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Table of Contents

1 Executive Summary

The global level of Responsible Research and Innovation (RRI) is still new territory. As a European coined idea, RRI is being discussed and implemented mainly in the context of Western countries. Yet, the importance of an international perspective of RRI seems clear, since the challenges societies face and the science and technology approaches towards them are of global scope. Therefore, uncovering how it is understood in different countries is of key importance to the further development and implementation of RRI. The societal challenges of an ageing society and possible ICT solutions is the main focus of the Responsible Industry project and therefore is also of interest regarding the international stakeholders' perspectives.

In the following, a report of the state of RRI in three countries outside of Europe is presented: USA, China and Japan. In short, one could conclude that in the U.S., discussions on responsibility are often challenged by demands for increased innovation regulated by the market. At the same time there are claims for RRI to become a way to smooth the development of predetermined technologies. Therefore, it seems that for RRI to actually be adopted in the US, it will have to move away from the top-down idea of implementation and align with innovators and drivers of economic growth to potentially reach a mutual advantage. For this, collaborations between academia, government, business and civil society are needed in order to reflect on experiences from other countries and adapt to the specific culture of innovation in the U.S.

China on the other hand, does not have an influential discussion in the context of policy making and public debate on RRI yet. The Chinese innovation policy discourses are focused on innovation-driven development strategy, mass entrepreneurship and supply-side reform. These stem from characteristics of traditional science and technology management, which revolve around developmentalism, scientism and top-down management. Therefore RRI would need to be translated into the policy making area. A main challenge in China is the ageing society, which is large scale and high speed, with problems of low levels of health and large regional differences. It seems that this particular societal challenge may have the potential to introduce RRI to some degree in China.

Ageing society is also a huge issue in Japan, which has been termed a "super-aged society". This has led to large changes in the structure of the population and has impacted the economy as well as society as a whole. There are many initiatives towards finding ICT solutions for this situation, which is expected to increase in the future. RRI is not known in Japan or discussed at policy or academic levels. Yet, the term "responsibility" has been increasingly discussed in the context of S&T and there are substantial similarities between the debates in Europe, the U.S. and Japan regarding S&T policies and debates.

2 RRI International Comparisons – Reports from the global and emerging stakeholders

As the Responsible Industry project description states, in the age of globalisation, S&T development and its consequences cannot be contained within country boundaries. At the same time trans-border collaborations are becoming the norm rather than the exception in highly-complex technological developments, and there is hardly any industry that remains unaffected by global research or indeed is undertaking research at multiple countries, cultures and jurisdictions.

Although the main aim of the project is to develop RRI for the European industry, it would be short-sighted to exclude the global dimension of research and the role that RRI can play there. For instance, USA, China and Japan are the most active non-EU collaborators in FP7 while the number of bilateral collaborations with EU individual member states is a multiple of the EU collaborations. Significantly, there is no major EU industry player that is not either financially tied with or owning subsidiaries in one of these countries. Responsible Industry has decided to include concrete input from these S&T global players' research and policy communities.

During the Berlin Workshop talks on the international perspectives of RRI were given by three external experts. Yandong Zhao from the Chinese Academy of Science and Technology for Development, Andrew D. Maynard of the School for the Future of Innovation in Society, Arizona State University, U.S.A. and Takenobu Inoue from the Department of Assistive Technology, Research Institute, National Rehabilitation Center for Persons with Disabilities, Japan, presented their reflections regarding RRI in their country's context and relations to ICT for ageing.

This is a valuable contribution to the Responsible Industry project, as it provides different perspectives of S&T developments (such as ICT) that are global in their development and impact. Therefore, even though the project is mainly focused on a framework for European companies, it remains important to include the global dimension and the role RRI can play in this. The three countries represented at the workshop have their own specific discussions regarding responsible S&T developments as well as the societal challenge of an ageing society and are key S&T players.

2.1 USA

Responsible Research and Innovation - A US Perspective

On January 20 2016, the Cato Institute – a conservative U.S. think tank – hosted a discussion on Genetically Modified Organisms (GMOs) and the future of the global food supply and medical innovations (CATO 2016). Addressing the issue were Robert Fraley, Executive Vice President and Chief Technology Officer of Monsanto, and Jennifer Kuzma, a Distinguished Professor at North Carolina State University, and a widely recognized scholar on the responsible development and use of emerging biotechnologies.

Two days later, the event was reported on the news and commentary website Reason.com (Bailey 2016). After commenting positively on Fraley's "non-confrontational talk", the article went on to critique Kuzma's discussion of responsible research and innovation:

> "…Kuzma does not think that regulation of biotech crops is adequate. Instead Kuzma favors "responsible research and innovation." Well, certainly no one wants irresponsible research and innovation. So what is so irresponsible about the current methods of evaluating new technologies? …
>
> "Kuzma cited a definition of responsible research and innovation that is apparently taking hold in Europe. It states that responsible 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)."
>
> "Clearly, the concept of permissionless innovation is anathema to Kuzma."

Fast forward to June 2016. On June 2, Researchers Jef Boeke, George Church *et al.* published an audacious plan in the journal Science to construct a full, synthetic human genome within ten years (Boeke, Church et al. 2016). The paper starts with the authors explicitly addressing responsible innovation, including these statements:

> "As human genome-scale synthesis appears increasingly feasible, a coordinated scientific effort to understand, discuss, and apply large-genome engineering technologies is timely. HGP-write will require public involvement and consideration of ethical, legal, and social implications (ELSI) from the start. Responsible innovation requires more than ELSI, though, and involves identifying common goals important to scientists and the wider public through timely and detailed consultation among diverse stakeholders.

> "We will enable broad public discourse on HGP-write; having such conversations well in advance of project implementation will guide emerging capabilities in science and contribute to societal decision-making."

These two examples provide extreme perspectives on responsible innovation beginning to percolate through the U.S. At one extreme, we have a vocal (although most likely marginal at present) rejection of "responsibility" in favour of unfettered innovation, driven by entrepreneurs and businesses, and governed by the market. At the other extreme, we have what comes close to a co-opting of responsible innovation to smooth the way toward a seemingly predetermined technological endpoint.

Between these extremes, there is little public discourse in the U.S. around Responsible Research and Innovation (RRI), or the less formal and more commonly used term this side of the Atlantic of Responsible Innovation (RI). Unlike in Europe, RI is not a concept that has caught the imagination of policy makers, researchers and manufacturers in the U.S. Rather, and somewhat anecdotally, the formalized ideas behind RI (such as those developed by René von Schomberg (von Schomberg 2011)) seem to jar with underlying economic and policy cultures within the U.S., appearing idealistic and impractical within a society that places such a strong emphasis on economic growth driving social well-being.

Yet, putting aside formal definitions and concepts of RRI and RI, there is a rich vein of scholarship and even practice within the U.S. that reflect the ideas and concepts that underpin both of these.

2.1.1 RRI in US scholarly debate

Scholarly work on responsibility and technology innovation has a long history within the U.S., with many of its roots being embedded in the Science and Technology Studies (STS) community. This has become manifest in many cases through research, dialogue and practice around the Ethical, Legal, and Social Implications (ELSI) of emerging technologies. In 1990 for instance, the National Human Genome Research Institute's Ethical, Legal and Social Implications Research Program was established as an integral part of the Human Genome Project to "foster basic and applied research on the ethical, legal and social implications of genetic and genomic research for individuals, families and communities" (National Human Genome Research Initiative). This program was seminal in establishing ELSI as an integral part of federally-funded research and development within the U.S., and was later influential in ELSI initiatives and dialogue around nanotechnology (Fisher 2005).

The U.S. government's investment in nanotechnology in particular saw a substantial commitment to exploring the societal dimensions of the technology, and led to initiatives that have spearheaded exploration around responsible innovation within the US. The 2003 Nanotechnology Research and Development Act (2003) for instance mandated research into societal and ethical aspects of nanotechnology, and five years later two major research centers addressing this were established – the Center for Nanotechnology in Society at the University of California Santa-Barbara (CNS-UCSB 2016), and the Center for Nanotechnology

in Society at the Arizona State University (CNS-ASU 2016). These, have since come to the end of their funding terms, but leave a living legacy of research and scholarship around responsible innovation and emerging technologies that extends beyond borders of the U.S. For instance, the Virtual Institute for Responsible Innovation (VIRI 2015) – a US-based virtual institute with international scope – was initially established through CNS-ASU. And in 2014 the Journal of Responsible Innovation (Taylor-Francis 2015) was launched by investigators engaged in CNS-ASU.

These and other scholarly initiatives indicate a commitment to exploring the socially responsible and responsive development of emerging technologies in the U.S. They also reflect a much broader set of activities and initiatives that do not readily fall under the heading of RRI, and yet set out to ensure that research technology innovation progress responsibly.

Notably, both the National Institutes of Health (NIH) and National Science Foundation (NSF) require that all funded personnel adhere to high standards of responsible conduct of research (NSF , NIH 2009). These specifically address ethical behaviour in research, and as such don't completely align with the broader concepts embedded within RRI. However, they do indicate the degree to which U.S. federal funding agencies consider ethical responsibility in research to be important.

While the NSF and NIH are focused on ethical research practices, the Government Accountability Office (GAO) has a mandate to "ensure the accountability of the federal government for the benefit of the American people", and has a strong track record of addressing the responsible use of emerging technologies, including nanotechnology. And before it was abolished in 1995, the U.S. Office of Technology Assessment provided a societally-relevant perspective on technology innovations (Sadowski 2015).

Such "responsible" initiatives and activities are not limited to government in the U.S. though. While in this day and age of globalization it is hard to attribute non-government public and private initiatives to one economy alone, there are a number of emerging public and private trends and initiatives that reflect the ideas underpinning responsible innovation that are active within the U.S. On the public side, these include the emergence and development of Real Time Technology Assessment (Guston and Sarewitz 2002), Expert and Citizen Assessment of Science & Technology (ECAST) and Risk Innovation (Maynard 2015). These and similar public initiatives are creating a creative and innovative ecosystem of thinking, methodologies and practice around the responsible and responsive development of emerging technologies that reflect many of the ideals embedded in RRI, without explicitly being promoted as formal RRI. Similar trends are seen in the private sector, with the growth of values-based corporate policies, and the emergence of "B-Corporations" (B Corps).

As a result, while there is little explicit dialogue around RRI in the U.S., there is a growing body of research, practice, thinking, and culture around social responsibility within the public and private sectors, that reflects many of the ideas embedded within RRI. Yet this

does have a uniquely U.S. "flavor" – in large part because of a number of cultural, political and social attributes that are particularly strong here.

In 2015, Jonathan Hankins wrote an article on the website IEEE Spectrum titled "What Does "Responsible Innovation" Mean?" (Hankins 2015). The article provides a good introduction to responsible innovation. What is interesting though is the first public comment that follows the piece:

> "I'm all for being ethical, but this sounds to me like a bunch of academic claptrap. From what was written here, it doesn't sound like these people know how things work in the real world." (Hankins 2015)

This succinctly reflects a potential culture clash between stakeholders and the implementation of RRI (or RI) – especially in the U.S., where RI is in danger of being seen as embodying nice ideas, but impractical in a society based on innovation and market-driven economic growth.

Taking a step back for a moment, it's not hard to see how RRI as envisioned by scholars and European policy makers could present such a cultural challenge in the U.S. Scholarship around RRI for instance is grounded in concepts such as anticipation, reflexivity, inclusion and responsiveness (Stilgoe, Owen et al. 2013). These are highly relevant to socially responsible, responsible and beneficial innovation within an academic framing. And yet they offer little to innovators and businesses in the way of practical guidance – especially when it comes to squaring legal fiduciary duties with being socially responsible.

According to the EU program "RRI Tools", these largely scholarly ideas have been translated into six "policy keys" that RRI is expected to address within Europe, covering ethics, gender equality, governance, open access, public engagement and science education (RRI Tools). These in themselves suggest a shift in thinking around RRI as it moves from the domain of ideas and scholarship toward practical implementation. However, even these top-down aspirations are likely to have a tough time gaining traction within the U.S. culture of innovation and entrepreneurship.

2.1.2 RRI in US Innovation Discourse

Part of the challenge here is the very different motivations underlying each of these three contexts – the scholarly, the European and the U.S. Much scholarly work on RRI focuses on *technology innovation that is mediated by social good* – that is, the goal is to increase social good, and responsible innovation provides a framework for ensuring technology innovation has positive outcomes, and that adverse outcomes are avoided. Even to the extent of limiting innovation if necessary. In comparison, the EC policy keys focus on *socially responsive innovation* – innovation that is steered toward social good. This is a non-trivial

shift in framing, but still allows many of the components of scholarly RRI to be developed and implemented. And importantly, both framings place importance on societal benefit, and support top-down policy-based initiatives to ensure innovation leads to positive rather than adverse outcomes for society.

In contrast innovation within the U.S. is part of a culture that values individual entrepreneurs and inventors that encourages bottom-up innovation that is economically successful, and is largely governed by the market. The implicit assumption is that "good" innovations will survive, and "bad ones will fail – with the secondary assumption that market success will also lead to societal benefits. It's an approach to innovation that tends to discount top-down direction in favour of bottom-up action. And because of this, there is a deep cultural disconnect between responsible innovation as envisaged in the U.S. and Europe.

This is reflected in both of the opening examples above. In the case of the CATO Institute forum, the resistance expressed was overtly grounded in a culture of bottom-up innovation that's ultimately governed by the market – what's termed "permissionless innovation" – and the belief that any top down constraints on innovation (as European style RRI would be seen as) ultimately impede technology innovation, economic growth, and societal benefit. The second example is a subtler reflection of a similar perspective. While it recognizes the importance of "society" in technology innovation, there is an undertone of needing to persuade people that a set innovation path is responsible, lest they try and impede it.

This may be an overly cynical interpretation. Yet both examples serve to illustrate the challenges of implementing a European version of RRI in the U.S. And yet this doesn't mean that responsible innovation is not possible in the U.S., nor that it isn't necessary (national and global social, technological and political trends suggest it is) – it's just that it needs to be tailored more to the culture of innovation within the U.S. As my co-author and I write in a forthcoming book chapter on responsible innovation in a culture of entrepreneurship:

> "America's unique flavor of entrepreneurialism has given birth to some of the biggest names in the technology business–Steve Jobs, Larry Page, and Mark Zuckerberg, among many others–and is attracting tens of thousands of entrepreneur-hopefuls to its ranks. It is built on a culture of experimentation and opportunism, of failing fast and "failing forward," of taking the latest technology and seeing how far you can run with it. And above all, a belief that, as an entrepreneur, you can make the world a better place, while having the personal ride of your life.
>
> "This is a culture of entrepreneurialism that, paradoxically, reflects the ideals of responsible innovation, yet rejects many of the manifestations of these ideals. It does not respond well to top-down governance; it pushes the boundaries of what is considered doable and acceptable; and it is powered by an economics of invention and investment that is often opaque to top-down interventions." (Maynard and Garbee 2016)

The history and presence of initiatives in the U.S. that might be described as "responsible innovation by another name" (including those outlined above) suggest that there is fertile ground for a U.S. "flavour" of RRI. And certainly, there is evidence in the public and private sector that organizations realize successful innovation depends on better understanding the dynamic between technology innovation and society. Yet for responsible innovation to help ensure economically and societally beneficial innovation in the U.S., there is a need for substantially more exploration around what responsibility in innovation means within this culture, and how it can be implemented.

This challenge was recently examined through the lens of nanotechnology in an article in the journal Nature Nanotechnology, under the title "Responsible Innovation: The (nano) Entrepreneurs Dilemma" (Maynard 2015). It specifically addresses the challenges faced by entrepreneurs who rarely have the luxury of taking a long-term view of their potential impacts when they may be out of business in days if they can't raise revenue. The irony here is that many entrepreneurs set out to improve lives and make the world a better place. And yet the financial risks, day-to-day survival, and short-term investment/expectations cycle lead to a system that has little room for impractical ideas – formal realizations of RRI being one of them.

Closing the circle between aspirations and abilities at the level of entrepreneurs and businesses will in itself require innovation in how people and organizations innovate responsibly. The scholarship around RRI and its implementation in Europe is a helpful starting point here. But it is not sufficient to ensure the adoption and successful implementation of RRI within an entrepreneurial culture like the one in the U.S. Instead, something new is needed – something that both fits the innovation culture, yet also serves the society this culture is embedded within.

2.1.3 Conclusions

For some form of RRI to succeed in the U.S., it will need to break away from current ideals that are prevalent in Europe and amongst some scholars, including the use of top-down direction to achieve socially beneficial outcomes from innovation. It will also need to be aligned with drivers of economic growth – recognizing that U.S. economic and social culture cannot easily be constrained, but they can potentially be steered where there is mutual advantage to be had.

Achieving this will require deep collaboration between stakeholders in academia, government, business and civil society. It will benefit strongly from lessons learned around social responsibility and innovation elsewhere. But ultimately, if what is developed does not have the buy-in of U.S. innovators and stakeholders within the U.S. culture of innovation, it will not succeed.

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2.2 China

Responsible Research and Innovation; A European discourse in the Chinese context.

RI/RRI attracts a considerable trend of academic interest in China. An increasing number of scholars in the country have started to pay attention to RI's theoretical meanings, its role in facilitating scientific and technological exchange between Europe and China, as well as its possibility of practice or application within the Chinese context. There is a variety of studies on RI in form of conceptual analysis, philosophical reflection, and empirical research (fieldwork and practice) in China.

Although it has started to appear more frequently in academic literature, RI has not yet become an influential discourse in the policy making process and public debates in China. The dominant discourses of the Chinese innovation policy are: Innovation-driven development strategy; Mass entrepreneurship and innovation, and; Supply-side reform. It is clear that a translation of discourse is needed if RRI is to reach the policy domain. According to the well-known definition of responsible research and innovation given by Rene von Schomberg (2012:9): "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)." Four key words can be drawn from this definition: transparent, interactive, ethical, and societal desirable. These four key words can be further categorized in two themes for the purpose and process of science, technology and innovation, namely serving the society (innovation **for** the society) and interactive deliberation (innovation **with** the society). The former theme has a long history in Chinese policy discourses though with changing form from time to time. The latter is indicated in some fundamental changes in the science and technology policy and innovation process in China in recent years.

It is important to note that some characteristics of the standard science and technology management system in China, namely, **developmentalism, scientism and top-down management model**, are not compatible with RRI.

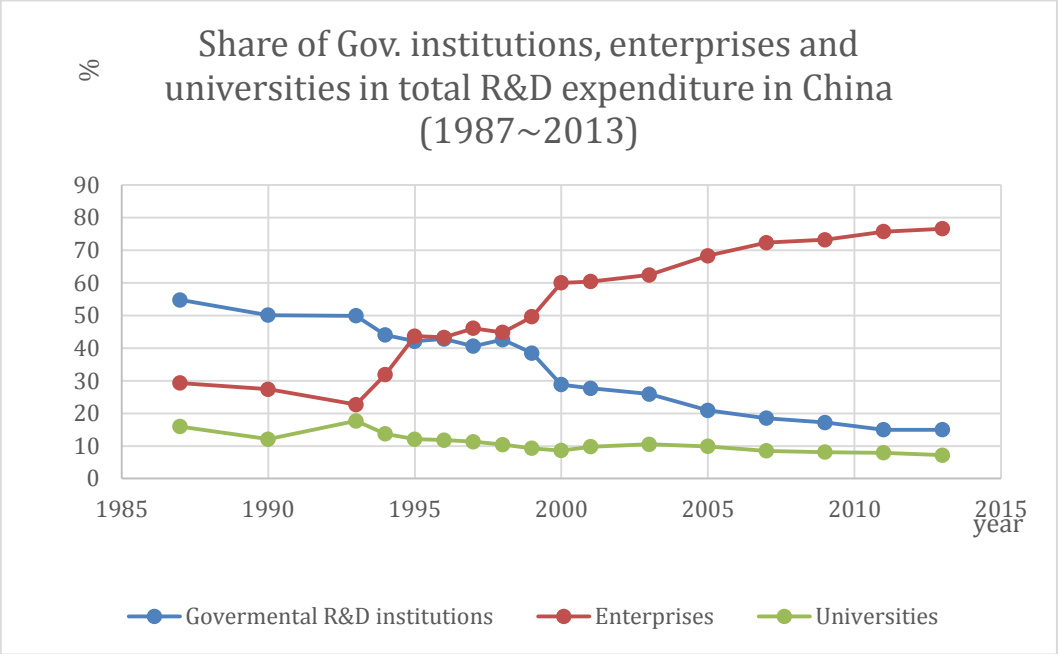
Developmentalism refers to the primacy of economic development for S&T. Since the reforms and opening up in the late 1970s, promoting economic development has become the main priority, as indicated by the former Chinese leader Deng Xiaoping, "Development is the absolute principle" (Wan 2008). The principle of developmentalism significantly influenced the distribution of S&T resources and the mode of S&T development. For

example, the main target of S&T development in China has been for a long time set to "serving the economic development (Zhang et al., 2013)".

Scientism appears as a particularly high praise of science and technology by government and the public. S&T has been considered the driving force of economic and social development. The Chinese government has frequently emphasized the important role of S&T in promoting economic development since the reforms and opening up. A typical example is another famous quotation of Deng Xiaoping: "Science and technology constitute the primary productive force" (Wan 2008). In 2012 the government declared the "innovation-driven development strategy", putting S&T in the key position of the transformation of the economic development mode. Meanwhile, public attitudes towards S&T have been positive in China. International comparative studies showed that Chinese public has a more positive perception of science and technology than the public of Europe and India (Rerimassie et.al, 2014). For instance, in a 2010 survey, 89% of the Chinese public agreed that "Science and Technology will make our lives healthier, easier and more comfortable" (Ren 2011), whilst only 66% of the European public (in 2010) and 77% of the Indian public (in 2005) agreed with that statement (European Commission 2010; NCAER 2005).

A *top-down management* system is the typical pattern of policy-making in China for several decades in which the government plays a dominant role in decision-making. The Chinese government has a strong control of the resources, including science and technology. Take the R&D expenditure as an example; in 1987, 1990, and 1993, governmental research institutes accounts for 55%, 50% and 50% respectively of the total R&D expenditure in China. From the figures below, one can see that governmental institutes have been playing the dominating role in R&D expenditure until 1995. As a result, society and market are very weak, compared to the strong state. While the market is becoming a more prominent power in recent years, public participation in S&T policy-making has still been rare.

Share of Gov. institutions, enterprises and universities in total R&D expenditure in China (1987~2013)



Source: China Statistical Yearbook on Science and Technology, 1998~2014.

However, the rapid social transition in China has led to a series of changes in attitudes towards the issue of responsibility in innovation in the public, in the scientific community, and even in enterprises and the government. That provides an ideal environment for the development of RRI in China.

2.2.1 Chinese enterprises: their social functions, economic roles and social responsibility

Enterprises are the main actors in innovation activities and the key component of the innovation system. In China, the enterprises' share in the total national R&D expenditure have been increasing gradually since 1980s. In 2013, enterprises account for 76.6% of the total R&D expenditure, far more than that of governmental institutes (15%) and universities (7.2%) (National Bureau of Statistics, 2014). Hence, enterprises should also play a prominent role in the RI system, and take the responsibility of serving society and protecting the environment in their R&D and marketing activities. Their attitudes and behaviour towards RI have a significant impact on its practice in China.

In the period of planned economy from 1949 to 1978, almost all enterprises in China were owned by the state or collectives. They were attachments of government, conducting production solely according to governmental plans and administrative instructions. At that

time, enterprises took not only the responsibility of manufacturing, but also providing social welfare to staff. This was known as the phenomenon of “enterprises performing social functions” and “enterprises as a society”. In the transitional period towards market economy from 1978 to 1990s, Chinese enterprises started to face fierce market competition. As a result, they focused on profit maximization as their sole pursuit. In this period, the priority of enterprises was temporary survival rather than long term development, and the responsibility to shareholders rather than that to stakeholders (Li, 2015).

Since the 1990s, market economy institutions in China have been gradually built up. More importantly, the Chinese market has been integrated into the global market. During this period, the concept of Corporate Social Responsibility (CSR) was introduced in China through transnational corporations and is becoming more popular since then. Nowadays, many Chinese enterprises release their CSR reports, revealing information on social responsibility and enhancing transparency of azctivities. The number of enterprises publishing CSR reports increased from 2 in the year of 2000, to about 30 in 2006, and to nearly 2000 in 2013 (*Chinese corporate social responsibility report* edit group, 2014). According to a survey on CSR in China conducted in 2010, half (49%) of the interviewed corporations had included CSR into their development strategies, another 33% said they intend to do so, 31% of the interviewed corporations said they have rules or norms about CSR, and another 36% said they intended to make rules of this kind. These statistics could to some extend reflect the awareness and willingness of Chinese corporations to face social responsibility (CASTED project team, 2010b).

CSR has also been involved in legal documents in China. In the Company Law of the People's Republic of China, "social responsibility" is mentioned in Chapter 1 Article 5: "When conducting business operations, a company shall comply with the laws and administrative regulations, social morality, and business morality. It shall act in good faith, accept the supervision of the government and general public, and bear social responsibilities." In June 2015, the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China and Standardization Administration of the People's Republic of China jointly announced three national standards: Guidance of Social Responsibility (GB/T36000-2015), Guidance on social responsibility reporting (GB/T36001-2015) and Guidance on classifying social responsibility performance (GB/T36002-2015). These documents indicated that CSR in China has been adopted and recognized nationwide in the form of legalization and standardization.

It is obvious that the emphases of CSR, including social and environmental concern, transparency and ethical behaviour, involvement of stakeholders and normative perspectives, correspond to the concept of RI. In fact, responsible innovation and corporate social responsibility are highly overlapping and intertwined in enterprises’ behaviour. Studies showed that the awareness of social responsibility in research and innovation is also

growing in Chinese enterprises. In 2008 GSSTP survey, researchers in enterprises showed higher awareness of social responsibilities than their colleagues in research institutes and universities. For example, when being asked if they agree with the statement "Should scientists be responsible for the misuse of their research output?" 64% of the enterprise respondents said "yes", much higher than the percentage in research institute (33%) and universities (54%). When answering another question "Government should have stricter limit and management on the research activities", 71% of the respondents in enterprises said "agree", whilst the agree percentage in research institutes, universities were 32% and 48% respectively (CASTED project team. 2010a).

2.2.2 ICT for ageing society: social challenge, policy mandate, and business opportunity

Ageing society is a big challenge for China. In 1999, people over 60 reached 10% of the entire population of China, and over 65 reached 7%, which makes China an ageing society. China is the only country in the world that has more than 100 million elderly people; it also has the most elderly people in developing countries. Until the end of 2013, there were 202 million people over 60 that makes up 14.9% of the total population. It is projected that in 2035, there will be 810 million working people (aged from 15 to 64) versus 294 million ageing people (over 65). Leaving alone students, unemployed, and low income citizens that do not pay tax, China will face a situation that every 2 taxpayers support 1 pensioner—a crisis point of ageing society! In the current rate, the peak of ageing population of China will reach 487 million in 2054. There will be 50 million more than the summation of ageing population in all developed countries, 100 million more than in India, and 50 million more than the total population in the US (Zhu, 2015).

The main characteristics of population ageing in China are that it is large scale and high speed, while there are low levels of health and big regional gaps. These result in many economic and societal effects: (1) Getting old before getting rich: per-capita GDP in China ranks 104 in the world while in the Human Development Index is 0.663 (2010) it is ranked 89; (2) Burden of economic development is increasing: as the productive population is decreasing, the consumptive population is increasing; (3) Social structure changing: dominant social group and interest group are rising and falling; (4) Family functions weakening: the current generation structure in a family is 4-2-1: A couple take care of over 4 elderly people and a child, that results in lack of human resources in taking care of the aged and increasing conflicts between generations; (5) Contradiction between development and livelihood: investment in maintaining and improving ageing people's livelihood will lead to decreasing of investment in development (Zhu, 2015).

On the other hand, the ageing society creates big opportunities for the elderly industry. From 2014 to 2050, elderly people's consumption capacity will rise from 4 trillion to 106 trillion Yuan, accounting for the share of GDP from 8% to 33 %. The central and local government are already increasing investment in public services for elderly people. More and more companies and organizations step in the field of services for ageing people. Concepts such as ageing estate, ageing finance and S&T for ageing people have emerged recently. This indicates increasing capital influx into a promising industry. However, this huge market still lacks adequate services supply and its development is unbalanced. For instance, potential demands for paramedics for ageing people are over 10 million, while the paramedics currently at work are only about 1 million. Nevertheless, it is clear that S&T innovation could improve the quality of services for the ageing people, relieve the lack of human resources and meet the demands of ageing people in medical care, social interaction, and consumption (Zhu, 2015).

There have been new policy initiatives in China on the elderly population and ageing society. In September 2013, the State Council's report "On accelerating the development of ageing population service industry" states the need to "develop information and internet service in house". Similarly, the Guidelines for Advancing Internet Action released in July 2015 aim to "stimulate the development of smart heath and elderly care industry". Also in the Ministry of Science and Technology's 12th Five-Year Plan for Science and Technology（2011-2015 mentions "digital medical and health care service for ageing people" as a focus area. In addition, the Ministry of Civil Affairs released a report "On launching national demonstration project of smart elderly care internet of thing" in June 2014. All these initiatives have a common aim to employ new and emerging technologies such as ICT to improve the management of and services for the ageing population.

2.2.3 Responsibility of smart elderly care industry: a case in China

The development of Smart Elderly Care (SEC) industry in China can be divided into three phases. The first one starts from the end of 1980, when a service system based on telephone calls (one key for first aid and house calls) was applied. The second one is from the beginning of 21st century, when Internet based service systems (virtual nursing home, information platform, household service) were being employed. The third one is from now on, characterized by service systems based on Internet of Things (smart city, smart community, remote medical consultation, management of health).

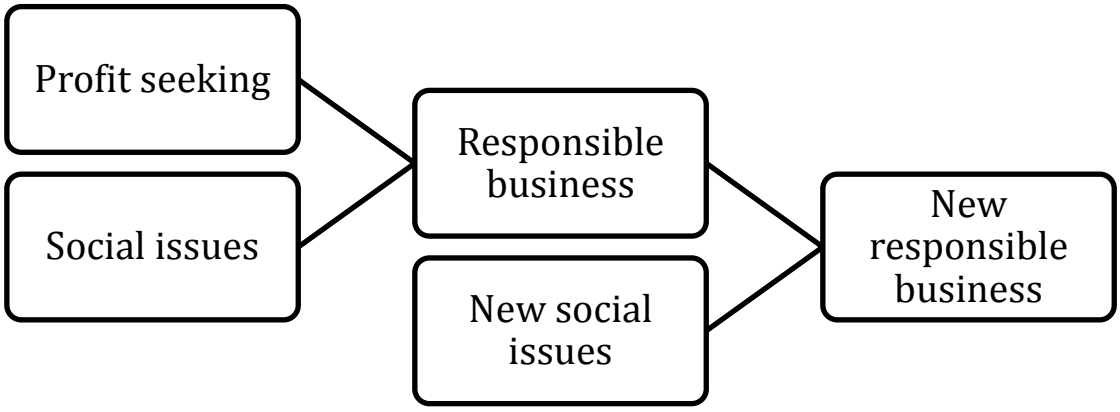
The SEC industry in China covers many services areas from residence, household and healthcare, to furniture, culture and education. But there are many issues, related to responsibility, that need to be addressed. We use here the anecdotal example of a smart elderly care service to analyze the issue of responsibility in the SEC industry. A small private

company has built a health management service system based on big data analysis. The company integrates small scale ageing people service centres in communities, meeting ageing people's needs by collecting health data via wearable devices, using it to manage chronic diseases but also profiting by exploiting the data resource. It uses new technologies (big data analysis) and a new business model (personalized health management service based on big data analysis and other business data) to perform for-profit community service and medical sales, while meeting ageing people's needs on elderly care and medical service.

In the industry of Internet+ and medical and life care combination services, collecting, storing and analysing personal health data is inevitable. We can witness a value chain of "technology innovation - customers' needs - social demands - companies' profit" in this business model. Such model could fulfil the responsibility to achieve social value and serve society. Translating social needs into business value via technology innovation is a sustainable way for companies to actively fulfil their social responsibilities. However, many issues appear in services based on big health data. They relate to ethical issues such as privacy, rights, security, trust, etc. that are intertwined with RRI.

2.2.4 A philosophical abstraction

From the case analysis above, we have tries to abstract a pattern of responsible industrial innovation. The intrinsic aim of a company is to seek profit. However, companies in modern societies create social effects that bring the issue of RRI in the forefront. A responsible business should integrate profit seeking and social problem solving. Meanwhile, businesses creating profit by solving existing social problems, lead to the creation of new social issues, that require new forms of responsible businesses. The overall pattern is like a spiral escalation whereby each form of responsibility results from and creates new needs for responsible action, as the simple diagram below denotes.



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2.3 Japan

Responsible Research and Innovation in Japan

In Japan, the term Responsible Research and Innovation (RRI) is not known or discussed as such. Responsibility is a concept that it is often, particularly recently, discussed in S&T debates but not the actual term RRI as it is known in Europe. This does not mean that Japanese S&T debates are different to those in other parts of the world. As a matter of fact, there are significant similarities between Europe, USA and Japan in S&T policies and debates. The topics of the Japanese debates are mainly local, as they are naturally influenced by current affairs and media coverage, but the themes are similar in dealing with the relationship between science and society. As with most European debates, the trigger for science and society thematic focus have been catastrophic events or scientific scandals.
The manner in which the concept of "responsibility" has entered the Japanese S&T debates in closely linked with the decision making structures and the priorities set by the Government. One has to acknowledge these aspects to provide an informed description of RRI in Japan.

2.3.1 Japanese S&T Policy Structures

Japan is the third largest economy in the world based on gross domestic product (GDP), following the US and China and preceding Germany and France. The unemployment rate (as of October 2014) was 3.6%4, which - by comparison to other modern economies - is very low. For instance, French unemployment for the same period was 10.2%4, UK unemployment 6.04% and German unemployment was 5.04. Keeping the unemployment rate is by far the top priority of most Japanese Governments' policy. Consequently, the Science, Technology and Innovation (STI) sector is also geared towards achieving higher employment rates.

The Japanese innovation policy is steered by the Council for Science, Technology and Innovation (CSTI), formerly known as the Council for Science and Technology Policy (CSTP). The CSTI is one of the four councils realizing the policy goals of the Cabinet Office, i.e. the highest decision making level of the Government. The other three councils are the Council on Economy and Fiscal Policy, the Central Disaster Management Council and the Council for Gender Equality. The CSTI is comprised by the Prime Minister, relevant Ministers and external experts. The roles of the CSTI are to: investigate and debate basic policies concerning S&T; investigate and debate S&T budgets and the allocation of human resources, and; assess Japan's key research and development areas.

In order to achieve these three major roles, the CSTI follows specific measures such as:

taking a lead role in science and technology budget decisions; taking responsibility for developing an innovation-friendly environment; investing in cross-cutting innovative research for the future, and; realizing an innovation cycle through the world's highest-level new research and development corporation system.

2.3.2 Grand Societal Challenges in Japan

As with most advanced economies in the world, Japan is faced with societal challenges that are not only new in content but also of significant scale. The Japanese government has identified five major challenges for the Japanese society with which it will be faced by 2030: 1) a declining population and rapidly ageing society; 2) an explosive development of the knowledge society, the information society, and globalization; 3) an increase in the number of issues that threaten sustainability (population, natural resources and energy, climate change and environmental change, water and food, terrorism, infectious diseases); 4) structural changes in the international economy due to the rapid economic growth of emerging countries; and, 5) increased urgency for the preparation to counter natural disasters.

In order to deal successfully with these challenges, the Japanese Government has put its faith in solutions that will be created through STI. For this reason, it has identified a number of specific goals on which Japanese STI must concentrate its efforts in the coming decades. These are:

1. Realization of a clean and economical energy system;
2. Realization of a healthy and active aging society as a top-runner in the world;
3. Development of a next-generation infrastructure as a top-runner in the world;
4. Fostering of new Industries by utilizing regional resources, and
5. Recovery and reconstruction from the Great East Japan Earthquake.

As the whole STI programme is geared towards these societal challenges and specific technological developments to achieve its aims, the Japanese research funding structure is the engine behind the whole programme.

2.3.3 Japanese S&T Public Funding Structure

Japanese S&T public funding for research is allocated both directly and indirectly to researchers. The Japanese Government allocates funding in four main categories: curiosity-driven, competitive funding; mission-oriented, competitive funding, and; curiosity-driven, subsidies. The first two categories refer to the type of research being undertaken while the second two categories refer to the allocation procedures. In detail:

curiosity-driven, competitive funding; In this category, scientific research is funded based on researcher's creative ideas and advanced through individual grants. Hence, this is a bottom-

up mechanism where project proposals are presented by researchers to the funders based on their own suggestions.

mission-oriented, competitive funding; In this category, scientific research is funded based on policy imperatives. The purposes of the research are set by ministries and researchers are recruited top-down to work on specific topics.

curiosity-driven, subsidies; In addition to project specific curiosity-driven research, the Japanese government also allocates subsidies to universities or approved research institutions. These subsidies are not allocated for specific topics; instead the institutes themselves make allocation decisions.

mission-oriented, subsidies; Equally, broad subsidies are given to some institutes for government-led strategic research.

This particular funding structure of the Japanese S&T sector is the result of the various debates that S&T developments have initiated in the country in the last three decades.

2.3.4 A historical perspective of RRI in S&T debates in Japan

The first Science and Technology Basic Law was enacted in 1995, followed by the First five-year Science and Technology Basic Plan in 1996. It was during this period of intense S&T policy debates that several big crises took place in the country. The first crisis was the magnitude 7. 3 earthquake that hit Kobe City near Osaka in January, resulting in extensive destruction and casualties. Soon after, in March, there was the sarin gas attacks on the Tokyo subway, perpetrated by a religious cult. And also in the end of the same year there was the sodium-leak fire accident at the fast breeder reactor Monju in Tsuruga city in Fukui prefecture. Later on in 1997, the Tokai nuclear reprocessing plant fire accident happened in Tokai village of Ibaraki Prefecture.

In parallel with these crises, the World Conference on Science was held in Budapest, whereby the so-called Budapest Declaration was issued. In this declaration, the concept of "science in society and science for society" was introduced as a new role of science. This concept was also introduced to Japanese science and technology policy in the 2001. The Second Science and Technology Basic Plan incorporated it as one of its main principal concepts; namely, science and technology in society and science and technology for society. Based on this new concept of the science and technology policy, a new institution called the Research Institute for Science Technology for Society (RISTEX) was established as an institution to promote the idea of science and technology for society. Thus, Japanese S&T structures recognized the need to research the relationship between science and society at large.

Another seminal point in this process was the Fukushima Daiichi Nuclear Power Plant Accident, on March 11, 2011. The repercussions of this accident are hard to overstate in

relation to the development of science & society debates in the country. Several months later, in August 2011, the Government introduced the fourth basic plan for science and technology.

This constituted a shift in the Japanese STI policy in relation to RRI with the incorporation of a number of issues concerning science, technology and society. For instance, continuing the first plan's research aim of public understanding or public awareness of science, the ethical, legal and social issues of science (ELSI) were introduced. In addition, the themes of science and technology communication, public participation in science and technology policy, and technology assessment were also introduced.

An aspect of RRI, public engagement, has been particularly promoted in the country as a result of the introduction of science and society themes in S&T policy. Participatory Technology Assessmetn (pTA) that involves the public in its assessment processes, has been developed in the last years and a number of pTA projects have taken place. There is a great variety of pTA methods that have been applied in the Japanese context, such as consensus conference, scenarios workshops, citizen juries, deliberative polling, etc. Most of these pTA projects are organized and conducted by academic researchers, but some of them have been carried out by the national government as well as local governments in cooperation with researchers.

Another key aspect of RRI, science communication, has also seen significant development. It has been introduced as a target of promotion in the second and the third basic plan for science and technology. As a result, several universities have created training course for science communicators and journalists. For example, Hokkaido University, University of Tokyo, and Waseda University have their own graduate courses for training in science communication or science journalism (the course of Hokkaido University is open to general citizens). Other universities and science museums have similar programmes including a number of science cafés.

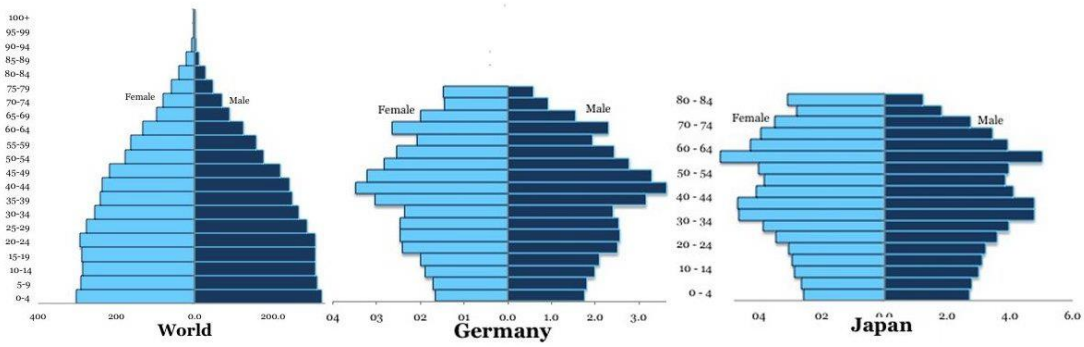
In terms of the "Innovation" part of RRI, there is also the introduction of the "innovation dialogue". This is a new initiative to promote university-industry collaboration that includes stakeholder engagement methodologies such as design thinking, backcasting, future sessions, world café, etc. It is a promising development in the S&T debates in the country.

It is evident then that RRI is getting a foothold in the STI debates in Japan. Nevertheless, there are many challenges that need to be addressed. One is the small number of practitioners and researchers in these areas. As a new area of expertise, RRI practitioners are far and between and have little impact in the actual policy making decisions in the country. Another challenge is that science communication has a narrow aim at mainly raising public awareness of science. There is little meaningful interaction between science and society to debate the social challenges. Similarly, there is lack of proper interaction amongst

stakeholders and their incorporation in policy making processes is evident. Although many projects based on stakeholder involvement have been funded so far, they face implementation difficulties in the actual policy structures. Finally, in terms of the innovation dialogue, it is still unclear how to incorporate societal values into the dialogue process. This refers to a cornerstone of RRI, i.e. the dimension of reflexivity that is necessary for a successful RRI.

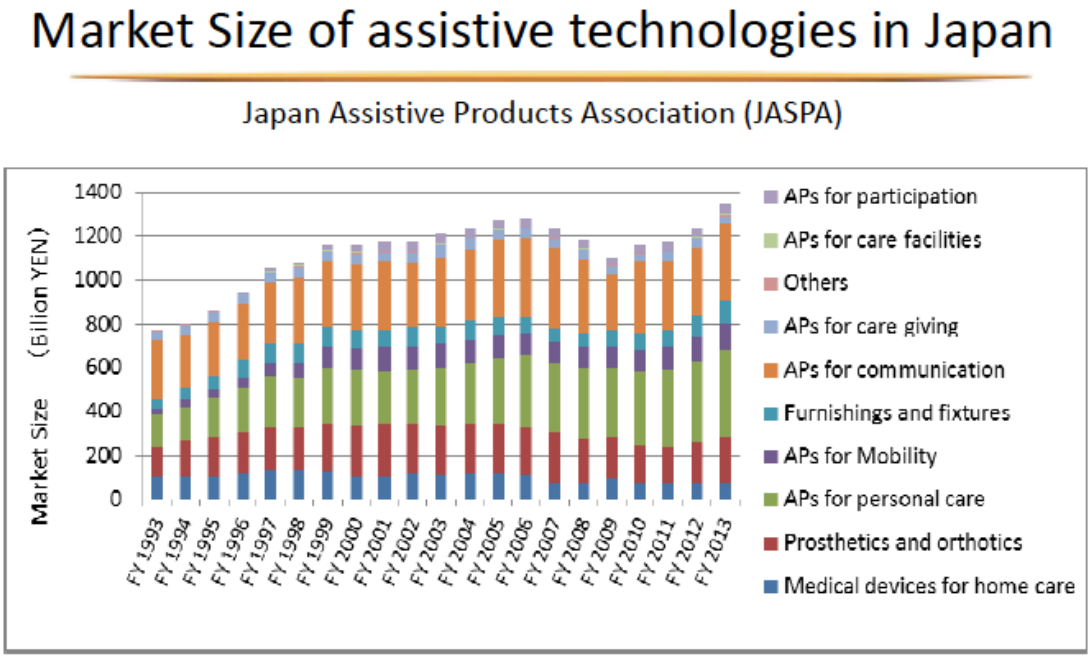
2.3.5 RRI in Ageing and Assisted Living

Japan has been termed a "super-aged society" with one of the lowest birth rates in the world. The last decades have seen a significant change in the composition of the population that has already had impact on society and the economy. The expectation is that the impact will increase further in the future. As one can see in the figure below, the age pyramid of Japan is considerably uneven compared to the world average and even to another ageing society, that of Germany[1]:

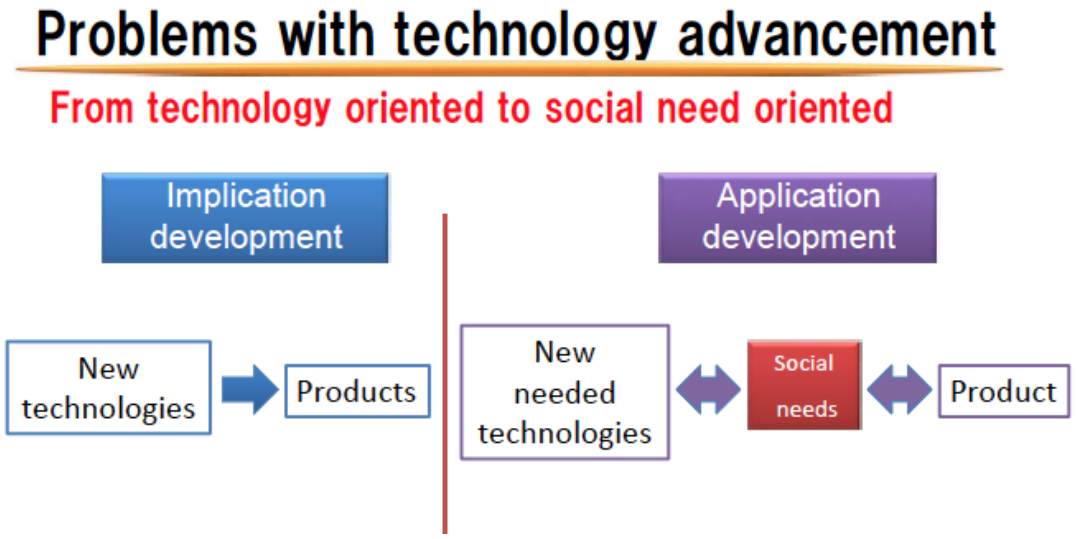


The Japanese Government has acknowledged the urgency to develop medical technologies for the aged, by expanding Japan's fundamental scientific research, to realize an extension of healthy longevity through cutting-edge medical care. It also acknowledged that one of the main aims in this development is to safeguard the sustainability of the health-care system. For this reason priority is given in creating a strategic industry with specific medical and health care products that are going to be needed in other ageing societies around the world. This thinking has led to measures on research and development for new medical fields whereby specific activities have already started. The interest of the private sector is significant as the market is expending rapidly as the following graph shows:

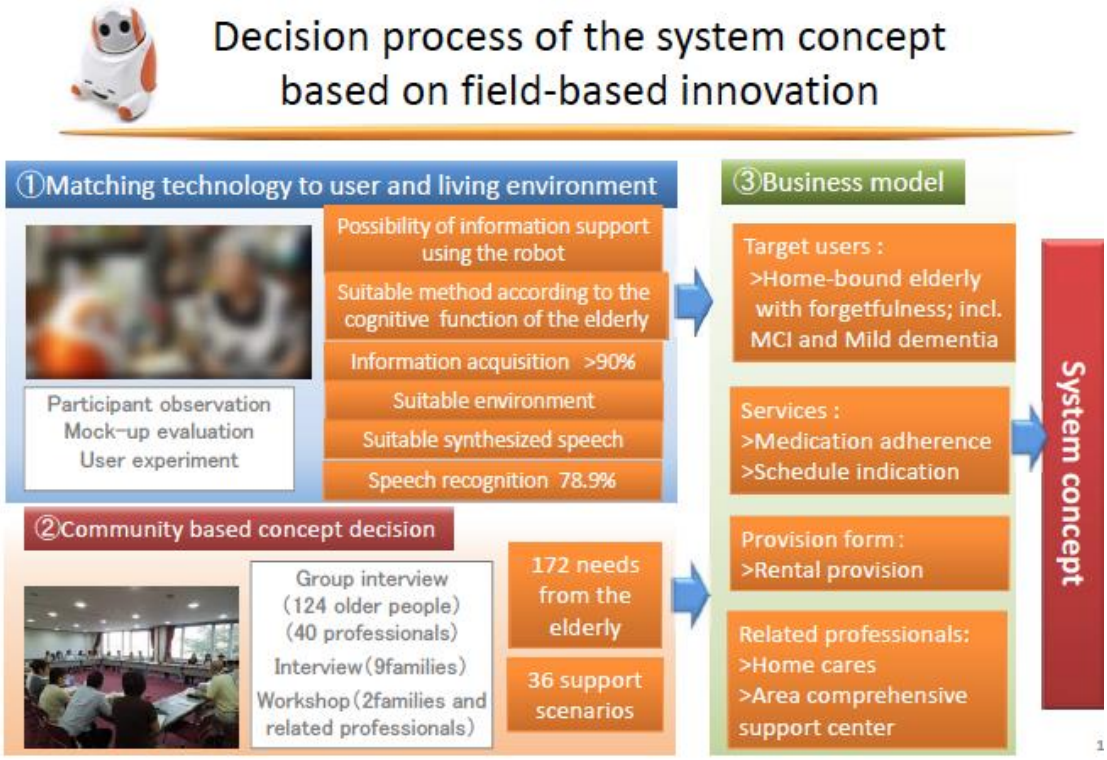
[1] Age pyramid 2012, World, Germany and Japan, modified from: http://www.davidmcwilliams.ie/wp-content/uploads/2014/01/Dodgy-Pyramids.jpg



Of particular interest in this field is development of devices for elderly people with mild dementia. According to the Ministry of Health, the number of people with mild dementia is about 4 million (2013 estimates) and increasing rapidly. A new type of attempt to develop Assistive Technologies for these people is the "Robotic Devices for Nursing Care Project" that is an ongoing project since 2013, bringing together the health care sector and manufactures to device robotics for nursing homes. A major aspect of this project is the incorporation of lay engagement processes in the identification of social needs that should be met by technology. As the graph below shows, the project introduces a new approach to Assisted Living based on "RRI" principles:



The structure of the project allows for a participatory design with the involvement of patients, families, care givers and other community members. The process of engagement employs interview and focus groups methodologies, along with specially structured workshops including both experts and lay stakeholders. The business model for the manufacturers is more coherent and closer to client needs, as the graph below shows:



In conclusion, it is rather early to say if RRI principles are going to be well-established in the development of new technologies. But the experience of the Assisted Living sector is very promising and offers optimism that public engagement will increasingly play a significant role in S&T debates and the innovation processes.

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3 Conclusion

The reports given by the international stakeholders provide important feedback for the Responsible Industry project's other activities. The project focuses on the issue of ICT for ageing, a main challenge of European countries, which, as the international reports show, is also of great importance on an international level. Therefore, it can be insightful for the further development of the project to look at how issues of ICT for ageing as well as RRI are discussed on different countries.

Especially the findings of the Delphi study (D 2.2) and the accounts of the different countries described above can complement each other. The Delphi study, which was based mainly on WP1, focused on several aspects such as awareness of RRI, responsible governance or integration of RRI in ICT for ageing. It questioned stakeholders from all over Europe and therefore provided feedback from the geographical area where RRI is mainly discussed and even implemented (at least to a certain degree). The reports given in this deliverable focus on key countries and provide a valuable addition on a wider international level.

Looking at the results of the Delphi regarding the awareness of RRI we find parallels to the international reports. Overall, there seems to be a lack of awareness of the concept as in the first Delphi round, only 44% of the respondents stated that they were aware of the concept. The level of awareness of the RRI concept is higher than the average amongst the Policy Makers and the Users and lower for Industry. (D 2.2, page 11). Very few of the Delphi participants (13%) seemed to be aware of measures taken by their government to implement the adoption of RRI principles. This corresponds with what the international stakeholders report. RRI is not a common concept in their countries and discussions of responsibility or ethical aspects take place in different ways. Yet, responsibility issues or ethical considerations surrounding S&T as well as ICT take place throughout the different countries in some form at least.

In all countries, U.S.A., China, Japan, there is either no or only a marginal discussion of RRI, similar to what was found in the Delphi. In the U.S. the concept is regarded as a top down approach, which, as often with discussion on responsibility or market regulation, stands in contrast to demands for innovation increases. This shows a certain tension between the concept of RRI as a more formal policy measure and what the "culture" of innovation is like in a specific country. RRI is not part of debates in China or Japan; here the concept remains largely unknown.

But the international reports do show the discussions and activities happening in the countries and therefore point to areas where RRI could be developed. Because CSR or ELSI are already established and used they can be crucial areas for RRI to further the development of a "responsible culture". The Delphi also shows connections to this, as the participants stress the importance of increasing the awareness of the concept and raising its visibility through initiatives. It seems that in the area of ICT for ageing, as we see in the Japanese account, not only is the technological development further developed than in

Europe, but ELSI has been being done for quite some time. Here the European countries can learn from Japan regarding communication of S&T, engagement in it as well as how to shape a dialogue around developments of ICT for ageing.

In the course of the Responsible Industry project, CSR has been identified as an important factor when searching for areas related to RRI. In the Delphi there are several considerations on this: CSR is seen by many of the Delphi-participants as the area or department (in a company) in which RRI could be integrated. For example, societal and ethical aspects should be part of existing CSR (D 2.2, page 33) and could be a way forward in operationalizing RRI in companies. According to the international reports, CSR is also an important area for considering RRI. For instance in the U.S. CSR is a long established concept and the Chinese report shows that discussions on CSR and reporting on it have increased in companies offering a possible entrance point for RRI.

Of course many challenges remain for RRI on an international level. As the reports above show, RRI is not an established concept. Yet, the reports also point to areas where discussions and activities are already taking place and on which ground RRI could possibly develop. Regarding the main output of the Responsible Industry project, the Implementation Plan, it seems that there is no clear-cut way to apply it seamlessly in the three countries. This is due to the very different levels of ethical discussions or assessments and because key pillars such as engagement aren't standardized or not an established part of thinking about S&T. Therefore, it seems that the actual implementation of RRI is, for now, a European endeavour. Yet, as the reports show there are also similar discussions and wider societal questions being raised across countries, especially in the area of ICT for ageing, being a common challenge. This also shows the importance of including this wider international perspective in the project. Based on common discussions or concepts presented here the Implementation Plan could have the potential to serve as a useful tool to introduce, integrate or even implement RRI beyond the European context.