufactured goods and are distinguished from services.

Concept	Definition
Service	Activities done by an individual or an organization on behalf of another individual or organization
Input	“What is put in, taken in, or operated on by any process or system” (Oxford Living Dictionaries, 2019), resources given to a process
Output	“The amount of something produced by a person, machine, or industry“ (Oxford Living Dictionaries, 2019) or even a process
Solution	Complex offering that solves a customer need or problem, delivers value, and includes product and service elements.
Process	The activities and decisions needed to transform certain inputs to valued outputs. In AM, for example design, manufacturing and service delivery are key processes.
Strategy	An organization’s means to survive and succeed in its business environment, including its purpose and position on the market and in the supply chain, plan of action, and path towards the future. Strategy may be focused on a certain issue, e.g. research strategy, development strategy, strategy for a certain market. Also individuals, groups or networks may have a strategy, for a certain purpose.
Project	“A project is a unique entity formed of complex and interrelated activities, having a predefined goal”, schedule, budget, and specification” (Artto et al., 2011). In AM, projects are used to develop AM technologies, implement them, and create AM products and services.
Organization	A group of people organized to serve a certain purpose. Typically a legal entity. A differentiation can be made e.g. to private organizations (for profit), public organizations, and non-profit organizations.
Inter-organizational	Something taking place between two or more organizations
Network	A group of individuals, organizations or technologies that are interconnected and fulfil a certain purpose.
Additive manufacturing (AM)	A manufacturing approach, where AM technologies are used to “process materials by joining and adding to them, usually layer-by-layer to make an object from a digital model” (Martinsuo and Luomaranta, 2018).
AM technology	Typically implies AM machinery / equipment developed from the application of scientific knowledge.
Actor	A firm or organization participating directly and adding value in the supply chain for AM. Could also be referred to as primary stakeholder.
Stakeholder	A firm or other organization influencing the AM supply chain, but not directly involved in it. Could also be referred to as secondary stakeholder.
AM firm/ AM manufacturer	A firm that owns AM equipment and uses AM as part of its manufacturing process
Original equipment manufacturer (OEM)	A firm producing parts and equipment that may be used and marketed by another manufacturer.

Concept	Definition
AM technology company /firm	A firm that owns AM equipment and uses AM as part of its manufacturing process. The firm may have also other roles in the supply chain, such as design and post-processing.
Service provider, service supplier	A firm supplying services (i.e. activities on behalf of) to another firm and receives earnings from it.
Customer	An organization or individual that receives AM products or services from AM firms and use them in their business (toward end-users).
End-user	An organization or individual that uses the products (or services) delivered in the AM supply chain.
Supplier	An organization that supplies raw material, components or services to another organization (for money or other benefits)
AM machine manufacturer	A firm that develops, constructs and sells AM technology (equipment). May also have other roles in the supply chain, e.g. including the design of AM machine-related software.
AM material supplier	A firm that supplies raw materials to be used as part of additive manufacturing.
AM software supplier	A firm that develops and sells software for AM. Such software may deal with AM design, AM process, or AM equipment (technology).
AM service provider	A firm that offers services in the AM value chain. The services may mean doing AM on behalf of other firms, design or consulting, pre-processing, post-processing, quality inspection, delivery/transport, or any other relevant activities done on behalf of other organizations as part of the value chain.
Insurance firm	A firm that offers insurances to other organizations and individuals. Public health insurance companies also included
Funding institution	A firm that facilitates the exchange of equity ownership, or research and development, for instance, in the form of loans, funding, investment support, and development support
Educational institution	An organization that offers education and training services. May be public (e.g. university, college, etc.) or private (educational firms). In this research, the interest is on educational institutions that offer education services concerning AM specifically.
Research institute	An organization that offers research and development services. May be public (e.g. university, college, etc.) or private (private research organizations). In this research, the interest is on research institutes that offer AM-related research services.
Standardization organization	A public sector agency or network that creates and defines standards for various issues. E.g. ISO, ITU, IEEE, DIN, etc.
End-user	Consumers that use AM products
Innovation	It can be a new product, process, or business model. New can be new to the company or new to the market or new to the world. The three

Concept	Definition
	keywords to define an innovation are 'new, implemented, and value'
Radical innovation	A significant technological development involving disruptive and architectural innovation that can potentially become a groundwork for a new system. Radicalness implies novelty and depends on whose perspective is taken: radical innovation may be new to the firm, industry or world.
Incremental innovation	An improvement to an existing technology, product or process.
Business model innovation	Changing the means by which an organisation or collection of organisations create, deliver and capture value. (see 'Business Model' below)
Invention	An invention refers to a new principle or new idea. A principle can be characterized in terms of its inner working (How does it work?) and functionality (What does it do?). This principle is often incomplete or rudimentary and hence cannot be directly implemented as innovation. This principle can later on be developed into an innovation. A discovery of a new scientific or technical idea. Invention differs from innovation because it does not include the process of turning the idea into a commercially or practically viable product, service or process.
Technology	The application of scientific discovery. Technology involves tools, materials, processes and systems resulting from the development of knowledge.
Business model	The means by which an organisation or collection of organisations create, deliver and capture value. The term is used variously to refer to this idea at the level of individual products or services, within one firm or across multiple firms, as well as at the level of an industry sector e.g. 'the low-cost airline business model'
Product design	Can refer to (a) the process of defining a new product (or, increasingly, service) to meet market demand or (b) the outcome of that process.
Product development	The process/stages involved in transforming a product from idea to marketable product. It includes the development or a new product or the improvement of an existing product. It can be applied to services. It is similar to innovation in that it is a process, but does not include early stages such as invention, and typically focusses on one product rather than a whole class of related products.
Supply chain	An organisation of individuals, organisations and resources that carries out the processes of production, distribution and exchange from raw material, to intermediate components to delivery of the final product to the end users. The term has recently also been applied to service activities and hybrid product/service combinations.
Supply network	A group or a system of interconnected individuals and organisations in delivering value to the end user. Supply network includes strategy, operations, system, governance and capabilities.
Value chain	A range of business process or activities to add value design, production,

Concept	Definition
	marketing and distribution activities. “The value chain disaggregates a firm into its strategically relevant activities with an aim to understand the behavior of costs and potential source of differentiation” (Porter, 1985).
Activities	“The condition in which things are happening or being done”, (Oxford living dictionaries, 2019) or actions being undertaken by individual organisations or in a supply chain or a innovation value chain, or in a innovation network
Innovation value chain	Innovation value chain is foremost an analytical tool to analyze innovation activities and how value cumulates and realizes (Hansen & Birkinshaw, 2007; Roper et al., 2008) Innovation value chain is “a sequential, three phase process that involves idea generation, idea development, and the diffusion of developed concepts” (Hansen & Birkinshaw, 2007, p. 122). Where each phase has a sub- “process through which firms source the knowledge they need to undertake innovation, transform this knowledge into new products and processes, and then exploit their innovations to generate added value” (Roper et al., 2008, p.961). Innovation processes, however, “involve feedback loops and external linkages” (Roper et al., 2008) where the wider knowledge sources and networking activities for the innovation process are important (Iansiti and Levien, 2004). Each phase, process stage and participating entity aims to produce some inputs/outcomes (value) for this innovation process in order it to become exploitable when the innovation is ready to be diffused (according to Porter’s (1985) value chain logic).
Value network	According to Allee (2000): “A value network generates economic value through complex dynamic exchanges between one or more enterprises and its customers, suppliers, strategic partners, and the community. These networks engage in more than just transactions of goods, services, and revenue. The two other currencies are knowledge value and intangible value or benefits.”
Web of innovation value chains	A set of inter-dependent chains of innovation activities, relating to different products or services, that span multiple organisations (Hansen and Birkinshaw, 2007; Ganotakis et al., 2012; Roper et al., 2008)
Competitive advantage	Competitive advantage refers to the ability of a firm to leverage its resources with respect to a vision in a way that is difficult for competitors to imitate (Prahalad, 1993).
Technology success	Encompassing success in terms of installed base, profits, social and societal acceptance.
Performance	Performance describes the behaviour of a system, e.g. a business unit, an engineering system, for quantification often performance indicators are applied which measureable factors of the systems.
Impact	An impact is the action of one object (e.g. research project) coming into contact with another.
Market impact	Impact which leads to a cumulative change in market (environmental) change over the time.

Concept	Definition
Strategic impact	"The effect that the relevant AM webs of value chains, or the "AM-industrial ecosystem" has on the EU. Strategic impact, in comparison to economic performance, thus deliberately looks outside the AM industrial ecosystem. Stimulating employment, increasing knowledge intensive and thus high-level activities in the EU, competitiveness vis-a-vis other parts of the world, and effects of the AM webs of value chains on traditional manufacturing activities all represent a kind of strategic impact", (Van de Kaa1 et al 2019)
Social performance	"The performance of the system in more normative and less monetary terms, [studying] the effects of the system on more actors than just suppliers/producers and customers alone. In doing so, stakeholders outside the directly involved actors on the supply and demand side of the market are considered. Considerations important for future generations, or EU-citizens that are not customers but are impacted by the behaviour of supply and demand, are also taken into account. In doing so, not only direct economic monetary indicators are used to study the system but also normative aspects that we consider as important for the society at large, now and in the future", (Van de Kaa1 et al 2019)
Social acceptance	"the fact that a new technology is accepted or merely tolerated by a community" (Taebi 2017: 1818)
Ethical acceptability	"a reflection on a new technology that takes into account the moral issues that emerge from its introduction" (Taebi 2017: 1818)
Adoption	"Adoption of […] technology has happened when the technology has been installed and is in use" (Broam et al 2014).
Diffusion	The movement of items (such as products and services) from areas with higher concentration to areas with lower concentration. In the domain of innovations, diffusion means the sharing/movement of the innovation from its original development location to other areas (such as new markets).
Driver	"A factor which causes a particular phenomenon to happen or develop" (Oxford Living Dictionaries, 2019), a driver is seen in natural science or engineering as a force leading a system to a certain direction
Barrier	"A circumstance or obstacle that keeps people or things apart or prevents communication or progress" (Oxford Living Dictionaries, 2019)
Social responsibility / corporate social responsibility	Various definitions exist of the concept of corporate social responsibility such as "obligation to respond to the externalities created by market action" (Crane et al 2008). Besides the different academic definitions, the European Commission has defined CSR as "the responsibility of enterprises for their impacts on society" (European Commission, 2011). Further, the EC states that "to fully meet their corporate social responsibility, enterprises should have in place a process to integrate social, environmental, ethical, human rights and consumer concerns into their business operations and core strategy in

Concept	Definition
	close collaboration with their stakeholders" (European Commission, 2011).
Sustainability	Sustainability can be defined "the ability to continue or be continued for a long time" (Oxford Learners Dictionaries, 2019)
System	"A set of things working together as parts of a mechanism or an interconnecting network; a complex whole" (Oxford Living Dictionaries, 2019)
Innovation systems	According to Fischer et al, 2001 an innovation system is seen as a set of actors like organizations that interact in the generation, diffusion und use of new knowledge in the production process. (Fischer et al, 2001)
Agent based model	An agent based model can be defined as "a class of computational models for simulating the actions and interactions of autonomous agents (both individual or collective entities such as organizations or groups) with a view to assessing their effects on the system as a whole." (Wilensky & Rand, 2015)
Agent	"Agents are parts of a program that are used to represent social actors or individual people, organizations, or bodies such as nations." (Ludu, 2016)
Environment	"The environment in agent-base model is the virtual world in which the agents act. It can represent geographical spaces, or knowledge spaces, or a network that links agents together." (Gilbert 2008, page 6)
Activity	Task carried out as part of a process, some activities are value adding
Indicator	"A measure that indicates the state or level of something" (Oxford Living Dictionaries, 2019)
Performance indicator	"A variable/measure by which the success or productivity of a venture, policy, or product can be gauged." (Oxford Living Dictionaries, 2019)
Production process	A process involving different types of tools, equipment, and materials in order to convert raw materials into final product.
Business process incl. strategic process	A series of activities and tasks performed by organisations to deliver the end products or services to users/consumers. This process is also influence by organisational objectives and goals.
Regulation process	A set of activities in making or developing regulation or policy
Deregulation	"The removal of regulations or restrictions, especially in a particular industry" (Oxford Living Dictionaries, 2019).
Liberalization	"The removal or loosening of restrictions on something, typically an economic or political system" (Oxford Living Dictionaries, 2019).

Table 1: Main concepts and definitions used within the entire research conducted in the IAMRRI project

3. Main concepts and indicators regarding RRI keys[1]

The responsible research and innovation approach is characterised by a various number of indicators. RRI in understanding of EC has to be seen as an intrinsic approach in innovation. RRI indicators are describing the ongoing orientation to the European innovation action by the following indicators. (Table 2)

Table 2: RRI Indicators

Concept	Definition/Explanations
Responsible research & innovation (RRI)	The understanding of the EC on RRI has undergone a change during the last years. In the beginning the responsible innovation approach and the responsible research and innovation approach and the concept of the EC had the same origin. According to Rene von Schomberg (2013) "Responsible Research and Innovation is 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). The author also emphasizes the anticipatory, deliberate, reflexive and inclusive approach of Responsible Research and Innovation and states that "The challenge is to arrive at a more responsive, adaptive and integrated management of the innovation process. A multidisciplinary approach with the involvement of stakeholders and other interested parties should lead to an inclusive innovation process whereby technical innovators become responsive to societal needs and societal actors become co-responsible for the innovation process by a constructive input in terms of defining societal desirable products."(Von Schomberg, 2013, p. 54). RRI war oriented more to that which is often referred as dimension. Actually the EC concentrates on RRI[2] keys –public engagement, open access, gender equality, ethics, and science education). The MORRI[3] project takes up that understanding and developed sets of indicators on that keys.[4] Governance is also seen as a key (RRI tools) but is currently not shown at the webpage of the EC as a key. The work of the MORRI project gives sets of indicators which will be used in the project. MORRI focuss on science (universities), public funding, governmental institution, and not so on industrial innovation. So for the I AM RRI work some indicators have to be adjusted to the characterization of the RRI performance of companies as well. The EC is currently collection data from work on H2020 projects under the umbrella of "Institutional Change" for measure RRI activities.

[1] Prepared by Tecnalia, MUL, NRI, authors are responsible for there text.

[2] https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation

[3] MORRI https://www.technopolis-group.com/morri/

[4] In MORRI the keys are named as dimensions as well, in the I AM RRI project the will be named "keys", see also D2.4

Concept	Definition/Explanations
European Values	European values are given in the Lisbon Treaty, Most relevant value for RRI coming from Lisbon Treat is Gender equality: TREATY OF LISBON, 2007/C 306/01, Article 2, values of EU: Article2 "The Union is founded ……. **equality between women and men**…."(RRI key gender equality)
Openings	Are defined in two ways: a.) Openings as a failure to address sufficiently any of the six key areas. In a strict sense, RRI is a defined "contract" between science and society on different intersection areas: Open access, Gender, Governance, Ethics, Science Education, Public Engagement;" (Spring et al. 2019) b) Openings in a prospective responsibility towards society, where stakeholders have the opportunity to undertake an honest effort to achieve the "right" social impact. In a broad sense, RRI promotes responsibility towards society and its beliefs, structures, norms, and values." (Spring et al. 2019)
RRI Indicators (MORRI) – References were taken from MORRI final report (MORRI, 2018)	
Gender	
Gender Reference (Lisbon treaty- defined European values)	Definitions and data on gender/ gender equality were taken from "Analytical report on the gender equality dimension" from MORRI project provided by Angela Wroblewski, Susanne Bührer, Andrea Leitner, Cheng Fan, March 2015, published on the Technopolis webpage[5] or from the final report "Monitoring the evolution and benefits of responsible research and innovation in Europe", RTD-PUBLICATIONS@ec.europa.eu European Commission, BE-1049 Brussels,
Gender and Gender equality	Gender is understood in MORRI as a social construct which derives from practices, it includes not only the differences between men and women, but also the distinction by social roles. Gender equality is given when women and men are equally represented in all disciplines and hierarchical levels; barriers for developing women and men are dismantled, and gender equality (key) is considered in all research and innovation activities.
Gender equality categorisations (MORRI pillars)	1. Promote women in fields where they are under-represented (number of women in AM) 2. Implementation structure measures aiming for change in organisation (structured measures in AM organisations) 3. Integration of a gender dimension on research and innovation content (gender innovation by AM) It is supposed that implementation of measures form one to three should lead to a cultural change
Indicator GE1 Share of RPOs with gender equality plans (according to MORRI,	Gender equality plan is an instrument to follow the strategic implementation of gender equality measured (first and second pillar). GE1 describes the share of research performing organisation have a

[5] http://www.technopolis-group.com/report/analytical-report-gender-equality-dimension-d2-3/

Concept	Definition/Explanations
2018)	gender equality plan, GE1: share of RPOs with gender equality plans measures institutional engagement in gender equality work
Indicator GE5 Share of RPOs with policies to promote gender in research content according to (according to MORRI, 2018)	Belongs to the third pillar, Share of RPOs with policies to promote gender in research content investigate the extent to which RPOs and RFOs take actions to ensure the integration of the gender dimension in research content
Indicator GE8 Share of female heads of RPOs according to MORRI, 2018)	Belongs to the first pillar, GE8 describes the number of females in research performing organisation
Indicator GE9 Share of gender-balanced recruitment committees at RPOs according to MORRI, 2018)	Belongs to the second pillar, GE9 Share of gender-balanced recruitment committees at RPOs monitor female participation in key gatekeeping positions that involve decision-making for strategy and employment.
Public engagement	
Public engagement categorisations	MORRI (Mejlgaard et all, 2015) public engagement was understood as activities with a distinct role for citizens and/or societal actors in research and innovation processes. Public engagement includes the engagement of other actors in science, in order to inform and/or educate citizens, to inform decision makers and create awareness in order to influence decision-making processes, to facilitate interaction and dialogue, and to involve citizens in decision-making. There are thus a number of aspects: participation, facilitation and actions to promote engagement. In the IAMRRI project public engagement is understood in the same manor, marketing activities which focuses on customer are not understood as public engagement.
Indicator PE5 Public engagement performance mechanisms at the level of research institutions	Is a composite indicator derived from the MORRI project, values are between zero and one, it derived from the evaluation of two questions of a MORRI survey asking which mechanisms does your institution apply in order to interact with citizen and societal stakeholders (14 answers categories provided), and which level of strategic priority has public engagement at our research institution (high/ moderate/no priority)
Indicator PE6 Dedicated resources for PE	MORRI proposed that indicator “Dedicated resources for public engagement”, but it was dropped because results from higher education institutions survey (HEI) and MORRI internal surveys on resources for PE6 are inconsistent, the I AM RRI project will go back to the definition if an organisation has dedicated resources for PE.
Science literacy and scientific education categorisations	
Science literacy and scientific education categorisations	According to MORRI – D2.2 “Science literacy and science education was defined as a bundle of activities provides citizens with a deeper understanding of science, to shape their attitudes towards science, and to develop their abilities to contribute to science and science-related policymaking. This includes three aspects: science education, science communication and the co-production of knowledge.”
Indicator SLSE2 RRI related	Provides information/training on whether and to what extent RRI-

Concept	Definition/Explanations
training	related aspects, i.e. ethical, economic, environmental, legal and social aspects (EEELSA), are included in the training of young researchers. In the I AM RRI project involvement of companies in the RRI training will be taken into account
Ethics categorisations	
Ethics	The definition of ethics adopted by the (MORRI project) is the following: "Ethics as a scientific discipline is concerned with normative rules for everybody. In the context of research and innovation, ethics is a common platform for deliberation and discussion of values in society that are based on perceptions of right and wrong, influenced by cultural norms and aiming at informing policymaking." From a more R&I focused perspective, Hahn et. al define ethics as "a common platform for deliberation and discussion of values in society, that is based on perceptions of right and wrong, is influenced by cultural norms, and aims at informing policy making" (Hahn et al., 2014, p. 3). From the perspective of the European Commission[6], the "Ethical research conduct implies the application of fundamental ethical principles and legislation to scientific research in all possible domains of research – for example biomedical research, nature sciences, social sciences and humanities. The most common ethical issues include: (i) involvement of children, patients and vulnerable populations; (ii) the use of human embryonic stem cells; (iii) privacy and data protection issues; and (iv) research on animals and non-human primates. It also includes the avoidance of any breach of research integrity, which means, in particular, avoiding fabrication, falsification, plagiarism or other research misconduct." (Retrieved from the European Commission's RRI-related website. Ethics is in engineering oriented topics is not so common as in medical societal areas." Due to the potential of additive manufacturing being interdisciplinary or diversification in different segment in future these scenarios will change in a "natural" way.
Ethics categorisations	Ethical engagement can be categorized several ways: (i) from a formalization point of view it can be a formal or an informal engagement with ethics. (ii) According to Brom et al., three typologies of ethical engagement can be categorized: ethical governance, ethical deliberation and ethical reflection. (iii) Different levels of engagement exist, namely, at individual level, level of individual organisations and regional, national, European and international level. European nation have different instruments and organization
Indicator E1 Ethics at the level of research organisation and companies[7]	E1 indicator, according to (MORRI project), is an index-measure using primary data collected via the Research Performing Organisations (RPO) survey and a survey addressing national research integrity offices to investigate the ethics performance of European universities.

[6] https://ec.europa.eu/programmes/horizon2020/node/767

[7] MORRI - The evolution of Responsible Research and Innovation in Europe: The MORRI indicators report Monitoring Report Pre-publication version (February 2018)

Concept	Definition/Explanations
	The indicator aims for full EU28 coverage and includes the possibility of repetitive data collection. More specifically, this measure has been designed to provide information on the level of mechanisms that should safeguard the observance of ethical standards in research ethics and research integrity implemented within universities at the country level. MORRI also proposed an indicator on ethics based on the HEI survey (Higher education institutions survey -HEI survey, MORRI 2017) E1 is defined primarily in direction of universities as research performing organization. In the I AM RRI project, companies are also included in the research process. So, the definitions of E1 should be also taken for companies. The indicators expresses if a university or public funded research organisation has a research ethics committee or a research integrity office. (The MORRI indicators report, 2018 – see MORRI project)
Indicator E2 National Ethics Committees Index (NEC Index)	The index measures existence, output, impact and quality of NECs. It measures the output both in terms of opinions and of the contribution to public debate and policy making. The index focuses on the role of public NECS by measuring the publication of work results, the organisation of public events, classification of existing public involvement mechanisms, involvement of target groups and the existence and quality of websites. Within the I AM RRI project, this indicator would allow us assessing the innovation system as a whole in terms of RRI beyond the research organisations and companies. The indicator will than express if an ethical committee for the innovation system AM exists.
Indicator E3 Research Funding Organisations Index	The indicator is based on the question "Has your organisation integrated any type of ethics assessment/review in its funding decisions?" from the dedicated survey of the funding organisations (MORRI, 2018). From the perspective of I AM RR, this indicator allows assessing how funding organisations have integrated RRI aspects in their activities and having an RRI-oriented perspective of the innovation system.
Indicators for ethical orientation of companies/industry	MORRI did not give indicators for companies or industry being involved in innovation actions. From the classification of MORRI, indicators E1, indicators like does the organisation has established processes on ethical assessments in innovation process or does the organisation has cooperation with ethical panels can be selected for characterising the company/industry activity on RRI key ethics.
Open access categories	
Reference	MORRI project, 2018
Indicator OA6 RPO support	This is a composite indicator built from the answers of three

Concept	Definition/Explanations
structures for researchers as regards incentives and barriers for data sharing	questions (MORRI, 2017) (1) Which of the following policies apply in your institution: • Your institution has explicit open data management regulations, • Your institution chooses to follow funder- or field-specific incentives for open data and publication sharing? (2) Which of the following open data sharing practices apply in your institution: • Repositories are provided by your institution/ by departments? (3) Which of the following support (in kind and in funding) options with regard to open access publishing and data sharing apply: • IT support for FAIR data practices, • budget for the implementation of Open Data sharing, • online communication on publication and data sharing practices • training in research data sharing
Governance categorisations	
Indicator GOV2 Existence of formal governance structures for RRI within RF and RP organisations (MORRI project 2018)	The indicator aims to provide an insight how far the RRI concept has reached the research system by addressing the following question to funding organisations and research-performing organisations is established in the organisation. A maximum score is given to organisations that cover all 5 key dimensions. (MORRI project, 2018).
Governance from stakeholders	Results of the I AM RRI project shows that stakeholders, like standardization organizations or public authorities, political decision maker, funding organizations can also establish governance activities to influence innovation system and actions. These can range from norms or standards, funding programs, laws and regulations or tax incentives. These can influence processes within the web of innovation value chain or set rules for innovation action in the various steps of the innovation process, or regulate interaction of actors in the innovation system.

4. Main concepts regarding factors for social and market acceptance

A workshop with all university and industrial partners selected the most relevant indicators for the innovation system of additive manufacturing due their experience. This list is of factors is based on the output of D2.1, but strongly shortened, relying on the requirements of the best-worth method (BWM), which requires a maximum of 7-9 categories with no more than 7 factors each. The shortening of the list of factors would have been necessary in any case, whether or not relying on the BWM. A more coherent and oversee able set of factors is in itself beneficial to general understandability.

We decreased the amount of factors by removing duplicates, excessive detail, and factors from WP6. We summarised factors when they seemed to describe another factor in more detail. The documentation of the process is available upon request. New categories were created, and categories

were renamed. The numbering (capital letters) of the old categories was kept for traceability and is not consecutive. (Table 3)

Table 3: Indicator selected by industrial partners

Factor	Definition
A. Innovator characteristics (demand side)	
Customer level of education	Ability of the customer to use and operate (e.g., familiarity)
Customer resources	Ability to buy (e.g., sensitivity to price)
Customer need	Necessity to buy. demand (both forecasted and current rate)
Customer installed base (previous, current, potential)	Refers to the number of units in which the innovation was in use (previous), is in use (current), or will potentially be in use (potential) (Van de Kaa, et. al 2011).
Intended frequency of use	The number of times within a given time a certain product is intended to be used. E.g. ”four times a week”, or “monthly” (i.e. once a month).
B. Innovation characteristics innovation itself)	
Relative technological performance	Compares the technological performance relative to other alternatives (e.g., complexity, reliability, defect rate, geometrical complexity, implementation with sliced data, part internal optimisation, product structure, quality, technological solutions, technology and tools, user friendliness).
Compatibility	Refers to compatibility with older versions of the innovation and other systems, knowledge and capabilities (also radicalness of innovation).
Flexibility	Refers to the incremental costs of adapting the innovation to new customer needs, developments, etc. (van de Kaa, et. al 2011)., (e.g., customization, path patterns and design, path planning, Variation of product shape complexity and cross-sectional area)
Perceived risk	Refers to in how far the innovation is perceived as risky by customers.
Relative price / cost / effort	(e.g., capital requirement (machine as well as printed products))
Complementary goods and services	Goods and services that are consumed together with the innovation (e.g. mobile phones and phone cases).
E. Innovator characteristics (supply-side)	
Financial strength	Refers to the financial resources of the parent organisation which are available to support the innovation, both current and prospective (van de Kaa, et. al 2011)
Brand reputation and credibility	E.g., trust in the brand, benefits for society and potential threats, "vendor trust")
Operational Supremacy	Refers to in how far the innovator exploits its resources more effectively than the competitors (van de Kaa, et. al 2011)., (e.g., agreed response time, AM production rate, capacity utilisation (time, material, component lifetime, labour and overhead costs, number of

Factor	Definition
	supply options, E-commerce channel design (Shukla, et al, 2018): tele-manufacturing, collaborative manufacturing, local manufacturing, user manufacturing)
Learning orientation	Refers to the firms' capacity to learn and absorb information.
Efficiency of production process	As opposed to operational supremacy, this factors concerns the characteristics of the production system itself(e.g., cost, ancillary process steps, build time, control, delays, cost of manufacturing and safety stock, electricity consumption, emerging manufacturing processes and their features, fluids consumption, identification of key issues in the, Lead time (that vary by production volume)process, Manufacturing time, Material consumption, process planning, Process and strategy, remaining usage period, stock resupply lead time, orders, back-orders, inventory, safety stock, Materials supply / availability, number of Suppliers)
Enabling infrastructure and technology / production method	Necessary infrastructure for the innovation to unfurl its utility, e.g. high-power grid for charging stations for electric cars)
F. Innovation support strategy	
Pricing strategy, price structure	"This refers to all actions taken to create market share through strategically pricing the products in which the format has been implemented." (van de Kaa et al., 2011, p. 1404).
Appropriability strategy (IPR)	Efforts to protect the innovation against imitation.
Timing of entry	Refers to the strategic choice of a point in time of an innovation's first market introduction (e.g., Pre-emption of scarce assets)
Marketing communications	Communication with customers is important to manage expectations, for example strategic pre-announcements (including Strategic market development, sense of mission, Lobbying activities, communicability)
Distribution strategy	"this factor refers to the extent to which a firm pursues a strategy which increases the strength of its distribution system" (Van de Kaa et al. 2011)
Commitment (supply side innovator)	Refers to the attention an innovation gets from the actors involved (e.g., support)
Network formation and coordination strategy	Future direction and plan of action for forming and coordinating a network.
G. Other stakeholders	
Big Fish	"A big fish is a player (other than the group of format supporters) that can exercise a lot of influence by either promoting or financially supporting a format or by exercising buying power that is so great that this will tip the balance for the format to become dominant in the market" (van de Kaa et al., 2011)

Factor	Definition
Regulator	A public sector official that specifies laws and regulations in a geographic area – continent, country or region (e.g., government, Lobbying activities, Regulatory backlog (Liability for 3D printed components))
Standardisation organisations	A public sector agency or network that creates and defines standards for various issues. E.g. ISO, IEEE, ITU.
Judiciary	Refers to the system of courts that interprets and applies laws as a means to solve conflicts.
insurance company/firm	A firm that offers insurances to other organizations and individuals.
H. Environmental-level factors	
Bandwagon effect	Users choosing an innovation because others have chosen it already (also network effects)
Uncertainty in the market	Customers are hesitant to adopt when the level of uncertainty is too high (van de Kaa et al., 2011), (e.g., Rate of change, Number of options available, unforeseen (micro) events (including e.g. International political conflicts)).
Switching costs	Cost required to switch between competing technologies / innovations (also, resistance to change).
Availability of rules and standards, information	The absence of rules and standards might prevent a technology from being used (e.g. no testing procedure for custom motor bike helmets)
Chances for attractive jobs	Refers to how appealing in an industry is to job searchers, both perceived and relative to other industries.
Sufficient education and skills development	Refers to the availability of arrangements to upgrade the skills of workers according to needs of the AM industry.
Dissemination of AM in society	Indicates in how far AM as a production method is known and used within the society. Higher dissemination would increase the familiarity with the technology.
I. Values and Norms	
Environmental sustainability	According to Morelli (2011), environmental sustainability from the perspective of environmental professionals can be defined "as meeting the resource and services needs of current and future generations without compromising the health of the ecosystems that provide them"
Data privacy, security and control	"Privacy refers to the concern that individuals' personal data can be used externally to infer information about activities that are considered as private" (McKenna et al, 2012 as cited by Milchram, 2018). "Security concerns on the other hand are defined in terms of the risk that personal data is subject to malicious external attacks, e.g., through hacking". (Muench, et al, 2014 as cited by Milchram, 2018)
Public health	"to fulfil society's interest in assuring conditions in which people can be healthy" (Heller et al. 2003)

Factor	Definition
Social justice	"full participation in society and the balancing of benefits and burdens by all citizens, resulting in equitable living and a just ordering of society." (Buettner-Schmidt and Lobo (2012))
Social inclusion	The concept can be defined in various ways including "the process of improving the terms for individuals and groups to take part in society." (Euchinasprp, 2019) and "the process of improving the ability, opportunity, and dignity of people, disadvantaged on the basis of their identity, to take part in society." (Bartsch, et. al, 2019).
(Social) norms	"Norms are social phenomena, and they are propagated among group members through communication" (Lapinski and Rimal, 2005)
Imitability, scalability, and integrability	The extent to which the innovation/business model can be imitated and whether there is a significant cost and disadvantage for another organisation to duplicate the innovation/business model.
Failure to identify actors/stakeholders	The capability of the business to be changed in size and scale.
Failure to consider influencing factors	The extent to which the new innovation can be integrated to the existing system.

5. Future research recommendations and next steps

The list of factors in tables 1-3, even already reduced with the feedback of industrial partner in AM, is still large. Therefore, future research and modelling should attempt to show the role of the factors on the dynamic of the AM web of innovation value chain systems.

As information on importance of factors with respect to AM is not available in the literature but information is available with the various partners that exist in the project, it is recommended to make use of their expertise and, by conduct a multi-criteria decision making method in order to arrive at weights of factors. **The top scoring factors could then be used in the simulation model. Given the large number of factors, applying an MCDM method that can deal with large number of factors simultaneously is recommended. In that respect, the best worst method (Rezaei 2015, Rezaei 2016) is preferred as this is one of its advantages.**

As the literature study showed, multiple factors can explain the success and failure of the AM innovation ecosystem which qualifies this problem as a Multi-criteria decision-making (MCDM) problem. MCDM methodologies were developed for analysing decisions in which many factors are involved, and the BWM, Analytic Network Process (ANP), or Analytic Hierarchy Process (AHP) are examples for such methods. Amongst these alternative methods, we opted for the BWM based on advantages such as data collection in a structured manner, the relatively low amount of data needed, and its user-friendliness. Similarly to other methods, it is based on pairwise comparison, but it stands out with a lower requirement of comparisons. As a vector-based method, the BWM needs (2n-3) comparisons, where n is the number of criteria (factors) compared, whereas matrix-based methods such as AHP require more comparisons, namely (n(n-1)/2) (Rezaei, 2015). Combined with the structured approach to comparisons (identifying the best factor (criterion), identifying the worst factor (criterion), comparing all factors to the best and worst factor), the BWM is well-suited for the comparison of many factors. The structured approach to comparing factors also contributes to the reliability of the method.

The BWM has already been applied, for example, to obtain the relative weights of logistics performance index indicators (Rezaei, 2018), in the selection of facility locations for bioethanol production (Kheybari, Kazemi, & Rezaei, 2019), in the analysis of competing technologies in the case of smart meter connectivity (van de Kaa3, et al., 2019), to evaluate importance of values (van de Kaa2, et al., 2019), or to prioritize barriers to sustainable manufacturing (Malek & Desai, 2019). With a comparison of 39 factors, the latter example is noteworthy as it proved that the BWM can used to compare higher number of factors in a reliable and consistent way. In this respect, the goal of the factor comparison is to rank (or prioritize) the factors based on their factor weights. In line with this goal, the use of the linear model of the BWM (Rezaei, 2016) is preferred as the non-linear version (Rezaei, 2015) may result in multiple optimal solutions, which is not ideal for the ranking of factors. Therefore, it seems reasonable to apply a linear method to the opinions of participants for which the assumption of linearity may or may not hold.

So we recommend future research to apply the list of factors mentioned in table 2 an table 3 in a multi-criteria decision making study where experts are asked to rate the importance of the various factors. The first step should be to ask experts which factors are relevant (without showing them the factors mentioned in table 2 and table 3 so to prevent any possible bias). Factors that are mentioned by experts or mentioned in the literature could then be taken into account in the BWM. Based upon the results of the BWM analysis, the most important factors can be chosen and included in an agent based model so that the openings for RRI in the webs of innovation value chains can be modelled.

6. References

Allee, V. (2000). Reconfiguring the value network. Journal of Business strategy, 21(4), 36-39

Artto K., Martinsuo M., Kujala J. (2011). Project business. Helsinki, Finland

Bartsch, B. Hellkötter, K. Menan, M. (2019), More than a market, How German companies are growing roots in Chinese society, http://aei.pitt.edu/74113/1/More_than_a_market.pdf

Brom F.W.A; Chaturved S., Ladikas M., Zhang W (2015): Institutionalizing Ethical Debates in Science, Technology, and Innovation Policy: A Comparision of Europea, India and China in Ladikas et al (eds) Science and Technology Govrenache and Ethics, Springer Cham

Broman Toft, M., Schuitema, G., & Thøgersen, J. (2014). Responsible technology acceptance: Model development and application to consumer acceptance of Smart Grid technology. Applied Energy, 134, 392–400. https://doi.org/10.1016/j.apenergy.2014.08.048

Buettner-Schmidt, K. and Lobo, M.L. (2012). Social justice: A concept analysis. J Adv Nurs, 68 (4) (2012), pp. 948-958, 10.1111/j.1365-2648.2011.05856.x

Crane, McWilliams, Matten, Moon, Siegel (2008), The Corporate Social Responsibility Agenda, Oxford University Press, https://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199211593.001.0001/oxfordhb-9780199211593-e-001?print=pdf

Euchinasprp, (2019), U-China Social Protection Reform Project Component 3, https://www.euchinasprp.eu/images/documents/Component3/04.07.2017.report%20on%20reseach%20study%20on%20social%20assistance_China&EU%20contributions_EN.PDF

European Commission, (2011), Communication from the Commission to the European Parliament, the council, the European economic and social committee and the committee of the regions: A renewed EU strategy 2011-14 for Corporate Social Responsibility, https://www.europarl.europa.eu/meetdocs/2009_2014/documents/com/com_com(2011)0681_/com_com(2011)0681_en.pdf

European Commission, (2018a), MORRI - Monitoring the evolution and benefits of responsible research and innovation in Europe, https://www.technopolis-group.com/wp-content/uploads/2018/05/Final_report_MORRI.pdf

European Commission, (2015), MORRI - Metrics and indicators of Responsible Research and Innovation, Progress report D3.2, http://www.technopolis-group.com/wp-content/uploads/2016/12/2171_D3.2.pdf

European Commission, (2018a), MORRI - Monitoring the evolution and benefits of responsible research and innovation in Europe, https://www.technopolis-group.com/wp-content/uploads/2018/05/Final_report_MORRI.pdf

European Commission, (2018b), MORRI - The evolution of Responsible Research and Innovation in Europe: The MORRI indicators report Monitoring Report Pre-publication version (February 2018)

European Commission, (2019), Ethics, https://ec.europa.eu/programmes/horizon2020/en/h2020-section/ethics

Fischer M.M., Fröhlich J., Gassler H., Varga Attila, (2001), Knowledge Complexity and Innovation Systems, eds. Fischer, Fröhlich, Springer, p 124

Friehe, T., Pham, C.T. (2020), Products liability when consumers are salient thinkers Economic Letters 186, 108804

Ganotakis, Panagiotis, and James H. Love. (2012) "The innovation value chain in new technology-based firms: Evidence from the UK." Journal of Product Innovation Management 29.5: 839-860

Gilbert, N., (2008), Agent-based models, Series: Quantitative Applications in the Social Sciences, Issue 153. Sage Publications

Hahn J, Ladikas M.(2004), Responsible Research and Innovation, Enterprise ans Work Innovation Studies, 10, IET, pp2-27

Hansen, M.T., Birkinshaw, J., (2007) The innovation value chain. Harvard Business Review, 85 (July), 121-130.

Heller, R.F., Heller, T.D., Pattison, S., (2003), Putting the public back into public health. Part I. A re-definition of public health, public health, 117, 1, 62-65

Iansiti, M., Levien, R., (2004), the keystone advantage, Harvard Business School Press, Boston, Ma

Kheybari, S., Kazemi, M., & Rezaei, J. (2019). Bioethanol facility location selection using best-worst method. Applied Energy, 242, 612–623. https://doi.org/10.1016/j.apenergy.2019.03.054

Lapinski, M.K., Rimal, R.N. (2005), An explication of social norms, Communication theory, 15, 2, 127–147

Ludu (2016), Boundaries of a complex world, https://link.springer.com/content/pdf/10.1007%2F978-3-662-49078-5.pdf

Malek, J., & Desai, T. N. (2019). Prioritization of sustainable manufacturing barriers using Best Worst Method. Journal of Cleaner Production, 226, 589–600. https://doi.org/10.1016/j.jclepro.2019.04.056

Martinsuo, M. and T. Luomaranta (2018). "Adopting additive manufacturing in SMEs: exploring the challenges and solutions." Journal of manufacturing technology management 29(6): 937-957.

McKenna, E.; Richardson, I.; Thomson, M. (2012) Smart meter data: Balancing consumer privacy concerns with legitimate applications. Energy Policy 2012, 41, 807–814.

Mejlgaard Niels, Ravn Tine, “Analytical report on the dimension of citizen engagement and participation of societal actors in research and innovation”, (March 2015), http://www.technopolis-group.com/report/analytical-report-dimension-citizen-engagement-participation-societal-actors-research-innovation-d2-1/

Milchram, C., Van de Kaa, G., (2018), Moral Values as Factors for Social Acceptance of Smart Grid Technologies. *Sustainability* 10, 8, 1-23

MORRI D2.2- Monitoring the Evolution and Benefits of Responsible Research and Innovation (MORRI), Analytical report on the dimension of science literacy and scientific education, by Larissa Talmon-Gros & Dr. Thomas Teichler

MORRI-Project, (2018), all documents https://www.technopolis-group.com/morri/

Muench, S.; Thuss, S.; Guenther, E. (2014) What hampers energy system transformations? The case of smart grids. Energy Policy 2014, 73, 80–92.

Morelli, J. (2011) Environmental Sustainability: A Definition for Environmental Professionals. Journal of Environmental Sustainability: Vol. 1: Iss. 1, Article 2. DOI: 10.14448/jes.01.0002

MORRI final report, "Monitoring the evolution and benefits of responsible research and innovation in Europe", V. Peter, F.Maier (editors) (Technopolis Group), N.Mejlgaard, C. E.B. Madsen (Aarhus University), E Griessler, M Wutekich (IHS), I. Meijer (CWTS, Leiden University), R.Wolley (Ingenio CSIC-UPV), R.Lindner, S. Bührer, A. Jäger (Fraunhofer ISI), L. Tsipouri (University of Athens), J.Stilgoe (UCL), RTD-PUBLICATIONS@ec.europa.eu European Commission, BE-1049 Brussels, May 2018, see http://www.technopolis-group.com/report/final-report-summarising-insights-from-the-morri-project-d13/

MORRI "Analytical report on the gender equality dimension" from MORRI project provided by Angela Wroblewski, Susanne Bührer, Andrea Leitner, Cheng Fan, (March 2015), published on the technopolis webpage http://www.technopolis-group.com/report/analytical-report-gender-equality-dimension-d2-3/ or from the final report "Monitoring the evolution and benefits of responsible research and innovation in Europe", RTD-PUBLICATIONS@ec.europa.eu European Commission BE-1049 Brussels

Monitoring the Evolution and Benefits of Responsible Research and Innovation (MoRRI), "Analytical report on the dimension of citizen engagement and participation of societal actors in research and innovation", Niels Mejlgaard & Tine Ravn, March 2015, can be found under http://www.technopolis-group.com/report/analytical-report-dimension-citizen-engagement-participation-societal-actors-research-innovation-d2-1/

Monitoring the Evolution and Benefits of Responsible Research and Innovation (MoRRI), Analytical report on the dimension of science literacy and scientific education, Dr. Larissa Talmon-Gros & Dr. Thomas Teichler, D2.2, http://www.technopolis-group.com/report/analytical-report-dimension-science-literacy-scientific-education-d2-2/

Oxford Learners Dictionaries, (November 2019). Retrieved from https://www.oxfordlearnersdictionaries.com/

Oxford Living Dictionaries. (2019). https://en.oxforddictionaries.com/

Porter ME. (1985) .Competitive Advantage: Creating and Sustaining Superior Performance. Free Press: New York.

Prahalad, C. K. (1993). The Role of Core Competencies in the Corporation. Research-Technology Management, 36(6), 40–47. https://doi.org/10.1080/08956308.1993.11670940

Rezaei, J. (2015). Best-worst multi-criteria decision-making method. Omega, 53, 49–57. https://doi.org/10.1016/j.omega.2014.11.009

Rezaei, J. (2016). Best-worst multi-criteria decision-making method: Some properties and a linear model. Omega, 64, 126–130. https://doi.org/10.1016/j.omega.2015.12.001

Rezaei, J. (2018). Measuring the relative importance of the logistics performance index indicators using Best Worst Method. Transport Policy, 12.

Rokeach, M. (1973). The nature of human values. New York, NY: The Free Press.

Roper, Stephen, Jun Du, and James H. Love (2008), "Modelling the innovation value chain." Research Policy 37.6-7: 961-977.

Schein, E. H., Schein, P. (2017). Organizational culture and leadership (5th ed.) USA: Wiley.

Shukla, S., Mohanty, B. K., & Kumar, A. (2018). Strategizing sustainability in e-commerce channels for additive manufacturing using value-focused thinking and fuzzy cognitive maps. Industrial Management & Data Systems, 118(2), 390–411. https://doi.org/10.1108/IMDS-03-2017-0122

Spring, M., et al, (2019), Deliverable 2.3 (version of 12-12-2019), IAMRRI project

Taebi, B. (2017). Bridging the Gap between Social Acceptance and Ethical Acceptability: Perspective. Risk Analysis, 37(10), 1817–1827. https://doi.org/10.1111/risa.12734

TREATY OF LISBON, 2007/C 306/01

Texas A&M University, (2019). The Value ChainFrom Competitive Advantage, by Michael Porter. http://people.tamu.edu/~v-buenger/466/Value_Chain.pdf

van de Kaa3, G., Fens, T., Rezaei, J., Kaynak, D., Hatun, Z., & Tsilimeni-Archangelidi, A. (2019). Realizing smart meter connectivity: Analyzing the competing technologies Power line communication, mobile telephony, and radio frequency using the best worst method. Renewable and Sustainable Energy Reviews, 103, 320–327.

van de Kaa1, G., Sobota, V. C. M., Ortt, J. R., van Beers, C., Soetanto, D., Spring, M., … Bierwirth, A. (2019, March 14). D2.1 Literature review.

van de Kaa, G., van den Ende, J., de Vries, H. J., & van Heck, E. (2011). Factors for winning interface format battles: A review and synthesis of the literature. Technological Forecasting and Social Change, 78(8), 1397–1411. https://doi.org/10.1016/j.techfore.2011.03.011

van de Kaa2, G., Rezaei, J., Taebi, B., Van de Poel, I., Kizhakenath A. (2019). An MCDM approach for determining weights for values: the case of smart metering. Science and Engineering Ethics

Von Schompeter R. (2013), Responsible Innovation, eds Owen R, Bessant J, Heintz M, Wiley, pp 51-71

Wilensky, U., & Rand, W. (2015). An introduction to agent-based modeling: modeling natural, social, and engineered complex systems with NetLogo: MIT Press