

**Horizon2020/EURO-6-2015**  
**Coordination and Support Actions**



**SONNETS**

***SOcietal Needs aNalysis and Emerging Technologies  
in the public Sector***

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**Deliverable D4.3**

**Roadmap for emerging research directions**

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<b>Workpackage</b>	WP4 – Roadmap for emerging research directions
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## Document Revision History

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## Definitions, Acronyms and Abbreviations

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<b>Acronym</b>	<b>Title</b>
API	Application programming interface
CSA	Coordination and support action
EIRMA	European Industrial Research Management Association
EU	European Union
ICT	Information and Communication Technology
OECD	Organisation for Economic Co-operation and Development
PS	Public Sector
R&D	Research and Development
TRM	Technology Roadmapping
UN	United Nations
WBAT	Weighted Bit Assessment Table
WP	WP

**Table 1: Definitions, Acronyms and Abbreviations**

## Executive Summary

SONNETS pursues the aim to develop a roadmap of necessary technological and implementation activities to modernize the public sector with emerging ICTs and addressing thereby related societal challenges.

Methodologically, SONNETS follows a technology roadmapping approach which is based, on the one side, on societal and public sector needs and, on the other side, on the opportunities of emerging ICTs. Thus, SONNETS incorporates the general idea of the European Industrial Research Management Association (EIRMA) [1] approach of including both 'market-pull' as well as 'technology-push' aspects into the development of the roadmap.

The development of the roadmap itself contains both elements of the EIRMA [1] approach as well as of the T-Plan process [2] and has further been adapted to the needs of SONNETS.

Overall, the SONNETS roadmap development follows a 3-step approach (plus a preparing one, in which the technologies and needs have been identified):

- 0. Identification of emerging ICTs** with the potential to transform and modernize the public sector and also **identification of societal, business and public sector needs** → this has been done by applying the **SONNETS innovation identification framework** in WP2 and WP3
- 1. Analysis of emerging ICTs and trends (identified in WP3)**
  - e.g. regarding their technological readiness level, current research activities, actors in this area and possible obstacles which could hinder a successful implementation into the public sector
- 2. Identification of gaps and research needs**
  - Each societal and public sector need (identified in WP2) has been assigned to one or more emerging ICTs which could help to satisfy the respective need.
  - For each of these technology-need pairs the gap between the technology as it is now and a fully implemented version in the public sector has been described.
- 3. Development of the roadmap**
  - This development of the roadmap itself has been performed by following another 3-step approach:
    - I. **Matching of emerging ICTs and societal or public sector needs** on a 1:1 base (each need is assigned to only one technology). This matching has been validated during an experts' workshop.
    - II. **Validating the activities** which are necessary to implement the emerging ICTs successfully in the public sector with the aim to satisfy the specific assigned societal or public sector need during an experts workshop.
    - III. Deciding on the **content of the roadmaps** on the basis of the identified necessary activities in D4.1, D4.2 and the experts' workshop, as well as in roadmaps in similar projects.



The roadmaps have subsequently been filled by using the previous results of SONNETS, as well as further literature reviews (e.g. from other EU research projects, intergovernmental organisations etc.)

This exercise has shown that the emerging ICTs identified during the course of SONNETS which could potentially play a major role to meet the assigned societal or public sector needs are already on a very advanced technological level. Even more, several applications or services are already in use somewhere within or outside Europe - in the public sector itself or with a comparable function in another domain.

Thus, the roadmaps to implement these technologies in the public sector contain only adaptations, modifications or improvements of these technologies or non-technological activities like, e.g. development of training, process-oriented issues, necessary infrastructure, promotion of applications, development of standards, and dealing with ethical, legal or societal issues.

Thus, the bottleneck of innovating the public sector is not the technological development - it is the implementation itself - including the adaptation to the specific necessities of the public sector and the consideration of the complex process-oriented, socio-economic and ethical issues.

The main part of this deliverable contains the summarized roadmaps of the 23 identified emerging ICTs and trends, including the recommended technological and non-technological activities necessary to implement these emerging technologies in the public sector with the aim to satisfy societal and public sector needs. The full roadmaps are presented in the Annex III of this deliverable.

# 1 Introduction

## 1.1 Purpose and Scope

SONNETS pursues the aim to meet the need for a better, more efficient, effective and quality delivering public service. This does not only imply transforming the public sector itself and covering the needs of public sector employees and policy makers, but it will also have a positive impact on citizens and businesses, that will in turn accelerate the EU economy and improve quality of life.

The work presented in this deliverable is based on the previous work in the context of Work Package (WP) 2 'Societal and Public sector Needs Analysis'. WP2 represents the demand-driven and need-based approach to public sector innovation. The final outcome of WP2 is a list of societal, business and public sector needs.

The second basis of this deliverable is the outcome of WP3 'Identification of Emerging Technologies and Innovation Identification Framework'. Within WP3, ICTs and trends have been identified and analysed regarding their impact and suitability for the public sector.

The present deliverable is released within the context of WP4 'Roadmap for emerging research directions' and is particularly associated with Task 4.3 'Roadmap development'. Within this task the necessary research and other activities to modernize the public sector and to address related societal challenges have been developed. This task builds on the results of Task 4.2 'Gap analysis and identification of research needs', which have been presented in D4.2. [3] These research needs have been developed to help bridge the gap between the expressed needs of the citizens and the public sector (WP2) and potential innovations due to the implementation of identified emerging technologies (WP3).

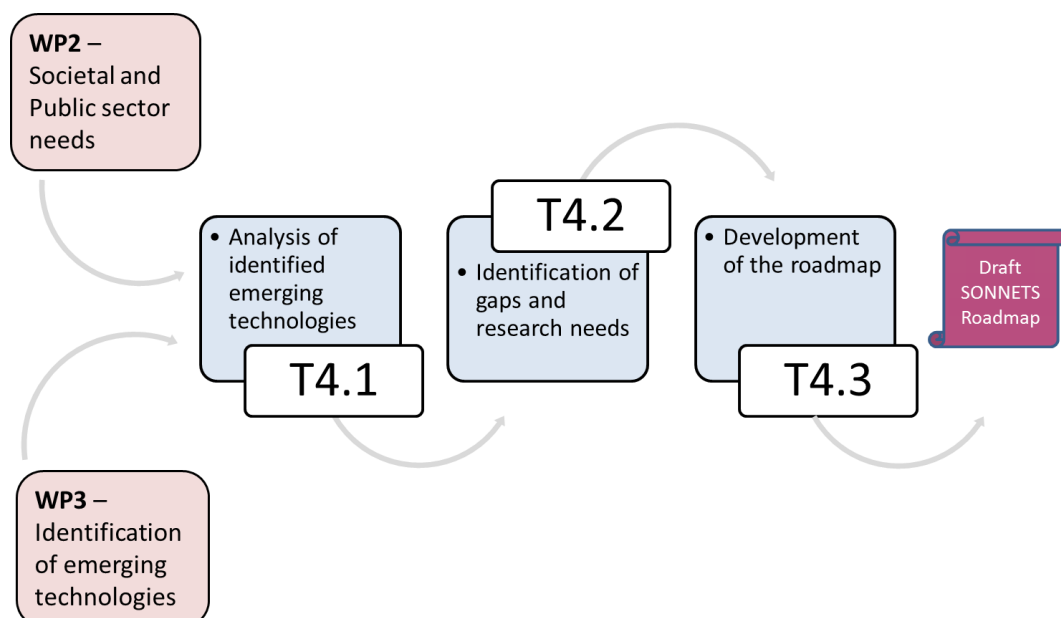


Figure 1: The different steps of the SONNETS roadmap development.

## 1.2 Structure of the Document

The report at hand is structured as follows:

- Section 1 describes the purpose and scope of this document and places it into the context of the overall WP structure of SONNETS,
- Section 2 describes and explains the methodology used to develop the roadmaps,
- Section 3 presents results of the development process and the summaries of the roadmaps
- Finally, Section 4 summarises the content of this deliverable and draws relevant conclusions.
- The full roadmaps as well as the results of the workshop in Cologne are presented in the annex.

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## 2 Methodology

SONNETS pursues the aim to develop a roadmap of necessary research, innovation and implementation activities to modernize the public sector with emerging ICTs and addressing thereby related societal challenges.

Technology Roadmaps were originally developed by MOTOROLA in the 70's in order to align the development of their products and their supporting technologies. [4]

The Technology Roadmaps (TRM) are part of a methodology that guarantees the alignment of investments in technology and the new development of capabilities, so that they are able to make capital out of future market needs. [4]

Roadmaps can have different applications. According to Phaal et ál [2], these can be classified into 8 areas. For example, roadmaps for:

**Planning of products:** This is the most common Technology Roadmap. In this case, the different generations of manufactured products are tied to the necessary technologies for their development. [4]

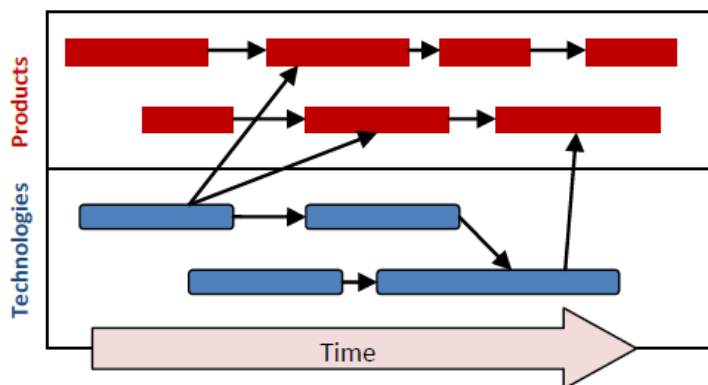


Figure 2: Technology Roadmap for the planning of products. [2]

**Strategic planning:** This kind of Roadmap assesses the different opportunities that markets and business tendencies can offer, at strategic level. [4]

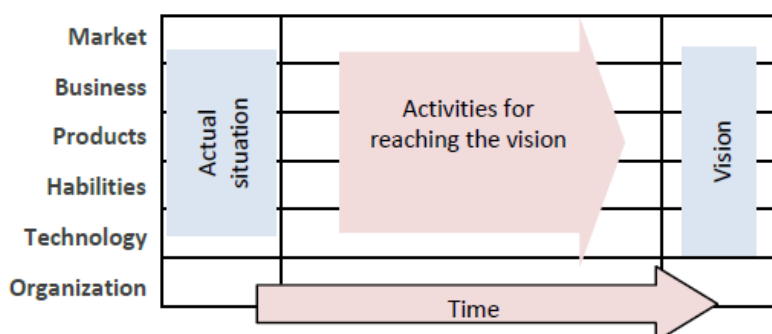


Figure 3: Technology roadmap for strategic planning. [2]

**Long run planning:** In this case, roadmaps are often used at regional and national levels, where planning is projected long-term. [4]

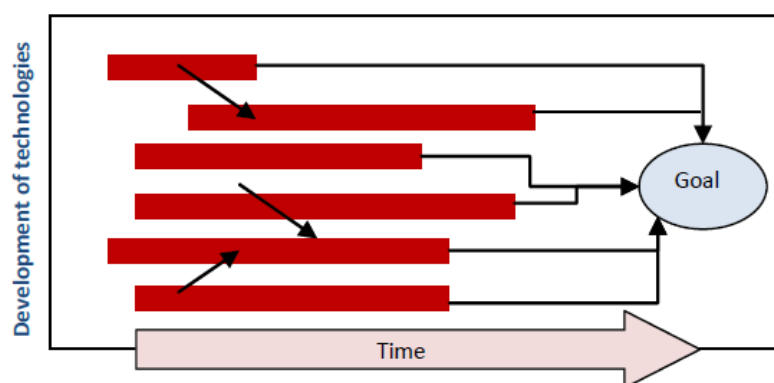


Figure 4: Technology roadmap for long run planning. [2]

SONNETS has the aim to base its recommendations on societal and public sector needs and also emerging ICTs which could potentially innovate the public sector. Therefore, it makes sense to use a roadmap approach which is also based both on needs (or on the 'market' in the business language) and also on available technologies, on the other side. Thus, SONNETS incorporates the general idea of the EIRMA (European Industrial Research Management Association) approach of including both **market-pull** as well as **technology-push aspects** into the development of the roadmap.[1]

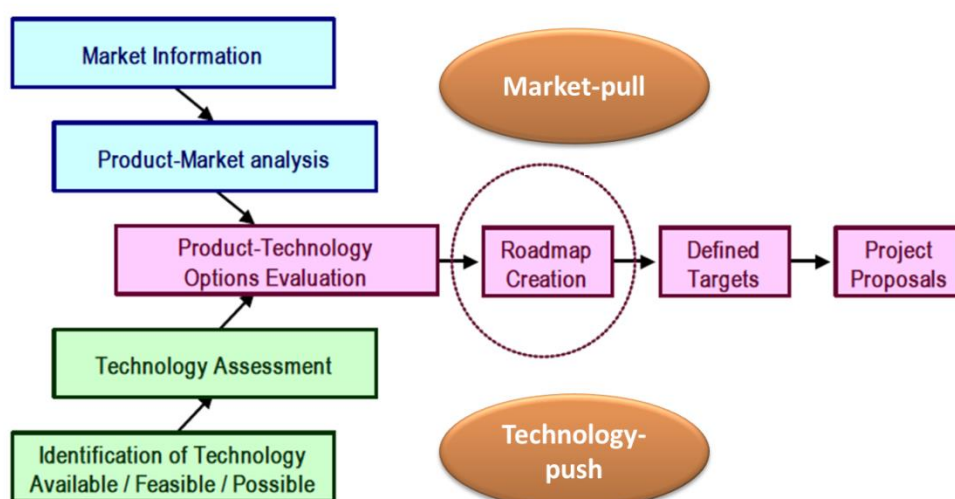


Figure 5: Technology Roadmaps integrating commercial and technological knowledge. [5]

The characteristics of these two aspects (market-pull and technology-push) are shown in the Table 2 below.

Market -pull	Technology-push
<ul style="list-style-type: none"> <li>• Planning</li> <li>• Market focus</li> <li>• Assumes product market opportunity</li> <li>• Deterministic</li> <li>• Convergent</li> <li>• Customer driven</li> </ul>	<ul style="list-style-type: none"> <li>• Technology focus</li> <li>• Looking for opportunities</li> <li>• Open ended</li> <li>• Divergent</li> </ul>

Table 2: Characteristics of the market-pull and technology-push approach. [5]

The generic roadmap according to the European Industrial Research Management Association (**EIRMA**) looks like in Figure 6. The generic roadmap is a time-based

chart, comprising a number of layers that typically include both commercial and technological perspectives. The roadmap allows the evolution of markets, products and technologies to be explored, and to be interlinked. [6]

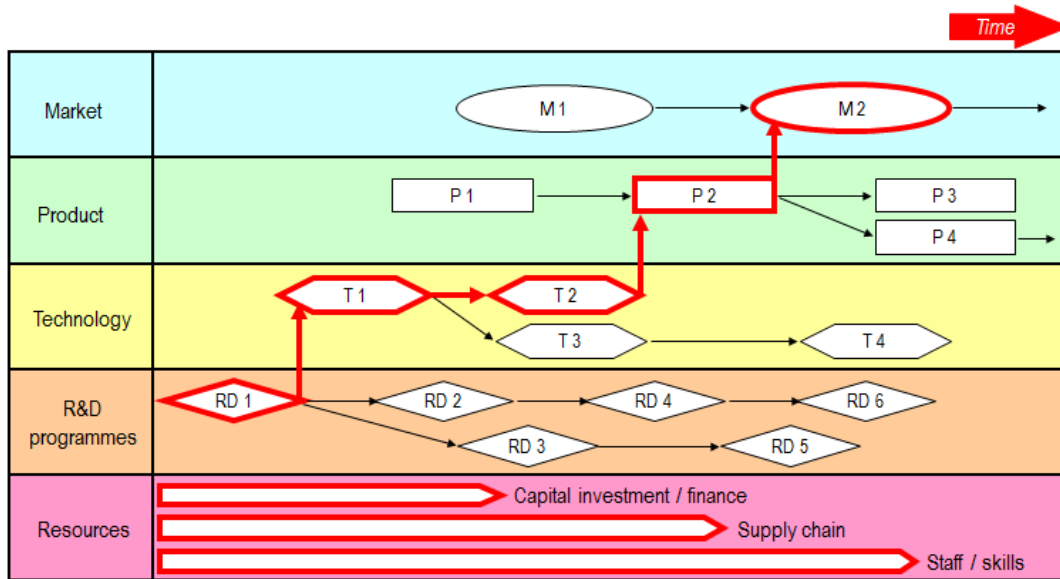


Figure 6: Generic roadmap according to EIRMA [7]

In SONNETS we had to make some **adaptions to this generic roadmap**, due to the fact that our roadmap is not intended to be used in a company, but as a recommendation how to innovate the public sector with emerging ICTs.

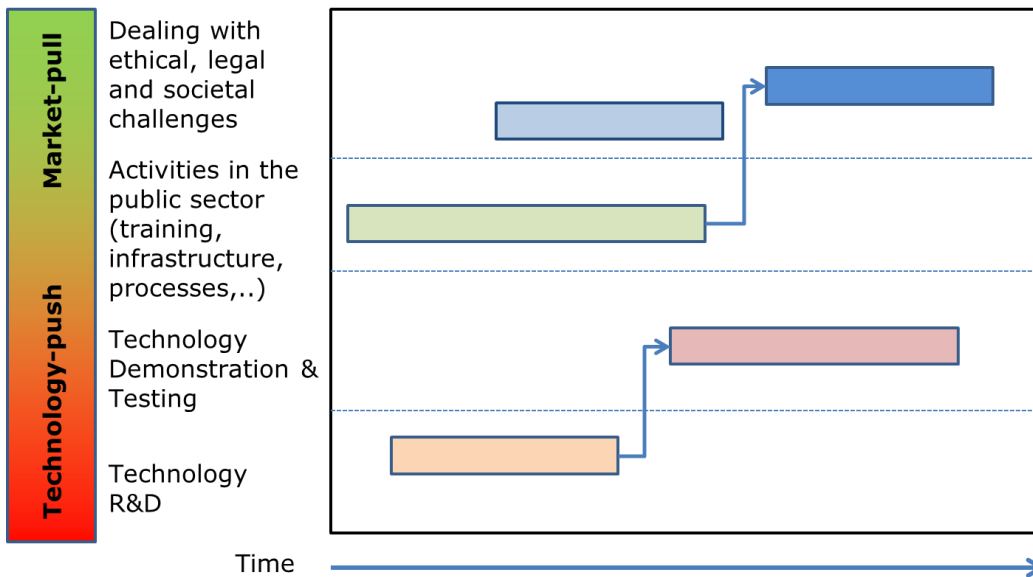


Figure 7: SONNETS roadmap Template

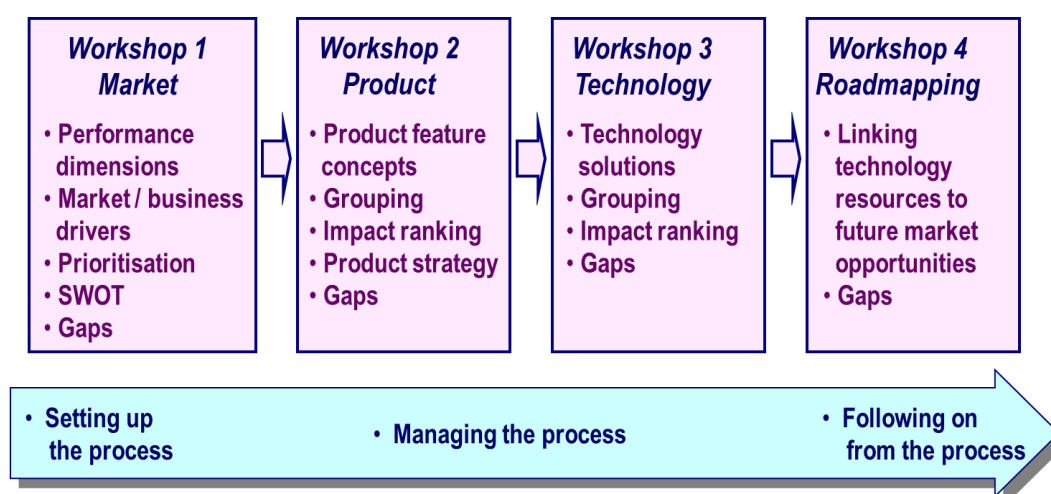
Therefore, the layer 'market' of the EIRMA approach in SONNETS is used to adapt the possible technological applications or services to the specific ethical, legal or societal challenges. This layer will contain necessary activities to deal with these challenges. The consideration of the societal and public sector needs itself is intrinsic in the whole roadmap development, as each technology (or technological trend) is assigned to a specific societal or public sector need (see chapter 3.1). The layer 'product' of the EIRMA approach within SONNETS will be used for activities necessary to adapt the technology to the specific needs of the public

sector (so that the technology can be used as a 'product'). This layer will typically contain activities like the development of a training programme for the public sector staff or the implementation of cyber security measurements or the adaptation of the IT infrastructure.

Regarding the **development of the roadmap** itself, EIRMA recommends to follow a process of 8 stages: [8]

1. Pre-project phase
2. Creation of the working group
3. Draft plan for the technology roadmap project
4. Processing information
5. Drafting a roadmap
6. Review, discussion and communication of the plan
7. Formulation of the decision document
8. Actualisation

Other possible processes of a roadmap development include the T-Plan approach. The T-Plan 'fast-start' approach has been developed as part of a three-year applied research programme, where more than 20 roadmaps were developed in collaboration with a variety of company types in several industry sectors. [2]

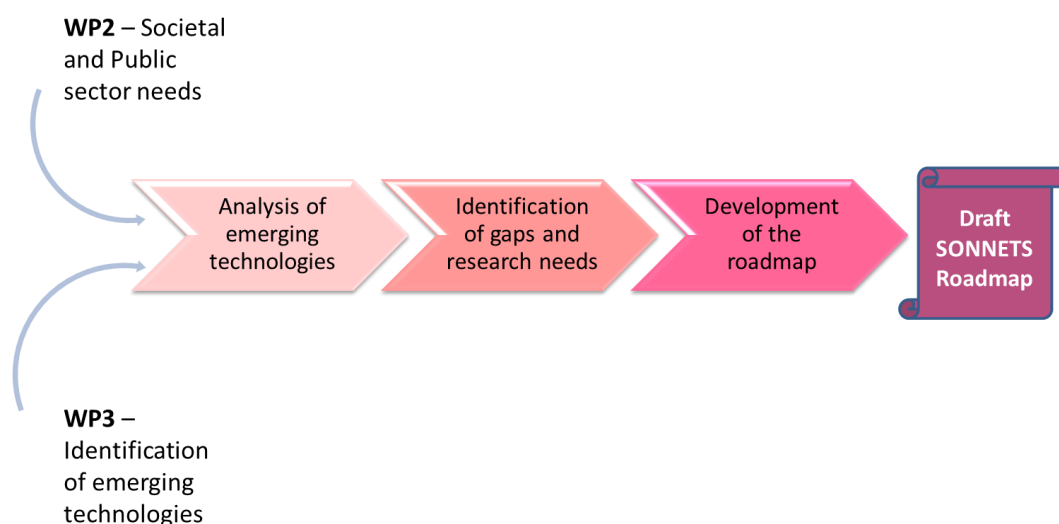


**Figure 8: T-Plan process of roadmap development. [2]**

The SONNETS approach includes elements of both roadmap processes mentioned above to adapt the development process to the specific case of innovating the public sector by meeting societal needs.

## 2.1 The SONNETS roadmap approach

The basis for the roadmap development of SONNETS is, on the one side, the compiled **list of societal and public sector needs** identified of WP2 [9] and, on the other side, the analysed and assessed **emerging ICTs and trends** of WP3 [10, 11] and D4.1 [12].

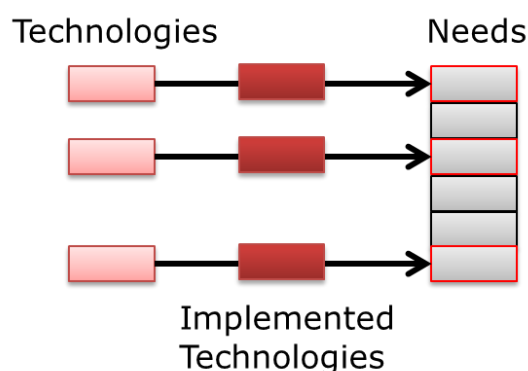


**Figure 9: The different steps of the SONNETS roadmap development.**

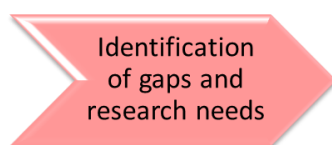
**Analysis of emerging technologies**

The aim of Task 4.1 was to describe the activities needed to further develop the current ICTs until their final implementation in the public sector. The list of technologies was taken from WP3. However, some small changes have been made to this list. In D4.2 there have been two technologies which could not be matched with any of the key priority needs (namely, geographical information systems and sentiment analysis). These two technologies have been deleted from the full list. Additionally, some of the technologies have been merged to a technology category, namely in the case in which one of the technologies is quite similar to or included in the other technology area (i.e. open data and open government; artificial intelligence and bots; big data and data analytics; e-identities and e-signatures). Thus, the focus within Task 4.1 was set on the emerging technologies themselves: their technology readiness level, necessary non-research activities before these technologies are ready to use in the public sector (e.g. standards, regulations, legal issues) and possible obstacles which could hinder a successful take-up of these technologies (e.g. necessary advanced infrastructure, know-how of personnel, social acceptance, costs).





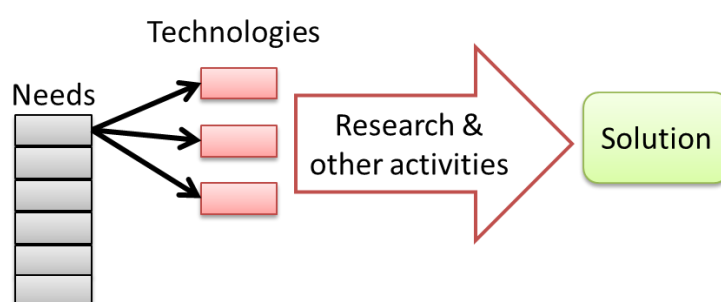
**Figure 10: Objective of Task 4.1: Describe the activities needed from the current status of technologies to a status ready to be implemented in the public sector**



In Task 4.2, we **changed the perspective and set the focus on the societal and public sector needs**. Before starting this project, we have reckoned that there might be societal and public sector needs which cannot be solved by ICTs at all. However, our work in WP3 has shown that, although ICTs can always be only a part of an overall solution to meet these needs, for nearly all needs, emerging technologies have been identified, which could help to (partly) satisfy these challenges. The exceptions are 'housing and secure shelters' and 'reduce taxation levels and lessen complexity', for which, ICTs cannot play a major role to meet these needs.

However, for all the other identified needs, we have started the analysis in Task 4.2 by using the assignment of different emerging ICTs to the respective societal, business or public sector needs already done in WP3.[10]

In Task 4.2, each of these assigned emerging ICTs and trends has been analysed with the aim to describe the gap between the technology as it is now and a fully implemented version (the solution), which is able to satisfy (at least partly) the assigned need.

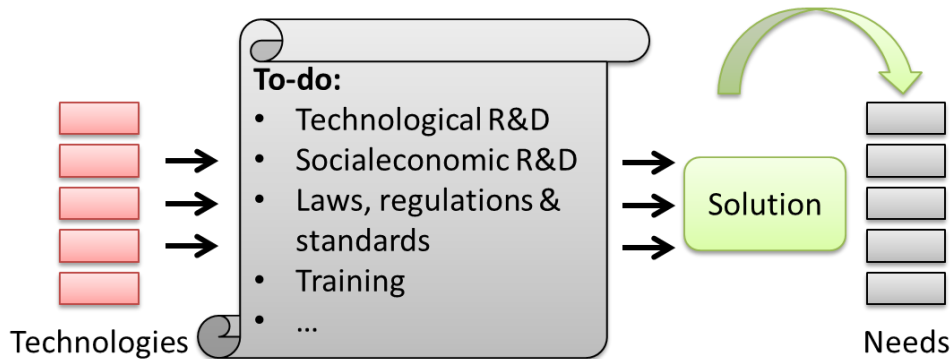


**Figure 11: Development of research needs in Task 4.2**

As a result, D4.2 presents an **overview of already existing solutions or services** which could possibly be helpful to meet the corresponding specific need and also potential uses or services of this technology regarding the respective need.

Additionally, D4.2 contains a **'to-do-list' for each of these assigned IC technologies**, with the aim to have a list of all necessary research and non-research activities needed to implement and use this technology successfully in

the public sector to satisfy the assigned specific need. Methodologically, this was done by using the Weighted Bit Assessment Table (WBAT) method [13, 14] developed by Fraunhofer INT.



**Figure 12: Aim of Task 4.2 - develop a to-do list of activities to implement ICTs with the objective to satisfy a specific societal or public sector need.**

The filled out Weighted-Bit Assessment Table (WBAT) forms the basis for the SONNETS research roadmap, which summarizes all necessary activities to implement the ICTs successfully in the public sector. For more details regarding WBAT and its adaption to the needs of SONNETS please refer to D4.2 [3].



The last step of the SONNETS process is the development of the roadmap itself. This has been done in the current Task 4.3 and will be explained in more detail in the following chapter 3.

## 3 Development of the roadmap

### 3.1 Step R1: Matching of technologies / trends and needs

In order to develop a roadmap for each of the technologies or technology trends, we first need to identify a specific societal or public sector need which the technology should address.

Obviously, the technologies can be implemented with different purposes and objectives, e.g. virtual reality can be used in the health area for patients with depressions or pains or in the education of employees in companies or also for training purposes in the public sector to prepare personnel for emergency or crisis situations. It would be far too time-consuming for a small CSA-project like SONNETS to develop several roadmaps for each technology for all the different types of applications. However, in most cases an outstanding main application in the public sector is clearly visible.

This matching has been done during the course of WP3 [10, 11] and has been validated during the WP4 workshop in Cologne in May 2017. For the validation, we have used an interactive polling system [15]. The participants of the workshop were asked if a specific technology would serve to satisfy a societal or public sector need. For example, they were asked if 'artificial intelligence and bots' could be used to meet one of the societal needs presented, when implemented in the public sector (see Figure 13).

The **workshop in Cologne** took place at 24th of May 2017.

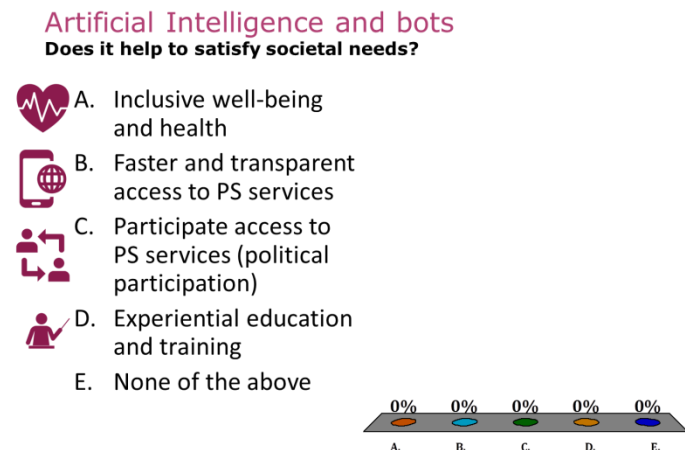
Overall, 16 participants discussed and rated which technologies are best suited to satisfy a specific societal or public sector need. Additionally, the necessary activities before implementing these technologies in the public sector have been discussed.

Apart from the members of the consortium and the members of the SONNETS experts committee, there has been one representative of the EU project SIMPATICO and further researchers and industry representatives in the area of IT and the public sector from Germany, Netherland, Greece and Spain.

For the validation exercise we used the validated list of key priority needs of D2.2, as the full number of needs would be too large to handle during a workshop environment. In Table 3 there is the list of key priority needs of D2.2 and a slightly modified version as used in this deliverable D4.3. The difference is that we have used the title of the need as in the full list of needs in D2.2, to be able to compare the results of this validation exercise with our own matching of needs and technologies. For example, one of the key priority needs of D2.2. is named 'education and training', while this need in the long list of 28 needs is named 'experiential education and training'. Another example is that the key priority need 'paperless state' is seen as one part of 'digitalization', which is also a need of the public sector itself. Therefore, 'paperless state / digitalization' is moved to the stakeholder group 'public sector'.

Stakeholder group	Needs title (as in D2.2)	Needs title (for the roadmap development)
<b>INDIVIDUALS</b>	Inclusive well-being and health	Inclusive well-being and health
	Faster access to public services	Faster and transparent access to PS services
	Political participation	Participate access to PS services (political participation)
	Education & training	Experiential education and training
	Paperless state	<i>moved to 'digitalization' in the 'public sector' part</i>
<b>BUSINESSES</b>	Easy access to public sector information	Access to public sector information
	Stimulate an entrepreneurial and start-up culture	Entrepreneurial and start-up culture
	Access to funds	Access to funds - business expansion
	Simplifying recruitment procedures	Talent acquisition and retention; simplifying recruitment procedures
	Talent acquisition and retention	<i>merged with 'recruitment procedures'</i>
<b>PUBLIC SECTOR</b>	Increase resources productivity	Increase resource productivity
	Employees remuneration and incentives	Employee remuneration and incentives
	Improve access to public services	Improve access to public services
	Civil servants as a community of change	Civil servants as a community of change
	Recruitment and training	Recruitment and training
		Digitalization

**Table 3: Key priority needs as in D2.2. and for the roadmap development in D4.3.**



**Figure 13: Example of a PowerPoint slide of the interactive polling system.**

Then, the participants were requested to press button A to D on their responder card, if they know of a specific service, application or potential use case. In all other cases, they were asked to press E 'none of the above'. If they know applications or use cases for more than one societal or public sector need, the participants were asked to prioritize – regarding for which of the needs this technology might have the highest impact.



**Figure 14: Turning technologies response card. [15]**

The results of the interactive polling are summarized in Table 4 to Table 6. The maximum percentage of votes for each technology is marked in red.

	<b>Technology / trend</b>	<b>Inclusive well-being and health</b>	<b>Faster and transparent access to PS services</b>	<b>Participate access to PS services (political participation)</b>	<b>Experiential education and training</b>	<b>None of the above</b>
1	Artificial Intelligence and bots	68.8%	12.5%	0.0%	6.3%	12.5%
2	Augmented Reality	25.0%	0.0%	0.0%	62.5%	12.5%
3	Big Data and data analytics	66.7%	13.3%	6.7%	0.0%	13.3%
4	Biometrics	18.8%	37.5%	12.5%	0.0%	31.3%
5	Blockchain	6.7%	40.0%	13.3%	6.7%	33.3%
6	Cloud Computing	25.0%	43.8%	0.0%	0.0%	31.3%
7	e-Identities (and e-signatures)	0.0%	66.7%	26.7%	0.0%	6.7%
8	Internet of Things	68.8%	0.0%	6.3%	0.0%	25.0%
9	Machine Learning	50.0%	6.3%	0.0%	18.8%	25.0%
10	Natural Language Processing	25.0%	25.0%	25.0%	0.0%	25.0%
11	Wearables	93.3%	0.0%	0.0%	0.0%	6.7%
12	Virtual Reality	13.3%	0.0%	0.0%	73.3%	13.3%
13	API Economy	6.3%	75.0%	0.0%	0.0%	18.8%
14	Crowd-sourcing	0.0%	7.7%	38.5%	7.7%	46.2%
15	Digitalization	13.3%	60.0%	6.7%	6.7%	13.3%
16	e-Participation	0.0%	7.1%	85.7%	0.0%	7.1%
17	Gamification	13.3%	0.0%	26.7%	46.7%	13.3%
18	Mobile Devices	21.4%	57.1%	0.0%	14.3%	7.1%
19	Open Data and Open Government	13.3%	40.0%	33.3%	0.0%	13.3%
20	Personalization	46.7%	20.0%	0.0%	13.3%	20.0%
21	Policy Making 2.0	12.5%	6.3%	68.8%	0.0%	12.5%
22	Smart Workplace	20.0%	6.7%	0.0%	33.3%	40.0%
23	Social Media	6.7%	13.3%	66.7%	0.0%	13.3%

**Table 4: Results of interactive polling in the area 'societal / individual' needs.**

	Technology / trend	Access to public sector information	Entrepreneurial and start-up culture	Access to funds - business expansion	Talent acquisition and retention; simplifying recruitment procedures	None of the above
1	Artificial Intelligence and bots	68.8%	12.5%	0.0%	6.3%	12.5%
2	Augmented Reality	25.0%	0.0%	0.0%	12.5%	62.5%
3	Big Data and data analytics	12.5%	37.5%	6.3%	31.3%	12.5%
4	Biometrics	18.8%	18.8%	0.0%	0.0%	62.5%
5	Blockchain	13.3%	20.0%	20.0%	0.0%	46.7%
6	Cloud Computing	37.5%	18.8%	0.0%	0.0%	43.8%
7	e-Identities (and e-signatures)	50.0%	0.0%	6.3%	6.3%	37.5%
8	Internet of Things	6.3%	25.0%	0.0%	0.0%	68.8%
9	Machine Learning	6.3%	12.5%	6.3%	18.8%	56.3%
10	Natural Language Processing	25.0%	18.8%	0.0%	12.5%	43.8%
11	Wearables	18.8%	12.5%	0.0%	0.0%	68.8%
12	Virtual Reality	6.3%	6.3%	6.3%	18.8%	62.5%
13	API Economy	40.0%	53.3%	0.0%	0.0%	6.7%
14	Crowdsourcing	0.0%	40.0%	13.3%	6.7%	40.0%
15	Digitalization	50.0%	21.4%	7.1%	0.0%	21.4%
16	e-Participation	20.0%	13.3%	0.0%	13.3%	53.3%
17	Gamification	0.0%	26.7%	0.0%	26.7%	46.7%
18	Mobile Devices	28.6%	21.4%	0.0%	7.1%	42.9%
19	Open Data and Open Government	40.0%	53.3%	0.0%	0.0%	6.7%
20	Personalization	12.5%	37.5%	0.0%	12.5%	37.5%
21	Policy Making 2.0	6.7%	33.3%	13.3%	0.0%	46.7%

	Technology / trend	Access to public sector information	Entrepreneurial and start-up culture	Access to funds - business expansion	Talent acquisition and retention; simplifying recruitment procedures	None of the above
22	Smart Workplace	13.3%	26.7%	0.0%	33.3%	26.7%
23	Social Media	26.7%	20.0%	0.0%	20.0%	33.3%

Table 5: Results of interactive polling in the area business needs.

	Technology / Trend	Increase resource productivity	Employee remuneration and incentives	Improve access to public services	Civil servants as a community of change	Recruitment and training	Digitization	None of the above
1	Artificial Intelligence and bots	25.0%	0.0%	25.0%	0.0%	6.3%	31.3%	12.5%
2	Augmented Reality	6.3%	0.0%	18.8%	0.0%	37.5%	6.3%	31.3%
3	Big Data and data analytics	37.5%	0.0%	18.8%	6.3%	0.0%	12.5%	25.0%
4	Biometrics	6.3%	6.3%	12.5%	0.0%	0.0%	31.3%	43.8%
5	Blockchain	6.3%	12.5%	18.8%	6.3%	0.0%	18.8%	37.5%
6	Cloud Computing	26.7%	0.0%	6.7%	0.0%	0.0%	33.3%	33.3%
7	e-Identities (and e-signatures)	0.0%	6.3%	37.5%	0.0%	0.0%	37.5%	18.8%
8	Internet of Things	12.5%	0.0%	12.5%	0.0%	6.3%	37.5%	31.3%
9	Machine Learning	31.3%	0.0%	0.0%	0.0%	6.3%	31.3%	31.3%
10	Natural Language Processing	13.3%	6.7%	20.0%	20.0%	0.0%	26.7%	13.3%
11	Wearable	6.7%	6.7%	6.7%	6.7%	0.0%	33.3%	40.0%
12	Virtual Reality	0.0%	6.3%	0.0%	0.0%	62.5%	0.0%	31.3%
13	API Economy	0.0%	6.7%	40.0%	13.3%	0.0%	20.0%	20.0%
14	Crowdsourcing	0.0%	6.7%	6.7%	46.7%	0.0%	0.0%	40.0%
15	Digitalization	46.7%	0.0%	26.7%	0.0%	6.7%	6.7%	13.3%
16	e-Participation	0.0%	0.0%	14.3%	42.9%	7.1%	7.1%	28.6%



	Technology / Trend	Increase resource productivity	Employee remuneration and incentives	Improve access to public services	Civil servants as a community of change	Recruitment and training	Digitization	None of the above
17	Gamification	14.3%	28.6%	0.0%	21.4%	14.3%	7.1%	14.3%
18	Mobile Devices	33.3%	0.0%	13.3%	6.7%	0.0%	33.3%	13.3%
19	Open Data and Open Government	20.0%	6.7%	40.0%	6.7%	0.0%	6.7%	20.0%
20	Personalization	18.8%	6.3%	25.0%	6.3%	6.3%	12.5%	25.0%
21	Policy Making 2.0	18.8%	0.0%	6.3%	50.0%	0.0%	6.3%	18.8%
22	Smart Workplace	66.7%	13.3%	0.0%	0.0%	6.7%	0.0%	13.3%
23	Social Media	0.0%	6.7%	33.3%	40.0%	0.0%	6.7%	13.3%

**Table 6: Results of interactive polling in the area public sector needs.**

As a next step, for each of the societal and public sector needs, a technology was selected which, according to the vote of the experts, is best suited to satisfy the need. For 13 of the overall 14 societal /business and public sector needs, a technology was identified. However, for one of these needs, namely 'access to funds (business expansion)', no technology was voted for or got the majority of votes for one technology. The need 'improve access to public sector' has not been explicitly assigned to a technology, as there is a significant overlap to the need 'faster and transparent access to public sector services' (societal need) and also to 'access to public sector information' (business need). The same applies to the need 'recruitment and training' (public sector need). There is also an overlap with the societal need 'experiential education and training'. Although the content of the training will be different for the two stakeholder groups, technically the application of virtual reality for training might be quite similar.

For all the remaining technologies, which have not been selected to be the best match for one of the needs, the societal or public sector need with the highest number of votes was identified as the assigned need (see Table 7).

So, in summary, the process of assigning technologies to needs is as follows:

1. For each of the **needs** a *technology* is selected, which according to the votes of the participants of the workshop, is best suited to satisfy the respective need.
2. For all remaining (**not-assigned**) **technologies** a *need* is selected for which, according to the votes of the participants of the workshop, the technology has the highest impact (highest number of votes of the participants).

	Technology / Trend	Societal needs				Business needs				Public sector needs					Assigned societal / business / public sector need	
		Inclusive well-being and health	Faster and transparent access to PS services	Participate access to PS services (political participation)	Experiential education and training	Access to public sector information	Entrepreneurial and start-up culture	Access to funds (business expansion)	Talent acquisition and retention - Simplifying recruitment proc.	Increase resource productivity <sup>1</sup>	Employee remuneration and incentives	Improve access to public services	Civil servants as a community of change	Recruitment and training		Digitization
1	Artificial Intelligence and bots	69%				69%									31%	Access to public sector information
2	Augmented Reality				63%									38%		Experiential education and training
3	Big Data and data analytics	67%					38%			38%						Inclusive well-being and health
4	Biometrics		38%													Faster and transparent access to PS services

<sup>1</sup> For the need 'Increase resource productivity' the technology 'digitization' was chosen, because the technology with the highest number of votes 'smart workplace' has already been matched to 'talent acquisition and retention' as the best technology-need match. Additionally digitization is an important basis for having a smart workplace environment.

	Technology / Trend	Societal needs				Business needs				Public sector needs					Assigned societal / business / public sector need	
		Inclusive well-being and health	Faster and transparent access to PS services	Participate access to PS services (political participation)	Experiential education and training	Access to public sector information	Entrepreneurial and start-up culture	Access to funds (business expansion)	Talent acquisition and retention - Simplifying recruitment proc.	Increase resource productivity <sup>1</sup>	Employee remuneration and incentives	Improve access to public services	Civil servants as a community of change	Recruitment and training		Digitization
5	Blockchain		40%													Faster and transparent access to PS services
6	Cloud Computing		44%											33%		Faster and transparent access to PS services
7	e-Identities (and e-signatures)		67%			50%					38%			38%		Digitization <sup>2</sup>
8	Internet of Things	69%												38%		Inclusive well-being and health
9	Machine Learning	50%							31%					31%		Inclusive well-being and health

<sup>2</sup> Here 'digitization' was chosen, because e-identities has been voted to be the best technological match for the public sector need 'digitization'.

		Societal needs				Business needs				Public sector needs						
Technology / Trend		Inclusive well-being and health	Faster and transparent access to PS services	Participate access to PS services (political participation)	Experiential education and training	Access to public sector information	Entrepreneurial and start-up culture	Access to funds (business expansion)	Talent acquisition and retention - Simplifying recruitment proc.	Increase resource productivity <sup>1</sup>	Employee remuneration and incentives	Improve access to public services	Civil servants as a community of change	Recruitment and training	Digitization	Assigned societal / business / public sector need
10	Natural Language Processing														27%	Digitization
11	Wearables	93%														Inclusive well-being and health
12	Virtual Reality				73%									63%		Experiential education and training & Recruitment and training
13	API Economy		75%				53%					40%				Faster and transparent access to PS services
14	Crowdsourcing						40%						47%			Civil servants as a community of change

	Technology / Trend	Societal needs				Business needs				Public sector needs					Assigned societal / business / public sector need	
		Inclusive well-being and health	Faster and transparent access to PS services	Participate access to PS services (political participation)	Experiential education and training	Access to public sector information	Entrepreneurial and start-up culture	Access to funds (business expansion)	Talent acquisition and retention - Simplifying recruitment proc.	Increase resource productivity <sup>1</sup>	Employee remuneration and incentives	Improve access to public services	Civil servants as a community of change	Recruitment and training		Digitization
15	Digitalization		60%			50%				47%						Increase resource productivity <sup>3</sup>
16	e-Participation			86%								43%				Participative access to PS services (political participation)
17	Gamification				47%						29%					Employee remuneration and incentives <sup>4</sup>
18	Mobile Devices		57%							33%				33%		Faster and transparent access to PS services
19	Open Data and Open		40%				53%					40%				Entrepreneurial and start-up

<sup>3</sup> Here 'Increase resource productivity was chosen', because this need has not been matched by a technology otherwise.

<sup>4</sup> Here 'Employee remuneration and incentives' was chosen, because no other technology has been matched to this need.

		Societal needs				Business needs				Public sector needs						
	Technology / Trend	Inclusive well-being and health	Faster and transparent access to PS services	Participate access to PS services (political participation)	Experiential education and training	Access to public sector information	Entrepreneurial and start-up culture	Access to funds (business expansion)	Talent acquisition and retention - Simplifying recruitment proc.	Increase resource productivity <sup>1</sup>	Employee remuneration and incentives	Improve access to public services	Civil servants as a community of change	Recruitment and training	Digitization	Assigned societal / business / public sector need
	Government															culture
20	Personalization	47%					38%					25%				Inclusive well-being and health
21	Policy Making 2.0			69%									50%			Civil servants as a community of change <sup>5</sup>
22	Smart Workplace								33%	67%						Talent acquisition and retention; Simplifying recruitment procedures <sup>6</sup>
23	Social Media			67%									40%			Participate access to PS services (political

<sup>5</sup> Here the technology /trend 'policy making 2.0'is according to the votes the best match for the need 'civil servants as a community of change'.

<sup>6</sup> Here 'talent acquisition and retention; simplifying recruitment procedures' was chosen, because no other technology has been matched to this need.

		Societal needs				Business needs				Public sector needs						
Technology / Trend		Inclusive well-being and health	Faster and transparent access to PS services	Participate access to PS services (political participation)	Experiential education and training	Access to public sector information	Entrepreneurial and start-up culture	Access to funds (business expansion)	Talent acquisition and retention - Simplifying recruitment proc.	Increase resource productivity <sup>1</sup>	Employee remuneration and incentives	Improve access to public services	Civil servants as a community of change	Recruitment and training	Digitization	Assigned societal / business / public sector need
																participation)

**Table 7: Results of interactive polling - matching of technologies and needs. The assigned need is highlighted in pink.**

During the voting process the following comments or clarifications were made:

- The main difference between the two needs 'Faster and transparent access to PS services' and 'Participate access to PS services (political participation)' is that the first need refers to the access to public services itself (e.g. to get information) and the second need refers to interactive processes like for example e-participation.
- Gamification refers to the application of game-design elements and game principles in non-game contexts, e.g. to improve the user engagement.
- Open data and open government refers mainly to the provision of open data.
- Virtual reality is an extreme case of augmented reality. Virtual reality refers to a 100% virtual environment, while augmented reality has virtual elements (below 100%).
- API economy refers to the provision of open data via APIs.



### 3.2 Step R2: Necessary R&D or other activities to implement the technologies successfully in the public sector

The WP4 workshop in Cologne was also used to validate the results of D4.2 regarding the list of necessary activities to successfully implement emerging ICTs in the public sector.

Methodologically the sticky dot method was applied to validate the SONNETS findings. For each technology or trend, a sheet with different questions regarding necessary activities was prepared. In more detail the following questions were presented:

Part 1 – R&D activities:

- The technology is at a **development** stage and has neither been used in the public sector nor in any other domain.
- The technology has been successfully tested as a **prototype**; a real use case for the public sector has yet to be defined.
- The technology is ready for the market in another domain, but **adaptions** to the public sector are necessary.

Part II – Other activities:

- Before using this technology a **specific training** is needed.
- For the implementation of this technology an advanced or interoperable **ICT infrastructure** is needed.
- The usage of this technology might raise **cyber security issues**.
- The implementation or maintenance of this technology is rather **costly**.
- The successful usage of this technology is only possible if the relevant stakeholders agree on a **common standard**.
- The technology has to be explained and **promoted** among business stakeholders or citizens.

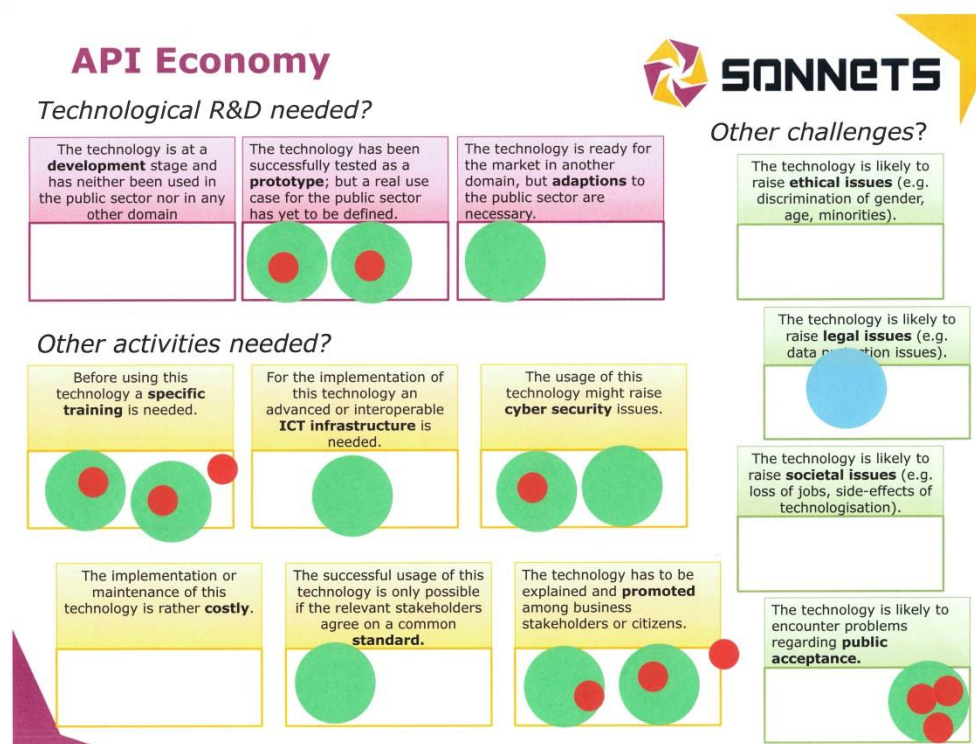
Part III - Other challenges:

- The technology is likely to raise **ethical issues** (e.g. discrimination of gender, age, minorities).
- The technology is likely to raise **legal issues** (e.g. data protection issues).
- The technology is likely to raise **societal issues** (e.g. loss of jobs, side-effects of technologisation).
- The technology is likely to encounter problems regarding **public acceptance**.

For each technology, a DIN A3 sheet with these questions was printed out and distributed in the workshop room (see Figure 15). The participants were asked to move freely through the room and answer these questions using sticky dots.

- Sticking a big green (or blue) dot means: "Yes"
  - If a second person has the same point of view, no further activity is required, but if the second person disagrees, he or she is asked to stick a little red dot above the other one.
- Sticking a red dot means: "No" or "disagreement with the green dot"
  - A third or fourth person is then asked to stick further green or red dots to be able to reach a clear statement.

- Sticking no dot at all means: The participants do not agree with the statement.



**Figure 15: Example sheet of applying the sticky dot method to list the necessary activities to implement ICTs in the public sector.**

In general it was observed that many controversial points of view regarding the answering of these questions persist among the participants. While for some technologies the participants agree on the assessment (e.g. for virtual reality, see Figure 16), other assessments (like for API economy, see Figure 15) have been very much under debate. For the consortium, this is a sign that this technology probably has several different potential applications for the public sector and that in the roadmap we have to be clear about the intended use case or service.

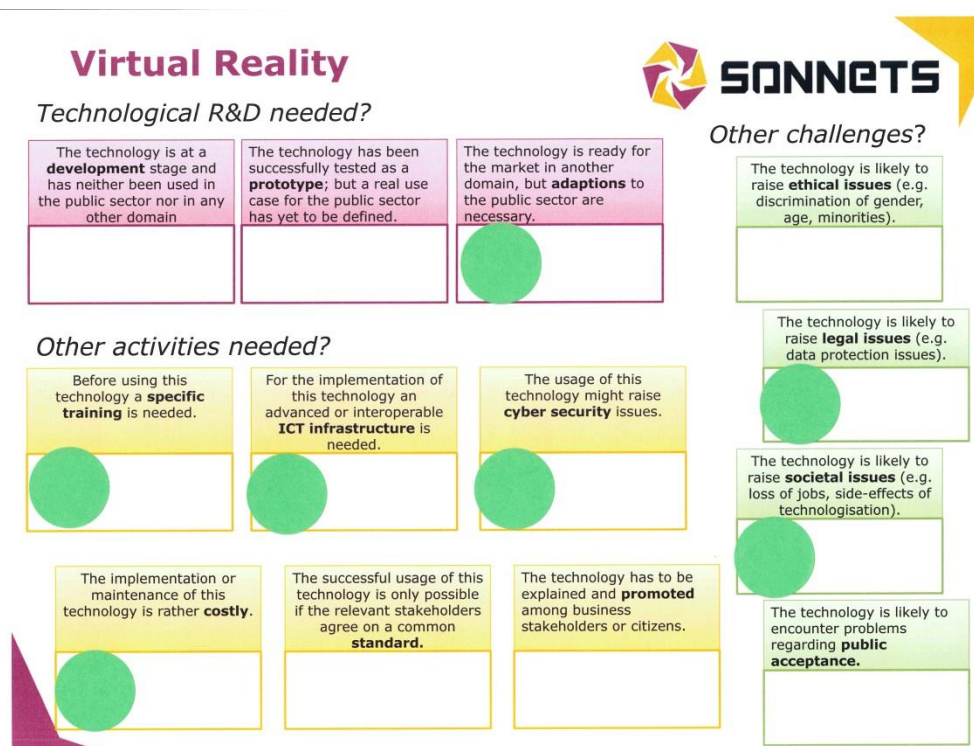


Figure 16: Another example sheet of the sticky dot method.

The results of this exercise are summarized in Table 8.



Figure 17: Participants of the WP4 workshop during sticky dot exercise.

- Red means that the majority has voted for “yes” (In the roadmap we have to deal with this issue and probably an R&D or other activity is required, e.g. development of a training, dealing with cyber security issues).
- Green means that the majority has voted for “no” / does not agree with the statement. (In the roadmap we probably do not have to deal with these issues, e.g. no ethical issues are related to this technology).
- Yellow means that an equal number of “yes” and “no” votes have been casted.

The full list of technology sheets is presented in Annex II.

		Technological R&D?			Other activities needed?					Other challenges?				
		The technology is at a <b>development</b> stage and has neither been used in the public sector nor in any other domain.	The technology has been successfully tested as a <b>prototype</b> ; a real use case for the public sector has yet to be defined.	The technology is ready for the market in another domain, but <b>adaptions</b> to the public sector are necessary.	Before using this technology a <b>specific training</b> is needed.	For the implementation of this technology an advanced or interoperable <b>ICT infrastructure</b> is needed.	The usage of this technology might raise <b>cyber security</b> issues.	The implementation or maintenance of this technology is rather <b>costly</b> .	The successful usage of this technology is only possible if the relevant stakeholders agree on a <b>common standard</b> .	The technology has to be explained and <b>promoted</b> among business stakeholders or citizens.	The technology is likely to raise <b>ethical issues</b> (e.g. discrimination of gender, age, minorities).	The technology is likely to raise <b>legal issues</b> (e.g. data protection issues).	The technology is likely to raise <b>social issues</b> (e.g. loss of jobs, side-effects of technologisation).	The technology is likely to encounter problems regarding <b>public acceptance</b> .
1	Artificial Intelligence and bots	Green	Green	Red	Red	Red	Green	Red	Green	Red	Red	Red	Red	Red
2	Augmented Reality	Green	Red	Red	Red	Green	Green	Red	Green	Red	Red	Red	Red	Red
3	Big Data and data analytics	Green	Green	Red	Red	Red	Red	Green	Green	Red	Red	Red	Red	Red
4	Biometrics	Green	Green	Red	Red	Green	Red	Green	Red	Red	Red	Green	Red	Red
5	Blockchain	Green	Red	Yellow	Green	Red	Red	Green	Red	Red	Green	Red	Red	Red
6	Cloud Computing	Green	Green	Green	Red	Red	Red	Green	Green	Red	Red	Green	Red	Red
7	e-Identities (and	Green	Green	Green	Red	Red	Red	Green	Red	Red	Red	Red	Green	Red

		Technological R&D?			Other activities needed?					Other challenges?				
		The technology is at a <b>development</b> stage and has neither been used in the public sector nor in any other domain.	The technology has been successfully tested as a <b>prototype</b> ; a real use case for the public sector has yet to be defined.	The technology is ready for the market in another domain, but <b>adaptions</b> to the public sector are necessary.	Before using this technology a <b>specific training</b> is needed.	For the implementation of this technology an advanced or interoperable <b>ICT infrastructure</b> is needed.	The usage of this technology might raise <b>cyber security</b> issues.	The implementation or maintenance of this technology is rather <b>costly</b> .	The successful usage of this technology is only possible if the relevant stakeholders agree on a <b>common standard</b> .	The technology has to be explained and <b>promoted</b> among business stakeholders or citizens.	The technology is likely to raise <b>ethical issues</b> (e.g. discrimination of gender, age, minorities).	The technology is likely to raise <b>legal issues</b> (e.g. data protection issues).	The technology is likely to raise <b>societal issues</b> (e.g. loss of jobs, side-effects of technologisation).	The technology is likely to encounter problems regarding <b>public acceptance</b> .
	e-signatures)	Green	Green	Green	Red	Red	Green	Red	Red	Red	Green	Red	Red	Red
8	Internet of Things	Green	Green	Red	Red	Red	Green	Red	Red	Red	Green	Red	Red	Red
9	Machine Learning	Green	Green	Red	Red	Red	Green	Red	Red	Red	Green	Red	Red	Red
10	Natural Language Processing	Green	Green	Red	Red	Red	Red	Green	Red	Red	Green	Red	Red	Red
11	Wearables	Green	Green	Red	Green	Yellow	Green	Red	Red	Red	Green	Red	Red	Red
12	Virtual Reality	Green	Green	Red	Red	Red	Green	Red	Red	Red	Green	Red	Red	Red
13	API Economy	Green	Yellow	Red	Green	Red	Green	Red	Red	Red	Green	Red	Red	Red
14	Crowdsourcing	Green	Yellow	Green	Red	Green	Green	Green	Red	Red	Green	Red	Red	Red
15	Digitalization	Green	Green	Green	Green	Red	Green	Red	Green	Yellow	Red	Red	Red	Red

		Technological R&D?			Other activities needed?					Other challenges?				
		The technology is at a <b>development</b> stage and has neither been used in the public sector nor in any other domain.	The technology has been successfully tested as a <b>prototype</b> ; a real use case for the public sector has yet to be defined.	The technology is ready for the market in another domain, but <b>adaptions</b> to the public sector are necessary.	Before using this technology a <b>specific training</b> is needed.	For the implementation of this technology an advanced or interoperable <b>ICT infrastructure</b> is needed.	The usage of this technology might raise <b>cyber security</b> issues.	The implementation or maintenance of this technology is rather <b>costly</b> .	The successful usage of this technology is only possible if the relevant stakeholders agree on a <b>common standard</b> .	The technology has to be explained and <b>promoted</b> among business stakeholders or citizens.	The technology is likely to raise <b>ethical issues</b> (e.g. discrimination of gender, age, minorities).	The technology is likely to raise <b>legal issues</b> (e.g. data protection issues).	The technology is likely to raise <b>societal issues</b> (e.g. loss of jobs, side-effects of technologisation).	The technology is likely to encounter problems regarding <b>public acceptance</b> .
16	e-Participation	Green	Green	Green	Red	Green	Red	Green	Green	Red	Yellow	Red	Green	Green
17	Gamification	Green	Yellow	Green	Red	Green	Green	Yellow	Green	Red	Green	Green	Green	Green
18	Mobile Devices	Green	Green	Green	Green	Green	Red	Green	Red	Green	Green	Red	Red	Green
19	Open Data and Open Government	Green	Red	Green	Red	Red	Red	Red	Red	Green	Green	Red	Green	Green
20	Personalization	Green	Green	Green	Green	Green	Red	Red	Red	Green	Yellow	Red	Green	Green
21	Policy Making 2.0	Green	Red	Green	Red	Green	Green	Green	Green	Red	Red	Green	Green	Red
22	Smart Workplace	Red	Red	Red	Green	Red	Red	Green	Green	Green	Red	Red	Red	Red
23	Social Media	Green	Green	Red	Red	Green	Green	Green	Green	Green	Red	Red	Red	Green

Table 8: Summary of results of the sticky dot exercise.

On the basis of the results of step 1 (matching technologies and needs) and step 2 (selecting necessary activities) for the following list of technologies (and their assigned societal or public sector needs) a full roadmap including technological R&D activities has to be developed for:

- Augmented Reality (need: Experiential education and training)
- Blockchain (need: Faster and transparent access to PS services)
- Open Data and Open Government (need: Entrepreneurial and start-up culture)
- Policy Making 2.0 (need: Civil servants as a community of change)
- Smart Workplace (need: Talent acquisition and retention, simplifying recruitment procedures)

Unfortunately, the technologies which have been identified during the workshop to be at the level of a prototype without a real use-case for the public sector are different from the ones identified by the consortium.

In D4.1 and D4.2 only 'artificial intelligence' and 'gamifications' have been assessed to be at that technological level. In Table 9 an explanation is given for each technology-need combination, why we think that for this technology and for this specific need (application) **it does not make sense to develop a R&D roadmap.**

Additionally we have looked at the three technologies for which in the WP4 workshop no clear vote regarding the technological readiness level has been given:

- API economy
- Crowdsourcing
- Gamifications

And also at the two technologies and their respective assigned need, which have been identified in D4.1 and D4.2:

- Artificial intelligence and bots
- Gamifications

A reasoning to exclude these technologies mentioned above from the list of full roadmaps (including technological R&D activity) is also given in Table 9. All the other technologies have already explicitly been assessed by the WP4 workshop and the results of D4.2 to need only some adaptations to the needs of the public sector and no further R&D activities.

	Technology / Trend	Assigned societal / business /public sector need	Existing solutions / products / services	Conclusion
<b>Technology-need combinations with a clear voting regarding their technology readiness level: 'no real use case for the public sector'</b>				
2	Augmented Reality	Experiential education and training	AR training is already in use the automotive industry (BMW, VW [16]) or in the printing industry [16]. Other educational apps are Construct3D for students of mechanical engineering or AR apps for students of chemistry, anatomy or astronomy.[17]	There are already several educational AR solutions in use, so that in the first place the content of the training has to be developed and not the technology itself.  <b>No technological R&amp;D roadmap necessary</b>
5	Blockchain	Faster and transparent access to PS services	<ul style="list-style-type: none"> <li>• Bitcoin (digital currency)</li> <li>• Bitnation[18]</li> <li>• Blockchain-based Guardtime service (Estonia) to develop and accelerate blockchain-based security, transparency and governance of patients' healthcare records[19, 20]</li> <li>• Bitnation &amp; Estonian eResidency initiative to allow Estonian e-residents, regardless of where they live or do business to be able to notarize their marriages, birth certificates, business contracts, and much more on the blockchain.[21]</li> </ul>	Blockchain is already in use in some places to help citizens to have a better access to public sector services  <b>No technological R&amp;D roadmap necessary</b>
19	Open Data and Open Government	Entrepre-neurial and start-up culture	Open data could help entrepreneurs to find necessary information about e.g. a specific region or economic or legislative conditions. There are a lot of initiatives which provide businesses with public sector information e.g.:	Already several open data portals are up and running. The content of these portals and the number of participating nations and municipalites should increase, but the



	Technology / Trend	Assigned societal / business /public sector need	Existing solutions / products / services	Conclusion
			<ul style="list-style-type: none"> <li>• EU Open Data Portal[22]</li> <li>• European Data portal[23]</li> <li>• Policy Compass Portal[24]</li> <li>• Public Contracts [25]</li> <li>• Open Coesione[26]</li> <li>• Visual OPML[27]</li> <li>• RES (Research and Education Space) [28]</li> <li>• 3cixty initiative of the Innovation Action Line Digital Cities[29]</li> <li>• Good Basic Data for Everyone” initiative in Denmark [30]</li> <li>• Publicspending.net[31]</li> </ul> <p>On the other hand IT-start-ups can also use open data to develop applications based on these data.</p>	<p>technology itself is already at a working level.</p> <p><b>No technological R&amp;D roadmap necessary.</b></p>
21	Policy Making 2.0	Civil servants as a community of change	<p>Policy making 2.0 offers a way of interaction between policy makers and citizens, e.g.</p> <ul style="list-style-type: none"> <li>• CROSSOVER[32]</li> <li>• PADGET [33]</li> <li>• OCOPOMO[34]</li> <li>• 2050 Pathways [35]</li> <li>• Opinion Space[36]</li> <li>• Homepage of the London Borough of Redbrige[37]</li> </ul>	<p>Policy making 2.0 refers to a number of emerging technologies that enable better, timely and more participated decision-making, like big data, opinion mining, modelling and simulation, visual analytics, collaborative governance and crowdsourcing and serious gaming. A roadmap for advancing ICTs in the area of policy making 2.0 already exists (CROSSOVER project [32]), so that it does not make sense to re-develop it.</p>

	Technology / Trend	Assigned societal / business / public sector need	Existing solutions / products / services	Conclusion
				<b>No further technological R&amp;D roadmap necessary.</b>
22	Smart Workplace	Talent acquisition and retention, simplifying recruitment procedures	<p>Many employees prefer to have a mobile working environment and mobile solutions to help them to improve their work-life-balance:</p> <ul style="list-style-type: none"> <li>• Mobile solutions (smartphones &amp; tablets, wearables, cloud computing), better collaboration e.g. Hamburg-Cloud[38], Samsung Smart Workplace[39], Fujitsu Smart Workplace[40], NEC Smart Workplace[41]</li> </ul> <p>According to a foresight study[42] in 2040 e.g. the following properties will characterize a smart workplace:</p> <ul style="list-style-type: none"> <li>• Flexible working contracts (increase mobility and unconventional working patterns)</li> <li>• “wellness” services at the workplace</li> <li>• Focus on collaboration</li> </ul>	<p>When comparing the current technological solutions in the area of ‘smart workplace’ and the vision of the foresight study, it seems that the main work to be done is in the area of change processes, mindsets and a general point of view how work will be seen and done in the future and not so much on the technological possibilities.</p> <p><b>No technological R&amp;D roadmap necessary.</b></p>

	Technology / Trend	Assigned societal / business /public sector need	Existing solutions / products / services	Conclusion
<b>Technology-need combinations with no clear voting regarding their technology readiness level</b>				
13	API economy	Faster and transparent access to PS services	<p>There are already many APIs and also apps building on this APIs available, which could help the citizens and businesses to access public sector services:                      On the homepage of programmableweb.com there are e.g. 712 <b>API</b>'s listed in the area of "government". Several of them will help to present public sector information to citizens and businesses, e.g.</p> <ul style="list-style-type: none"> <li>• World Government Data, GeoGratis (geospatial data), opengov.es (data from the Spanish government).[43]</li> <li>• Swiss public transport API[44]</li> <li>• Geospatial information provided by Swiss Confederation[45]</li> <li>• Open311 (collaborative model and open standard for civic issue tracking)[46]</li> <li>• Catalogue of services performed by local governments in several EU countries[47]</li> <li>• LG Inform Plus (Open Data API)[48]</li> <li>• Citadel project[49]</li> <li>• CitySDK APIs[50]</li> </ul> <p><b>Apps</b> for public sector service delivery: Lovecleanstreats (UK)[51]; FixMyStreet[52]; Numberhood (local stats)[53]; OpenCoesion[26] ; Visual OPML[27]; Abu Dhabi e-government app[54]; Swiss 'Gemeinde App'[55]; Swiss TaxMe[56];</p>	<p>There are already many solutions and services available. The main work consists in promoting these information and services among the stakeholder and expand the number of possible applications.</p> <p><b>No technological R&amp;D Roadmap necessary.</b></p>

	Technology / Trend	Assigned societal / business /public sector need	Existing solutions / products / services	Conclusion
			Butterfly Smart App[57] The page "Intelligent city software solutions" contains a list of apps also including public sector –citizen interaction[58].	
14	Crowdsourcing	Civil servants as a community of change	In a way, crowdsourcing could help to introduce fresh ideas and new applications into the public sector. However, crowdsourcing itself can only play a small role – the main challenge is to change the mind-sets and improve the flexibility of the staff. There are already many crowdsourcing platforms available: <ul style="list-style-type: none"> <li>• Spacehive[59]</li> <li>• goteo[60]</li> <li>• MIT Climate CoLab [61]</li> <li>• Arcbazar[62]</li> <li>• Pillar[63]</li> <li>• InnoCentive[64]</li> <li>• crowdSPRING[65]</li> <li>• innoget[66]</li> <li>• Start Some Good[67]</li> </ul>	Crowdsourcing itself is more a trend and less a technology. The technology which allows individuals or organizations the use of contributions from Internet users to obtain needed services or ideas, is already ready-to-use. However, the processes of allowing crowdsourcing in a public sector environment have yet to be defined and implemented.  <b>No technological R&amp;D Roadmap necessary.</b>
17	Gamifications	Employee remuneration and incentives	Workplace incentive programs can be improved through the introduction of gamification which provides the employees with frequent and meaningful recognition. Gamified incentives can keep employees engaged on their daily tasks, allowing them to better serve the needs of other internal staff and customers.[68]	Although the area gamifications (and more specifically serious games) are still under development, the applications to satisfy the need 'employee remuneration and incentives' are from a technological point of view not very demanding.

	Technology / Trend	Assigned societal / business /public sector need	Existing solutions / products / services	Conclusion
				<p>So that the challenge will probably not be a technological one, but to decide on the type of rewards, the recognition circles, how to encourage healthy competition and how to ensure long-term engagement.</p> <p><b>No technological R&amp;D Roadmap necessary.</b></p>
<b>Technology-need combinations with an assessment 'no real use case for the public sector' on the basis of D4.1 and D4.2</b>				
1	Artificial Intelligence and bots	Access to public sector information	<p>There are already several examples of the use of artificial intelligence and especially chatbots in the public sector</p> <ul style="list-style-type: none"> <li>• Inteliwise eGov Virtual Assistant[69]</li> <li>• Virtual Agents and Chatbots Directory[70]</li> <li>• Use of artificial intelligence in IT support to lead clients e.g. through a password reset process[71]</li> <li>• Chatbot Amelia in Enfield Council[72]</li> </ul>	<p>Artificial intelligence itself is a rather new and emerging technology, for which a lot of research and development work has yet to be done. However for the specific need 'access to public sector information' there are already many use cases like chatbots available.</p> <p><b>No technological R&amp;D Roadmap necessary.</b></p>

**Table 9: Explanation why the consortium will not follow the results of the sticky dot exercise regarding the selection of full R&D roadmaps.**

Thus to summarize the results of step 1 and 2 of the roadmap development we can state the following:

1. To satisfy the societal and public sector needs identified in the first part of SONNETS, it is not necessary to set the focus on further technological development or advanced or even basic technological research.
2. For all societal / business and public sector needs the assigned technologies or trends which could potentially play a major role to meet these needs are already on a very advanced technological level.
3. Thus, the roadmaps to implement these technologies in the public sector will contain only adaptations, modifications or improvements of these technologies or non-technological activities like, e.g. development of training, process-oriented issues, necessary infrastructure, promotion of applications, development of standards, and dealing with ethical, legal or societal issues.

**The bottleneck of innovating the public sector is not the technological development - it is the implementation itself – including the adaption to the specific necessities of the public sector and the consideration of the complex process-oriented, socio-economic and ethical issues.**

Thus, on the basis of our literature review and the results of the experts' workshop in Cologne, we **further adapt the format of the SONNETS roadmap** presented in Figure 7 of this deliverable.

As the ICTs presented in this deliverable are already on an advanced level ready to be implemented in the public sector after perhaps some modifications, we set the focus on technological and non-technological activities which could or should be performed right now.

Thus, instead of developing R&D steps on a time scale as presented in Figure 7, we present a list of necessary technological and non-technological activities for each ICT. Thus, the general methodological approach and the type and content of the suggested activities remain the same as described earlier, but **the time-scale has been removed, because these types of activities can all be started right now.**

The content of the roadmaps is explained in further detail in the next chapter 3.3.

### 3.3 Step R3: Identification of technological and non-technological activities

As a next step we compile all the necessary technological and non-technological activities necessary to implement the technologies in the public sector with the objective to satisfy the assigned need respectively.

An overview of the different types of information provided for each technology is presented in Figure 18. The type of content of the roadmaps has been selected by taking into account the following aspects:

- the compiled information about the identified emerging technologies in D3.1 [10], D3.2 [11] and D4.1 [12]
- the list of necessary activities on the basis of the work in Task 4.1 [12] und Task 4.2 [3]
- the content of roadmaps for similar cases, e.g.
  - The roadmap of the project CROSSROAD [73]
  - The roadmap of the project CROSSOVER [74]

<b>SONNETS roadmap</b>	<b>CROSSROAD roadmap [73]</b>	<b>CROSSOVER roadmap [74]</b>
Definition	Description and link with the state of the art	Introduction and definition
Addressed societal or public sector need		
Existing solutions /applications / services	Current status	Current practices and inspiring cases Available tools
Current research activities	Type of research (disciplines) Relationships with other research in parallel fields - what is specific about governance	Current research
Impact assessment		Why it matters in governance
Potential use cases		
Technological challenges		Key challenges and gaps
Necessary non-technological and non-research activities (in or for the public sector)		
Ethical, legal or societal challenges		
Recommendation of activities (technological and non-technological)	Timeline Possible research instruments	Future research

**Table 10: Comparison of the content of different roadmaps in the area of new ICTs for the public sector.**

When comparing the different types of content provided by CROSSROAD, CROSSOVER and SONNETS, it shows that there is a shift from a more technological oriented roadmap to a more holistic roadmap with a focus on societal and public sector needs, societal challenges and necessary specific public sector adaptations. This goes back to the fact that, since the closure of CROSSROAD and CROSSOVER, a lot of technological development has been done in the area of policy making 2.0, e-government etc. Therefore, today relevant ICTs are at a more advanced level and a roadmap like SONNETS can focus on specific needs of the society and the public sector and necessary activities in the area of the implementation itself.

For the roadmaps presented in the Annex III, and their respective summaries presented in this chapter, we have used the following data and information:

- Previous SONNETS deliverables: D2.2, D2.3, D3.2, D3.3, D4.1 and D4.2
- Results of the SONNETS WP4 workshop in Cologne
- Results from EU projects in similar areas (e.g. deliverables, briefs, presentations)
- Publications from intergovernmental organisations (e.g. European Parliament, European Commission, OECD, UN organisations)
- Further literature review (e.g. Web of Science)



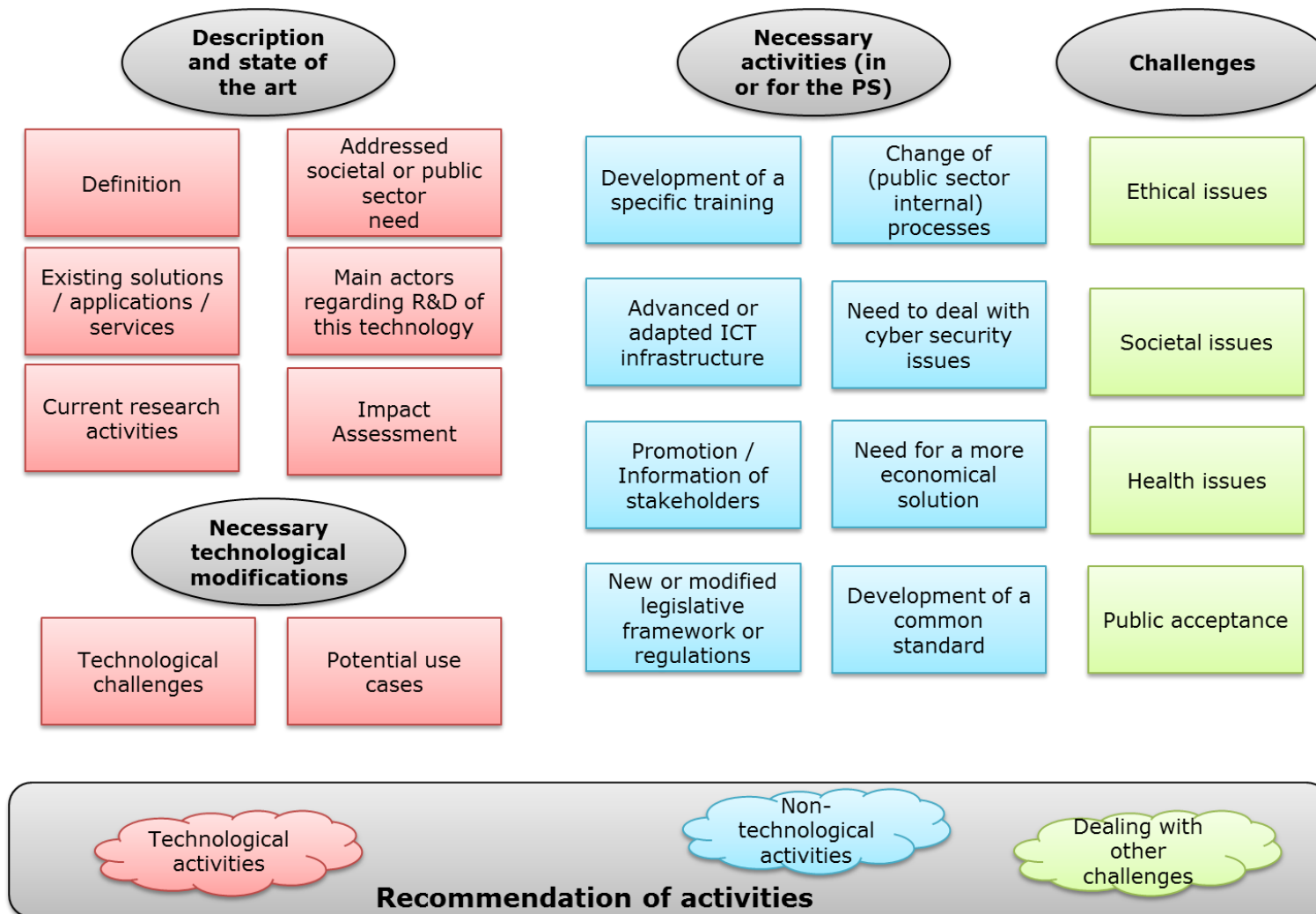



Figure 18: Overview of content of the SONNETS roadmaps

### 3.3.1 Artificial intelligence and bots





#### Summary and recommended activities on the basis of the roadmap for artificial intelligence and bots (assigned need: 'access to public sector information')

Technological activities	<p>In general it can be observed that artificial intelligence is one of the top 10 emerging technologies in which a lot of research and development is happening right now.[75]</p> <p>However, the state of the art of artificial intelligence already permits to have several applications which could help to satisfy the need to access public sector information.</p> <p>There are already many administrations, like Enfield Council, the Department of Homeland Security, North Carolina's Innovation Center, the Australian Tax Office or the government of Singapore which use artificial intelligence in the form of chatbots to interact with their citizens.</p> <p>Current challenges on which several countries (with an exponentially rising number of patents and publications)[76] are working currently are:</p> <ul style="list-style-type: none"> <li>• Natural communications between artificial intelligence systems and humans</li> <li>• Advancement in natural language processing (e.g. regarding local language)</li> <li>• Learn and reason of artificial intelligence systems, as they encounter new tasks and situations</li> <li>• 'cold user' experience; lack of personality of artificial intelligence systems</li> </ul> <p>Regarding the usage of artificial intelligence to improve the access to public sector information it is recommended, to use one of the already existing chatbot infrastructures (like from Microsoft, Google or Amazon) or use one's own IT infrastructure and one of the virtual agents or chatbots of the online directory.[70]</p>
Non-technological activities	<p>In summary the following issues have to be address when using artificial intelligence in the public sector:</p> <p>On a local level:</p> <ul style="list-style-type: none"> <li>• Make sure that <b>well educated and trained</b></li> </ul>


 <b>Summary and recommended activities on the basis of the roadmap for artificial intelligence and bots (assigned need: 'access to public sector information')</b>	
	<p><b>personnel</b> is available to set-up and run a public sector chatbot</p> <ul style="list-style-type: none"> <li>• Prepare a long-term plan regarding the <b>future of the current personnel</b> (new tasks and possible displacements)</li> <li>• Decide on the chatbot <b>infrastructure</b> (from a private company or one's own IT infrastructure)</li> <li>• <b>Promote</b> the use of artificial intelligence in the respective public sector organization to deal with possible reluctances of the citizens</li> <li>• Deal with <b>cyber security issues</b> (regarding hacker and scammers)</li> </ul> <p>On a national / EU level:</p> <ul style="list-style-type: none"> <li>• Prepare regulations and possible new laws in the area of <b>ethics, liability, intellectual property, security, privacy, dignity and autonomy.</b></li> </ul>
Dealing with other challenges	<p>The most important threat is the <b>digital divide</b> (due to lack of digital skills or literacy or missing digital infrastructure).</p> <p>Other big issues are <b>privacy</b> concerns, the issue of <b>liability</b> and the threat of <b>labour displacement.</b></p>


### 3.3.2 Augmented reality (AR)

 <b>Summary and recommended activities on the basis of the roadmap for augmented reality (assigned need: 'experiential education and training')</b>	
Technological activities	<p>According to Gartner his augmented reality (AR) belongs to the <b>key technology trends</b> and is showing promise in delivering a high degree of competitive advantage over the next five to 10 years.[77]</p> <p>But already now there are a <b>lot of augmented reality apps for the classroom</b>, which are also in use in some schools.[78] In the French curriculum augmented reality is already recommended to be used in middle school. [79]</p> <p>Also more specialized AR systems for <b>university students</b>[17] or in the <b>automotive or printing industry</b> exist.[16] In a <b>military environment</b> AR has been used since 2009. [80]</p> <p>Regarding the use in education and training the current technological state of art is already very advanced, so that there are several ready-made systems on the market. However, some technological challenges persist, like e.g.[81–83]</p> <ul style="list-style-type: none"> <li>• Stability of the <b>marker-less tracking technique</b></li> <li>• <b>Recognition algorithms</b> for human forms</li> <li>• <b>AR environment development tools</b> (usability; still high technical knowledge and considerable time is needed to generate educational content)</li> </ul>
Non-technological activities	<p>In summary the following issues have to be address when using augmented reality in education and training:</p> <ul style="list-style-type: none"> <li>• the <b>educational programs</b> have to be re-designed from scratch with the possibilities of AR fully in mind</li> <li>• the teacher have to be <b>trained</b> in the usage of AR</li> <li>• regulations regarding <b>privacy and intellectual property rights</b> have to be adapted or introduced</li> <li>• <b>cyber security aspects</b> have to be dealt with (e.g. hacker attacks, exfiltration of</li> </ul>


 <b>Summary and recommended activities on the basis of the roadmap for augmented reality (assigned need: 'experiential education and training')</b>	
	personal or behavioral data, privacy risks, risk of the introduction of malicious applications)
Dealing with other challenges	One has to be aware of the risk that the students do not become too dependent on technology or the risk of the <b>technologisation</b> of the society in general.

### 3.3.3 Big data and data analytics

 <b>Summary and recommended activities on the basis of the roadmap for big data and data analytics (assigned need: 'inclusive well-being and health')</b>	
Technological activities	<p>Big Data technologies will definitely open new opportunities and enable breakthroughs related to healthcare data analytics addressing different perspectives: (i) <b>descriptive</b> to answer what happened, (ii) <b>diagnostic</b> to answer the reason why it happened, (iii) <b>predictive</b> to understand what will happen and (iv) <b>prescriptive</b> to detect how we can make it happen.[84]</p> <p>There are already many examples for the application of big data analytics in health care up and running as can be seen in the 36 examples presented in the roadmap (see Annex of this deliverable) – ranging from applications for asthma patients, treatments for cancer patients, rare diseases, to the personnel planning in emergency rooms.</p> <p>There are also a lot of platforms and initiatives available as e.g. the Hadoop Distributed File System[85], which can also be used for big data applications in health care.</p> <p>Also industrial solutions like IBM Watson[86] exist and can be used for big data purposes.</p> <p>Although there are several big data applications already in use there is still a lot to be done – also in the technical area, like e.g.</p> <ul style="list-style-type: none"> <li>• <b>Data quality and cleaning of data</b></li> <li>• <b>Data quantity</b> (dealing with the large volume and velocity of data; including new data sources)</li> <li>• Dealing with <b>multi-modal data</b></li> <li>• <b>Data access</b> (to different isolated data silos)</li> <li>• <b>Healthcare knowledge</b> (include the knowledge of the healthcare professionals)</li> <li>• <b>Analytical methods</b> (constantly improve and update existing analytical methods)</li> </ul>
Non-technological activities	<p>In summary the following issues have to be address when using big data analytics in health care:</p>


 <b>Summary and recommended activities on the basis of the roadmap for big data and data analytics (assigned need: 'inclusive well-being and health')</b>	
	<ul style="list-style-type: none"> <li>• recruit personnel with sufficient <b>technical expertise</b></li> <li>• provide <b>digital training and education</b> programs for health professionals</li> <li>• provide solutions for <b>data storage</b> (e.g. cloud-storage) and cross-border exchange</li> <li>• change the health care <b>organizations to become data driven</b> (e.g. value data as strategic asset, encourage sharing of data)</li> <li>• raise <b>awareness of the practical use of big data</b> in health and make it more understandable to the public</li> <li>• develop a <b>robust and integrated security</b> (especially regarding the privacy and security of patient data)</li> <li>• on EU level provide information on models of <b>good practice</b> for good data governance</li> <li>• also on EU level set <b>common standards</b> across the big data value chain (addressing the issues of interoperability)</li> </ul>
Dealing with other challenges	The most important challenge is the dealing with the <b>privacy and security of patients' data.</b>


### 3.3.4 Biometrics

 <b>Summary and recommended activities on the basis of the roadmap for biometrics (assigned need: 'faster and transparent access to public sector services')</b>	
Technological activities	<p>Biometric methods are used in many different areas of applications. The solutions and systems available on the market are able to serve a broad range regarding performance, security, usability and standard conformance.[87]</p> <p>Many EU countries already use biometric identity cards (e.g. Bulgaria, Finland, France, Germany, Luxembourg, Netherlands) or biometric visa programs. Some EU countries use biometric ID cards for social security systems, requesting car licence plates or conducting tax declarations.</p> <p>Current technological challenges persist in the area of:</p> <ul style="list-style-type: none"> <li>• Identifying the <b>best feature representation scheme</b> for a given biometric trait</li> <li>• Designing <b>robust matcher</b> for a given representation scheme</li> <li>• <b>Handling poor quality biometric samples</b></li> <li>• <b>Shielding the biometric system</b> (cyber security)</li> <li>• Improving the <b>distinctiveness of biometric traits</b></li> <li>• Improving the <b>persistence of biometric traits</b></li> <li>• <b>Unconstrained biometric sensing environment</b></li> <li>• <b>System security</b> and user privacy</li> </ul>
Non-technological activities	<p>In summary the following issues have to be address when using biometrics to satisfy the need of faster and transparent access to public sector services:</p> <ul style="list-style-type: none"> <li>• Provide for the necessary <b>infrastructure/hardware</b> (sensor, processor, storage)</li> <li>• Adapt the <b>public processes</b> to the usage of biometric systems</li> <li>• Deal with <b>cyber security</b> and data protection issues</li> </ul>
Dealing with other challenges	<ul style="list-style-type: none"> <li>• Deal with issues regarding <b>privacy, autonomy, informed consent, confidentiality, liberty and bodily integrity</b></li> <li>• Deal with the <b>low public acceptance</b> of biometric systems in some countries of the EU</li> </ul>




### 3.3.5 Block chain technology


 <b>Summary and recommended activities on the basis of the roadmap for block chain technology (assigned need: 'faster and transparent access to public sector services')</b>	
Technological activities	<p>There are many possible ways that blockchain can make government more accountable, transparent, efficient and fraud-proof, which include <b>contract management, electronic voting and health care</b>. [88]</p> <p>There are already <b>several pilot projects</b> in different countries regarding the use of block chain technology in e-health, e-resident systems, elections and especially land and property registration.</p> <p>A prominent country which has already several applications of blockchain technology in use is <b>Estonia</b>. Other countries include for example Sweden, Hong Kong, Ghana, Kenya, Nigeria or Georgia.</p> <p>However, despite these pilot projects blockchain technology is still in its infancy, so that there are still unknown factors and vulnerabilities.[89]</p> <p>Issues to be dealt with in the upcoming years are.</p> <ul style="list-style-type: none"> <li>• the dealing with <b>cyber issues</b> like external hacking, corruption and loss of data[90]</li> <li>• to provide a <b>balance between privacy and confidentiality on the one side and transparency on the other side</b>[90]</li> <li>• resolve challenges such as <b>transaction speed, the verification process and data limits</b>[91]</li> <li>• provide <b>high-performance, low-latency operations</b>[92]</li> <li>• ensure that distributed ledgers are <b>scalable, secure and provide proof of correctness of their contents</b>:[92]</li> <li>• <b>energy efficiency</b>[92]</li> <li>• ensure high level of <b>cryptography</b>[92]</li> </ul>
Non-technological activities	<p>In summary the following issues have to be address when using blockchain technology to address the need for faster and transparent access to public sector services:</p> <ul style="list-style-type: none"> <li>• Recruit or train <b>personnel</b> in blockchain</li> </ul>

 <b>Summary and recommended activities on the basis of the roadmap for block chain technology (assigned need: 'faster and transparent access to public sector services')</b>	
	<p>technology</p> <ul style="list-style-type: none"> <li>• Decide if <b>blockchain-as-a-service</b> is an acceptable solution for the public sector organization or if other infrastructure solutions have to be found</li> <li>• Develop a <b>strategy for shifting the public sector processes</b> towards placing trust and authority in a decentralized network</li> <li>• Deal with cyber security issues (e.g. Sybil-attacks and distributed denial of service attacks)</li> <li>• Deal with <b>legal issues</b> arising from the use of blockchain technology in the public sector on governmental level</li> <li>• Consider the <b>economic pro and cons</b>: <ul style="list-style-type: none"> <li>◦ <i>Pro</i>: no third party intermediaries, audits are redundant, reduces fraud and error, savings in transaction costs and time</li> <li>◦ <i>Cons</i>: high initial capital costs; substantial amounts of computer power (energy costs)</li> </ul> </li> </ul>
Dealing with other challenges	<p>The most important ethical issue is that the transparency of the blockchain transfers also might compromise the <b>privacy and anonymity</b> of the actors. The immutability may additionally compromise the "<b>right to be forgotten</b>".</p> <p>Another challenge is the <b>digital divide</b> – i.e. that probably not all citizens are able or willing to access blockchain services of the public sector.</p>


### 3.3.6 Cloud computing

 <b>Summary and recommended activities on the basis of the roadmap for cloud computing (assigned need: 'faster and transparent access to public sector services')</b>	
Technological activities	<ul style="list-style-type: none"> <li>• Development of <b>IT infrastructure</b> where necessary.</li> </ul>
Non-technological activities	<p>In summary the following issues have to be addressed when using cloud computing in the public sector:</p> <ul style="list-style-type: none"> <li>• <b>Educating</b> staff and the general public on the underlying technology, its use and advantages.</li> <li>• Creating/adapting <b>legislation</b> to address privacy and security concerns, and to create clear rules for service providers.</li> <li>• Adapt internal public service <b>procedures</b> to make full use of cloud computing, allowing it to reap all the benefits.</li> <li>• <b>Work closely with the industry/service providers</b> to create the best solutions for public sector needs (requires prior identification of needs and requirements).</li> <li>• Maintain a continuously high level of <b>security</b> through technological advances and staff training.</li> </ul>
Dealing with other challenges	


### 3.3.7 E-identities (and e-signatures)

 <b>Summary and recommended activities on the basis of the roadmap e-identities (and e-signatures) (assigned need: 'digitization')</b>	
Technological activities	<p>In general it can be observed that the main challenge regarding the use of e-identities is not a technical one.</p> <p>There are already many countries in the EU that have introduced e-identities, e.g. in Belgium, several Scandinavian countries, Italy, Germany, Spain, Croatia to mention just view.</p> <p>These cards are used for different services within the public sector in the individual countries: for banks, for universities etc. In Estonia the ID card is even used for internet-based voting systems (also see <b>e-participation</b>).</p>
Non-technological activities	<p>In summary the following activities have to be performed before implementing an e-identity system in the public sector:</p> <ul style="list-style-type: none"> <li>• The public organization needs to <b>procure the e-ID infrastructure</b> itself and possibly further components like the e-identity cards for the citizens.</li> <li>• The <b>processes</b> of the public sector organizations have to be <b>adapted</b> to the usage of e.g. e-identity authorization processes.</li> <li>• The public sector organizations have to deal with <b>cyber security issues</b> or implement the necessary security regulations.</li> <li>• the public has only limited knowledge of the electronic data and functions ePassports include, and often have no clear opinion on various potential uses for ePassports and related personal data, so there should be <b>information and education for the public</b> beforehand.</li> </ul>
Dealing with other challenges	No issues identified.


### 3.3.8 Internet of things

 <b>Summary and recommended activities on the basis of the roadmap for internet of things (assigned need: 'inclusive well-being and health')</b>	
Technological activities	<ul style="list-style-type: none"> <li>• Ensure smooth development of <b>IoT networks</b>, embedding the necessary security features, parallel to adding up new devices or new functionalities.</li> <li>• Ensure <b>connectivity</b>; create meshes with no single point of failure: Decentralize IoT networks by moving tasks to the edge such through the use of fog computing models or alternatively develop peer-to-peer ecosystems, without the involvement of a broker.</li> <li>• Develop <b>common IoT standards</b>, including network protocols, communication protocols and data aggregation standards.</li> </ul>
Non-technological activities	<ul style="list-style-type: none"> <li>• Educate end users on <b>best practices</b> around the use of IoT devices for improving privacy and security.</li> <li>• Develop strategies to respect individual <b>privacy</b> choices across a broad spectrum of expectations.</li> <li>• Develop <b>legislation and regulations</b> around the ownership of data and how it is used.</li> </ul>
Dealing with other challenges	No issues identified.


### 3.3.9 Machine learning

 <b>Summary and recommended activities on the basis of the roadmap for machine learning (assigned need: 'inclusive well-being and health')</b>	
Technological activities	<ul style="list-style-type: none"> <li>• Ensure that <b>data sets</b>, upon which machine learning systems are trained are unbiased and of good quality.</li> <li>• Ensure the availability of <b>big data infrastructure</b> to grasp results at meaningful time.</li> </ul>
Non-technological activities	<ul style="list-style-type: none"> <li>• Hire <b>data analysts</b> and modelers that are able to design fit models which in turn provide meaningful and correct results.</li> <li>• <b>Educate</b> end users around the use of machine learning methods.</li> <li>• Educate end users around the use of machine learning infrastructures and tools.</li> <li>• Devise a plan for <b>ethical compliant</b> data access and processing.</li> </ul>
Dealing with other challenges	No issues identified.

### 3.3.10 Natural language processing


 <b>Summary and recommended activities on the basis of the roadmap for natural language processing (assigned need: 'digitization')</b>	
Technological activities	<ul style="list-style-type: none"> <li>• Resolve <b>semantics and pragmatics</b> issues.</li> <li>• Develop <b>domain-specific ontologies</b>.</li> <li>• Develop <b>language-specific dictionaries</b>.</li> <li>• Develop <b>efficient, large-scale solutions</b>.</li> </ul>
Non-technological activities	<ul style="list-style-type: none"> <li>• Opt for <b>analysts and experts</b> in data science and related fields.</li> </ul>
Dealing with other challenges	No issues identified.

### 3.3.11 Wearables


 <b>Summary and recommended activities on the basis of the roadmap for wearables (assigned need: 'inclusive well-being and health')</b>	
Technological activities	<ul style="list-style-type: none"> <li>Invest in progressing with <b>power consumption issues</b> and advancing the <b>design and the aesthetic aspects</b> of wearable devices.</li> </ul>
Non-technological activities	<ul style="list-style-type: none"> <li>Debate questions around the use of eHealth and mHealth programmes across a <b>wide range of expertise</b>, professional and other relevant experience and not just within the narrow aggregates of policy actors, who - so far - appear to have exclusive access to policy development and decision-making procedures.</li> <li>The 2012 ESF (European Social Fund) forward look on personalised medicine recommends a flexible health technology assessment (HTA) framework to support the adoption of new technologies of added value to conventional care. However, if wearable gadgets and devices are not strictly classified as medical, and regulated as such, they effectively sit in a policy vacuum. Thereby, care needs to be taken in order to establish an adequate <b>legal framework</b>, with binding rules, to cover safety and performance requirements of quasi-medical devices[93].</li> <li>Adequately address issues of <b>data protection</b> by enabling users to make privacy-friendly choices when registering onto or navigating through online data platforms that accommodate wearable sensor data.</li> </ul>
Dealing with other challenges	The success of any innovative wearable product depends very much on the extent of <b>behavioral change</b> needed to use the new product as well as its cost.




### 3.3.12 Virtual Reality

 <b>Summary and recommended activities on the basis of the roadmap for virtual reality (assigned need: 'experiential education and training &amp; recruitment and training')</b>	
Technological activities	<ul style="list-style-type: none"> <li>• Find <b>more natural ways</b> for users to interact with virtual reality systems.</li> <li>• Design quality virtual reality solutions for <b>domain specific training purposes</b>.</li> <li>• Adapt and reuse existing VR systems and ensure platform and components <b>compatibility</b>.</li> </ul>
Non-technological activities	<ul style="list-style-type: none"> <li>• Explore the <b>long-term effects</b> of VR in health.</li> <li>• Develop new, <b>more effective and cheaper models</b> for the incorporation of virtual reality systems in public sector practices and related training contexts.</li> <li>• Develop a strategy to <b>promote</b> virtual reality to the general public.</li> </ul>
Dealing with other challenges	No issues identified.


### 3.3.13 API Economy


 <b>Summary and recommended activities on the basis of the roadmap for API economy (assigned need: 'faster and transparent access to public sector services')</b>	
Technological activities	<ul style="list-style-type: none"> <li>• Take a <b>"data first" approach</b>, to unlock all data from current applications. Create a data marketplace where different creators and consumers of data can buy, sell, request or freely exchange data</li> <li>• Deploy <b>real-time analytics</b> broadly, by moving analytics to the data</li> <li>• Think of the required <b>ancillary components</b>: documentation, code samples, testing and certification tools, support models, monitoring, maintenance, and upkeep.</li> <li>• Put <b>cyber security</b> at the forefront</li> <li>• Follow <b>standards</b></li> </ul>
Non-technological activities	<ul style="list-style-type: none"> <li>• APIs should have a <b>clear intention, a clear definition of the value</b>, and a clearly defined audience. So, focus on pilots to quickly determine which APIs are really adding value with the biggest impact and be aware that incentives and attempts to influence stakeholders should be tied to the target audiences and framed accordingly.</li> <li>• <b>Make APIs more discoverable and usable</b>, looking for opportunities to create communities around APIs that can eventually become self-sustaining, as Government alone can't create the API economy. When you discover a winning solution, spread the word to others.</li> <li>• <b>Organize competitions</b> to attract talented developers to build applications that use government data.</li> </ul>
Dealing with other challenges	<p>Creating the API economy in the public sector will require <b>executive-level leadership</b> and governance. Public sector leaders will need to champion API initiatives in order to overcome organizational inertia.</p>

### 3.3.14 Crowdsourcing


 <b>Summary and recommended activities on the basis of the roadmap for crowdsourcing (assigned need: 'civil servants as a community of change')</b>	
Technological activities	Crowdsourcing is not just a collection of technology tools but rather a strategic process, so we cannot offer any particular recommendation for technological activities.
Non-technological activities	<ul style="list-style-type: none"> <li>• Offer <b>telework opportunities</b> for government employees</li> <li>• <b>Build collaborative spaces.</b> Employees can reside in a central talent pool, accessible by many agencies. They can be assigned to specific agencies to complete tasks/projects and then return to the central talent pool once the work is complete</li> <li>• Address carefully the way in which <b>individual contributions</b> are planned, assigned, coordinated and appraised</li> <li>• Train leaders to learn how to <b>motivate and manage employees</b> in a distributed environment. This requires an emphasis on communication, accountability, trust and performance.</li> <li>• Conduct a pilot to <b>document lessons learned</b> and determine its viability on a wider scale</li> <li>• Allow employees to help with projects or tasks that interest them. This will allow them to <b>expand their networks, build new skills, and chase their passions</b></li> <li>• Consider new ways to <b>evaluate performance</b> and help workers gain skills and build careers.</li> </ul>
Dealing with other challenges	In a way, crowdsourcing could help to introduce fresh ideas and new applications into the public sector. However, crowdsourcing itself can only play a small role – the main challenge is to <b>change the mind-sets and improve the flexibility of the staff.</b> And this may be a hard task with senior employees in comparison with young employees, who value career growth over job security or compensation.


### 3.3.15 Digitalization

 <b>Summary and recommended activities on the basis of the roadmap for digitalization (assigned need: 'increase resource productivity')</b>	
Technological activities	<ul style="list-style-type: none"> <li>To overcome the challenge of legacy IT systems that can be risky to replace with new ones, McKinsey recommends <b>two speed IT model</b>: a reliable and low-risk foundation of familiar systems, plus a more flexible digital layer that accommodates the rapid creation and deployment of new services.</li> <li>Put <b>cyber security</b> at the forefront</li> </ul>
Non-technological activities	<p>There are five main factors that should be considered to shape the digital transformation in the public sector:</p> <ul style="list-style-type: none"> <li><b>Strategy</b> Align your digital strategy with organizational goals, determining drivers and directions and identifying barriers, which could be rules and regulations. Take the digital transformations deeper, beyond the provision of online services. Take stock of what you already have but foster access to a robust and innovative technology marketplace. Think about return on investment. Publish your strategy, schedule targets for each department and report performance against those targets frequently.</li> <li>Strong central <b>leadership</b>, since a clear mandate helps steer the implementation and build awareness. Include seasoned digital leaders from different public departments.</li> <li>Workforce <b>skills and employee satisfaction</b> Leaders who understand digital trends and technologies are more likely to provide organizational support to their workforce to help them build digital skills, compared to those who lack that understanding. Find ways to attract or nurture IT talent for digital projects, like offering fast-track career opportunities for high performers.</li> <li>Digital and collaborative <b>culture</b> Apply a test-and-learn approach, using pilot projects to ensure investments are effective and then bringing lessons learned to other agencies.</li> </ul>


 <b>Summary and recommended activities on the basis of the roadmap for digitalization (assigned need: 'increase resource productivity')</b>	
	<p>Translate private-sector best practices into the public context to achieve broader and deeper public-sector digitization</p> <ul style="list-style-type: none"> <li>• <b>User focus</b> Have in mind improving customer/citizen experience and engagement.</li> </ul>
Dealing with other challenges	<p>Government bodies seeking to make the transformation to digital must cope with several challenges that are out of step with a technologically advanced era that demands a seamless experience for the end user, be it a government worker, a business user, an average citizen, or another intergovernmental office.</p> <ul style="list-style-type: none"> <li>• <b>Funding</b> Currently, public sector organisations must do more with less while trying to meet new customer demands.</li> <li>• <b>Short time frames</b> It is a challenge to maintain strategic continuity even as political administrations change. Public sector budgets are tied with these political cycles, meaning new projects must show results quickly for constituents.</li> <li>• <b>System issues</b> Many public sector organisations operate a range of outdated systems that need replacement.</li> <li>• <b>Management issues</b> Systems and data are owned by different departments and functions, on a range of platforms and with differing taxonomies and access requirements. Silos, fragmentation, and the absence of a central owner for nationwide IT infrastructure and common components make it difficult to invest at scale and generate sufficient economies.</li> </ul>

### 3.3.16 E-participation

 <b>Summary and recommended activities on the basis of the roadmap for e-participation (assigned need: 'participation access to public sector services (political participation)')</b>	
Technological activities	<p>In general it can be observed that the main challenge regarding the use of e-participation technologies to promote the political participation of the citizens is not a technical one.</p> <p>There are already many e-participation platforms in several EU states up and running, e.g. in Estland, several Scandinavian countries, UK, Germany, Spain to mention just view. Sometimes these applications are used on a national level and sometimes on a local one (e.g. in Frankfurt, Reykjavik, Gothenburg). Additionally there are running e-participation platforms on a European level, like the European Citizens Initiative or the Online EU Public Consultations among others.</p> <p>There are a view reports and articles which mention technical challenges. Older reports mention that the development of web 2.0 has to be pushed forward, but in recent reports this is no longer mentioned. Instead the following issues should be addressed in future research works:</p> <ul style="list-style-type: none"> <li>• <b>anonymity or real name policies;</b> the challenge of fake profiles</li> <li>• <b>Reduction of complexity;</b> improvement of user-friendliness &amp; user-experience; appealing and yet simple, attractive and easy to use system</li> <li>• <b>Appropriateness</b> for the targeted participants</li> <li>• <b>Accessibility</b></li> </ul>
Non-technological activities	<p>In summary the following issues have to be addressed before implementing e-participation technologies in the public sector:</p> <ul style="list-style-type: none"> <li>• Create a process how to guarantee that the opinions of the citizens are taken into consideration in the policy process and have an impact (<b>transparency, accountability</b>)</li> <li>• Take care that enough personnel is available to act as moderator for e-participation applications, as user support or help desk, to promote and encourage citizens, responding to aggressive, inappropriate or abusive behavior</li> </ul>


 <b>Summary and recommended activities on the basis of the roadmap for e-participation (assigned need: 'participation access to public sector services (political participation)')</b>	
	<p><b>(personnel resources)</b></p> <ul style="list-style-type: none"> <li>• Promotion and encouraging citizens; combining online and offline participatory approaches <b>(promotion)</b></li> <li>• Deal with cyber security issues (prevent manipulation by organized groups, privacy, data protection, confidentiality, secure system) <b>(cyber security)</b></li> <li>• Develop guidelines for safe and acceptable use (record-keeping, data security, intellectual property, privacy, internet freedom versus copyright &amp; privacy) <b>(guidelines)</b></li> <li>• On EU level there is a need for harmonized rules for identification requirements <b>(e-identification)</b></li> </ul>
Dealing with other challenges	The most important threat is the <b>digital divide</b> (due to lack of digital skills or literacy or missing digital infrastructure). The stakeholders have to take care that the e-participation results are representative.

### 3.3.17 Gamification


 <b>Summary and recommended activities on the basis of the roadmap for gamification (assigned need: 'employee remuneration and incentives')</b>	
Technological activities	Gamification is not a technology-driven methodology but rather a design methodology to digitalize motivation, so we cannot offer any particular recommendation for technological activities.
Non-technological activities	<ul style="list-style-type: none"> <li>• The use of gamification is more recommended for repetitive tasks, not always intellectually stimulating and not necessarily rewarding in themselves.</li> <li>• Designing the game is not just about coming up with new ideas, scout existing trends in the gaming community and simply adapt them.</li> <li>• A successful implementation of gamification requires a <b>solid design process</b>. The technique will work better if the scenario is fun and builds a genuine sense of competition. At the same time, it is needed to identify what motivates people in an organization and build a system around that motivation.</li> <li>• Users want to see <b>continuous progress</b> along the way, so give them an immediate incentive to continue participating, do not leave them hanging for weeks or they will quit the entire endeavor.</li> <li>• Give something as simple as a virtual badge or tokens as <b>rewards</b>, it is enough to give people an immediate incentive to continue participating.</li> </ul>
Dealing with other challenges	<p>There are gamification detractors that fear it's just another form of control. Besides, games by their nature must be <b>voluntary</b>, so when a department insists its employees play along, it stops being a game to be a form of coercion.</p> <p>With regards to peer relationships, efforts to increase internal competition could provoke employees to actively <b>sabotage</b> each other or make unethical choices rather than work together for the good.</p>




### 3.3.18 Mobile devices


 <b>Summary and recommended activities on the basis of the roadmap for mobile devices</b> (assigned need: 'faster and transparent access to public sector services')	
Technological activities	<ul style="list-style-type: none"> <li>• Most preparatory technical activities need to be carried out within the restructuring and change of the given <b>ICT structure in a country</b>. If this is not done correctly the overall implementation of mobile devices in the public sector will not be possible. The ICT structure has to be transferred into some kind of <b>medianet</b> with a high enough bandwidth for different collaborative services and for sharing information and documents. One condition for this is that connectivity can be achieved in all kinds of regions, even in rural areas.</li> </ul>
Non-technological activities	<ul style="list-style-type: none"> <li>• The technologies have to be within a reasonable <b>cost limit</b> so everyone can use it, so relatively cheap solutions have to be found/be developed.</li> <li>• It is important to prepare <b>training</b> for the public and for employees of the public sector.</li> <li>• <b>Guidelines and fact sheets</b> have to be produced as well to fully inform the public and to minimize the risk of a failing societal acceptance.</li> <li>• The consequences of this new dimension of connectivity have to be thought through and common practices have to be changed. There will be a lot of <b>changes within work life</b> in the public sector for example. People will not be bound to a certain location for working, they will be more mobile and flexible and can be connected to their work data everywhere and every time. To regulate the misuse of this, new practices and rules have to be developed and introduced.</li> </ul>
Dealing with other challenges	<p>One of the main challenges will be to use mobile devices in the public sector to the <b>inclusion of all citizens</b> and to be aware of the danger that this might lead to exclusion for some citizens, for example for citizens who will not be able to afford a mobile device or those who will not know how to handle the technology.</p>


### 3.3.19 Open data and open government

 <b>Summary and recommended activities on the basis of the roadmap for open data and open government (assigned need: 'entrepreneurial and start-up culture')</b>	
Technological activities	<ul style="list-style-type: none"> <li>• <b>Digitalization</b> of current processes in order to streamline the process of data generation</li> <li>• Adoption of an <b>open-by-design principle</b> allowing data to be born open thus allowing to get rid of a "data liberation" approach currently still necessary due to the close approach with which data are produced.</li> <li>• Promotion of <b>semantically enriched</b> and <b>machine readable</b> outputs</li> </ul>
Non-technological activities	<p>A savvy approach to data exploitation should account for five important principles[94]:</p> <p><b>Size is not synonymous of value.</b> That is to say, the assessment of data value should be based on a plurality of criteria: relevance for decision making, quality, availability overtime to name a few.</p> <p><b>Openness is a key driver of value multiplication.</b> In other words, data should be released in formats maximizing the opportunities for the generation of economies of scope.</p> <p><b>Move beyond retrofitting.</b> Rather than liberating data ex-post, the processes of data generation have to be open-by-design in order to minimize the cost of making them available to relevant stakeholders.</p> <p><b>Shared and clear values.</b> The exploitation of open data should be driven by shared values clearly identifying priorities in terms of advancing the environmental, social and economic conditions of the city.</p> <p>The promotion of such cultural change would contribute to make a further step towards the obtainment of an <b>outcome-based government</b> whose actions demonstrate a clear link with their results generated (i.e., outcomes) in terms of value that, in turn, could be internalized by the governments (e.g., efficiency, effectiveness) without overlooking the quest for the creation of value for society at large ("public value").</p>


 <b>Summary and recommended activities on the basis of the roadmap for open data and open government (assigned need: 'entrepreneurial and start-up culture')</b>	
Dealing with other challenges	<p>The most important challenge to be addressed in the implementation of an open government model where the public sector acts as platform on which private actors may be engaged for the delivery of services of public interest is represented by a <b>proper alignment of incentives</b>. As a matter of fact, the tension between the attainment of a societal common good and the maximization of individual profit requires the design of an <b>appropriate system of rules and incentives</b>.</p>


### 3.3.20 Personalization

 <b>Summary and recommended activities on the basis of the roadmap for personalization (assigned need: 'inclusive well-being and health')</b>	
Technological activities	<p>According to the Strategic Research and Innovation Agenda (SRIA) of the PERMED project the main technological challenges to implementing personalised medicine are integrating big data and ICT solutions and bringing innovation to the market.</p> <p>SRIA also provides recommendations which have the highest potential impact and outcome in facilitating the introduction of personalised medicine for the benefit of patients, citizens and society:[95, 96]</p> <ul style="list-style-type: none"> <li>• Develop new decision support tools and methodologies of ICT to analyse and interpret data in order to support physicians and other key stakeholders in their decision-making process.</li> <li>• Develop methods to better integrate and evaluate the information provided by genomic, epigenetic, transcriptomic, proteomic, metabolomic and micro-biome analyses.</li> </ul>
Non-technological activities	<p>According to the Strategic Research and Innovation Agenda (SRIA) of the PERMED project the main non-technological challenges to implementing personalised medicine are:</p> <ul style="list-style-type: none"> <li>• developing awareness and empowerment</li> <li>• integrating big data and ICT solutions</li> <li>• translating basic research to clinical research and beyond</li> <li>• bringing innovation to the market</li> <li>• shaping sustainable healthcare</li> </ul> <p>SRIA also provides recommendations which have the highest potential impact and outcome in facilitating the introduction of personalised medicine for the benefit of patients, citizens and society:[95, 96]</p> <ul style="list-style-type: none"> <li>• Demonstrate the impact and potential benefits of PM for health systems, citizens and society by supporting public health evaluations to</li> </ul>


 <b>Summary and recommended activities on the basis of the roadmap for personalization (assigned need: 'inclusive well-being and health')</b>	
	<p>assist decision-making and develop appropriate, equitable and sustainable access for all patients.</p> <ul style="list-style-type: none"> <li>• Incorporate patient participation and responsibility in all phases of research and development in the healthcare system and in the ownership and control of personal health data.</li> <li>• Develop common principles and regulatory frameworks that enable sharing of personal data for research in a way that is ethical and acceptable to patients and the public.</li> <li>• Promote the development of high quality sustainable databases including clinical, environmental, social, health and wellbeing information.</li> <li>• Support translational research infrastructures and enforce data harmonisation fostered by specific ICT infrastructures designed to health data.</li> <li>• Support development of new clinical trial designs taking into account best available evidence on the individual level and promote integration with concomitant preclinical testing.</li> <li>• Encourage a systematic early dialogue between innovators, citizens and decision-makers throughout all regulatory steps to provide guidance and clarity.</li> </ul>
Dealing with other challenges	<p>In the PERMED project the barriers to implement personalised medicine are identified in 7 areas:[97]</p> <ul style="list-style-type: none"> <li>• stakeholder involvement,</li> <li>• standardisation,</li> <li>• interoperable infrastructure,</li> <li>• European-level policy making,</li> <li>• funding,</li> <li>• data and research,</li> <li>• healthcare systems.</li> </ul>

### 3.3.21 Policy Making 2.0

 <b>Summary and recommended activities on the basis of the roadmap for policy making 2.0 (assigned need: 'civil servants as a community of change')</b>	
Technological activities	<p>The technological activities conducted to be conducted in the field of policy making 2.0 should focus on pushing forward the state of the art for the following enabling technologies[74]:</p> <ul style="list-style-type: none"> <li>• <b>Big data</b></li> <li>• <b>Opinion mining and sentiment analysis</b></li> <li>• <b>Visual analytics for collaborative governance</b></li> <li>• <b>Serious gaming for behavioral change</b></li> <li>• <b>Linked open government data</b></li> <li>• <b>Participatory sensing</b></li> <li>• <b>Block chain</b></li> <li>• <b>Global System science</b></li> </ul>
Non-technological activities	<p>The activities aimed at improving the public value generated by policy making 2.0 solutions will have to be aimed at attaining the following objectives:</p> <ul style="list-style-type: none"> <li>• increase the <b>pro-activeness</b> of policy making in dealing with societal issues before they reach unmanageable sizes and/or chronic phases,</li> <li>• improve the <b>reactiveness</b> in dealing with unexpected abrupt events,</li> <li>• <b>reduce the gap between expected outcomes and delivered results.</b></li> </ul> <p>Looking at the policy cycle below are a number of important aspects to consider for each phase[74]:</p> <p><b>Agenda Setting phase:</b></p> <ul style="list-style-type: none"> <li>• Detect and understand problems before they become unsolvable</li> <li>• Manage crisis and the “unknown unknowns”</li> <li>• Ensure long-term and sustainable thinking:</li> </ul> <p><b>Design phase:</b></p> <ul style="list-style-type: none"> <li>• Encourage behavioural change and uptake</li> <li>• Identify “good ideas” and innovative solutions to long-standing problems</li> <li>• Reduce uncertainty on the possible impacts of policies</li> <li>• Generate high involvement of citizens in policy-making</li> </ul> <p><b>Implementation phase:</b></p>


 <b>Summary and recommended activities on the basis of the roadmap for policy making 2.0 (assigned need: 'civil servants as a community of change')</b>	
	<ul style="list-style-type: none"> <li>• Moving from conversations to action</li> <li>• Reduce uncertainty on the possible impacts of policies</li> </ul> <p><b>Monitor and Evaluation phase:</b></p> <ul style="list-style-type: none"> <li>• Detect non-compliance and mis-spending through better transparency</li> <li>• Manage crisis and the “unknown unknowns”</li> </ul>
Dealing with other challenges	The main challenge will be in striking the right balance in the collaboration between algorithms and humans in the definition of new decision making processes.

### 3.3.22 Smart Workplace




 <b>Summary and recommended activities on the basis of the roadmap for smart workplace (assigned need: 'Talent acquisition and retention; Simplifying recruitment procedures')</b>	
Technological activities	<p>Already now there are a lot of technologies to enhance the work-live-balance:</p> <ul style="list-style-type: none"> <li>• <b>Mobile working environments</b></li> <li>• <b>Mobile solutions: smartphones and tablets, wearables, cloud computing</b></li> <li>• <b>Communication platforms</b></li> <li>• <b>Time accounts</b></li> </ul> <p>Various recruiting activities can be found in <b>Social Media</b> and these become more and more important. In this case Social Media is principally used for the dissemination of job advertisements to find the adequate employee for the work.</p>
Non-technological activities	<p><b>Strategies for acquisition and retention and training possibilities</b> should be developed. Stakeholders have to be aware of the future risks. A flexible smart workplace is a great possibility to acquire and retain employees that lead a family life.</p> <p>A flexible smart workplace additionally strengthens globalization processes and enables the collaboration with partners in different time zones. So business can grow fast, and enable high-powered freelancers to emerge.</p> <p>When dealing with flexible smart workplaces the <b>24/7 work culture</b> have to be covered by regulations or a legal framework. Otherwise health issues, like psychological diseases, can be the result.</p>
Dealing with other challenges	<p>Further a <b>good working atmosphere</b> (good working relationship with the supervisor) and the <b>salary</b> are decisive factors for the retention of employees.</p>






### 3.3.23 Social media / social networking

 <b>Summary and recommended activities on the basis of the roadmap for mobile devices (assigned need: 'participative access to public sector services (political participation)')</b>	
Technological activities	<p>Social media are <b>very popular</b> in Europe. Currently there are 412 million active users in Europe and 39 out of 43 European countries offer social networking features in their national portals.[98, 99]</p> <p>There are <b>no real technological challenges</b>, as social media services are already provided by big companies (e.g. Facebook, twitter). Current challenges persist in other areas like e.g. cyber security or issues regarding privacy and data protection.[100]</p>
Non-technological activities	<p>However, the following issues have to be addressed before implementing social media in the public sector:</p> <ul style="list-style-type: none"> <li>• make sure that the public sector personnel has the necessary <b>digital literacy</b> to deal with social media and the <b>capacity</b> to deal with the inputs received via social media services</li> <li>• the public sector personnel need to show <b>commitment</b> to actively engage citizens via social media</li> <li>• the public sector organizations have to <b>promote their social media presence</b> (e.g. by publishing content on different platforms or mentioning the links in their contact details</li> <li>• <b>cyber security and also privacy and data protection issues</b> are important and have to be dealt with</li> <li>• governments and local administrations should set up <b>social media strategies</b> including e.g. privacy requirements, acceptable and forbidden content, data handling, citizen engagement, etc.</li> </ul>
Dealing with other challenges	<p>An important challenge is the <b>digital divide</b>, that there is a widening gap between citizens which are engaged via social media and citizens which are not.</p>

## 4 Conclusion

 <p>©openclipart.org</p>	<p><b>What is the purpose of this report?</b></p> <p>This report is released within the context of WP4 'Roadmap for emerging research directions' and is particularly associated with Task 4.3 'Roadmap development'.</p> <p>Within this task, the necessary research and other activities to modernize the public sector and to address related societal challenges with emerging ICTs have been developed.</p> <p>The centrepiece of this report contains roadmaps of 23 emerging ICTs and trends including the recommended technological and non-technological activities necessary to implement these emerging technologies in the public sector with the aim to satisfy societal and public sector needs.</p>
 <p>©openclipart.org</p>	<p><b>Which objective of SONNETS does this report pursue?</b></p> <p>The related task to this report pursues the following objective:</p> <ul style="list-style-type: none"> <li>• Describing the <b>methodology</b> applied to develop 23 roadmaps of emerging ICTs with the view to modernize the public sector and address societal challenges</li> <li>• <b>Presenting the roadmaps</b> of the identified ICTs and trends including both technological activities as well as the adaption to the specific necessities of the public sector and the consideration of the complex process-oriented, socio-economic and ethical issues</li> <li>• Incorporating the results of the <b>validation activities</b> (WP4 workshop in May in Cologne)</li> </ul>
 <p>©openclipart.org</p>	<p><b>Which methods form the basis for this report?</b></p> <p>Overall the SONNETS roadmap development follows a 3-step approach:</p> <ol style="list-style-type: none"> <li><b>1. Analysis of emerging ICTs and trends</b> <ul style="list-style-type: none"> <li>• e.g. regarding their technological readiness level, current research activities, actors in this area and possible obstacles which could hinder a successful implementation into the public sector</li> </ul> </li> <li><b>2. Identification of gaps and research needs</b> <ul style="list-style-type: none"> <li>• Each societal and public sector need has been assigned to one or more emerging ICTs which could help to satisfy the respective need.</li> <li>• For each of these technology-need pairs the gap between the technology as it is now and a fully implemented version in the public sector has been described.</li> </ul> </li> </ol>

	<p><b>3. Development of the roadmap</b></p> <ul style="list-style-type: none"> <li>• This development of the roadmap itself has been performed by following another 3-step approach:             <ol style="list-style-type: none"> <li>I. <b>Matching of emerging ICTs and societal or public sector needs</b> on a 1:1 base (each need is assigned to only one technology). This matching has been validated during an experts' workshop.</li> <li>II. <b>Validating the activities</b> which are necessary to implement the emerging ICTs successfully in the public sector with the aim to satisfy the specific assigned societal or public sector need.</li> <li>III. Deciding on the <b>content of the roadmaps</b> on the basis of the identified necessary activities in D4.1, D4.2 and the experts' workshop as well as in roadmaps in similar projects. The roadmaps have subsequently been filled by using the previous results of SONNETS as well as further literature reviews (e.g. from other EU research projects, intergovernmental organisations etc.)</li> </ol> </li> </ul>
 <p>©openclipart.org</p>	<p><b>Which stakeholders have been involved in the process?</b></p> <p>This report uses information from the 16 participants of the <b>WP4 Validation Workshop</b> which took place at 24<sup>th</sup> of May in Cologne.</p> <p>A draft version of this <b>deliverable was also reviewed</b> by one member of the Experts Committee (Filippo Addarii) to validate the methodology of our approach.</p>
 <p>©openclipart.org</p>	<p><b>How will this report be used within the project?</b></p> <p>This deliverable forms the base for the stakeholder tailored recommendation briefs which pursue the aim to inform the different stakeholders (researcher, policy maker, public sector personnel) about the needs of the citizens, emerging ICTs as well as necessary technological and non-technological activities to implement these ICTs successfully into the public sector and thereby addressing societal needs.</p>
 <p>©openclipart.org</p>	<p><b>What are the next steps?</b></p> <p>The results of this deliverable will be published and disseminated as widely as possible to inform the stakeholders about the opportunities of using emerging ICTs to meeting societal needs and also to start a discussion about experiences and best practices in related fora (see Deliverable 5.3 'Final Dissemination Report' and 5.4 'Sustainability Plan' for further details).</p>

## 5 References

1. EIRMA - European Industrial Research Management Association (1997) 'Technology roadmapping - delivering business vision', Working group report, Paris, No. 52.
2. Phaal R, Farrukh C, Probert D (2001) Technology Roadmapping: linking technology resources to business objectives. <https://pdfs.semanticscholar.org/55fb/0b1eb724e60f95a3ab1baaa4e404be8917bb.pdf>. Accessed 7 June 2017.
3. Grigoleit S, Löscher M, Garrido E, Markaki O, Ferro E (2017) D4.2 Gap analysis and identification of research needs.
4. Bernal L, Dornberger U, Torres O, Byrnes T (2009) Technology Roadmapping HANDBOOK: International SEPT Program. [http://www.graine-export.com/pdf/Handbook\\_Roadmapping.pdf](http://www.graine-export.com/pdf/Handbook_Roadmapping.pdf). Accessed 7 June 2017.
5. Phaal R (2003) Fast-start Technology Roadmapping: UNIDO - Technology Foresight for Practitioners. <http://slideplayer.com/slide/5940744/>. Accessed 7 June 2017.
6. Bucher PE (2003) Integrated Technology Roadmapping: Design and Implementation for Technology-Based Multinational Enterprises: Diss. ETH Zürich. <http://e-collection.library.ethz.ch/eserv/eth:27323/eth-27323-02.pdf>. Accessed 7 June 2017.
7. Phaal R Technology Roadmapping. <http://docslide.net/documents/16963technologyroadmapping.html>. Accessed 7 June 2017.
8. Zernial P (2007) Technology Roadmap Deployment - Eine Methodik zur Unterstützung der integrierten strategischen Planung technologischer Innovationen. <http://publications.rwth-aachen.de/record/50294?ln=de>. Accessed 8 June 2017.
9. Gaur A, Ferro E, Rodriguez N, Grigoleit S (2017) SONNETS Deliverable D2.2 Societal and Public sector Needs Analysis.
10. Markaki O, Koussouris S, Garrido E, Grigoleit S (2017) SONNETS Deliverable D3.3 - Emerging ICTs and Innovation Potential for the Public Sector.
11. Markaki O, Koussouris S (2017) Deliverable D3.2 - Emerging ICTs and Innovation Potential for the Public Sector - 1st Version: Horizon2020/EURO-6-2015 - Societal Needs Analysis and Emerging Technologies in the public Sector (SONNETS).
12. Grigoleit S, Müller L, Römer S, Renata Blab, Esther Garrido, Ourania Markaki, Enrico Ferro (2017) SONNETS Deliverable D4.1 - Analysis of the identified emerging technologies.
13. Burbiel J, Grigoleit S, Schulze J (2008) The weighted-bit assessment table of hazardous chemicals: Fraunhofer Symposium Future Security. 3rd Security Research Conference 2008 10th - 11th September 2008, Congress Center Karlsruhe, Germany.
14. Burbiel J, Grigoleit S, Schulze J (2008) The weighted-bit assessment table of hazardous chemicals: Konferenzbeitrag auf der Jahrestagung der Deutschen Pharmazeutischen Gesellschaft.
15. Turning Technologies (2017) Homepage. <https://www.turningtechnologies.com/turningpoint>. Accessed 29 May 2017.

16. Haufe Online Redaktion (2015) Lernen mit Augmented Reality: "Das ideale Mittel um Jugendliche zu erreichen". [https://www.haufe.de/personal/hr-management/berufsausbildung-mit-augmented-reality-jugendliche-erreichen\\_80\\_322806.html](https://www.haufe.de/personal/hr-management/berufsausbildung-mit-augmented-reality-jugendliche-erreichen_80_322806.html). Accessed 11 April 2017.
17. Wikipedia (2017) Augmented Reality. [https://en.wikipedia.org/wiki/Augmented\\_reality](https://en.wikipedia.org/wiki/Augmented_reality). Accessed 11 April 2017.
18. bitnation BITNATION: Governance 2.0. <https://bitnation.co/>. Accessed 3 May 2017.
19. Ruubel M (2017) Estonian eHealth Authority Partners with Guardtime to Accelerate Transparency and Auditability in Health Care. <https://guardtime.com/blog/estonian-ehealth-partners-guardtime-blockchain-based-transparency>. Accessed 3 May 2017.
20. Redman J (2016) Estonian Health Records to Be Secured by Blockchain. <https://news.bitcoin.com/estonian-health-records-secured-by-blockchain/>. Accessed 3 May 2017.
21. Lyon N (2015) Estonian e-Residency and BitNation launch new Public Notary in 'Blockchain Jurisdiction'. <https://cointelegraph.com/news/estonian-e-residency-and-bitnation-launch-new-public-notary-in-blockchain-jurisdiction>. Accessed 3 May 2017.
22. EU Open Data Portal EU Open Data Portal homepage. <http://data.europa.eu/euodp/en/data>. Accessed 6 April 2017.
23. Open Knowledge Foundation European Data Portal. <http://publicdata.eu/>. Accessed 6 April 2017.
24. Policy Compass project (2017) Policy Compass. <https://policycompass.eu/>. Accessed 7 April 2017.
25. Nexa Center for Internet & Security Linked open data sui contratti pubblici. <http://public-contracts.nexacenter.org/>. Accessed 6 April 2017.
26. Presidenza del Consiglio dei Ministri (2017) Opencoesione: Verso un migliore uso delle risorse: scopri, segui, sollecita. <http://www.opencoesione.gov.it/>.
27. Provincia di Torino, Istituto Superiore Mario Boella OPML Visual Lab. <http://visual.opmltorino.it/>. Accessed 6 April 2017.
28. JISC (2017) The research and education space (RES): Connecting the UK's publicly held archives to inspire new ways of learning in the digital age. <https://www.jisc.ac.uk/rd/projects/research-education-space>. Accessed 7 April 2017.
29. eit digital (2016) From Big Data to Big Deals - EIT Digital innovation activity 3sixty lands first contracts. <https://www.eitdigital.eu/news-events/news/article/from-big-data-to-big-deals-eit-digital-innovation-activity-3sixty-lands-first-contracts/>. Accessed 7 April 2017.
30. Ministry of Finance Denmark (2012) Good basic data for everyone. <https://uk.fm.dk/publications/2012/good-basic-data-for-everyone/>. Accessed 7 April 2017.
31. Publicspending.net where public money goes worldwide. <http://www.publicspending.net/>. Accessed 7 April 2017.
32. crossover Bridging Communities for Policy-Making 2.0. <http://www.crossover-project.eu/ProjectHome.aspx>. Accessed 1 June 2017.
33. padgets (2010) What is PADGETS about? <http://www.padgets.eu/>. Accessed 11 April 2017.

34. OCOPOMO project (2012) D2.1 Platform Architecture and Functional Description of Components. [http://www.ocopomo.eu/results/public-deliverables/OCOPOMO\\_D2.1.pdf/view](http://www.ocopomo.eu/results/public-deliverables/OCOPOMO_D2.1.pdf/view). Accessed 11 April 2017.
35. gov.uk (2013) 2050 Pathways. <https://www.gov.uk/guidance/2050-pathways-analysis>. Accessed 11 April 2017.
36. Berkley Automation Lab (2013) Opinion Space. <http://opinion.berkeley.edu/>. Accessed 11 April 2017.
37. London Borough of Redbrige (2017) Homepage. <https://www.redbrige.gov.uk/>. Accessed 11 April 2017.
38. Hamburg Cloud Smart Workplace. <https://www.hamburg-cloud.de/iaas/smart-workplace/>. Accessed 1 June 2017.
39. Samsung (2017) Smart Workplace. [http://www.samsung.com/de/business/industry/smart-workplace/?cid=de\\_ppc\\_google\\_it\\_solutionsb2b\\_20160527\\_smartworkplace-broad&tmcampid=7&tmad=c&tmplaceref=c\\_DCO\\_FY17\\_Solutions\\_Workplace\\_Generic+Category\\_B&tmclickref=b\\_%2Bsmart%20%2Bworkplace](http://www.samsung.com/de/business/industry/smart-workplace/?cid=de_ppc_google_it_solutionsb2b_20160527_smartworkplace-broad&tmcampid=7&tmad=c&tmplaceref=c_DCO_FY17_Solutions_Workplace_Generic+Category_B&tmclickref=b_%2Bsmart%20%2Bworkplace). Accessed 1 June 2017.
40. Fujitsu (2017) Smart Workplace. <https://www.fujitsu.com/th/en/microsites/smart-workplace/overview/index.html>. Accessed 1 June 2017.
41. NEC (2017) Smart Workplace. <https://www.necam.com/trends/SmartWorkspace/>. Accessed 1 June 2017.
42. CBRE SMART WORKPLACE 2040 THE RISE OF THE WORKSPACE CONSUMER. <http://www.cbre.us/services/globalcorporateservices/AssetLibrary/SW2040-CBRE-ENG-DIGITAL.pdf>. Accessed 25 April 2017.
43. programmableweb.com (2017) Search the Largest API Directory on the Web. <https://www.programmableweb.com/category/all/apis?page=1&keyword=government>. Accessed 19 April 2017.
44. opendata.swiss Swiss public transport APIs. <https://transport.opendata.ch/>. Accessed 6 April 2017.
45. Schweizerische Eidgenossenschaft GeoAdmin API's documentation. <http://api3.geo.admin.ch/>. Accessed 6 April 2017.
46. OpenPlans Open311. <http://www.open311.org/>. Accessed 6 April 2017.
47. Local Government Association (2016) Service List. <http://standards.esd.org.uk/?uri=list%2Fservices&tab=details>. Accessed 6 April 2017.
48. Local Government Association Open Data API from LG Inform and LG Inform Plus. <http://about.esd.org.uk/>. Accessed 6 April 2017.
49. Citadel (2017) Citadel Open Data. <http://www.citadelonthemove.eu/>. Accessed 6 April 2017.
50. Forum Virium Helsinki (2016) Open, harmonized CitySDK APIs. <http://www.citysdk.eu/>. Accessed 6 April 2017.
51. lovecleanstreets (2016) lovecleanstreets homepage. <http://www.lovecleanstreets.com/reports/home>. Accessed 6 April 2017.
52. mySociety Limited FixMyStreet platform. <http://fixmystreet.org/sites/>. Accessed 6 April 2017.
53. OCSI (2017) Numberhood. <http://numberhood.net/>. Accessed 6 April 2017.
54. init (2015) Abu Dhabi Services: Eine E-Government-App für alles. <https://www.init.de/de/projekt/eine-e-government-app-f%C3%BCr-alles>. Accessed 7 April 2017.

- 55.backslash AG (2012) GEMEINDE APP - Die innovative Mobile-Lösung für Schweizer Gemeinden.  
<https://www.backslash.ch/asset/files/egovernment/gemeinde-app-backslash.pdf>.
- 56.Finanzdirektion Schweiz (2017) TaxMe.  
<http://www.fin.be.ch/fin/de/index/steuern/taxme.html>. Accessed 7 April 2017.
- 57.Amsterdam Smart City (2016) Amsterdam Smart City App.  
<https://amsterdamsmartcity.com/projects/amsterdam-smart-city-app>. Accessed 7 April 2017.
- 58.Aristotele Universty of Thessaloniki Intelligent City & Software and Solutions.  
<http://icos.urenio.org/city-functions/city-governance/>. Accessed 7 April 2017.
- 59.Spacehive (2017) Spacehive - UK's dedicated crowdfunding platform for places. <https://www.spacehive.com/>. Accessed 4 April 2017.
- 60.GOTEO (2017) GOTEO homepage. <https://www.goteo.org/>. Accessed 4 April 2017.
- 61.MIT Center for Collective Intelligence (2017) MIT Climate CoLab.  
<https://climatecolab.org/>. Accessed 4 April 2017.
- 62.arcbazar (2017) arcbazar homepage. <https://de.arcbazar.com/>. Accessed 4 April 2017.
- 63.Co-contest (2017) gopillar.com. <http://gopillar.com/>. Accessed 4 April 2017.
- 64.InnoCentive (2017) Innovate with InnoCentive.  
<https://www.innocentive.com/>. Accessed 4 April 2017.
- 65.crowdSPRING (2017) crowdspring. <https://www.crowdspring.com/>. Accessed 4 April 2017.
- 66.innoget (2017) innoget homepage. <https://www.innoget.com/>. Accessed 4 April 2017.
- 67.StartSomeGood (2017) StartSomeGood homepage.  
<https://startsomegood.com/>. Accessed 4 April 2017.
- 68.Zichermann G (2014) How to introduce Gamification in Employee Incentives Programs.  
<http://www.incentivemag.com/Strategy/Non-Sales/How-to-Introduce-Gamification-Into-Employee-Incentive-Programs/>. Accessed 19 April 2017.
- 69.Inteliwise (2017) eGov Virtual Assistant.  
<https://www.inteliwise.com/products/egov-virtual-assistant/>. Accessed 6 April 2017.
- 70.chatbots.org (2017) Virtual Agents and Chatbots Directory.  
<https://www.chatbots.org/>. Accessed 6 April 2017.
- 71.UKAuthority (2017) What can the public sector do with AI?  
<http://www.ukauthority.com/news/6841/what-can-the-public-sector-do-with-ai>. Accessed 6 April 2017.
- 72.Every A (2017) Government eyes artificial intelligence opportunities.  
[http://tech.newstatesman.com/public-sector/government\\_artificial\\_intelligence](http://tech.newstatesman.com/public-sector/government_artificial_intelligence). Accessed 6 April 2017.
- 73.Osimo D, Szkuta K, Armenia S, Lampathaki F, Koussouris S, Mouzakitis S, Charalabidis Y, Askounis D, Bicking M, Misuraca G, Pizzicannella R (2010) CROSSROAD - D4.3 Final Roadmap.  
<https://www.w3.org/2012/06/pmod/roadmap.pdf>. Accessed 8 June 2017.
- 74.Osimo D, Mureddu F, Riccardo O, Armenia S, Misuraca GC, (Keine Angabe) (2013) Towards Policy--making 2.0: The International Research Roadmap on ICT for Governance and Policy Modelling. crossover-

- project.eu/Portals/0/0205F01\_International%20Research%20Roadmap.pdf. Accessed 8 June 2017.
75. World Economic Forum (2016) These are the top 10 emerging technologies of 2016. <https://www.weforum.org/agenda/2016/06/top-10-emerging-technologies-2016/>. Accessed 20 June 2017.
76. National Science and Technology Council (2016) THE NATIONAL ARTIFICIAL INTELLIGENCE RESEARCH AND DEVELOPMENT STRATEGIC PLAN. [https://www.nitrd.gov/news/national\\_ai\\_rd\\_strategic\\_plan.aspx](https://www.nitrd.gov/news/national_ai_rd_strategic_plan.aspx). Accessed 20 June 2017.
77. Gartner (2016) Gartner's 2016 Hype Cycle for Emerging Technologies Identifies Three Key Trends That Organizations Must Track to Gain Competitive Advantage. <http://www.gartner.com/newsroom/id/3412017>. Accessed 11 July 2017.
78. edutopia (2016) 6 Exciting AR Apps for Student Learning. <https://www.edutopia.org/blog/ar-apps-for-student-learning-monica-burns>. Accessed 6 July 2017.
79. Augment (2017) Augmented Reality for Education. <http://www.augment.com/education/>. Accessed 6 July 2017.
80. Augmented Reality in Education Augmented Reality and Training. <https://augmented-reality-in-education.wikispaces.com/Augmented+Reality+and+Training>. Accessed 10 July 2017.
81. Bacca J, Baldiris S, Fabregat R, Graf S, Kinshuk (2014) Augmented Reality Trends in Education: A Systematic Review of Research and Applications 17(4), 133–149.
82. Zarraonandia, T., Aedo, I., Díaz, P., & Montero, A. (2013) An augmented lecture feedback system to support learner and teacher communication. *British Journal of Educational Technology* 44(4), 616–628.
83. Martins VF, Gomes L, Paiva Guimarães M de (2015) Challenges and Possibilities of Use of Augmented Reality in Education, in: Gervasi O, Murgante B, Misra S, Gavrilova ML, Rocha AMAC, Torre C, Tanir D, Apduhan BO (eds.) *Computational science and its applications - ICCSA 2015: 15th international conference, Banff, AB, Canada, June 22-25, 2015; proceedings*, pp. 223–233. Cham: Springer.
84. BDV (2016) Big Data Technologies in Healthcare - Needs, opportunities and challenges. <http://www.bdva.eu/sites/default/files/Big%20Data%20Technologies%20in%20Healthcare.pdf>. Accessed 2 May 2017.
85. Heise Verarbeiten großer verteilter Datenmengen mit Hadoop. <https://www.heise.de/developer/artikel/Hadoop-Distributed-File-System-964808.html>. Accessed 18 July 2017.
86. IBM IBM Watson. <https://www.ibm.com/watson/>. Accessed 18 July 2017.
87. Federal Office for Information Security (Germany) (2011) Technical Guideline TR-03121-1 Biometrics for Public Sector Applications Part 1: Framework Version 2.3. [https://www.bsi.bund.de/SharedDocs/Downloads/EN/BSI/Publications/TechGuidelines/TR03121/TR-03121-1\\_Biometrics\\_2\\_3.pdf?\\_\\_blob=publicationFile&v=3](https://www.bsi.bund.de/SharedDocs/Downloads/EN/BSI/Publications/TechGuidelines/TR03121/TR-03121-1_Biometrics_2_3.pdf?__blob=publicationFile&v=3). Accessed 20 July 2017.



- 88.govtech (2015) Public-Sector Blockchain Pilot Pushes the Tech Forward. <http://www.govtech.com/budget-finance/Block-Chain-Pilot-Pushes-Tech-Forward.html>. Accessed 18 July 2017.
- 89.Bendor-Samuel P (2017) The Primary Challenge To Blockchain Technology. <https://www.forbes.com/sites/peterbendorsamuel/2017/05/23/the-primary-challenge-to-blockchain-technology/2/#24e685c77a12>. Accessed 19 July 2017.
- 90.Wu H, Lee SW, Chang H, Liang J (2013) Current status, opportunities and challenges of augmented reality in education. *Computers & Education* 62, 41–49. 10.1016/j.compedu.2012.10.024.
- 91.Deloitte Blockchain technology: 9 benefits & 7 challenges. <https://www2.deloitte.com/nl/nl/pages/innovatie/artikelen/blockchain-technology-9-benefits-and-7-challenges.html>. Accessed 19 July 2017.
- 92.Government Office for Science (2016) Distributed Ledger Technology: beyond block chain: A report by the UK Government Chief Scientific Adviser. <http://www.ameda.org.eg/files/gs-16-1-distributed-ledger-technology.pdf>. Accessed 20 July 2017.
- 93.EPINET Policy Recommendations: Wearable Sensors. <http://www.epinet.no/content/policy-recommendations-wearable-sensors>. Accessed 28 August 2017.
- 94.Ferro E (2013) Leveraging Big Data for Smart City Governance. <https://web.archive.org/web/20160605190653/http://businessvalueexchange.com:80/blog/2013/11/22/leveraging-big-data-smart-city-governance/>. Accessed 28 August 2017.
- 95.CORDIS PERMED - Towards personalised medicine for all EU citizens. [http://cordis.europa.eu/result/rcn/182837\\_en.html](http://cordis.europa.eu/result/rcn/182837_en.html). Accessed 29 August 2017.
- 96.CORDIS PERMED Report Summary. [http://cordis.europa.eu/result/rcn/176551\\_en.html](http://cordis.europa.eu/result/rcn/176551_en.html). Accessed 29 August 2017.
- 97.Horgan D, Jansen M, Leyens L, Lal J, Sudbrack R, Hackenitz E, Bußhoff U, Ballensiefen, Wolfgang, Brand A (2014) An Index of Barriers for the Implementation of Personalised Medicine and Pharmacogenomics in Europe. *Public Health Genomics* 17, 287–298.
- 98.United Nations (2016) UN E-Government Survey 2016. <https://publicadministration.un.org/egovkb/en-us/Reports/UN-E-Government-Survey-2016>.
- 99.Hootsuite - we are social (2017) Digital in Eurpe. <https://wearesocial-net.s3.amazonaws.com/uk/wp-content/uploads/sites/2/2017/01/Slide019.png>. Accessed 15 August 2017.
100. Lemay A (2014) The 5 Biggest Challenges of Doing Social Media in the Public Sector. <https://www.govloop.com/community/blog/the-5-biggest-challenges-of-doing-social-media-in-the-public-sector/>. Accessed 15 August 2017.