Report of online public consultation: research and innovation at EU level under Horizon 2020 in support of ICT-driven public sector innovation

Contents

1   Introduction

This document provides an overview and synthesis of 39 contributions made during a public consultation by the European Commission on directions for ICT-driven public sector innovation at European Union level in the context of Research and innovation in Horizon 2020. The contributions will help to prepare the Horizon 2020 2014-15 work programme. All interested stakeholders were addressed: national administrations, businesses, researchers, innovators, academia and interested users. The consultation was open from 8 March 2013 to 15 April 2013.

Three questions were posed during the public consultation:

Question 1: What should be the drivers needed to cover the important changes and challenges in the area of ICT-driven public sector innovation?

Question 2: Which enablers, whether technology or non-technology, are relevant to this ICT-driven public sector innovation area? Are there any important ones missing or irrelevant ones included?

Question 3: Which focus areas of ICT-driven public sector innovation should be addressed up to 2020? Are there any areas requiring research and innovation, missing?

An overview and synthesis of the contributions made to each question are presented in the following.

2 Question 1: What should be the drivers needed to cover the important changes and challenges in the area of ICT-driven public sector innovation?

2.1 Open government and open governance

Governance should be inclusive, transparent and require collaboration through regular input and learning. Compared with existing governance models which are paper-based, hierarchical, exclusive and slow to change, this is a long overdue shift. Governance is central to upholding a culture, so innovation should be web-based, user-focused, and participative.

Government is unlikely to be a technology leader, but has the influencing power to be a catalyst for change, acting as a coordinating power to an even wider group of stakeholders. Open Government should be a natural occurrence, with SMEs and citizens gratefully soaking up the opportunity to increase the value of government data files, improving both public value and their own business models and benefits. Whilst it is certainly true that the openness of technology (standards, open source, open data, etc.) has enabled this, it is primarily the change in government economics and cultures that has been the leading influence. This is a long term not a short term opportunity.

"De-stove-piping" public organizations is the critical challenge, integrating different parts of the public sector, and linking the public sector with other actors. Coordination between external stakeholders and organisations in the public sector is necessary. Digital communication and customer relations management are the drivers, the challenge is 'relevance management'. Every communication provided, every service delivered should be as relevant as possible, as personalized as possible. From a technological point of view the issue of relevance is related to the consumerization of IT. In order to achieve this, the underlying principles must be 'openness' (open standards, open access, and freedom from restriction allowing innovation for all) as well as transparency, collaboration and the ability as well as willingness to set up infrastructure and define processes to support innovation. The overall goal is public value creation in the context of the changing face of society enabled by technology, and the need for public administrations to follow societal changes.

2.2 Government as a broad platform for public value creation

First, there is a need for a shared digital platform, commissioning all government online information and content from all departments across the public sector. New capabilities will be required, including open standards and open technologies, in order to build a reputation as a centre of excellence in the area of digital communication and customer relations management. It is an option that departments stop publishing to their own websites and instead produce only content for an open, centralized digital platform.

Second, an online platform for public value innovation is a great enabler. For example, where can actors get support for new innovative public sector ICT products or services? Collaborators need to know where to go, with whom to talk, how much financial support is available, etc. The overriding trend is for self-organizing networks for public service delivery and public value creation.

Europe is currently plagued by several crises at the same time, which problematizes the current model of public service delivery. Budget austerity, for example, puts pressure on public organizations to create and deliver public services with fewer resources. However, shifts in governance from eGovernment to eGovernance are taking place. Especially, micro-actors (such as citizens, (social) entrepreneurs and businesses) increasingly organize themselves in local networks to create public value, outside the traditional realm of public organizations. In contrast

to co-creation, such self-organization stresses the autonomy and empowerment of citizens and other users.

All this requires a collaborative culture based on a broad supported platform and framework for collaboration across government departments and by sharing and connecting data, content and competences with external actors, using for example a Creative Commons license. To make this work, a widespread change in mindset is needed, and for collaborators to start thinking in kick-starter mode.

2.3 Open services and new service approaches

Users' needs must come first. Typically, government services are built after long and costly procurement processes. In this way of working, users are seldom - if ever - consulted. The first time the public might see a service is when it goes live, by which time it's too late to make any changes if it turns out to be unfit for purpose. Instead, teams need to constantly iterate against user feedback. This means building and testing in small chunks, working quickly to deliver improvements to a service. Teams will work out how to best meet the needs of users, releasing code regularly and working in an agile way. Whilst not all governments have seen the light, many citizens are leading the way through a rise in their level of expectation. As a result of social networking, mobile internet, smartphones and gaming, more and more users are becoming comfortable with ownership and control of their own data.

Self-organization requires public organizations to facilitate and participate in 'open service delivery' rather than determine everything themselves. One way to do this is centralized service centers specialized in specific services that are commonly used by all departments and ministries, as takes place in the private sector. The shift from traditional communication towards digital communication means, for example, that government can communicate with citizens on a permanent basis anytime, anywhere, anyplace and with any device. Indeed, many service innovations are taking place at local and smart city level, being driven by location-based services drawing on local data and apps and geared to local requirements. Smart cities are at the forefront of this development. Information multicasting will be part of this with a strong focus on maximising the customer experience, especially in a context where citizens are moving faster than politicians and civil servants and require more information and openness. The goal is universally accessible, personalisable, shared and joined-up services, driven by lifestyle, social and cultural pluralism. For example in health, the aim is to achieve personalised, predictive, participatory and preventative medicine.

This needs to be balanced, however, against the strong need to guarantee the accessibility of (next-generation) public services to avoid a digital divide, and ensuring that all citizens should benefit equally from ICT-driven innovation in the public sector. The goal is to make life simpler for citizens and at the same time raise government standards in performance and in customer-oriented policy. A citizen-dashboard where every citizen has access to her information which is context aware depending on the citizens' age and situation, and where, for example, she is informed of new laws and their impacts in almost real time would be one way to achieve this. Government services are complex so the digital channel should reduce bureaucracy. Standards need to be developed for a 'service culture' which will force departments to improve citizens' experience of key transactions. Part of this is also reducing the innovation-privacy paradox so that improvements are made without undermining data protection and integrity.

2.4 Open participation and engagement

The primary enablers for a sea change in public section innovation leading to online democracy and interactive policymaking are the nearly wholesale elimination of bureaucracy, politics, and for-profit IT consultancy from problem-solving for the residents of the EU. By (1) enabling residents to drive the identification, creation, and evolution of digitalization services, (2) empowering actors with the skills and interest to effect lightweight digital solutions to public sector IT problems, (3) putting citizens' digital information rights at the core of the solution, and

(4) ensuring the underlying theoretical and technical infrastructure reflects the micro-economics of modern value-chains in IT, it is possible to (a) create an open government initiative that is bottom-up rather than top-down, (b) is economically attractive to the government, bureaucracies, and IT SMEs, (c) eliminates the myriad of problems with today's centralized, insecure reliance on poor, proprietary authentication technologies, and (d) efficiently solves the needs of the citizenry now rather than some day in the future. The technical underpinnings necessary to effect this change includes a variety of modern economic, business, cryptographic, programming languages, and software engineering principles.

It can be argued that such a change has the potential to challenge the current balance of power between citizens and political leaders, and it might require major revisions in current organizational structure of governments and public administrations and even in their leaders' management style. Several scholars state that rich and clear information can improve society and more informed citizens demand to be better governed, and that transparency can reduce corruption and improve accountability. In such a scenario, organisational structures built upon consolidated and normally accepted mechanisms, like the pyramidal power structure, a sole source of official information, and a usually undisclosed decision making process, may no longer fit into the organization's environment with its new pressures

It is also important that government stops attempting to create new tools for participation, but instead starts looking at those platforms where people already are, and use these to develop / integrate applications into existing platforms such as Facebook Apps, Google Plus Apps, etc.

2.5   Experimentation and bottom-up innovation

Innovation occurs when four critical factors are present: a need or opportunity, enablers (including technology), capability, and resources. Another way of approaching this is to see innovation comprising creativity (the generation of ideas), decision-making (what ideas to pursue and spend time and money on), and execution (constructing something new and putting it into use); $I = C + D + E$ for short. In the European public sector, creativity needs time and space to match needs and enablers such as technology, and within that time and space the bringing together of a diversity of knowledge and understanding of the nature of the need and the potential of technology. Decision-making requires more sophisticated tools and methods for public value investment appraisal than are commonly used at present. The public value of an innovation is derived from its impact on the need in question, and thus appraisals must be problem-focused, not solution focused. All too often today we see projects that are focused on a technology as a solution out of any problem context, frequently arising from political motivations or the availability of funding linked to technology: these are economically and socially irrelevant, and causing opportunity costs, and must be avoided. Execution requires the ability to manage complex projects with many stakeholders to change an aspect of the public sector. This is a difficult and high risk task, dependent on scarce skills.

There have been many studies of why ICT projects fail, that show up a large number of critical enabling success factors. The one certainty is that if the project does not solve a problem that all stakeholders are committed to solving, then the project will fail. The corollary is that the smaller and more local an initiative, the greater the chance of success. The items listed in the previous paragraph highlight a few enablers for technology-enabled public sector innovation, where technology forms part of a solution to a need. However, another consideration is the role of technology in supporting the innovation process, that is supporting each of the three stages C, D and E.

Existing knowledge should be tested in practice, before it can become a product, and the involvement of end-users in all phases of research is essential. However, experimentation and bottom-up innovation require a culture change, different people's skills and different policies compared to introducing technological innovation top-down. If technology, processes and e.g. the culture of an organization do not match, then it is very difficult to achieve effective change in an organization. The challenge is that the capability to implement change involving

technology is scarce, especially so in the public sector, and under increasing pressure as public sector staffing reduces in many Member States. Likewise, resources in the public sector are inevitably applied first to maintaining current operations, leaving little to address new initiatives. Both these challenges could productively be addressed at European level.

One way to tackle this is a bottom-up, small-scale experimental approach based on rigorous science-based empirical studies and standard frameworks. This should comprise a new scientific approach to public sector management and innovation involving field-tests, experiments and bottom-up innovations, as well as new development technologies like Scrum and Agile support. Multi-disciplinarity should also be sought for, as well as legal changes in many Member States to encourage entrepreneurship. Failures are not a bad thing but a required element in an evolutionary process towards higher and better levels of service delivery. The most important driver of public sector innovation is to create a very entrepreneurial culture in Europe where talented young people get the chance to innovate and where investors take risk again. The Europe Union should be seen as a startup lab and accelerator for ICT-driven public sector innovation.

Public innovation is best described as a process of mutual shaping: both the social and technological context shape innovations. Public sector innovation depends, for example, on political ambitions to reduce costs, the will to invest in new technologies and to have a better focus on its primary tasks: governance with equal rights for all citizens and enterprises according to (inter)national laws and regulations ('agile government').

3 Question 2: Which enablers, whether technology or non-technology, are relevant to this ICT-driven public sector innovation area? Are there any important ones missing or irrelevant ones included?

3.1 Infrastructures and processes

The main technology enablers are the increasing penetration of the Internet and mobile ICT into people's lives, along with increasingly available, large-scale, high-powered and virtualised resources through cloud computing and other hosting developments. To maximize the benefits of these trends an ICT acquisition and provision process needs to increasingly take place at European level to cut out the inefficiencies and loss of scale which at present undermines value for money. This can support both technology independence and vendor neutrality through smart public procurement. Better procurement standards are needed to improve the success of ICT projects and the quality of project results. Many Member States have decided that companies delivering ICT-systems to them shall follow nationally-defined processes. Examples are Germany with the V-Modell®XT, Spain with Métrica 3 and Great Britain with Prince 2. However, all these processes are different isolated approaches and not compatible with each other. Whenever a company wants to deliver some ICT product to a governmental organization in a particular country, it will have to change its development process according to the requirements of that country. This is relatively easy if a company delivers only for a single country, but can be an insurmountable barrier for companies, especially SMEs, if they want to deliver to several countries. The efficient collaboration of European companies is necessary for fast reaction to market requirements and calls for tender. But that is not possible when the companies have different processes aligned to their national regulatory constraints and process standards.

Such ambitions cannot be realized without the structured approach of enterprise architecture (EA): the design (and implementation) of organizational and IT components with minimal overlap and maximum consistency. The main drivers for the next generation innovation of a single user centric interface for all governmental actions is the enterprise architecture integration (EAI) which is both cross-border and cross-topic. Unfortunately, few governments have

achieved a satisfactory level of EA-maturity yet. EA-driven solution design should therefore remain a focus. Cloud computing is also an increasingly important issue as its benefits stretch from improving energy efficiency to easier and quicker access to data. Public authorities also face legal, privacy and security barriers. Hybrid solutions, combining public cloud, company cloud, personal cloud with in house solutions, can lead to a permanent tuning and optimization of the organization's IT landscape and therefore also innovate working processes.

Also necessary is risk management in PPP projects, the appropriate strategic management and governance of IT, performance and conformance (compliance) management, as well as robust best practice frameworks. All this will depend on an appropriate legal framework and intelligent regulation including IPR protection and enhanced interoperability, and will also enable the better roll-out of cross-border services. Increasingly important in this context is semantic interoperability and the use of semantic technologies.

A key enabler for designing, implementing and operating a more homogeneous, efficient and effective public ICT infrastructure is ICT best practice frameworks and reference models (IT governance frameworks and standards). The major reasons are, first, best practice frameworks (e.g. COBIT, ITIL, CMMI, TOGAF, diversity of ISO/IEC-Standards, CMMI (Capability Maturity Model Integration) for Development or for Services or SPICE/ISO 15504 with ISO 12207 for Development) of ICT Governance offers the opportunity to incorporate available knowledge and methods currently developed mostly for industry. Second, intensified usage of frameworks would accelerate the buildup of best practice management knowledge for public service. Third, governance frameworks provide best practice guidance and methods for designing and managing the ICT infrastructure for public services. Applying these frameworks (and others) will need a changed public ICT management approach towards a more integrated and more method based system.

Effectively working together across the public sector and with non-government actors requires common assets such as definitions of entities and services and a service bus, onto which administrative units can dock. ADMS and other efforts of ISA establish the required foundations. For example, multi-thematic information from other providers can be enabled through an open and interoperable approach based on the reference location framework (as provided by the public infrastructure). The public sector service bus should have interface descriptions which should be used by the administrative units and external public sector vendors to prevent the technological impedance mismatch. In the long run the distinction between those in administration and those outside will have to become more and more fuzzy. To achieve that goal, every European should have access to his data in administrative registers at every federal level on a citizens' dashboard. This mechanism will make use of the eID system and the public sector service bus. Every citizen will have the right to delegate access rights to this data to other entities, whether they are within administration or outside (like medical institutions, lawyers, interest groups, airlines, etc.)

Public institutions use a vast amount of open source software, often adapted to their needs, yet these institutions give little back to the community. Public sector institutions should maintain a repository of used open source software so that others can track changes and integrate these changes to prevent re-inventing the wheel. Research is needed in enabling composition of software - both in terms of robustness - connecting services/systems that were not meant to be connected, hence are resilient against superfluous/missing data or imperfections in protocols; also the scaling of composition must be improved. Altogether, web-enabled platforms must be created that enable end-user-driven composition.

Already a key infrastructure which will also further increase in importance is the cloud coupled with the Internet of Things (IoT). The virtualization of public service infrastructure in the cloud enables the centralization and virtualization of storage, computing power, software into services in the public sector. Cloud computing offers functionality to public organizations and SMEs to support their operation and administration. These cloud solutions, which might be provided by third parties, allow data management in a private environment. Most cloud solutions are offered

outside formal legislation which can lead to privacy and security risks. Hence, a pan-European infrastructure for cloud services could help public organizations to balance efficiency and innovation with privacy and security.

Public services and their infrastructure are subjected to stronger cyber-security requirements and closer supervision by governments concerning the protection of citizens. In particular, in relation to ICT-driven innovation, the protection of privacy and personal data are at the heart of society. The protection of these rights is a core task of the government. The implication of this is that infrastructures and processes provided by the government may gain more trust than those of private companies. Thus, Privacy Enhancing Technologies (PET) remain an important technological driver to protect privacy and personal data, while not compromising user experience and security of public services. Examples of PETs are encryption, revocable consent, personal data management and privacy by design. Politics and trust in public ICT also have an enabling role, given that not all enablers of public innovations are technology-oriented. Safe-keeping is also promoted electronic identification, electronic signature, trust service, electronic seal, and electronic time stamp.

Thus, a European strategy for the security of information should be developed, such as the development of an eID system with well-defined interfaces. For example, a new form of a passport or an addendum to the passport should be developed, which becomes the eID. This system must be a mix of 'possessing' a security token and 'knowing' that token. Every new born European should receive such an eID automatically. Technical specifications of such an eID system should be established whilst leaving it to the Member States to actually issue or revoke those eIDs not to curtail their sovereignty.

Other important technology enablers include:
- Social media in governance
- Application Programming Interfaces (API) that are interoperable i.e. which offer shared access to information and the potential development of online services by public administrations, private citizens and business enterprises especially SMEs.
- Web 3.0 and the semantic web.
- Agile development, expansion of mobile and BYOD. What is probable is that data will be at the core, as will be openness and interoperability of solutions
- Robots and automation for undertaking routine tasks where human empathy is not important, e.g. in greenhouse climate control, energy saving, sensors, actuators, etc. In such cases, labour can be replaced by robots and autonomous vehicles. Robots could also secure food safety.
- Ubiquitous computing is both an enabler and disruptor; it is an important area of needed research.

3.2   Open data and big data

Big, open data fuels public services. However, the successful extraction of value from enormous quantities of data is a challenge and offers the public sector both opportunities and threats. There are three key drivers of this data explosion: (1) Linked Open Data (LOD), (2) the Internet of Things (IoT) and (3) Social Sensor Networks (SSNs). Firstly, semantic web technologies, such as LOD, enable the publication of freely available and directly processable public data to end-users and software developers. Data platforms and intermediaries that enable public organizations to act as sources of LOD have already been developed. Most of these data platforms or adapters use semantics (ontologies) and support various formats to open up data, including APIs for updating and deletion of data with proper authorizations. It is expected that this so-called trend of programmable web will only continue. LOD at a large scale, however, also requires good models for assessing privacy and security risks related to the disclosure of data sets. Also the possible combination of data sets and the new information this may bring has to be taken into account. So, openness is supported with certain safeguards.

Secondly, we are currently witnessing the emergence of the IoT. Every electronic device has the potential to connect to the Internet. Many of these devices are personal and/or mobile devices and carry sensors. The combined sensors of all these devices will create an enormous stream of data that will make today's big data seem small. This data alone will provide a wealth of information on which to base future public services.

Thirdly, citizens will increasingly organize social sensor networks (e.g. with their phones, watches and wearable technologies) to collect, analyse and publish data on public services. Emergent examples are peer-to-peer mobile networks of citizens monitoring crime in the neighbourhood or tracking the performance of public transport services. This growing stream of citizen-generated data is valuable for government agencies, but also poses political (e.g. assessing the value of citizen-generated data), technological (e.g. combining open data and citizen-generated data) and organizational (e.g. the role of policy makers in these citizen activities) challenges.

The analysis and visualization of big data can generate big value. The enormous quantities of data described above need to be processed before they add value to public services. Hence, big data requires analysis and interfaces/visualization. Additionally, big data can be semantically analysed and visualized to derive personal context information for future personalized, situation-aware and transient public services. Big data and its analysis and visualization can be input to an increasing number of intelligent agents that helps to generate public value. Public service delivery in domains such as health and education will increasingly rely on collaborative networks of intelligent autonomic systems (e.g. robots or online agents) as well as civil servants. For example, medical data can be converted into prediction models and clinical decision support systems (e.g. www.predictcancer.org). The re-use of (external) medical data is crucial to offer sufficient quality and quantity but sharing this data is hampered by technology and regulations.

All government data should be open data. Open data is the starting point, other data can be added. There is huge value to be gained from the development of services from reusable open public data, economically, socially and environmentally. However, the concept of ´sensible governance' which tries to measure the action of the government, not only by economics results but with other indicators measuring 'social' aspects of the policies, should also be pursued. Those social aspects could be ethics, healthcare, family conciliation, security, etc. One should understand the data to be able to use it correctly. Open public data can also be used to reduce the use by citizens of multiple applications. Citizens and civil servants should have a single interface to all governmental data, also connected to their private data, in the form of a citizen dossier. Aggregation and query information tools, which are independent of language or other semantic issues, can be an important issue.

Public portals and web services should be connected with the semantic web integrating public sector information infrastructures by means of linked data and linked open services approaches, which is key to facilitating optimal use of such information. This should also include the issue of multilingual ontology alignment research. Smart processes to extract or make available information are a key technology for example in examining terabytes of images and laser data in the form of geographic and environmental datasets.

3.3 Policy modeling and making

Insights in complexity science fuel innovations in the testing, simulation and modeling of policy decisions and services. In turn, simulation, modeling and gaming increase public service effectiveness and give policy makers greater insight into the outcome of an intended public service innovation, thus supporting the decision-making process for ICT-driven public innovation. More powerful analysis tools help public organizations to increase the effectiveness of public services. Future focus should be on massive multiplayer policy games, value network analysis, business modeling, market attractiveness analyses, adoption forecasts, complex value propositions and societal cost and benefit analysis. These innovations in policy modeling and

simulation are enabled by the opportunities of big data, mobile platforms, artificial intelligence and intuitive interfaces.

At the personalized level, for example in health, computer simulation technologies should be developed which are capable of integrating all quantitative data available on each patient into individualised predictions of how the patient's health status will evolve because of the progression of the disease, or because of the various treatment options. From a VPH (Virtual Physiological Human) perspective, which aims to provide truly personalized healthcare services, modeling and simulation technologies are critical. This brings with it the need for an integrated e-infrastructure including seamless access to an entire, secure computing ecosystem, including high performance and cloud computing resources, data warehouses and safe havens for patient data, and secure, high performance (optical/light path) networks for data transfers. Indeed, an ICT ecosystem that maintains the anonymity of the patient in the face of the massive amounts of data being processed (e.g. genetic imaging) is of paramount importance. This can be achieved through a combination of technical and legal/ethical information governance protocols/procedures. Importantly, education and training of healthcare specialists to make use of these innovations is necessary to ensure uptake of this approach by healthcare professionals.

Other examples of policy modeling techniques which are key for well-founded decision making include environmental and situational simulations such as infrastructure or building insertion in a given environment or urban growth simulation, flood simulation, or other crisis situation. Foresight-predictive orientation of administrations with the help of citizens, in order to better predict social phenomena, could also be important indicators for the economy and for society. The use of ICT to support policy aims through directly encouraging aspects of public behavior requires a behavioral modeling approach to individuals, as well as to groups and society as a whole, taking into account differences in the emotions and will of citizens. Overall, these approaches provide new ways for reaching justified decisions, based upon sound evidence and which give proof to citizens and businesses on how decisions are reached, and thereby gaining citizen trust.

3.4 Measurement and monitoring

Measurement and assessment, for example to monitor performance and accountability, will make government and public services more efficient and effective. This is critical in times of limited budgets and the need to do more for less.

3.5 Civil servants and working practices

There should be more focus on the way of working within the ICT-driven public sector, i.e. on methodologies, methods, and best practice models to be used by civil servants and across organizational structures. Many perceive the public sector as being inefficient, obstructionist and bureaucratic. Whilst this is not the case as a broad generalization, there are real issues to tackle, such as too much 'not invented here' attitude, organizational silos and tackling fraud and the 20% 'black economy' across Europe.

The education and training of civil servants is important to support their adaptation to the multiple functions they have to fill in the new eGovernment environments. This includes information literacy, complex problem solving and collaboration skills, lack of in-house or unbiased technical expertise, as well as all-round service-minded capability.

Digitizing the public sector means a cultural change. It is not only about technology and ICT capacity, it's also about people management, managing and optimizing back office processes and creating awareness for the opportunities of opening up content and data. It's about learning to deal with constant change and about integrating permanent monitoring and measurement into decision-making process. Indeed, the concept a 'civil servant' should be changed, for example, it is a very restrictive concept related to externalized services. The civil servant in the organization must be engaged as well as empowered and have the support from their

management to 'think and work' in new ways. For example, the concept of digital badges should be developed to motivate civil servant to develop competencies throughout their career, certify these competences and recommend resources.

Technology-enhanced learning platforms focusing on OER (open educational resources) and OEP (open educational processes) could be developed across the public sector. Currently, just simple conventional learning platforms exist, but none of them offer personalised learning services. Further, there is no support for assessment (self-assessment in particular). Current solutions are not workplace learning solutions - civil servant need to leave their working place to learn. This does not fit with life-long-learning.

4   Question 3: Which focus areas of ICT-driven public sector innovation should be addressed up to 2020? Are there any areas requiring research and innovation, missing?

4.1   In relation to the drivers and trends

The following suggestions were made in the public consultation regarding focus areas for research and innovation in relation to the main drivers and trends (some suggestions are relevant for more than one type of driver or trend):

Open government and open governance:
- New governance models, such as those based on a public value management approach. Such an approach facilitates the shift to networked organizations or networks of organizations, and of local initiatives. Governments are no longer able to steer the output of such networks, but they can coordinate the activities and guide outcomes according to public values that these outcomes need to achieve.
- Success factors for the emergence and facilitation of self-organizing networks.
- Implications of new governance and business models for the current organizational structure, culture and processes of public organizations.
- Processes, applications and end-to-end solutions will only work when people will be able to handle constant change. Public sector organizations will need to start thinking more like a start-up, which requires a more agile and flexible approach. So best practices in change management are required, and how can we become more digital in our thinking.

Government as a broad platform for public value creation:
- How the public sector can create open ICT-supported platforms for public value creation needs to have a broader vision. The information provided by public and private actors should be integrated. The concept is to organize a network of actors who provide information and facilitate decision-taking in real time with personalized and contextualized information.
- Governance and business models for public value creation through cooperation with other actors, or by enabling other actors to independently deliver public value.
- The social and economic dynamics of self-organizing networks of public service delivery.

Open services and new service approaches:
- Service personalization will be the trend in digital for years to come. That creates challenges for institutions and governments. If we have access to user data, the user needs to trust us. To such an extent that he prefers handing over his data to the public sector rather than to Facebook. A European standard or verification process would be beneficial in winning that trust.
- The development and impact of mobile, adaptive (content and context aware), personalized, unobtrusive and automated public services. An important application domain is healthcare, for example life style coaching using mobile health (mHealth) that receives input from social media and sensor networks.

- The deployment and governance of a seamlessly interoperable digital single market for public services.
- The impact of open and transparent infrastructures and processes for public services on the trust of citizens.
- The implications of big data (e.g. linked open data) for the effectiveness and efficiency of public service delivery.
- The provision of resources (e.g. an appropriate amount and type of data / information) that actually empowers open, public-private networks to (co-)produce public services. Focus areas for privacy, identity and data management for public services

Open participation and engagement:
- How do we get valuable, continuous, public, transparent citizen feedback about public sector innovation, and feedback that is actually respected and responded to?
- Research into the democratisation of big data analysis and visualisation tools.
- How can we harness IT citizenry to solve their own needs?

Experimentation and bottom-up innovation:
- Significant work needs to be done on how to bring together problem knowledge with technical knowledge: there is a history of technologists applying their tools to a domain they little understand, and a lack of technical knowledge in front-line public servants
- Effective and usable methods and tools to support the difficult and poorly-done components of public sector innovation are a great need; this constitutes a domain for innovation in its own right.
- How can ICT-development, ICT-experiments and providing ICT-based services be accelerated to be better aligned with business / population needs and be improved in terms of quality and costs (development and service provider costs)
- Note the success of "prize" schemes in the third world that drive innovation around for example eradicating a disease or providing drinking water or a self-sustaining toilet. Capability to manage both an end-to-end innovation process and each of the component phases within it is a universal challenge. Research on how to overcome it is needed.
- Smart Cities, including opportunities presented by "the Internet of Things" build on integration across the whole ICT system, drawing in cloud computing and energy-efficiency, with important research needs into the possibility for interventions in highly innovative cross-cutting services.

4.2   In relation to basic technology tools and other enablers

The following suggestions were made in the public consultation regarding focus areas for research and innovation in relation to basic technology tools and other enablers (some suggestions are relevant for more than one type of technology tool or other enabler):

Infrastructures and processes:
- IT management and governance of federated organizations and services, which will be radically different from managing and governing today's traditional monolithic IT organizations.
- The technological dynamics of interoperability, including interoperability tools and methods (technical, semantic and organisational).
- Focus on the (pan-European) interoperability of public services
- How can public and private organizations use each other's data and services without having to invest in long implementation projects?
- How do we eliminate single-vendor solutions and pseudo-monopolies that cause vendor lock-in and economic hardship via project disasters or, perhaps worst yet, project successes that entail overvalued multi-year or multi-decade contracts

- To support the interests of both public administrations and industry in Europe, a harmonization of different European processes in both technology acquisition and provision is needed.
- Include professional frameworks for IT-Governance like e.g. COBIT 5.0, ISO 38500 and TOGAF. Also, the CMMI-for-Development Model together with the CMMI-for-Services framework might help to cover the whole IT-lifecycle from generating a project idea to doing the implementation to later providing the IT-supported service to the public. Similarly, the maturity levels 2 and 3 from CMMI might also help to make ICT development and usage more effective in the public domain. All these best-practice frameworks do not only help in making progress with compliance but actually they can really be used to boost performance – both in ICT development and in providing ICT-supported (public) services.
- Technology independence is an important goal, as is encouraging best practice implementations of public sector solutions rather than reinventing component technology. The latter should be left to the industry/community through information sharing, community development, added value (solutions building) rather than pure research.
- How do we do the continuous deployment of new IT solutions to public sector problems at a pace that matches that of the evolution of the law, bureaucracy, and, most importantly, the public?
- Research and development of a pan-European platform for cloud services (e.g. storage, computing power and services).
- Cloud computing is likely to reconfigure the provision of all public services. As well as changing the citizen experience, this will create new challenges for service provision, including a complex mix of public, private, and hybrid Clouds
- How do we eliminate centralized data-stores of critical information about citizenry?
- Energy-efficient computing, increasingly important as enterprises and public authorities take a lead in meeting green objectives, should have a greater focus, and research in this area should cover the full Data Centre eco-system, including low-carbon energy generation, efficient computing, and use of excess heat and power.
- The digital revolutions in four main areas (cloud, mobile, social, big data) create a big challenge to makers and vendors of new digital solutions. Therefore, newly created solutions should be designed as future-proof as possible. To this end, the creators of digital solutions must be made aware of this permanent challenge, and should be stimulated, trained and supported.
- A main focus on the Internet of Things and sensor networks is essential.
- It would be useful to develop mobile computing (e.g. smart-phone) "apps" to use in participatory citizen-science projects for biodiversity and ecosystem service monitoring. These could range from simple standardised survey tools (e.g. with integrated GPS and photographic functions) to more complex automated specimen ID programmes.
- It is crucial to focus more on research to enhance the safety aspects of identification and authentication. In terms of security, one can question for example the sufficiency of two-factor authentication. It may be still sufficient for some purposes, but for others not. For example, in transactions by bank cards two-factor authentication (based on the card number and PIN) seems to be insufficient and it is upgraded to the multi-factor authentication and combined with other security features (limited lifetime period of the card, setting of limits, locking a card etc.).
- The increasing digitization and technical developments come with different security challenges. In a world where cloud hosting, open data, big data, remote working, co-creation become the norm, how do we keep all those data safe and secure? More research into future-proof standards, best practices and legislation will be necessary. It is fair to say the public sector has been slow to embrace digital. If we want to catch up, we need to make a fundamental shift. We don't need to think about the next website; we need to accept that 'digital' is never finished.

- The development and impact of Privacy Enhancing Technologies (e.g. encryption, revocable consent, etc.) on public service delivery. How can privacy and data rights optimally be balanced with security and user experience?
- Research on self-controlled data and identity management for citizens and SMEs: ownership, identification, authentication and authorization. Focus areas for the implications of ICT-driven innovation for public organizations

Open data and big data:
- Research into conditions that facilitate or hamper the implementation and efficient use of linked open data generated by the public sector.
- The techniques to extract value out of big data, such as device, service and data discovery, semantic context analysis of data, data mining, metadata extraction and visualization / interfaces.
- Linked services and linked data to facilitate public value creation and open or new services. ICT supported collaborative decision making and big data. Smart processes to fuse or integrate big data (such as geographic or environmental information) and to extract information from these for the purpose of environmental monitoring, policy making.
- Create a group in the shared service center that are called 'data scientists' who are able to control data quality (avoiding political manipulation of data) and deliver analysis and prognosis accessible to citizens.
- There is a need to develop radically innovative ICT, organisational models, and ethical-legal frameworks that make possible to collect data about each citizen's health in digital format, whenever possible in quantitative form, and make it available, properly organised and integrated. For example, in the medical context where and when it is needed, while maintaining the anonymity of the patient/citizen. All this information should be incorporated into the formation of a personalised Digital Patient. A Digital Patient is a technological platform which enables interactive health analytics (ICT support to the exploration and the understanding of the patient health status from a large amount of digital data), optimal personalised management (individualisation of prevention, diagnosis and treatment), personal health forecasting (citizen-centric health management, where the ICT provides to each of us predictions on how our daily choices will impact our health status), and ePublic health (the use of population-wide digital patient data for the planning of health policies).

Policy modeling and making:
- Innovative use of open and big data should include policy modeling tools in order to provide proper safeguards and risk assessments concerning privacy and security
- The effective use of policy modeling, simulation and gaming for the design, testing, monitoring and ex-ante evaluation of public services, situational awareness and policy related to public services.
- Opinion mining and sentiment analysis (both for citizens and policy makers)
- New modeling approaches mixing techno-economic with behavioral models for analysis and prediction of social phenomena
- Formal ways to express complex, important societal problems in an undisputable way, together with partial or context-specific solutions.
- Model-based decision support systems (e.g. fusion of system dynamics models for different parts of the economy / public sector)
- Societal simulation systems and services

Measurement and monitoring:
- The development and deployment of monitoring and evaluation tools to articulate and evaluate the impact of social innovation in terms of their contribution to people's wellbeing.
- Measuring the economic and social impact of ICT-driven innovations.
- Social media monitoring. What can we learn from unprompted social media conversations, how can we analyze trends and how do they relate to more traditional ways of monitoring and research?

Civil servants and working practices:

- Using ICT, new working practices for knowledge workers have come within reach. Working from where you want, within a personal workspace (multiple devices, cloud tools, business applications, etc.), is expected to be adopted more and more. Nevertheless many challenges still exist, like the wide variety of devices, security issues or legal constraints. The (virtual) working place of the future (front or back office) should be a focus area for innovation.
- How do we bring the results and the experiences from this research and innovations into the daily work of the organization and the civil servant?
- Focus on organizational change management is needed, as is life-long qualification programs for employees in the public domain. Especially ongoing qualification programs for employees in the public sector need to be supported because of the rapid socio-technological change that we are facing.
- Fully dynamic, automatic re-configuration workflow and service systems, to support the open-service paradigm
- Legal informatics methods and tools to manage legal elements collaborative creation and maintenance (from constitutions to laws to decrees).
- The implications of ICT-driven innovations on the competences and knowledge that civil servants need.
- The opportunities that learning analytics (e.g. personalized advices on learning objectives) offer to the training of civil servants.
- Personalised learning for 21st century skills is required in public administration with a focus on information literacy: More and more services are offered online, there is less and less personal contact with citizens, so information needs to be gathered from online forms, community platforms where citizen discussions take place, etc. This requires that civil servants acquire relevant skills such as understanding the information needs, building the right query, extracting relevant information from different sources etc.
- New tools are needed for public officials training (engaging simulation, serious games, mobile apps …).

4.3   Societal challenges

The following suggestions were made in the public consultation regarding the societal challenges which ICT-driven public sector innovation should focus upon:

- Ambient Assisted Living and ageing, for example health professionals and robots working together to expand the time elderly safely live on their own.
- eHealth, including oncology, radiotherapy, quality of life, prediction models, clinical decision support systems, orthopaedics, biomechanics, mechanical engineering, kinematics, gait analysis, etc.
- The pan-European digital single market
- Energy-efficiency
- Environmental simulation
- Urban planning
- Digital literacy and e-learning, technology-enhanced learning and 21st century skills.
- Minorities and disadvantaged groups.