

1 API Economy

1.1 Analysis

API Economy	
Identifier	TT#1
Type	Trend, based on engineering and software development advances.
Description	
<p>The <i>API Economy</i> refers to the trend of turning a business or organization into a platform by using Application Programming Interfaces (APIs) to integrate and connect people, places, systems, data, things and algorithms, create new user experiences, share data and information, authenticate people and things, enable transactions and algorithms, leverage third-party algorithms, and create new product/services and business models, thus positively affecting the organization's profitability¹. An API is a set of subroutine definitions, protocols, and tools for building software and applications by abstracting the underlying implementation and only exposing objects or actions the developers need in order to reduce their cognitive load². Essentially, an API is a customer interface for technology products that allows software components to communicate³.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Engineering / software development
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • The ProgrammableWeb directory of APIs reported that in 2015, 2,000 APIs were added to the site. This works out to around 40 APIs being added per week, and the total number of APIs represented on the directory currently stands at around 15,000. APIhound on the other hand estimates there are 50,000 public web APIs⁴. • The market for API management tools is still young. There is a need for more maturity in most of the offerings available in the market⁵.
Related Terms	<ul style="list-style-type: none"> • Platform economy

¹ Smarter with Gartner, Welcome to the API Economy, <http://www.gartner.com/smarterwithgartner/welcome-to-the-api-economy/>

² Wikipedia - Application programming interface, https://en.wikipedia.org/wiki/Application_programming_interface

³ TechTarget, API economy (application programming interface economy), <http://searchsoa.techtarget.com/definition/API-economy-application-programming-interface-economy>

⁴ Nordic APIs, Tracking the Growth of the API Economy, <http://nordicapis.com/tracking-the-growth-of-the-api-economy/>

⁵ ComputerWeekly.com – Clive Longbottom, The API economy – or the API Tower of Babel?, <http://www.computerweekly.com/feature/The-API-economy-or-the-API-Tower-of-Babel>

API Economy	
Source(s) of Documentation	API Economy appears among a series of eight current technology trends that will shape, according to Deloitte's report "Tech Trends 2015" the future of government ⁶ .

1.2 Impact Assessment

API Economy	
Identifier	TT#1
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Integration of applications pertaining to different domains. • Reliability and user friendliness – through APIs developers can change applications without affecting the way they interact with each other. • Speed of new services development. • Extensibility and interoperability. • Reusability - content can be created once and be automatically published or made available to many channels. • Efficiency and automation of work – workflows within an organisation can be updated with fewer steps and greater productivity. • Enabling the development of mashup applications. • Facilitating the development of mobile applications. 	<ul style="list-style-type: none"> • Programming knowledge required. • Poor or badly written APIs. • Associated costs (development costs, maintenance costs, API documentation, support provision to users of the API). • Maintenance required. • Potential of system crash when testing APIs. • Steep learning curve to knowing how to program APIs • No standardised documentation
Opportunities	Threats
<ul style="list-style-type: none"> • Design of innovative online services for citizens and businesses. • Cross-sector integration • More integrated user experience • Entrepreneurship and innovation acceleration • Exposure of Public Data and Services to third parties • Personalization 	<ul style="list-style-type: none"> • Security exposure / security concerns - API vulnerabilities may be used by hackers. • Improper use of APIs by third parties • High utilisation of Public Sector infrastructures
Relevant Needs	<p>Individuals' needs:</p> <ul style="list-style-type: none"> • Connected and integrated Europe <p>Businesses' needs:</p> <ul style="list-style-type: none"> • Streamlined and reliable administrative

⁶ Deloitte (2015). Tech Trends 2015 - The fusion of business and IT: A public sector perspective, <https://www2.deloitte.com/us/en/pages/public-sector/articles/tech-trends-2015-public-sector-perspective.html>

API Economy	
	procedures in the public sector <ul style="list-style-type: none"> • Easy access to public sector information (open data) • Access to a unified European market • Technology implementation Governments' needs: <ul style="list-style-type: none"> • Resource optimization • Digitization • Accessible public sector information
Potential uses / applications/ services	<ul style="list-style-type: none"> • Central point of service portals • Access to open data from the municipalities
Existing solutions / products / services	<ul style="list-style-type: none"> • ECIM⁷ Smart Mobility API • STORK project⁸ • WatchUK, CitaDel, Public Contracts http://public-contracts.nexacenter.org/, Open Coesione⁹ (to monitor how EU money is spent) http://www.opencoesione.gov.it/, Visual OPML¹⁰ (to make available employment data through innovative interfaces) • CitySDK APIs (Amsterdam)¹¹

2 Artificial Intelligence

2.1 Analysis

Artificial Intelligence	
Identifier	TE#1
Type	Technology field that draws upon computer science, mathematics, psychology, linguistics, philosophy, neuroscience and artificial psychology.
Description	

⁷ European Cloud Marketplace for Intelligent Mobility, <http://ecim-cities.eu/>

⁸ <https://www.eid-stork.eu/>

⁹ <http://www.opencoesione.gov.it/>

¹⁰ <http://visual.opmltorino.it/>

¹¹ <http://www.citysdk.eu/>

Artificial Intelligence	
<p><i>Artificial Intelligence (AI)</i> is intelligence exhibited by machines. In computer science, an "intelligent" machine is ideally a flexible rational agent that perceives its environment and takes actions that maximize its chance of success at some goal. Colloquially, the term "artificial intelligence" is applied when a machine mimics cognitive functions such as "learning" and problem solving¹².</p> <p>From another point of view, artificial intelligence is the science of doing by computer the things that people can do and in contrast to normal hardware and software, enables a machine to perceive and respond to its changing environment¹³.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Computer science (calculating machines intending to perform operations on concepts rather than numbers, expert systems, data mining, search engines, image recognition, spam filtering) • Healthcare industry (medical diagnosis) • Automotive industry (self-driving vehicles) • Logistics
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • The overall artificial intelligence market is expected to be worth 16.06 bn USD by 2022, growing at a CAGR of 62.9% from 2016 to 2022¹⁴. • Global Intelligent virtual assistant Market was valued at 579.7 m USD in 2014 and is forecast to grow at a CAGR of 31.8% from 2015 to 2022¹⁵. • The Intelligent Virtual Assistant (IVA) market size was 750 m USD in 2015. The IVA market is expected to witness a substantial growth over the forecast period, owing to the rising adoption across several applications including BFSI, healthcare and automotive¹⁶.

¹² Wikipedia – Artificial intelligence, https://en.wikipedia.org/wiki/Artificial_intelligence

¹³ World Economic Forum, Top 10 emerging technologies of 2015, <https://www.weforum.org/agenda/2015/03/top-10-emerging-technologies-of-2015-2/#emergent-ai>

¹⁴ Markets and markets, "Artificial Intelligence Market - Global Forecast to 2022", <http://www.marketsandmarkets.com/PressReleases/artificial-intelligence.asp%20.asp>

¹⁵ Intelligent Virtual Assistant Market - Global Industry Analysis, Size, Share, Growth, Trends and Forecast 2015 – 2022, <https://www.marketresearchengine.com/reportdetails/intelligent-virtual-assistant-market>

¹⁶ Grand View Research, Intelligent Virtual Assistant (IVA) Market Analysis - Forecasts To 2024, <http://www.grandviewresearch.com/industry-analysis/intelligent-virtual-assistant-industry>

Artificial Intelligence	
Related Terms	<ul style="list-style-type: none"> • Machine Intelligence • Smart Machines • Machine Learning • Autonomic Computing • Cognitive Computing • Autonomous Agents • Software Agents • Intelligent Personal Assistants (IPAs) • Virtual Personal Assistants (VPAs) • Bots • Chatbots / Chatterbots • Cognitive Expert Advisors
Source(s) of Documentation	Smart Machines appear in Gartner’s “Top 10 Strategic Technology Trends for 2015” ¹⁷ , whereas Emergent Artificial Intelligence is considered among the list of the top 10 emerging technologies of 2015, compiled by the World Economic Forum’s Meta-Council on Emerging Technologies ¹⁸ .

2.2 Impact Assessment

Artificial Intelligence	
Identifier	TE#1
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Greater precision and accuracy – almost nil chances of error. • Overcoming the limitations of human nature (not limited by fatigue, boredom or emotions intercepting rational thinking). • Undertaking laborious tasks – reducing human effort. • Convenience – making daily life a lot easier with its several applications (auto-correct apps, personal assistants, gps, etc.) • Saving the need of organisations for human resources. • Carrying out repetitive and time-consuming tasks efficiently. • Capable of carrying out dangerous or risky tasks. 	<ul style="list-style-type: none"> • Ethical and moral issues, found in embedding intelligence in a machine. • Significant maintenance and repair costs to suit changing requirements. • Lacking common sense, creativity, intuitiveness and the human touch. • Difficulty in ensuring that AI will be used ethically. • Not as efficient as humans in adapting responses, depending on changing situations.

¹⁷ Gartner, Gartner Identifies the Top 10 Strategic Technology Trends for 2015 (Press Release), <http://www.gartner.com/newsroom/id/2867917>

¹⁸ World Economic Forum, Top 10 emerging technologies of 2015, <https://www.weforum.org/agenda/2015/03/top-10-emerging-technologies-of-2015-2/>

Artificial Intelligence	
Opportunities	Threats
<ul style="list-style-type: none"> • Personal Public Services Assistance. • Intelligent Agents for Policy Decisions • Automation in mainstream tasks 	<ul style="list-style-type: none"> • Hesitancy in fully delegating important tasks to AI applications. • Fear of replacing humans in their job positions /unemployment. • Fear of lateral thinking and multitasking abilities of humans gradually declining due to the reduced need to use their intelligence - humans becoming overly dependent on machines. • Fear of destructive consequences if control of AI goes to the wrong hands. • Fear of smart machines superseding and enslaving humans.
Relevant Needs	<p>Individuals' needs:</p> <ul style="list-style-type: none"> • Transparent and participative access to Public Sector services <p>Businesses' needs</p> <ul style="list-style-type: none"> • Easy access to Public Sector information (open data) <p>Governments' needs:</p> <ul style="list-style-type: none"> • Resource Optimization • Accessible Public Sector information
Potential uses / applications/ services	<ul style="list-style-type: none"> • Bots to answer simple citizen questions / automated online assistants instead of call centers with humans to provide a first point of contact. • Smart personal advisors to control and support proper dietary habits. • Citizen personal agents taking action on the behalf of citizens (alerting citizens with regard to their obligations toward the Public Administration, retrieving information for them, filling out forms for them, etc. • Buyer agents/shopping bots, retrieving information about goods and services. • data mining agents finding trends and patterns in the interaction of citizens with public organisations. • Ambient Assisted Living.
Existing solutions / products / services	<ul style="list-style-type: none"> • Inteliwise eGov Virtual Assistant¹⁹ • Chatbots Directory²⁰

¹⁹ <https://www.inteliwise.com/products/egov-virtual-assistant/>

²⁰ <https://www.chatbots.org/country/gr>

3 Augmented Reality

3.1 Analysis

Augmented Reality	
Identifier	TE#2
Type	Technology, based on the advancements of computer vision and object recognition.
Description	
<p><i>Augmented Reality (AR)</i> is the real-time use of information in the form of text, graphics, audio, video, GPS data and other virtual enhancements integrated with real-world objects, whose elements are thus augmented²¹. It is this "real world" element that differentiates AR from virtual reality, which in contrast replaces the real world with a simulated one. Augmentation is conventionally in real time and in semantic context with environmental elements.</p> <p>With the help of advanced AR technology, the information about the surrounding real world of the user becomes interactive and digitally responsive. Information about the environment and its objects is overlaid on the real world. This information can be virtual or real. Overall, AR brings out the components of the digital world into a person's perceived real world and enhances one's perception of reality²².</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Military and Defence • Navigation • Architecture • Archaeology • Commerce (Marketing) • Video games • Industrial design • Spatial immersion • Workplace • Tourism & sightseeing
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • The global augmented reality market is expected to reach USD 117.40 bn by 2022, at a CAGR of 75.72% between 2016 and 2022²³. • Augmented Reality (AR) Market size was over USD 2 bn in 2015, and is expected to grow at 75% CAGR from 2016 to 2024 to exceed USD 175 bn by 2024. Growing

²¹ Gartner IT Glossary – Augmented reality (AR), <http://www.gartner.com/it-glossary/augmented-reality-ar/>

²² Wikipedia – Augmented reality, https://en.wikipedia.org/wiki/Augmented_reality

²³ Markets and markets, "Augmented Reality and Virtual Reality Market - Global Forecast to 2022", <http://www.marketsandmarkets.com/PressReleases/augmented-reality-virtual-reality.asp>

Augmented Reality	
	demand of in healthcare, architecture, e-commerce and retail sectors will drive revenue in the coming years ²⁴ .
Related Terms	<ul style="list-style-type: none"> • Mediated Reality • Mixed Reality
Source(s) of Documentation	Augmented Reality appears in Gartner’s Hype Cycle for Emerging Technologies, 2015 (Sliding Into the Trough) ²⁵ , whereas it is considered, according to Deloitte’s Tech Trends 2016 Report, as one of the eight trends that are likely to disrupt businesses in the months to come ²⁶ . It further shows up in the list of the top 9 technology trends for 2016, compiled by the IEEE Computer Society ²⁷ .

3.2 Impact Assessment

Augmented Reality	
Identifier	TE#2
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Creating a more interactive and personal experience. • Allowing to experience the word at one’s ease and convenience. • Revolutionising mobile user experience. • Improving mobile usability by acting as the interface itself, requiring little interaction. • Enabling more cost-effective and risk-free training – allowing to simulate practices without to actually expose people to risky situations or hazardous environments. • Advancing and facilitating education (visualize “difficult” to explain concepts, facilitate learners’ interaction, apply trial and error methods, etc.). • Providing real-time feedback. • Broad field of applications. 	<ul style="list-style-type: none"> • Hampering the interaction with the real world – replacing human interaction. • Still facing technical challenges and limitations. The accurate tracking of the position and the line of sight of the user are still challenging aspects. However, this is important for the accuracy of the alignment of the virtual objects on the real world).

²⁴ Global Market Insights - Augmented Reality (AR) Market Size, Industry Analysis Report, Regional Outlook, Application Development Potential, Price Trend, Competitive Market Share & Forecast, 2016 – 2024, <https://www.gminsights.com/industry-analysis/augmented-reality-ar-market>

²⁵ Gartner (2015). Hype Cycle for Emerging Technologies, 2015, <https://www.gartner.com/doc/3100227>

²⁶ Deloitte (2016). Tech Trends 2016, <https://www2.deloitte.com/global/en/pages/technology/articles/tech-trends.html>

²⁷ Computing Now (IEEE Computer Society), Top Technology Trends for 2016 <https://www.computer.org/web/computingnow/trends/Top-Technology-Trends-2016>

Augmented Reality	
<ul style="list-style-type: none"> Supporting research. 	
Opportunities	Threats
<ul style="list-style-type: none"> Public employees training. Safer and informative navigation. Aiding disabled people by providing vital information, otherwise cumbersome to obtain and enhancing their environment. AR can be utilized to support decision-making processes of personnel in the areas of safety and security, or medicine. They can also be used for maintenance tasks, as virtual labels or for training purposes. 	<ul style="list-style-type: none"> (Individual) privacy concerns – probability of access to information that one should not readily possess about a given person. High development costs Need for investments in wearables
Relevant Needs	<p>Individuals' needs:</p> <ul style="list-style-type: none"> Inclusive well-being and health <p>Governments' needs:</p> <ul style="list-style-type: none"> Recruitment, training
Potential uses / applications/ services	<ul style="list-style-type: none"> AR-enhanced learning applications Virtual tours on Museums Transportation checking points with people consenting to be scanned digitally. Customs and border protection. Augmented emergency management (enhancing search and rescue through geospatial AR application). Contact lens displays or systems for augmenting tactile information (still in development). Future developments will include the improvement of the collection of gestic data from the user e. g. with time-of-flight cameras, ultrasonic- and acceleration sensors, magnetometers or GPS navigation devices²⁸.
Existing solutions / products / services	<ul style="list-style-type: none"> The technology for visual augmentation is already in use, especially by private persons for gaming purposes. By now, the growing sophistication of the systems could enable e.g. security personnel to use the technology on a regular basis e.g. for crime detection and prevention. There are already commercial systems available, which add visual information (e.g. AR apps for mobile phones or

²⁸Fraunhofer for the SOURCE project, Technology Trend Card „Augmented Reality Systems“, <http://societalsecurity.net/sites/default/files/document-database/files/2016-01/pdf/2669935-augmented-reality-systems.pdf>

Augmented Reality	
	Google glass) ^{Error! Bookmark not defined.}

4 Big Data

4.1 Analysis

Big Data	
Identifier	TE#3
Type	Technology, resulting from the advances in data storage and computation.
Description	
<p><i>Big Data</i> is a term for data sets with sizes and complexity beyond the ability of commonly used software tools to capture, curate, manage and process data within a tolerable elapsed time.</p> <p>According to Gartner’s definition, Big data is high volume, high velocity, and/or high variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation²⁹. That definition, which includes the 3Vs (Volume, Velocity, Variety) has been recently complemented to include also Value of data as well as Veracity, coining in this manner a 5V Big Data definition.</p> <p>The term often refers simply to the use of Big Data Analytics to collect, organize and analyze large sets of data to discover hidden patterns, unknown correlations and other useful information³⁰.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Science • Social media • Manufacturing • Health • Education • Government
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • The big data market is expected to grow from USD 28.65 bn in 2016 to USD 66.79 bn by 2021, at a high Compound Annual Growth Rate (CAGR) of 18.45%³¹.

²⁹ Gartner IT Glossary – Big Data, <http://www.gartner.com/it-glossary/big-data/>

³⁰ Wikipedia – Big data, https://en.wikipedia.org/wiki/Big_data

³¹ Markets and markets (2016). Big Data Market - Global Forecast to 2021, <http://www.marketsandmarkets.com/Market-Reports/big-data-market-1068.html?qclid=Cj0KEQiA9ZXBBRC29cPdu7yuvrQBEiQAhyQZ9BzTre7Kfv-tiUd1bnaWxmitMD6L0S-obB5kWgb0W78aAvYR8P8HAQ>

Big Data	
	<ul style="list-style-type: none"> • Big Data investments are further expected to grow at a CAGR of 12% over the next four years, eventually accounting for over \$72 bn by the end of 2020³². • The global big data market will grow from \$18.3B in 2014 to \$92.2B by 2026, representing a compound annual growth rate of 14.4 percent. Wikibon predicts significant growth in all four sub-segments of big data software through 2026. Data management (14% CAGR), core technologies such as Hadoop, Spark and streaming analytics (24% CAGR), databases (18% CAGR) and big data applications, analytics and tools (23% CAGR) are the four fastest growing sub-segments according to Wikibon³³. • International Data Corporation (IDC) predicts that worldwide revenues from the sales of big data and business analytics applications, tools, and services will grow from nearly \$122 bn in 2015 to more than \$187 bn in 2019, marking an increase of more than 50% over the five-year forecast period³⁴. • The global business intelligence and analytics software market is expected to increase from \$17.9B in 2014 to \$26.78B in 2019, attaining a CAGR of 8.4%³⁵.
Related Terms	<ul style="list-style-type: none"> • Big Data Analytics • Big Data Computing • Big Data Infrastructure • Big Data Value Chains • Descriptive/Predictive/Prescriptive Analytics • Business Intelligence
Source(s) of Documentation	<p>Big Data appears in Gartner’s Hype Cycle for the Internet of Things, 2015 (Sliding Into the Trough)³⁶. Big Data and Analytics further appear in IEEE CS 2022 Report as one of the 23 potential technologies that could change the landscape of computer science and industry by the year 2022³⁷.</p>

³² Reportlinker, The Big Data Market: 2016 - 2030 - Opportunities, Challenges, Strategies, Industry Verticals and Forecasts, <http://www.reportlinker.com/p03895289-summary/The-Big-Data-Market-Opportunities-Challenges-Strategies-Industry-Verticals-and-Forecasts.html>

³³ Wikibon forecasts Big Data market to hit USD 92.2B by 2026, <http://siliconangle.com/blog/2016/03/30/wikibon-forecasts-big-data-market-to-hit-92-2bn-by-2026/>

³⁴ IDC, Worldwide Big Data and Business Analytics Revenues Forecast to Reach USD 187 Billion in 2019, According to IDC (Press Release), <https://www.idc.com/getdoc.jsp?containerId=prUS41306516>

³⁵ Blog post on Marketresearch.com, The Business Intelligence and Analytics Software Market, <http://blog.marketresearch.com/the-business-intelligence-and-analytics-software-market>

³⁶ Gartner (2015). Hype Cycle for the Internet of Things, 2015, <https://www.gartner.com/doc/3098434>

³⁷ IEEE, IEEE CS 2022 Report, <https://www.computer.org/cms/Computer.org/ComputingNow/2022Report.pdf#page=5>

4.2 Impact Assessment

Big Data	
Identifier	TE#3
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Faster, better decision making. • Informed and often real time insights on issues of interest. • Development of new products and services. • Ever-narrower segmentation of customers and therefore much more precisely tailored products or services. 	<ul style="list-style-type: none"> • Using real-time insights requires a different way of working within organisations. • Data quality concerns. • Imperfect methodology issues – questionable quality of predictions.
Opportunities	Threats
<ul style="list-style-type: none"> • Better simulation services for the Public Sector • Development of Smart Cities. • Traffic management systems. • Development of improved public services. • 	<ul style="list-style-type: none"> • Privacy concerns. • Limited data availability relevant to Public Sector operations
Relevant Needs	<p>Individuals' needs:</p> <ul style="list-style-type: none"> • Inclusive well-being and health • Connected and integrated Europe <p>Businesses' needs:</p> <ul style="list-style-type: none"> • Easy access to public sector information (open data) <p>Governments' needs:</p> <ul style="list-style-type: none"> • Accessible public sector information
Potential uses / applications/ services	<ul style="list-style-type: none"> • Public opinion mining during elections (sentiment analysis) • Statistics generation to help understand local, regional and global patterns and trends • Predictive Analytics (pattern analysis to predict future developments or behaviour (e.g. of consumer)) • Complex event processing • Social Network Analysis (using data from social networks) • Network Attack Monitoring <small>Error! Bookmark not defined.</small> • Tailored healthcare services. • Early detection of pandemics.

Big Data	
	<ul style="list-style-type: none"> • Crime control. • Counterterrorism³⁸.
Existing solutions / products / services (tentative)	<ul style="list-style-type: none"> • Customer 360 degree view (Online Retailer analyse consumer behaviour) by IBM³⁹ or Pentaho⁴⁰. • Optimization of business processes (Retailers are able to optimize their stock based on predictions generated e.g. from social media data, web search trends and weather forecasts) • Big data analytics before president elections in US or before Brexit votum

5 Biometrics

5.1 Analysis

Biometrics	
Identifier	TE#4
Type	Self-standing technology field.
Description	
<p><i>Biometrics</i> as a characteristic is a measurable biological and behavioral characteristic that can be used for automated recognition and as a process it encompasses automated methods of recognizing an individual based on measurable biological and behavioral characteristics⁴¹. Biometric identifiers are often categorized as physiological and behavioral characteristics, where the former are related to the shape of the body (fingerprint, palm veins, face recognition, DNA, palm print, hand geometry, iris recognition, retina, odour/scent, etc.), while the latter are related to the pattern of behavior of a person (e.g. typing rhythm, gait, voice, etc.).</p> <p>Biometrics authentication (or realistic authentication) is used in computer science as a form of identification and access control⁴². Biometric authentication methods use</p>	

³⁸ Thomas Euting (2014), „Big data“, Europäische Sicherheit und Technik, März 2014.

³⁹ <https://www-01.ibm.com/software/data/bigdata/use-cases/enhanced360.html>

⁴⁰ <http://www.pentaho.com/customer-360-degree-view>

⁴¹ Mordor Intelligence, Global Next Generation Biometric Market - By Type, By Technology, End User Industry, Vendors and Geography Market Shares, Forecasts and Trends (2015-2020), https://www.mordorintelligence.com/industry-reports/next-generation-biometric-market-industry?qclid=CjwKEAiAgavBBRCA7ZbqgrLskUcSJACWDexAp3Ow-UWL-2Del_XtWHDGul5wOyEYtVPH7AkzfVeKqBoCVcTw_wcB

⁴² Wikipedia – Biometrics, <https://en.wikipedia.org/wiki/Biometrics>

Biometrics	
biometric characteristics or traits to verify users' claimed identities when users access endpoint devices, networks, networked applications or Web applications ⁴³ .	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Military and Defence • Forensics (Criminal Identification and Prison Security) • Safety and Security • Travel and Immigration • Banking and Finance
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • The next generation biometrics market is expected to reach \$24,448.84 Million by 2020, growing at a CAGR of 17.9% between 2015 and 2020⁴⁴. • The biometric system market size is expected to increase from USD 10.74 bnb in 2015 to USD 32.73 bn by 2022, at a CAGR of 16.79% between 2016 and 2022⁴⁵. • Biometrics Market size was USD 9.58 bn in 2015, and is forecast to surpass USD 31 bn by 2023, with 16.1% CAGR from 2016 to 2023⁴⁶. • Tractica forecasts that the global biometrics market will increase from \$2.0 bn in 2015 to \$14.9 bn by 2024, with cumulative revenue for the 10-year period totaling \$67.8 bn⁴⁷. • Juniper Research Ltd. predicts that in 2019, apps with biometric authentication capability will rise to 770 million⁴⁸.
Related Terms	<ul style="list-style-type: none"> • Behaviometrics • Biometric Authentication • Realistic Authentication • Biometric Verification • Face Recognition • Fingerprint Recognition • Iris Recognition • Palm Recognition • Voice Recognition
Source(s) of	<ul style="list-style-type: none"> • As per Gartner, 30 Percent of Organizations Will Use Biometric Authentication for Mobile Devices by 2016⁴⁹.

⁴³ Gartner IT Glossary – Biometric Authentication, <http://www.gartner.com/it-glossary/biometric-authentication/>

⁴⁴ Markets and markets, Biometric System Market - Global Forecast to 2020, <http://www.marketsandmarkets.com/PressReleases/biometric-technologies.asp>

⁴⁵ Markets and markets, Biometric System Market - Global Forecast to 2022, <http://www.marketsandmarkets.com/PressReleases/biometric-technologies.asp>

⁴⁶ Global Market Insights, Biometrics Market Size, 2016 – 2023, <https://www.gminsights.com/industry-analysis/biometrics-market>

⁴⁷ Tractica, Biometrics Market Forecasts, <https://www.tractica.com/research/biometrics-market-forecasts/>

⁴⁸ 20 Reasons To Choose Biometrics Technology For Your Business | Advantages Of Biometrics <http://authenticid.co/blog/2015/01/31/20-advantages-of-biometrics-technology-for-your-business/>

⁴⁹ Gartner Newsroom (February 4, 2014), <http://www.gartner.com/newsroom/id/2661115>

Biometrics	
Documentation	<ul style="list-style-type: none"> • <i>Interviews</i>

5.2 Impact Assessment

Biometrics	
Identifier	TE#4
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Unique and accurate identification. • Accountability (clear, definable audit trail of transactions or activities – connection of activities to a particular person). • Time saving (a person can be identified or rejected in a matter of seconds), increasing productivity. • Easy and safe to use (no need for excessive training). • Convenience and user friendliness (no need to remember passwords – also cannot forget or lose it). • Higher degree of security than traditional authentication methods (no issues of sharing, duplication or fraud). • Versatility (several types of biometric scanners available, several applications). • Scalability. • Reduced password administration cost and increased ROI in areas such as Loss Prevention or Time & Attendance. 	<ul style="list-style-type: none"> • High cost • Cannot be cancelled or replaced by a new version as passwords or tokens. • Offending human dignity (turning the human subject into a collection of biometric parameters, dehumanizing the person, infringing bodily integrity). • Low social acceptability/User resistance.
Opportunities	Threats
<ul style="list-style-type: none"> • Novel identification and authentication schemes • Improved public sector services security. • Assistance for impaired people. • International sharing of biometric data. 	<ul style="list-style-type: none"> • Privacy concerns – fear that that data obtained during biometric enrolment may be used in ways for which the enrolled individual has not consented. • Discrimination concerns (Soft biometrics traits complementing the identity information provided by the primary biometric identifiers are strongly cultural based.) • Danger to owners of secured items (chance of assaulting the owner him/herself). • The accuracy of biometric recognition technologies depends on the user and on environmental conditions (e.g. lighting during print capture). Additionally, there are concerns about the safety of stored data, as biometric

Biometrics	
	data cannot be changed if compromised.
Relevant Needs	Individuals' needs: <ul style="list-style-type: none"> • Transparent and participative access to public sector services
Potential applications / services	<ul style="list-style-type: none"> • Physical access control • Computer log-in • Welfare disbursement • International border crossing / Border management / Speed mobility in borders • National ID cards • Passports • Airport kiosks for checking passports • Driver's license • Facial recognition to speed up processes and manage queues • Instructions to get to the specific room to impaired people entering a hospital through their smartphone or trough panels • Identify criminals on the fly • Avoid fraud on competitive examinations • Life identification against watch lists (terrorism) • The safety of biometric data will be crucial for user acceptance and wide spread implementation of biometric recognition technologies. If it is possible to succeed in the assurance of the safety of biometric data and high accuracy the technology can be implemented from personal computers to nuclear power plants⁵⁰
Existing solutions / products / services	<ul style="list-style-type: none"> • The technology is already in use, however increasing advancements (eg. in mobile biometrics) and further developments (e.g. biometrics for banking) due to enhanced tools such as big data analysis can be expected. • Airport security (automated passport control) • Fingerprint access to buildings • Voice recognition in cars • Fingerprint scanner for mobiles, laptops, etc. • ATM iris recognition

⁵⁰ Fraunhofer for the SOURCE project, Technology Trend Card, „Biometric recognition technologies“, <http://societalsecurity.net/sites/default/files/document-database/files/2016-12/pdf/2647490-biometric-recognition-technologies.pdf>

6 Blockchain

6.1 Analysis

Blockchain	
Identifier	TE#5
Type	Software technology for financial transactions, based on distributed database advances.
Description	
<p><i>Blockchain</i> is a peer to peer software technology that protects the integrity of a digital piece of information⁵¹. It is a type of distributed ledger or database in which value exchange transactions (in bitcoin or other token) are sequentially grouped into blocks. Each block contains a timestamp and is chained to the previous block and immutably recorded across a peer-to-peer network, using cryptographic trust and assurance mechanisms⁵². The data in a block cannot be altered retrospectively.</p> <p>Though originally invented to create the alternative currency titled "Bitcoin", blockchain may be used for other cryptocurrencies as well, as the digital ledger underpinning them⁵³. In fact, not only information, but anything of value - money, titles, signatures, deeds, music, art, scientific discoveries, intellectual property, and even votes – can be moved and stored securely and privately.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Digital transactions processing (underpinning digital currency) • Royalty collection and management of copyrights in music industry • Insurance industry (peer-to-peer insurance, parametric insurance and microinsurance) • Smart contracts (software programs that self-execute complex instructions)
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • The blockchain technology market is estimated to grow from USD 210.2 Million in 2016 to USD 2,312.5 Million by 2021, at a Compound Annual Growth Rate (CAGR) of 61.5%⁵⁴.

⁵¹ MinuteVideos, Blockchain Introduction, http://minutevideos.com/project/blockchain-introduction-mgm0hv8m/pub?qclid=Cj0KEQjw3ZS-BRD1xu3qw8uS2s4BEiQA2bcfM3wG0IOXHxvCkQoPLY_xlLri5C9IrHMm1THERDyG34MaAizX8P8HAQ

⁵² Gartner IT Glossary – Blockchain, <http://www.gartner.com/it-glossary/blockchain>

⁵³ CIO, 4 emerging technologies that will drive digital businesses, <http://www.cio.com/article/3044067/leadership-management/4-emerging-technologies-that-will-drive-digital-businesses.html>

⁵⁴ Markets and markets, Blockchain Technology Market - Global Forecast to 2021, <http://www.marketsandmarkets.com/Market-Reports/blockchain-technology-market-90100890.html>

Blockchain	
Related Terms	<ul style="list-style-type: none"> • Cryptocurrency
Source(s) of Documentation	Blockchain appears, according to Deloitte's Tech Trends 2016 Report, as one of the eight trends that are likely to disrupt businesses in the months to come ⁵⁵ .

6.2 Impact Assessment

Blockchain	
Identifier	TE#5
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Trustful exchanges (reducing or even eliminating counterparty risk) without the oversight or intermediation of a third party. • User empowerment – users are in control of all their information and transactions (easy to audit). • High quality data - blockchain data is complete, consistent, timely, accurate, and widely available. • Durability, reliability, and longevity (decentralization allows to better withstand malicious attacks). • Process integrity – transactions executed exactly as the protocol commands. • Transparency and immutability – transactions are publicly viewable by all parties cannot be altered or deleted. • Ecosystem simplification - single public ledger, instead of multiple ones. • Faster transactions – transactions are processed 24/7 enabling faster transaction settlement. • Lower transaction costs - third party intermediaries and overhead costs are eliminated. 	<ul style="list-style-type: none"> • Irreversible transactions. • Nascent technology - challenges exist with regard to transaction volume and speed, the verification process, and data limits (data storage). • Uncertain regulatory status, impeding widespread adoption. • Large energy consumption – the bitcoin blockchain network's miners are attempting 450 thousand trillion solutions per second in efforts to validate transactions, using substantial amounts of computer power. • High initial capital costs. • Concerns on control, security, and privacy. • Integration concerns - significant changes to, or complete replacement of, existing systems are needed. • Complex to implement and maintain (especially private blockchains).
Opportunities	Threats
<ul style="list-style-type: none"> • Verify integrity of transactions. • Reduce fraud and corruption. • Openness and Transparency • Distributed Control of Operations 	<ul style="list-style-type: none"> • Widespread adoption is challenging. • Blockchain's linkage with illegal activities. • Large scale deployments are necessary to ensure integrity.

⁵⁵ Deloitte (2016). Tech Trends 2016, <https://www2.deloitte.com/global/en/pages/technology/articles/tech-trends.html>

Blockchain	
Relevant Needs	Individuals' needs: <ul style="list-style-type: none"> • Transparent and participative access to public sector services
Potential uses / applications/ services	<ul style="list-style-type: none"> • Vehicle registries • Storing citizens' identities - personal details/data • Voting records (Electronic voting) • Benefits disbursements • Electronic medical records - Use of blockchain technologies to secure data integrity of patients' health records. • Property/Land record registry. • Use by Resident Registration Offices. • Decentralised crowdfunding. • Use of blockchain technologies to access public service providers based on performance rather area of residence. • Decentralized management of information and data related to citizens and enterprises which involve or are monitored by public sector entities. • Management of property titles and monitoring/regulating transactions among citizens and enterprises. • Smart contracts (self-executing contractual states, stored on the blockchain, which nobody controls and therefore everyone can trust) • Music industry (start-up Ujo; blockchain-based distribution of songs) • Connecting smart consumer electronics, cars or bicycles with a mini-computer to a blockchain system to use them as part of the sharing economy • 75 of the biggest banks in the R3 consortium are working on Corda - a distributed ledger platform. Corda is heavily inspired by blockchain systems⁵⁶ • elections⁵⁷
Existing solutions / products / services	<ul style="list-style-type: none"> • Bitcoin (digital currency) • Bitnation⁵⁸ • Blockchain-based Guardtime service (Estonia) to develop and accelerate blockchain-based security, transparency and governance of patients' healthcare records^{59, 60}.

⁵⁶ Sebastian Stommel, „Blockchain Ökosysteme“, Datenschutz und Datensicherheit, 1/2017.

⁵⁷ Stefan Mey, Die Verkettung der Welt, Spektrum, 7/2016, <http://www.spektrum.de/news/die-blockchain-koennte-die-weltwirtschaft-revolutionieren/1416132>

⁵⁸ <https://bitnation.co/>

⁵⁹ <https://guardtime.com/blog/estonian-ehealth-partners-guardtime-blockchain-based-transparency>

Blockchain	
	<ul style="list-style-type: none"> • Bitnation & 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 blockchain⁶¹.”

7 Bots

7.1 Analysis

Bots	
Identifier	TE#6
Type	Trend, based on the advancements of Artificial Intelligence and of the WWW.
Description	
<p>A <i>Bot</i> (short for "robot" and often referred as “Internet bot” or “chat bot”) is a program that operates as an agent for a user or another program or simulates a human activity⁶². It is a software application that is designed to automate tasks one would usually do on their own, like making a dinner reservation, adding an appointment to their calendar or fetching and displaying information. Typically, bots perform tasks that are both simple and structurally repetitive, at a much higher rate than would be possible for a human alone⁶³.</p> <p>The increasingly common form of bots, chatbots, simulate conversation. They often live inside messaging apps — or are at least designed to look that way — and it should feel like one is chatting back and forth as one would with a human⁶⁴.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Communication / messaging • Gaming • Commercial use
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • Boteogo CEO predicts 2017 will be the year of the bots with \$2 bn market size⁶⁵.

⁶⁰ <https://news.bitcoin.com/estonian-health-records-secured-by-blockchain/>

⁶¹ <https://cointelegraph.com/news/estonian-e-residency-and-bitnation-launch-new-public-notary-in-blockchain-jurisdiction>

⁶² TechTarget - bot (robot), <http://searchsoa.techtarget.com/definition/bot>

⁶³ Wikipedia – Internet bot, https://en.wikipedia.org/wiki/Internet_bot

⁶⁴ recode - Bots, explained, <http://www.recode.net/2016/4/11/11586022/what-are-bots>

Bots	
Related Terms	<ul style="list-style-type: none"> • Software robots • Chatbots • Internet bots / Web bots / WWW bots
Source(s) of Documentation	<ul style="list-style-type: none"> • <i>Interviews</i> • Smart robots appear in Gartner’s Hype Cycle for Emerging Technologies, 2015 (On the Rise)⁶⁶. Bots are also considered, according to Harvard Business Review, as one of the eight Tech Trends to Watch in 2016⁶⁷.

7.2 Impact Assessment

Bots	
Identifier	TE#6
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Chatbots are more “human”. • They speak the real language. • Improved interaction with users. • Easy to use – simple interface. • Can be developed fast. • Not expensive to build. • Saving manpower – Cutting resources down. • Providing answers faster. • Able to multi-task. • Performing constantly-not restricted by time limits. • Unbiased and straight to the point. 	<ul style="list-style-type: none"> • Can also be used as malware, allowing attackers to take control over an affected computer. • Can be used to generate spam, and spread viruses, spyware. • Can be used to steal personal and private information (like credit card numbers, bank credentials, other sensitive information) and communicate it back to the malicious user. • Launching denial of service (DoS) attacks against a specified target.
Opportunities	Threats
<ul style="list-style-type: none"> • Save manpower – Channel manpower to other tasks. • Facilitate interaction with the public sector for citizens. • Providing service to citizens 24/7. • Enable easier identification of/access to services and quicker transaction processing. • More natural interaction with services. 	<ul style="list-style-type: none"> • Privacy Considerations • Limited Interaction Patterns

⁶⁵ PR Newswire - Botego CEO predicts 2017 will be the year of the bots with \$USD 2 billion market size, <http://www.prnewswire.com/news-releases/botego-ceo-predicts-2017-will-be-the-year-of-the-bots-with-2-billion-market-size-300243119.html>

⁶⁶ Gartner (2015). Hype Cycle for Emerging Technologies, 2015, <https://www.gartner.com/doc/3100227>

⁶⁷ Amy Webb (Harvard Business Review), 8 Tech Trends to Watch in 2016, <https://hbr.org/2015/12/8-tech-trends-to-watch-in-2016>

Bots	
Relevant Needs	<p>Individuals' needs:</p> <ul style="list-style-type: none"> • Transparent and participative access to Public Sector services <p>Governments' needs:</p> <ul style="list-style-type: none"> • Resource optimization • Accessible Public Sector information
Potential uses / applications/ services	<ul style="list-style-type: none"> • Bots to answer simple citizen questions / automated online assistants instead of call centers with humans to provide a first point of contact. • Buyer agents/shopping bots, retrieving information about goods and services. • Votebots • Smart Agents in citizens' offices, e.g. in Resident Registration offices or call centers. If someone would like to register himself in a new city, then the software robot could answer the call and direct the citizen to the different systems (e.g. registration at school, kindergarten)
Existing solutions / products / services	<ul style="list-style-type: none"> • Inteliwise eGov Virtual Assistant⁶⁸ • Chatbots Directory⁶⁹

8 Cloud Computing

8.1 Analysis

Cloud Computing	
Identifier	TE#7
Type	Mainly based on the enabling technology of virtualization (datacentre scale virtualization of computing resources) and the Service-oriented Architecture (SOA) paradigm.
Description	
<p><i>Cloud Computing</i> is a style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service using Internet technologies⁷⁰. It refers to the practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer. It is a type of</p>	

⁶⁸ <https://www.inteliwise.com/products/egov-virtual-assistant/>

⁶⁹ <https://www.chatbots.org/country/gr>

⁷⁰ Gartner IT Glossary – Cloud Computing, <http://www.gartner.com/it-glossary/cloud-computing/>

Cloud Computing	
<p>internet-based computing and a model for enabling ubiquitous, on-demand access to a shared pool of configurable computing resources (e.g., computer networks, servers, storage, applications and services) which can be rapidly provisioned and released with minimal management effort.</p> <p>Cloud Computing and storage solutions provide users and enterprises with various capabilities to store and process their data in third-party data centers that may be located far from the user – ranging from across a city to across the world. Cloud computing relies on sharing of resources to achieve coherence and economy of scale, similar to a utility (like the electricity grid) over an electricity network. It provides users with access to an integrated set of IT solutions, including the Applications (SaaS), Platform (PaaS), and Infrastructure (IaaS) layers⁷¹.</p> <p>In a cloud computing environment, end users can choose their devices, applications and services, synchronize content and application state across multiple devices and address application portability across devices⁷².</p>	
<p>Mainstream Domains of Application</p>	<ul style="list-style-type: none"> • Telecommunications - Telecommunications companies offering virtual private network (VPN) services with comparable quality of service as dedicated point-to-point data circuits but at a lower cost. • NASA's OpenNebula was the first open-source software for deploying private and hybrid clouds, and for the federation of clouds.
<p>Related Market Potential/Forecasted Growth</p>	<ul style="list-style-type: none"> • IDC predicts external cloud adoption will increase from 22% today to 32.1% in 24 months achieving 45.8% growth⁷³. • The worldwide cloud computing market grew 28% to \$110B in revenues in 2015⁷⁴. • IDC predicts cloud IT infrastructure spending will grow at CAGR of 15.1% from 2014 to 2019, reaching \$53.1B bn by 2019⁷⁵. • Worldwide spending on public cloud services will grow at a 19.4% compound annual growth rate (CAGR) from nearly \$70B in 2015 to more than \$141B in 2019⁷⁶. • TBR predicts worldwide public cloud revenue will increase from \$80B in 2015 to \$167B in 2020⁷⁷.

⁷¹ Wikipedia – Cloud Computing, https://en.wikipedia.org/wiki/Cloud_computing

⁷² Gartner, Gartner Identifies the Top 10 Strategic Technology Trends for 2015 (Press Release), <http://www.gartner.com/newsroom/id/2867917>

⁷³ IDC, IDC's Latest CloudView Multiclient Study Reveals Attitudes and Strategies of the 58% of Organizations Embracing Cloud, February 26, 2016 (Press Release), <http://www.idc.com/getdoc.jsp?containerId=prUS41039416>

⁷⁴ Synergy Research Group (January 7, 2016), 2015 Review Shows USD 110 billion Cloud Market Growing at 28% Annually, <https://www.srgresearch.com/articles/2015-review-shows-110-billion-cloud-market-growing-28-annually>

⁷⁵ IDC, IDC Forecasts Worldwide Cloud IT Infrastructure Market to Grow 24% Year Over Year in 2015, Driven by Public Cloud Datacenter Expansion, <http://www.idc.com/getdoc.jsp?containerId=prUS25946315>

⁷⁶ IDC, Worldwide Public Cloud Services Spending Forecast to Double by 2019, According to IDC (Press Release), <https://www.idc.com/getdoc.jsp?containerId=prUS40960516>

Cloud Computing	
Related Terms	<p>Related terms:</p> <ul style="list-style-type: none"> • Private/Community/Public/Hybrid Cloud • Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service (IaaS) <p>Shares characteristics with:</p> <ul style="list-style-type: none"> • Client Computing (Client-server model) • Distributed Computing • Edge Computing • Fog Computing • Grid Computing
Source(s) of Documentation	<p>Cloud Computing appears in Gartner's "Top 10 Strategic Technology Trends for 2015"⁷⁸, as well as in IEEE CS 2022 Report as one of the 23 potential technologies that could change the landscape of computer science and industry by the year 2022⁷⁹.</p>

8.2 Impact Assessment

Cloud Computing	
Identifier	TE#7
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • High computing power and performance • Agility and flexibility • Scalability and elasticity • Productivity (capability of users simultaneous work on the same data) • Device and location independence • Portability across devices • Speed and improved manageability in getting applications up and running • Cost reductions (operational expenditure instead of capital expenditure, lower needs for in-house IT skills, lower maintenance costs) • Improved security (at central level) 	<ul style="list-style-type: none"> • Absence of legislative framework about cloud services • Loss of control over sensitive data • Non strict SLAs

⁷⁷ TBR, Soaring Toward USD 167B: TBR Projects Key Trends in Cloud

⁷⁸ Gartner, Gartner Identifies the Top 10 Strategic Technology Trends for 2015 (Press Release), <http://www.gartner.com/newsroom/id/2867917>

⁷⁹ IEEE, IEEE CS 2022 Report, <https://www.computer.org/cms/Computer.org/ComputingNow/2022Report.pdf#page=5>

Cloud Computing	
Opportunities	Threats
<ul style="list-style-type: none"> • Low infrastructure Costs • Ability to open up services and data • Data Resilience and Sharing • Big data analytics enablement • Low Cost for testing and development environments • Vendor independence 	<ul style="list-style-type: none"> • Insecure Interfaces and API's • Data Loss & Leakage • Risk of vendor lock-in in certain cases • Vagueness around legal ownership of the data • DevOps roles necessary • Unexpectedly high charges (e.g. ingress of data might be free, but extracting it can be costly)
Relevant Needs	Individuals' needs: <ul style="list-style-type: none"> • Transparent and participative access to public sector services Businesses' needs: <ul style="list-style-type: none"> • Easy access to public sector information (open data). Governments' needs: <ul style="list-style-type: none"> • Resource optimization • Accessible public sector information
Potential applications / services	<ul style="list-style-type: none"> • Share ICT resources among multiple agencies • Collaboration applications (e-mail, web conferencing) • Cloud bursting for increased availability at peak seasons (gsis, final exams' results, etc.)
Existing solutions / products / services (tentative)	<ul style="list-style-type: none"> • Public clouds (Google docs, Microsoft Office 365, SAP Business by Design) • Private Cloud of companies • Hybrid Clouds (has elements of private and public cloud)⁸⁰ • Infrastructure as a service (IaaS) (e.g. Amazon Web Services, Google Compute Engine, Windows Azure)⁸¹ • Platform as a service (PaaS) (e.g. Google App Engine, Amazon Elastic Beanstalk)⁸² • Software-as-a-Service (SaaS) (e.g. from Microsoft, Google, Salesforce.com, Cisco, Intuit)⁸³

⁸⁰ Maamar Ferkoun, „Cloud computing news“, 2014, <https://www.ibm.com/blogs/cloud-computing/2014/02/top-7-most-common-uses-of-cloud-computing/>

⁸¹ Heinrich Seeger, „IaaS - vergleichen lohnt sich“, Computerwoche, 8.12.2014, <http://www.computerwoche.de/a/iaas-vergleichen-lohnt-sich,3060832>

⁸² Klaus Manhar, „PaaS-Anbieter im Vergleich“, Computerwoche, 15.12.2014, <http://www.computerwoche.de/a/paas-anbieter-im-vergleich,3066351>

⁸³ Top100 - Cloud Computing“, <http://www.computerwoche.de/q/top100-cloud-computing,103280,3>

9 Crowdsourcing

9.1 Analysis

Crowdsourcing	
Identifier	TT#2
Type	Trend, based on the enabling technologies of the internet and social media.
Description	
<p><i>Crowdsourcing</i>, a combination of the words 'crowd' and 'outsourcing', is a specific sourcing model, which describes the processes for sourcing a task or challenge to a broad, distributed set of contributors using the Web and social collaboration techniques. It consists in obtaining needed services, ideas, or content by soliciting contributions from a large group of people, especially an online community, rather than from employees or suppliers.</p> <p>By definition, crowdsourcing combines the efforts of numerous self-selected volunteers or part-time workers; each person's contribution combines with those of others to achieve a cumulative result. Crowdsourcing applications typically include mechanisms to attract the desired participants, stimulate relevant contributions and select winning ideas or solutions^{84, 85}.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Competitions • Data gathering • Money raising • Business/Market research
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • 85% of the 2014 Best Global Brands have used crowdsourcing in the last ten years⁸⁶. • The internet is the engine of the modern-day crowdsourcing platform. It provides both a broadcast mechanism for organisations to set or announce challenges and a network for connecting people and their diverse ideas, skill sets and knowledge. The number of internet users worldwide is growing exponentially, and has risen from just 414 million in 2000 to over 3.4 bn in 2016. At the current rate of growth, there will be approximately five bn internet

⁸⁴Wikipedia - Crowdsourcing, <https://en.wikipedia.org/wiki/Crowdsourcing>

⁸⁵Gartner IT Glossary – Crowdsourcing, <http://www.gartner.com/it-glossary/crowdsourcing/>

⁸⁶eYeka, The state of crowdsourcing in 2015, <https://en.eveka.com/resources/reports#CSreport2015>

Crowdsourcing	
	users, and thus potential crowdsourcing workers by 2020 ⁸⁷ .
Related Terms	<ul style="list-style-type: none"> • Citizensourcing • Crowdfunding • Crowdvoting • Crowdsolving • Crowdsearching • Mobile crowdsourcing • Macrowork • Microwork • Implicit crowdsourcing/ Passive crowdsourcing
Documentation Source(s) of	Gartner reports that by 2018, crowdsourcing will constitute 20% of all enterprise application development sourcing initiatives ⁸⁸ .

9.2 Impact Assessment

Crowdsourcing	
Identifier	TT#2
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Access to new pools of external talent and expertise from a diversity of fields. • Reduced cost of conducting research and development. • Less cost compared to outsourcing. • Incorporation of end users/customers early in the development process. • Faster design and prototyping. • Potential for higher quality. • Increased agility and faster time to market. 	<ul style="list-style-type: none"> • Recruiting and retaining users can be a challenge. • Types of users' contributions are mostly limited (e.g. review/rate/tag/etc.). • Difficulty in combining and evaluating user contributions - unstructured information gathered, cumbersome to filter. • Good quality of user contributions is not guaranteed. • Difficulty in keeping hold of confidential information and intellectual property.
Opportunities	Threats
<ul style="list-style-type: none"> • Pervasive use of smartphones. • Collective Intelligence. • Cocreation and collaboration for needs tackling. • Citizens' greater public awareness. • Sharing Economy business models. 	<ul style="list-style-type: none"> • Ethical concerns. • Private Data Exposure. • IPR issues.

⁸⁷ Deloitte, The three billion Enterprise crowdsourcing and the growing fragmentation of work, <https://www2.deloitte.com/content/dam/Deloitte/us/Documents/strategy/us-cons-enterprise-crowdsourcing-and-growing-fragmentation-of-work.pdf>

⁸⁸ Revolution IT, <http://revolutionit.com.au/by-2018-crowdsourcing-will-constitute-20-of-all-enterprise-application-development-sourcing-initiatives-gartner/>

Crowdsourcing	
Relevant Needs	<p>Individuals' needs:</p> <ul style="list-style-type: none"> • Political participation • Education and training <p>Businesses' needs:</p> <ul style="list-style-type: none"> • Business Expansion (Access to funds) <p>Governments' needs:</p> <ul style="list-style-type: none"> • Civil servants as a community of change
Potential uses / applications/ services	<ul style="list-style-type: none"> • Collaborative Policy making • production of public services. • Urban and transit planning.
Existing solutions / products / services	<ul style="list-style-type: none"> • Spacehive⁸⁹ • Goteo.org⁹⁰ • Crowdcube crowdfunding platform⁹¹ • Paribas Securities Services and Smart Angels crowdfunding platform⁹² • FinStat Data Feeds⁹³

10 Data Analytics

10.1 Analysis

Data Analytics	
Identifier	TE#8
Type	Software technology, relying on the most current methods in computer science, statistics, and mathematics.
Description	
<p><i>Data Analytics</i> refers to the discovery, interpretation, and communication of meaningful patterns in data, based on the simultaneous application of statistics, computer programming and operations research to quantify performance. It further often favours data visualization to communicate insight. The goal of Data Analytics (big and small) is to get actionable insights resulting in smarter decisions and better business outcomes⁹⁴. Data Analytics can be descriptive (explaining in more detail a phenomenon which is represented with data), predictive (trying to forecast the future behaviour of a system</p>	

⁸⁹ <https://www.spacehive.com/>

⁹⁰ <https://www.goteo.org/>

⁹¹ <https://www.crowdcube.com/>

⁹² <https://group.bnpparibas/en/news/putting-blockchain-work-crowdfunding>

⁹³ <http://www.interactivedataclients.com/web/vista/finstat>

⁹⁴ Wikipedia – Analytics, <https://en.wikipedia.org/wiki/Analytics>

Data Analytics	
<p>for which past and present data is available) or prescriptive (targeting the prediction of the impact of the behaviour of a system in a future scenario)).</p> <p>Data analytics are closely related with Big Data, as the advent of the latter propelled the rapid development of novel analytics methods, capable of handling bigger data loads and of providing more evidence-based results with less uncertainty due to the bigger data samples available.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Marketing (marketing optimization, digital analytics) • Finance / Bank sector / Insurance industry (portfolio analytics, risk analytics) • IT security / software engineering (security analytics, software analytics)
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • Global revenue in the business intelligence (BI) and analytics market is forecast to reach 16.9 bn USD in 2016, an increase of 5.2 percent from 2015, according to the latest forecast from Gartner, Inc⁹⁵. • The Total Data market is expected to nearly double in size, growing from \$69.6B in revenue in 2015 to 132.3 bn USD in 2020⁹⁶. • The market for prescriptive analytics software is estimated to grow from approximately \$415M in 2014 to \$1.1B in 2019, attaining a 22% CAGR⁹⁷. • By 2020, predictive and prescriptive analytics will attract 40% of enterprises' net new investment in business intelligence and analytics⁹⁸.
Related Terms	<ul style="list-style-type: none"> • Descriptive Analytics • Predictive Analytics • Prescriptive Analytics • Big Data Analytics
Source(s) of Documentation	<p>Advanced, Pervasive and Invisible Analytics appear in Gartner's "Top 10 Strategic Technology Trends for 2015"⁹⁹, whereas Advanced Analytics With Self-Service Delivery appear in Gartner's Hype Cycle for Emerging Technologies, 2015 (At the Peak)¹⁰⁰. Real time Analytics and Predictive</p>

⁹⁵ Gartner (2016). "Gartner Says Worldwide Business Intelligence and Analytics Market to Reach USD 16.9 Billion in 2016", <http://www.gartner.com/newsroom/id/3198917>

⁹⁶ 451 Research, Total Data market expected to reach USD 132bn by 2020, https://451research.com/report-short?entityId=89339&referrer=marketing&utm_source=website_homepage&utm_medium=website&utm_term=data_platforms_analytics&utm_content=apply_for_trial&utm_campaign=2016_market_insight

⁹⁷ Gartner Forecast Snapshot: Prescriptive Analytics, Worldwide, 2016; 5 February 2016.

⁹⁸ Gartner, 100 Data and Analytics Predictions Through 2020 Published: 24 March 2016 ID: G00301430 Analyst(s): Douglas Laney | Ankush Jain.

⁹⁹ Gartner, Gartner Identifies the Top 10 Strategic Technology Trends for 2015 (Press Release), <http://www.gartner.com/newsroom/id/2867917>

¹⁰⁰ Gartner (2015). Hype Cycle for Emerging Technologies, 2015, <https://www.gartner.com/doc/3100227>

Data Analytics	
	Analytics are also placed within the Gartner’s Hype Cycle for the Internet of Things, 2015 ¹⁰¹ . Analytics is further considered in IEEE CS 2022 Report as one of the 23 potential technologies that could change the landscape of computer science and industry by the year 2022 ¹⁰² .

10.2 Impact Assessment

Data Analytics	
Identifier	TE#8
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Analysis of unstructured data types. • Greater and faster insights. • Faster and better decision making. • Competitive advantage. • Better customer service. • Enabling anticipation of business opportunities. • High ROI if implemented successfully. 	<ul style="list-style-type: none"> • Potential of high initial investment. • Special computer power required (particularly for big data). • New way of working within an organisation required to leverage real-time insights. • Biases, imperfect data (incomplete, inaccurate, of variable quality and format).
Opportunities	Threats
<ul style="list-style-type: none"> • Better citizen service. • Rapid understanding of citizens, applicants and providers across multiple programs, cases and locations. • Benefit eligibility determination and fraud determent. • Improved risk management and resource optimization. 	<ul style="list-style-type: none"> • Data management and access to talent can be problematic. • Structure around coordination and alignment of the use of data analytics is needed, as typically analytics is managed by a variety of executive roles and can benefit a wide range of functions.
Relevant Needs	<p>Individuals’ needs:</p> <ul style="list-style-type: none"> • Inclusive well-being and health <p>Businesses’ needs:</p> <ul style="list-style-type: none"> • Easy access to public sector information (open data). <p>Governments’ needs:</p> <ul style="list-style-type: none"> • Accessible Public Sector information
Potential uses / applications/ services	<ul style="list-style-type: none"> • Public services’ usage analytics. • Report generation.

¹⁰¹ Gartner (2015). Hype Cycle for the Internet of Things, 2015, <https://www.gartner.com/doc/3098434>

¹⁰² IEEE, IEEE CS 2022 Report, <https://www.computer.org/cms/Computer.org/ComputingNow/2022Report.pdf#page=5>

Data Analytics	
	<ul style="list-style-type: none"> • Citizen information repository with shared access by multiple government organisations (while adhering to privacy restrictions). • Predictive analytical framework to identify crime "hot spots", based on historical and real-time crime data, to efficiently allocate resources and reduce crime. • What if scenarios analysis. • Policy making, but also public sector management based on data analytics. • Predictive Analytics (pattern analysis to predict future developments or behaviour (e.g. of consumer)).
Existing solutions / products / services	<ul style="list-style-type: none"> • data analytics for financial markets (banking) • Betting firms use big data analytics • Big data analytics for insurance companies • Data analytics for selling fast moving consumer goods • Data Analytics for Social Networks (e.g. Topic Detection) • Data Analytics for Smart Cities • Watson Analytics, guided and automated analytics from the cloud¹⁰³ • ForecastThis: automated predictive modelling solutions¹⁰⁴ • Natero Customer Success platform that predicts churn and up-sell opportunities¹⁰⁵ • Wise machine Learning for Customer Success¹⁰⁶

11 Digitalization

11.1 Analysis

Digitalization	
Identifier	TT#3
Type	Trend, based on the advancements of digital technologies
Description	

¹⁰³ <https://www.ibm.com/analytics/watson-analytics/us-en/>

¹⁰⁴ <http://www.forecastthis.com/>

¹⁰⁵ <https://www.natero.com/>

¹⁰⁶ <http://www.wise.io/>

Digitalization	
<p><i>Digitalization</i> is the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business¹⁰⁷.</p> <p>Digitalization is a sub-process of a much larger technological progress, involving digitization (the conversion), digitalization (the process) and digital transformation (the effect) that are collectively accelerating the global and societal transformation process. In this context, digitization represents the conversion of analog information into digital form that can be understood by computer systems or electronic devices, digitalization corresponds the process of the technologically-induced change, whereas digital transformation is described as the total and overall societal effect of digitalization¹⁰⁸. In a narrower sense, digitalization as well as digital transformation may refer to the concept of "going paperless".</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Administrative processes • Research processes • Manufacturing processes
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • The 2016 CIO Agenda Survey data shows that digitalization is intensifying. In the next five years, CIOs expect digital revenues to grow from 16% to 37%. Similarly, public-sector CIOs predict a rise from 42% to 77% in digital processes¹⁰⁹.
Related Terms	<ul style="list-style-type: none"> • Digitization • Digital transformation • Paperless state
Source(s) of Documentation	<ul style="list-style-type: none"> • According to IDC, Digitalization is one of the 10 most needed CIO trends for 2015¹¹⁰. • <i>Interviews and focus groups</i>

11.2 Impact Assessment

Digitalization	
Identifier	TT#3

¹⁰⁷ Gartner IT Glossary – Digitalization, <http://www.gartner.com/it-glossary/digitalization/>

¹⁰⁸ Wikipedia – Digital transformation, https://en.wikipedia.org/wiki/Digital_transformation

¹⁰⁹ Gartner, (Gartner Executive Programs) Building the Digital Platform: Insights From the 2016 Gartner CIO Agenda Report, https://www.gartner.com/imagesrv/cio/pdf/cio_agenda_insights_2016.pdf

¹¹⁰ ComputerWoche, Die wichtigsten IT-Trends 2015 von IDC, <http://www.computerwoche.de/a/die-wichtigsten-it-trends-2015-von-idc,3090179>

Digitalization	
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Offering more communication and transaction channels. • Convenience – enabling access through a digital device. • Flexibility in manipulating information. • Innovation. • Scalability. • Speed of doing business. 	<ul style="list-style-type: none"> • High initial investment and maintenance costs. • Availability of digital equipment (e.g. computer) needed. • Digital literacy and competence needed both in the backoffice and in the front desk.
Opportunities	Threats
<ul style="list-style-type: none"> • Digitalisation of public services. • Use of electronic files and electronic records. • Citizens’ demand for digital processes. • 24/7 services availability. • Increased system interoperability. • Information and service reuse • Economies of scale enabled. 	<ul style="list-style-type: none"> • Changes required in both processes and IT systems of the public sector. • Digital illiteracy of public sector employees, citizens. • Resistance to change. • Security and Vulnerability threats.
Relevant Needs	<p>Individuals’ needs:</p> <ul style="list-style-type: none"> • Transparent and participative access to public sector services • Connected and integrated Europe <p>Businesses’ needs:</p> <ul style="list-style-type: none"> • Ease of doing business • Easy access to public sector information (open data) • Access to a unified European market <p>Governments’ needs:</p> <ul style="list-style-type: none"> • Digitization • Accessible public sector information
Potential uses / applications/ services	<ul style="list-style-type: none"> • Online citizens accounts – common source database of relevant citizens’ documents (applications, certificates, IDs, etc.). • Full scale eGovernment • Make available state archives in a linked open data format.
Existing solutions / products / services	<ul style="list-style-type: none"> • STORK project¹¹¹ • PAE (Portal Administracion electronica)¹¹² • Cita Previa de Atención Primaria (online medical appointment)¹¹³ • Agencia Tributaria¹¹⁴

¹¹¹ <https://www.eid-stork.eu/>

¹¹² <https://administracionelectronica.gob.es>

¹¹³ <https://www.citaprevia.saludmadrid.org/Forms/Acceso.aspx>

12 e-Identities

12.1 Analysis

e-Identities	
Identifier	TE#9
Type	Technology, based on smart cards, RFID and recently biometrics.
Description	
<p>An <i>e-Identity</i> or <i>Electronic Identity</i> is a means for people to prove electronically that they are who they say they are and thus gain access to benefits or services provided by government authorities, banks or other companies¹¹⁵.</p> <p>One form of Electronic Identification (eID) is an electronic identification card (eIC), which is a physical identity card that can be used for online and offline personal identification or authentication. The eIC is a smartcard in ID-1 format of a regular bank card, with identity information printed on the surface (such as personal details and a photograph) and in an embedded RFID microchip, similar to that in biometric passports. The chip stores the information printed on the card (such as the holder's name and date of birth) and the holder's biometric photo. It may also store the holder's fingerprints. The card may be used for online authentication, such as for age verification or for e-government applications. An electronic signature, provided by a private company, may also be stored on the chip. Apart from online authentication, an eIC may also provide users the option to sign electronic documents with a digital signature (e-signature)¹¹⁶.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Financial Sector (Banking and Financial Transactions) • Military and Defence (Access and Control) • Business Sector (Access and Control) • E-Government (Access and Control)
Related Market Potential/Forecasted Growth	<p>According to "The Global National eID Industry Report: 2014 Edition" by Acuity¹¹⁷:</p> <ul style="list-style-type: none"> • 127 countries will implement National eID programs by 2018 issuing more than 740 million eIDs annually while generating more than \$55 bn in revenue from 2013 to 2018. • By 2018, the number of National eID issuing countries will exceed those issuing traditional National IDs by a ratio of more than 5 to 1. This rapid acceleration in the deployment of National eIDs means that by the end of

¹¹⁴ <https://www.agenciatributaria.gob.es/>

¹¹⁵ European Commission, Electronic Identities – a brief introduction, http://ec.europa.eu/information_society/activities/ict_psp/documents/eid_introduction.pdf

¹¹⁶ https://en.wikipedia.org/wiki/Electronic_identification

¹¹⁷ Acuity Market Intelligence, The Global National eID Industry Report: 2014 Edition, http://www.acuity-mi.com/GNeID_Report.php#sthash.BLADol5k.dpuf

e-Identities	
	<p>2018, 84% of all National IDs issued will be eIDs and that there will be nearly 3.5 bn National eIDs in circulation.</p> <ul style="list-style-type: none"> Shipments of electronic government (e-government) credentials – including e-passports, e-identity cards, e-health cards and e-driving licenses and others are projected to reach 1 bn in 2020, nearly doubling 2015 volume¹¹⁸. The global market for Personal ID credentials was valued at \$5.3 bn in 2009, and is forecast to reach \$9.1 bn by 2019. This increase equals a global compound annual growth rate (CAGR) over the 10 years of 5.6%, with a CAGR of 2.6% for the period 2014-19 as investments shift to digital identity¹¹⁹.
Related Terms	<ul style="list-style-type: none"> Electronic Identity Electronic Identification (eID)
Source(s) of Documentation	<ul style="list-style-type: none"> eID especially as a means of citizen’s identification towards the Public Sector is identified as one of the key top-10 technology strategies.¹²⁰. <i>Interviews</i>

12.2 Impact Assessment

e-Identities	
Identifier	TE#9
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> Supporting e-services and customized service-delivery. Improving security in terms of accountability (establishing a direct trusted link between a person and an action within an application or website). Increasing administrative efficiency and reducing cost (deployment of fully transactional systems, diminishing 	<ul style="list-style-type: none"> High costs of the eID infrastructure itself and organisational costs (card issuance and cardholder enrolment).

¹¹⁸ HIS Markit, Don Tait (SeptemberSeptember 27, 2016). Shipments of cards for eGovernment to reach 1 billion units in 2020, <https://technology.ihs.com/583936/shipments-of-cards-for-egovernment-to-reach-1-billion-units-in-2020>

¹¹⁹ Smithers Pira, The Future of Personal ID to 2019, <http://www.smitherspira.com/industry-market-reports/security/personal-id/personal-identification-information-2019>

¹²⁰ Gartner, Gartner Highlights Top 10 Strategic Technologies for Government in 2016, <http://www.gartner.com/newsroom/id/3360317>

e-Identities	
<p>manual/repetitive work and interactions.</p> <ul style="list-style-type: none"> • Reducing burden for citizens when engaging with the public administration. • Limiting possibilities for fraud, identity theft and phishing. • Supporting mutual recognition of documents and certificates in cross-border situations. • Facilitating mobility. 	
Opportunities	Threats
<ul style="list-style-type: none"> • Faster Access to Services • Global Identification Services for all organisations • Potentially improving national security. • Building a more inclusive European society (a seamless use of eID should offer EU wide service provision). • Stimulating the introduction of new e-services and generating economies of scale, as eID is part of an 'infrastructural approach'. 	<ul style="list-style-type: none"> • Privacy concerns for end users. • Interoperability challenges (multiple identity schemes applied on a per-sector/per-country basis – multitude of standards used and lack of a commonly accepted one. • Legal difficulties (different legal frameworks on a per-country basis) in case of a cross-country infrastructure. • High costs for securing identity registries
Relevant Needs	<p>Individual's needs:</p> <ul style="list-style-type: none"> • Transparent and participative access to public sector services <p>Businesses' needs:</p> <ul style="list-style-type: none"> • Streamlined and reliable administrative procedures in the Public Sector • Lessen complexity • Technology implementation • Easy access to public sector information (open data). <p>Governments' needs:</p> <ul style="list-style-type: none"> • Participative democracy • Accessible public sector information
Potential uses / applications/ services	<ul style="list-style-type: none"> • e-Identities for citizens (also for refugees and migrants). • Pan-European electronic-identity authentication system. • Use digital IDs in European processes.
Existing solutions / products / services	<ul style="list-style-type: none"> • Electronic identity cards in many European Countries (e.g. in Estonia for logging into bank accounts, as pre-paid public transport ticket, for digital signatures, for i-voting, for assessing government databases to check medical records, taxes, for picking up e-prescriptions)¹²¹

¹²¹ „ Electronic ID Card“, <https://e-estonia.com/component/electronic-id-card/>

13 e-Participation

13.1 Analysis

e-Participation	
Identifier	TT#4
Type	Trend, based on the developments in CSCW (Computer Supported Cooperative Work) and groupware, e-democracy and e-government. It can be considered as part of e-democracy.
Description	
<p><i>e-Participation</i> refers to the ICT supported participation in processes involved in government and governance. Such processes may concern administration, service delivery, decision making and policy making. E-Participation is hence closely related to e-government and e-governance participation. According to a more detailed definition, e-participation is the use of ICT to broaden and deepen political participation by enabling citizens to connect with one another and with their elected representatives¹²².</p> <p>E-Participation involves complex processes, as a result of the large number of different participation areas, involved stakeholders, levels of engagement, and stages in policy making, which characterize the research and applications¹²³.</p>	
Mainstream Domains of Application	Human ICT-mediated interaction, both work-related and social (supported by the use of CSCW and groupware)
Related Market Potential/Forecasted Growth	<p>According to the UN e-Government Survey 2016¹²⁴:</p> <ul style="list-style-type: none"> • E-decision making, the most challenging aspect of public participation, rose substantially among the top 25 countries in EPI, from 36% in 2014 to 62% in 2016. • E-consultation has seen remarkable growth in 2016 topping 91% from 73% in 2014.
Related Terms	<ul style="list-style-type: none"> • e-Democracy • e-Consultations • e-Voting • e-Petitioning

¹²² Macintosh, A. (2004), "Characterizing E-Participation in Policy-Making", In the Proceedings of the Thirty-Seventh Annual Hawaii International Conference on System Sciences (HICSS-37), January 5 – 8, 2004, Big Island, Hawaii.

¹²³ Wikipedia – e-Participation, https://en.wikipedia.org/wiki/E-participation#cite_note-1

¹²⁴ United Nations, UN E-Government Survey 2016, <https://publicadministration.un.org/egovkb/en-us/Reports/UN-E-Government-Survey-2016>

e-Participation	
Source(s) of Documentation	<i>Interviews and focus groups</i>

13.2 Impact Assessment

e-Participation	
Identifier	TT#4
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> Active citizenship. Engagement and empowerment of people with mobility problems. Enhanced transparency and increased acceptance of political decisions (e.g. with regard to planning processes, cost savings, etc.). Reducing democratic deficit. 	<ul style="list-style-type: none"> Internet access and familiarity with e-participation technologies as prerequisites. Lack of participants' identification. Resolutions often not considered seriously by decision makers
Opportunities	Threats
<ul style="list-style-type: none"> Alternative forms of engagement and (young) people's disengagement in 'traditional' politics. Non discrimination of participants Technological advancements in ICTs, which make traditional democratic institutions look sluggish, irresponsive and 'outdated'. 	<ul style="list-style-type: none"> Digital divide (both in terms of digital infrastructure and in terms of citizens' experience with e-participation). Manipulation by organised groups (especially in small scale applications). Online propaganda. If not properly addressed, e-participation can be frustrating for the citizenship.
Relevant Needs	<p>Individuals' needs:</p> <ul style="list-style-type: none"> Transparent and participative access to public sector services Connected and integrated Europe <p>Businesses' needs:</p> <ul style="list-style-type: none"> Agile and participative public sector Stimulate an entrepreneurial culture <p>Governments' needs:</p> <ul style="list-style-type: none"> Participative democracy Civil servants as a community of change
Potential uses / applications/ services	<ul style="list-style-type: none"> Cross Boarder/National/Regional/Local Community resolutions Active dialogue e-voting Participatory Budgeting

e-Participation	
Existing solutions / products / services	<ul style="list-style-type: none"> • Agora Voting¹²⁵ • OpenKratio¹²⁶ • VTaiwan¹²⁷ • Policy Compass¹²⁸ • Sirvo A Mi Pais¹²⁹

14 e-Signatures

14.1 Analysis

e-Signatures	
Identifier	TE#10
Type	Technology, based on encryption or biometrics technology.
Description	
<p>An <i>e-Signature</i> or Electronic Signature refers to data in electronic form, which is logically associated with other data in electronic form and which is used by a signatory party to sign a data document¹³⁰. Such data may be a traceable e-mail or a biometric data structure, which may be based on digitized handwriting (i.e. handwriting that is converted by cryptography into a digital signature) or some other biometric characteristic (e.g. a fingerprint that can be combined with a hash or digest of the message to show the signer's intent)¹³¹. This type of signature provides the same legal standing as a handwritten signature as long as it adheres to the requirements of the specific regulation it was created under (e.g., eIDAS in the European Union, NIST-DSS in the USA or ZertES in Switzerland)¹³². The electronic signature cannot be removed and applied to other documents to forge a signature.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Military and Defence • E-Commerce • E-Government

¹²⁵ <https://agoravoting.com/>

¹²⁶ <http://openkratio.org/open-government/>

¹²⁷ <https://vtaiwan.tw>

¹²⁸ <https://policycompass.eu/app/#/>

¹²⁹ <https://www.sirvoamipais.gov.co/>

¹³⁰ Dawn Turner, "What is a Digital Signature - What It Does, How It Works". Cryptomathic, <https://www.cryptomathic.com/news-events/blog/what-is-a-digital-signature-what-it-does-how-it-works>

¹³¹ Gartner IT Glossary - Electronic Signature (e-Signature), <http://www.gartner.com/it-glossary/electronic-signature>

¹³² Wikipedia - Electronic signature, https://en.wikipedia.org/wiki/Electronic_signature#cite_note-Cryptomathic_WHATISADIGITALSIGNATURE-1

e-Signatures	
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • The global e-signature market is expected to grow at a CAGR of 39.2% in terms of value during 2016-2020¹³³. • The global digital signature market is expected to increase from \$501.7 million in 2015, and reach \$3,318.6 million by 2022, growing at a CAGR of 31.5%¹³⁴. • The digital signature market size is estimated to grow from USD 512.5 Million in 2015 to USD 2.02 bn by 2020, at an estimated Compound Annual Growth Rate of (CAGR) of 31.6% from 2015 to 2020¹³⁵. • Forrester Research estimates that the electronic signature market is seeing an average annual growth rate of 53 percent, with transactions estimated to grow from 210 million in 2014 to 700 million in 2017¹³⁶.
Related Terms	<ul style="list-style-type: none"> • Electronic signature • Digital signature
Source(s) of Documentation	<i>Interviews</i>

14.2 Impact Assessment

e-Signatures	
Identifier	TE#10
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Digital authenticity (documents signed with a digital signature can stand up in court)/integrity of electronic documents. • Non-repudiation (signing an electronic document digitally identifies one as the signatory and that cannot be later denied). • Enhanced security and imposter 	<ul style="list-style-type: none"> • High costs (verification software and signing certificates from certification authorities to encrypt a file with one's digital signature are needed). • Incompatibility among different digital signature standards.

¹³³ P&S Market Research, Global E-Signature Market Size, Share, Development, Growth and Demand Forecast to 2020, <https://www.psmarketresearch.com/market-analysis/e-signature-market>

¹³⁴ P&S Market Research, Global Digital Signature Market Size, Share, Development, Growth and Demand Forecast to 2022, <https://www.psmarketresearch.com/market-analysis/digital-signature-market>

¹³⁵ Markets and markets, Digital Signature Market - Global Forecast to 2020, http://www.marketsandmarkets.com/Market-Reports/digital-signature-market-177504698.html?qclid=CjwKEAiAmdXBBRD0hZCVkYHTI20SJACWsZj9mAkD0vBWf8Kr2j3cASKIwAylYi2ZdYArPMQyePyRohoCz-Lw_wcB

¹³⁶ Geek Wire, Tricia Duryee, E-signatures are going to hit more than 700M in 2017 as consolidation gobbles up the competition, <http://www.geekwire.com/2015/e-signatures-to-hit-more-than-700m-in-2017-as-consolidation-gobbles-up-the-competition/>

e-Signatures	
<p>prevention (e-signatures cannot be forged).</p> <ul style="list-style-type: none"> • Ease of use. • Ease of tracking digitally signed documents. • Improved accuracy-reduced manual data errors. • Time-stamp inclusion. • Expansion of e-commerce. • Enhanced efficiency and speed of doing business. • Cost savings (in terms of time, printouts, stationery, postage, storage space). • Enhanced customer service. 	
Opportunities	Threats
<ul style="list-style-type: none"> • Faster completion of administrative procedures. 	<ul style="list-style-type: none"> • Trading with the help of digitally signed documents can be risky in states and countries where relevant laws are weak or non-existent. • Risk of financial loss and damage to corporate image and shareholder value in case of mishandling electronic files and signatures. • Related products may have a short shelf life.
Relevant Needs	Businesses' needs:
	<ul style="list-style-type: none"> • Streamlined and reliable administrative procedures in the Public Sector • Lessen complexity. • Technology implementation
Potential uses / applications/ services	<ul style="list-style-type: none"> • Citizen to Citizen Transactions • Business to Citizens transactions • eGovernment Services
Existing solutions / products / services	<ul style="list-style-type: none"> • DigiSigner, free e-signature service¹³⁷ • DocuSign¹³⁸ • eSignGenie¹³⁹ • Adobe Document Cloud / Adobe Sign

¹³⁷ <https://www.digisigner.com/>

¹³⁸ <https://www.docuSign.com/>

¹³⁹ <https://www.esigngenie.com/>

15 Gamification

15.1 Analysis

Gamification	
Identifier	TT#5
Type	Trend, based on the use of game mechanics.
Description	
<p><i>Gamification</i> is the use of game mechanics to drive engagement in non-game business scenarios and to change behaviours in a target audience to achieve business outcomes. Many types of games include game mechanics such as points, challenges, leaderboards, rules and incentives that make game-play enjoyable.</p> <p>Gamification applies these to motivate the audience to higher and more meaningful levels of engagement. Humans are “hard-wired” to enjoy games and have a natural tendency to interact more deeply in activities that are framed in a game construct¹⁴⁰.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Marketing • Education
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • The global gamification market is expected to grow from 1.65 bn USD in 2015 to 11.10 bn USD by 2020, at a CAGR of 46.3%, because of increasing need of gamification solutions and applications in consumer and enterprise brands¹⁴¹. • In addition, gamification will be the primary mechanism that 40% of the Global 1000 organizations will employ to improve their business operations¹⁴². • According to MarketsandMarkets, the size of the global gamification market would be 5.5 bn USD by 2018¹⁴³.
Related Terms	<ul style="list-style-type: none"> • Serious Gaming • Edutainment • Gamelearn

¹⁴⁰ Gartner IT Glossary – Gamification, <http://www.gartner.com/it-glossary/gamification-2/>

¹⁴¹ Markets and markets (2016). Gamification Market - Global Forecast to 2020, <http://www.marketsandmarkets.com/Market-Reports/gamification-market-991.html>

¹⁴² The Top Gamification Statistics And Facts For 2015 You Need To Know, <https://elearningindustry.com/top-gamification-statistics-and-facts-for-2015>

¹⁴³ pr web, Gamification Market is Estimated to Grow from USD 421.3 Million in 2013 to USD 5.502 Billion in 2018 – New Report by MarketsandMarkets, <http://www.prweb.com/releases/gamification-market/07/prweb10893419.htm>

Gamification	
Source(s) of Documentation	Gamification appears in Gartner's 2014 Hype Cycle for emerging technologies on Digital Marketing ¹⁴⁴ .

15.2 Impact Assessment

Gamification	
Identifier	TT#5
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Availability of a minimal shared language, which enables simplicity and speed in implementation by designers, facilitates widespread adoption by services and systems far away from the entertainment world and shortens the learning curve for users. • Availability of ready-to-use solutions. • Enhanced user engagement and motivation. 	<ul style="list-style-type: none"> • Unclear effects on user attitudes and behaviours. • Simplification and limitation of the game elements employed. • One-size-fits-all approach that impedes customization of the game mechanics for specific user groups. • Legal restrictions applying to gamification with regard to the use of virtual currencies and virtual assets, data privacy laws and data protection, or labour laws. • High development costs. • Target groups being mostly youngsters and those familiar with gaming. • Need for expertise in information systems, organization behaviour and human psychology.
Opportunities	Threats
<ul style="list-style-type: none"> • Changing behaviour towards better practices. • Enhance engagement of youngsters, which are politically alienated. • New marketing strategies for the public sector. • Increasing IT literacy skills of users. 	<ul style="list-style-type: none"> • Failure by poor design. • Behaviour manipulation and ethical issues – promotion of mechanical behaviours without any improvement of the user experience. • Unrealistic expectations.
Relevant Needs	<p>Individuals' needs:</p> <ul style="list-style-type: none"> • Experiential education and training <p>Businesses' needs:</p> <ul style="list-style-type: none"> • Agile and participative public sector <p>Governments' needs:</p> <ul style="list-style-type: none"> • Participative democracy • Appropriate remuneration and incentives • Employee empowerment and recognition

¹⁴⁴ Gartner (2014). Gartner's 2014 Hype Cycle for Emerging Technologies Maps the Journey to Digital Business, <http://www.gartner.com/newsroom/id/2819918>

Gamification	
	<ul style="list-style-type: none"> • Civil servants as a community of change
Potential uses / applications/ services	<ul style="list-style-type: none"> • Services supporting collaboration among teams – Provision of work incentives. • Awareness on and adoption of e-government systems. • Education and awareness raising
Existing solutions / products / services	<ul style="list-style-type: none"> • Economie.gouv.fr¹⁴⁵ • The UVA baygame¹⁴⁶ • PEPC, MISIVIAS¹⁴⁷ • Games of Social Change by Engagement Lab @ Emerson College¹⁴⁸ • MIT, Education arcade¹⁴⁹ • https://www.youtube.com/watch?v=Xw4DTcinBss • MMOWGLI Portal¹⁵⁰

16 Geographic Information Systems

16.1 Analysis

Geographic Information Systems	
Identifier	TE# 11
Type	Technology based on geographic information science (or geo-informatics).
Description	
<p>A <i>Geographic Information System (GIS)</i> is a computer system for capturing, storing, manipulating, analyzing, checking, sharing and displaying every form of geographically referenced information, often called spatial data.</p> <p>GIS can show many different kinds of data on one map, using also layers as presentation formats, enabling to more easily see, analyze and understand patterns and relationships¹⁵¹. GIS applications allow in particular to create interactive queries, analyze spatial information, edit data in maps and present the results of all these operations¹⁵².</p>	

¹⁴⁵ <http://www.economie.gouv.fr/facileco/dr-cac-serie-pedagogique-sur-leconomie>

¹⁴⁶ <http://www.virginia.edu/baygame>

¹⁴⁷ <http://www.pepco.fr/misivias.aspx>

¹⁴⁸ <https://elab.emerson.edu/projects/games-for-social-change>

¹⁴⁹ <http://education.mit.edu/>

¹⁵⁰ <https://portal.mmowgli.nps.edu/game-wiki>

¹⁵¹ Gartner IT Glossary – Geographic information system (GIS), <http://www.gartner.com/it-glossary/geographic-information-systems-gis/>

Geographic Information Systems	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Military and Defence • Engineering • Transport/logistics
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • The global geographic information system (GIS) market is expected to increase from \$7,612.9 million in 2014 to reach \$14,623.8 million by 2020, growing at a CAGR of 11.4%. Among the various industry verticals, the Government sector accounted for about 28.3% share of the global GIS market in 2014¹⁵³.
Related Terms	<ul style="list-style-type: none"> • Geographic information science • Geoinformatics • 3D based GIS
Source(s) of Documentation	<i>Interviews</i>

16.2 Impact Assessment

Geographic Information Systems	
Identifier	TE#11
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Multi-layer visualization opportunities - 3D representation of territories. • Mature and reliable technologies. • Significant number of players on the market. • Improving communication. • Facilitating and improving decision making and management with regard to specific geographic locations. 	<ul style="list-style-type: none"> • Updating and maintenance costs. • GIS accuracy depends upon source data, and how it is encoded to be data referenced. • GIS systems are not "off the shelf" solutions - they must be assembled and constructed to a user design. This could be a long, complex and costly process. • GIS require a complex command language.
Opportunities	Threats
<ul style="list-style-type: none"> • Location-enabled services for citizens, businesses and public organisations 	<ul style="list-style-type: none"> • High rate of obsolescence as GIS technology expands rapidly

¹⁵² Wikipedia – Geographic information system, https://en.wikipedia.org/wiki/Geographic_information_system

¹⁵³ PR Newswire, Global Geographic Information System (GIS) Market Expected to Grow at 11% CAGR During 2015 - 2020: P&S Market Research, <http://www.prnewswire.com/news-releases/global-geographic-information-system-gis-market-expected-to-grow-at-11-cagr-during-2015---2020-ps-market-research-567650721.html>

Geographic Information Systems	
<ul style="list-style-type: none"> • Smart urban planning. • Possibilities to integrate crowd sensing and IoT data streams. 	
Relevant Needs	<p>Individuals' needs:</p> <ul style="list-style-type: none"> • Environmental Amicability <p>Businesses' needs:</p> <ul style="list-style-type: none"> • Technology implementation • Reduce taxation levels and lessen complexity
Potential uses / applications/ services	<ul style="list-style-type: none"> • Traffic updates • Local services suggestion • Indoor localization services • Integration with cadastral and energy consumption data for tax collection and energy saving purposes.
Existing solutions / products / services	<ul style="list-style-type: none"> • Google earth¹⁵⁴ • Integrated Land and Water Information System (ILWIS) GIS and remote sensing software for both vector and raster processing by ITC Enschede (International Institute for Geo-Information Science and Earth Observation) in the Netherlands for use by its researchers and students¹⁵⁵. • System for Automated Geoscientific Analyses (SAGA GIS) a free and open-source GIS computer program, used to edit spatial data by the Department of Physical Geography, University of Göttingen, Germany¹⁵⁶.

17 Internet of Things

17.1 Analysis

Internet of Things	
Identifier	TE#12

¹⁵⁴ <https://www.google.com/earth/>

¹⁵⁵ Wikipedia - ILWIS, <https://en.wikipedia.org/wiki/ILWIS>

¹⁵⁶ https://en.wikipedia.org/wiki/SAGA_GIS

Internet of Things	
Type	Technology, based on the convergence of multiple technologies, including ubiquitous wireless communication, real-time analytics, machine learning, commodity sensors, and embedded systems and the proliferation of smart devices.
Description	
<p>The <i>Internet of Things (IoT)</i> stands for the internetworking of physical devices, vehicles (also referred to as "connected devices" or "smart devices"), buildings and other items – embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data¹⁵⁷. IoT allows objects to be sensed and/or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, smart homes, intelligent transportation and smart cities¹⁵⁸.</p> <p>The Internet of Things, Industrial Internet, and Internet of Everything will gradually morph into the <i>Internet of Anything (IoA)</i>. IoA envisions a common software "ecosystem" capable of accommodating any and all sensor inputs, system states, operating conditions, and data contexts – an overarching "Internet Operating System"¹⁵⁹.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Home automation • Logistics • Military and Defence
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • Gartner, Inc. forecasts that 6.4 bn connected things will be in use worldwide in 2016, up 30 percent from 2015, and will reach 20.8 bn by 2020. In 2016, 5.5 million new things will get connected every day. • The Internet of Things market size is estimated to grow from USD 157.05 bn in 2016 to USD 661.74 bn by 2021, at a Compound Annual Growth Rate (CAGR) of 33.3% from 2016 to 2021¹⁶⁰.

¹⁵⁷ Gartner IT Glossary – Internet of Things, <http://www.gartner.com/it-glossary/internet-of-things/>

¹⁵⁸ Wikipedia – Internet of things, https://en.wikipedia.org/wiki/Internet_of_things

¹⁵⁹ <https://www.computer.org/web/computingnow/trends/top-technology-trends-2015>

¹⁶⁰ Markets and markets, Internet of Things (IoT) Market - Global Forecast to 2021, http://www.marketsandmarkets.com/Market-Reports/internet-of-things-market-573.html?qclid=Cj0KEQIAhNnCBRCqkP6bvOjz_IwBEiQAMn_TMXu3AOASq9jmD5A8ztGP8uRSeGU50_QbKbCrwY_C9seUaAsfy8P8HAQ

Internet of Things	
Related Terms	<ul style="list-style-type: none"> • Web of Things • Cyber-physical systems • Everything Connects • Internet of Everything • Internet of Anything • Internet of Dust
Source(s) of Documentation	<p>The Internet of Things appears in Gartner’s “Top 10 Strategic Technology Trends for 2015”¹⁶¹, as well as in Gartner’s “Top 10 Strategic Technology Trends for 2016”¹⁶². It is also found in Gartner’s “Hype Cycle for Emerging Technologies, 2015”¹⁶³ (At the Peak), as well as in IEEE CS 2022 Report as one of the 23 potential technologies that could change the landscape of computer science and industry by the year 2022¹⁶⁴. IoT is further considered as one of the eight trends that are likely to disrupt businesses in the months to come¹⁶⁵.</p>

17.2 Impact Assessment

Internet of Things	
Identifier	TE#12
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Advanced connectivity of devices, systems and services beyond machine-to-machine communications. • Advanced levels of automation, control and monitoring (avoiding human intervention). • Availability of more information and better decision making. • Higher Efficiency, Safety and Comfort. • Covering a variety of protocols, domains, and applications. • Enabling advanced applications (smart grid, smart cities, etc.). • Constant and diffused territory control. 	<ul style="list-style-type: none"> • Compatibility/interoperability issues – platform fragmentation and lack of a common standard. • Complexity – more opportunities of failure/failures may have serious consequences. • Single point of vulnerability of multiple systems. • Batteries dependency. • Fewer requirements in human resources – rise of unemployment. • Creating dependence of daily life upon technology.

¹⁶¹ Gartner, Gartner Identifies the Top 10 Strategic Technology Trends for 2015 (Press Release), <http://www.gartner.com/newsroom/id/2867917>

¹⁶² Gartner, Gartner Identifies the Top 10 Strategic Technology Trends for 2016 (Press Release), <http://www.gartner.com/newsroom/id/3143521>

¹⁶³ Gartner (2015). Hype Cycle for the Internet of Things, 2015, <https://www.gartner.com/doc/3098434>

¹⁶⁴ IEEE, IEEE CS 2022 Report, <https://www.computer.org/cms/Computer.org/ComputingNow/2022Report.pdf#page=5>

¹⁶⁵ Deloitte (2016). Tech Trends 2016, <https://www2.deloitte.com/global/en/pages/technology/articles/tech-trends.html>

Internet of Things	
<ul style="list-style-type: none"> • Shorter reaction times. • Context awareness. 	
Opportunities	Threats
<ul style="list-style-type: none"> • Better Human-Machine integration for public services • Empowering Big Data • Creation of smart cities/smart buildings. • Production of context-aware products/services. • Generation of dynamic and distributed information. 	<ul style="list-style-type: none"> • Physical safety in case of private and confidential information being accessed by unauthorized intruders. • Privacy and security issues. • Issues around the ownership of data and how the latter is used.
Relevant Needs	<p>Individuals' needs:</p> <ul style="list-style-type: none"> • Inclusive well-being and health • Housing and secure shelters <p>Businesses' needs:</p> <ul style="list-style-type: none"> • Agile and participative Public Sector <p>Governments' needs:</p> <ul style="list-style-type: none"> • Digitization
Potential uses / applications/ services	<ul style="list-style-type: none"> • Use of IoT solutions for fall prevention or quick responses. • Logistics and Supply Chain Management in the public sector. • Health care applications: <ul style="list-style-type: none"> ○ remote health monitoring ○ emergency notification systems/contacting the hospital in case of emergencies ○ telemedicine ○ early detection of and warning about patients at risk • Transportation-related applications: <ul style="list-style-type: none"> ○ road condition monitoring ○ public transport vehicle monitoring system ○ inter and intra vehicular communication ○ smart traffic control, smart parking ○ connected cars (data of mobile phones to compute the density of traffic) ○ electronic toll collection systems ○ logistic and fleet management ○ vehicle control ○ safety and road assistance • Environmental and Disaster Management applications: <ul style="list-style-type: none"> ○ Energy management <ul style="list-style-type: none"> ○ Smart lighting (depending on the twilight value) ○ smart irrigation of green areas ○ Waste management - management of garbage bins (with individual

Internet of Things	
	sensors) <ul style="list-style-type: none"> ○ Forest fire detection ○ earthquake or tsunami early-warning systems ○ Monitoring and controlling operations of urban and rural infrastructures (e.g. bridges, railway tracks, on- and offshore- wind-farms, etc.)
Existing solutions / products / services	<ul style="list-style-type: none"> • Greencity solutions¹⁶⁶ • IBM Watson IoT Platform¹⁶⁷ • Marvell's EZ-Connect platform™¹⁶⁸

18 Machine Learning

18.1 Analysis

Machine Learning	
Identifier	TE#13
Type	Technology that has evolved from the study of pattern recognition and computational learning theory in artificial intelligence. It is closely related to (and often overlaps with) computational statistics, while it has strong ties to mathematical optimization, which delivers methods, theory and application domains to the field.
Description	
<p><i>Machine learning</i> is the subfield of computer science that "gives computers the ability to learn without being explicitly programmed" (Arthur Samuel, 1959)¹⁶⁹. It explores the study and construction of algorithms that can learn from and make predictions on data. Within the field of data analytics in particular, machine learning is a method used to devise complex and algorithms that lend themselves to prediction. Machine learning algorithms are composed of many technologies (such as deep learning, neural networks and natural-language processing), used in unsupervised and supervised learning that operate guided by lessons from existing information¹⁷⁰.</p> <p>Originally, targeting to achieve artificial intelligence, machine learning has shifted its focus towards tackling solvable problems of practical nature, whereas it has benefited</p>	

¹⁶⁶ <http://greencitysolutions.de/>

¹⁶⁷ <http://www.ibm.com/internet-of-things/>

¹⁶⁸ <http://www.marvell.com/solutions/internet-of-things/>

¹⁶⁹ Phil Simon (March 18, 2013). Too Big to Ignore: The Business Case for Big Data. Wiley. p. 89.

¹⁷⁰ Gartner IT Glossary – Machine Learning, <http://www.gartner.com/it-glossary/machine-learning/>

Machine Learning	
from the increasing availability of digitized information, and the possibility to distribute that via the Internet ¹⁷¹ .	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Spam filtering • Optical character recognition (OCR) • Search engines • Computer vision
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • The artificial intelligence market is estimated to grow from USD 419.7 Million in 2014 to USD 5.05 bn by 2020, at a CAGR of 53.65% from 2015 to 2020¹⁷².
Related Terms	<ul style="list-style-type: none"> • Predictive analytics • Artificial Intelligence/Machine Intelligence • Autonomic Computing • Smart Machines
Source(s) of Documentation	Smart Machines appear in Gartner's "Top 10 Strategic Technology Trends for 2015" ¹⁷³ , whereas Advanced Machine Learning appears in Gartner's "Top 10 Strategic Technology Trends for 2016" ¹⁷⁴ .

18.2 Impact Assessment

Machine Learning	
Identifier	TE#13
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Produce reliable, repeatable decisions and results. • Uncover "hidden insights" through learning from historical relationships and trends in the data. • Faster processing than the human brain. 	<ul style="list-style-type: none"> • Poor results if not investing in training • Technology not advancing in the paces expected.
Opportunities	Threats

¹⁷¹ Wikipedia-Machine learning, https://en.wikipedia.org/wiki/Machine_learning#cite_ref-arthur_samuel_machine_learning_def_1-0

¹⁷² Artificial Intelligence (AI) Market by Technology (Machine Learning, Natural Language Processing (NLP), Image Processing, and Speech Recognition), Application & Geography - Global Forecast to 2020, <http://www.marketsandmarkets.com/Market-Reports/artificial-intelligence-market-74851580.html>

¹⁷³ Gartner, Gartner Identifies the Top 10 Strategic Technology Trends for 2015 (Press Release), <http://www.gartner.com/newsroom/id/2867917>

¹⁷⁴ Gartner, Gartner Identifies the Top 10 Strategic Technology Trends for 2016 (Press Release), <http://www.gartner.com/newsroom/id/3143521>

Machine Learning	
<ul style="list-style-type: none"> • Value extraction from large volumes of data currently underexploited. • Identification of weak signals and patterns. • Intelligent Service Providers. 	<ul style="list-style-type: none"> • Machine ethics - Systems which are trained on datasets collected with biases may exhibit these biases upon use, thus digitizing cultural prejudices such as institutional racism and classism. Responsible collection of data thus is a critical part of machine learning.
Relevant Needs	Governments' needs: <ul style="list-style-type: none"> • Digitization • Recruitment, training
Potential uses / applications/ services	<ul style="list-style-type: none"> • Adaptive web sites • Text-based sentiment analysis (opinion mining) • Natural Language Processing and Speech recognition applications for enhanced customer service • Handwriting recognition • E-mail spam filtering • Recommendation systems • Fraud detection • Network intrusion detection • Machine learning systems for identification over the phone (e.g. via the pulse frequency of the caller). • Machine learning systems used in the waiting room of a general practitioner to ask the patient about his/her symptoms and suggest the doctor a first diagnose on which the doctor can agree or disagree.
Existing solutions / products / services	<ul style="list-style-type: none"> • AmazonML (Amazon Machine Learning)¹⁷⁵ • AzureML (Azure Machine Learning)¹⁷⁶ • BigML¹⁷⁷ • Google Prediction API, a Machine Learning black box for devs¹⁷⁸ • Wise, Machine Learning for Customer Success¹⁷⁹

¹⁷⁵ <http://cloudacademy.com/blog/aws-machine-learning/>

¹⁷⁶ <http://cloudacademy.com/blog/azure-machine-learning/>

¹⁷⁷ <http://cloudacademy.com/blog/bigml-machine-learning/>

¹⁷⁸ <http://cloudacademy.com/blog/google-prediction-api/>

¹⁷⁹ <http://www.wise.io/>

19 Mobile Devices

19.1 Analysis

Mobile Devices	
Identifier	TT#6
Type	With more mobile-only internet users than desktop-only users, it is a sign that digital media is evolving towards "mobile first."
Description	
<p>A <i>mobile device</i> (or handheld computer) is a small computing device, typically small enough to hold and operate in the hand and having an operating system, capable of running mobile apps. These may provide a diverse range of functions. Typically, the device will have a display screen with a small numeric or alphanumeric keyboard or a touchscreen providing a virtual keyboard and buttons (icons) on screen. Many mobile devices can connect to the internet and interconnect with other devices via Wi-Fi, Bluetooth or near field communication (NFC)¹⁸⁰.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Communications
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • According to Statista, the overall number of mobile phone users reached 4.43 bn in 2015. This number is expected to grow to 4.61 bn in 2016 and 4.77 bn in 2017. • According to StatCounter, 37% of website visits in 2015 were generated by mobile web browsers. • 87% of people always have their smartphone at their side¹⁸¹.
Related Terms	<ul style="list-style-type: none"> • Handheld computer • Mobility
Source(s) of Documentation	<i>Interviews and focus groups</i>

¹⁸⁰ Wikipedia – Mobile device, https://en.wikipedia.org/wiki/Mobile_device

¹⁸¹ Device Atlas, 16 mobile market statistics you should know in 2016, <https://deviceatlas.com/blog/16-mobile-market-statistics-you-should-know-2016>

19.2 Impact Assessment

Mobile Devices	
Identifier	TT#6
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Ease of communication. • Flexibility and dynamicity. • Portability. • Efficiency. • Support for several applications – all-in-one device. 	<ul style="list-style-type: none"> • Internet access required for certain functions. • Variable connectivity. • Hindering real human interaction. • Increasing the probability of accidents.
Opportunities	Threats
<ul style="list-style-type: none"> • Public Services reaching more people. • Increased personalisation opportunities. • Increased sensory data collection. • Enablement of novel technologies related to mobile devices (wearables, biometrics, eIDs, etc.). 	<ul style="list-style-type: none"> • Cyberattacks and security breaches. • Privacy and Personal Data. • Vendor lock-in.
Relevant Needs	<p>Individuals' needs:</p> <ul style="list-style-type: none"> • Modern workplaces <p>Businesses' needs:</p> <ul style="list-style-type: none"> • Technology implementation <p>Governments' needs:</p> <ul style="list-style-type: none"> • Digitization
Potential uses / applications/ services	<ul style="list-style-type: none"> • M-learning. • Mobile services. • Booking and payment of health services. • Reservation of doctor appointment in mobile. • Transport-related services (traffic updates, footprint monitoring)
Existing solutions / products / services	<ul style="list-style-type: none"> • https://play.google.com/store/apps/details?id=cat.gencat.mobi.conduint&hl=es • http://sem.gencat.cat/ca/061CatSalutRespon/app_mobil_061_catsalut_respon/ • PlatgesCat¹⁸² • ECIM¹⁸³ Smart Mobility API • Gov2go app (personal government assistant)¹⁸⁴. • Commercial Driver License (CDL) practice knowledge test mobile application¹⁸⁵.

¹⁸² <http://aca-web.gencat.cat/aca/platgescat/index.html>

¹⁸³ European Cloud Marketplace for Intelligent Mobility, <http://ecim-cities.eu/>

¹⁸⁴ <https://www.getgov2go.com/>

Mobile Devices	
	<ul style="list-style-type: none"> • Mobile inspections app for agencies to easily conduct inspections in the field right from a tablet¹⁸⁶ allows users in Thailand to make police reports using their phones, instead of having to locate a police station. DubaiNow, Unified Government Services App, to enable citizens transact with government services through a single platform¹⁸⁷. • Whim, Mobility-as-a-Service App, linking all transport networks in Finland and suggesting travel routes using all available means of transport¹⁸⁷. • Qlue, City Improvement and Monitoring App (Jakarta)¹⁸⁷. • Beeline, Adaptive Transport App (Singapore), allowing commuters to pre-book rides on express shuttle buses, track bus arrivals in real-time and pay for their rides through mobile¹⁸⁷. • Home Guard, Police Services App (Thailand), allowing users to make police reports using their phones, instead of having to locate a police station¹⁸⁷.

20 Natural Language Processing

20.1 Analysis

Natural Language Processing	
Identifier	TE# 14
Type	Subfield of artificial intelligence and based on the advances in machine learning.
Description	
<p><i>Natural Language Processing (NLP)</i> is a field of computer science, artificial intelligence, and computational linguistics concerned with the interactions between computers and human (natural) languages. As such, NLP is related to the area of human-computer interaction¹⁸⁸. NLP technology involves the ability to turn text or audio speech into encoded, structured information, based on an appropriate ontology¹⁸⁹.</p>	

¹⁸⁵ <http://wisconsin.gov/Pages/dmv/com-drv-vehs/cdl-how-aply/practiceapplication.aspx>

¹⁸⁶ http://www.alabama.gov/inspection_demo/

¹⁸⁷ <http://www.enterpriseinnovation.net/article/6-innovative-mobile-apps-citizens-1659286554>

¹⁸⁸ Wikipedia-Natural Language Processing, https://en.wikipedia.org/wiki/Natural_language_processing

Natural Language Processing	
<p>NLP solutions enable communication between human and machine by analysing the content written and spoken in natural human language and converting it into the machine understandable language¹⁹⁰. Individual challenges within NLP involve natural language understanding, enabling computers derive meaning from human or natural language input, natural language generation, etc.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Automatic machine translation • Human - computer interaction
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • The NLP market size is estimated to grow from 7.63 bbn USD in 2016 to 16.07 bbn USD by 2021, at a Compound Annual Growth Rate (CAGR) of 16.1%¹⁹¹.
Related Terms	<ul style="list-style-type: none"> • Natural Language Search • Natural Language Question Answering • Speech recognition / Voice and tone recognition • Speech-to-Speech Translation / Text-to-Speech Translation
Source(s) of Documentation	<p>Natural Language Processing (particularly Natural Language Question Answering) appears in Gartner's Hype Cycle for Emerging Technologies, 2015 (Sliding Into the Trough)¹⁹².</p>

20.2 Impact Assessment

Natural Language Processing	
Identifier	TE#14
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Enhanced customer experience. • Improved documentation efficiency and accuracy. • Identification of the most pertinent information from large databases. • Contextual understanding. 	<ul style="list-style-type: none"> • Domain specific ontologies required. • Language specific dictionaries required. • Difficulty to identify irony.
Opportunities	Threats

¹⁸⁹ Gartner IT Glossary – Natural Language Processing, <http://www.gartner.com/it-glossary/natural-language-processing-nlp/>

¹⁹⁰ Future Market Insights, Natural Language Processing NLP Market: Global Industry Analysis and Opportunity Assessment 2015-2025, <http://www.futuremarketinsights.com/reports/natural-language-processing-nlp-market>

¹⁹¹ Markets and markets, Natural Language Processing Market - Global Forecast to 2021, <http://www.marketsandmarkets.com/PressReleases/natural-language-processing-nlp.asp>

¹⁹² Gartner (2015). Hype Cycle for Emerging Technologies, 2015, <https://www.gartner.com/doc/3100227>

Natural Language Processing	
<ul style="list-style-type: none"> • Perspectives and perceptions identification. • Extraction of value from large volumes of data currently underexploited. • Fighting Digital Divide 	<ul style="list-style-type: none"> • Government rules and regulations hindering natural language processing solutions to be widely adapted. • Need for smart devices, web & cloud-based applications. • Privacy Considerations
Relevant Needs	Governments' needs: <ul style="list-style-type: none"> • Digitization • Rework the trust deficit
Potential uses / applications/ services	<ul style="list-style-type: none"> • Conversational interfaces / Voice interfaces • Automated online assistants (question answering) • Sentiment analysis • Native language identification
Existing solutions / products / services	<ul style="list-style-type: none"> • Clarabridge NLP¹⁹³ • RASA NLU¹⁹⁴

21 Open Data

21.1 Analysis

Open Data	
Identifier	TT#8
Type	Trend, based on the advancements of networking technologies, enabling worldwide availability and distributed process of scientific data in an open manner, making it available to everybody (but not always free to use)
Description	
<p>The trend of <i>Open Data</i> pertains to the idea that data (especially that retrieved/generated through public funding and that which is important for the greater good) should be freely available to everyone to use and republish, without major restrictions from copyright, patents or other mechanisms of control¹⁹⁵. The trend has gained popularity with the rise of the Internet and World Wide Web and, especially, with the launch of open-data government initiatives such as Data.gov and Data.gov.uk, and has many similarities with the Open Source software movement.</p>	

¹⁹³ <http://www.clarabridge.com/nlp-natural-language-processing/>

¹⁹⁴ <https://techcrunch.com/2016/12/16/nlpforeveryone/>

¹⁹⁵ Wikipedia – Open data, https://en.wikipedia.org/wiki/Open_data

Open Data	
<p>The Open Data Charter, launched by the Open Government Partnership, in October 2015, prescribes six open data principles: 1. Open by Default, 2. Timely and Comprehensive, 3. Accessible and Usable, 4. Comparable and Interoperable, 5. For Improved Governance and Citizen Engagement, 6. For Inclusive Development and Innovation¹⁹⁶.</p>	
Mainstream Domains of Application	<p>Open access to scientific data. The concept of open access to scientific data was institutionally established with the formation of the World Data Center system, to minimize the risk of data loss and to maximize data accessibility¹⁹⁷.</p>
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • For 2016, the direct market size of Open Data was expected to be 55.3 bn EUR for the EU 28+. Between 2016 and 2020, the market size will increase by 36.9%, to a value of 75.7 bn EUR in 2020, including inflation corrections. For the period 2016-2020, the cumulative direct market size is estimated at 325 bn EUR. • In 2016, there were 75,000 Open Data jobs within the EU 28+ private sector. By 2020, this number will increase to just under 100,000 Open Data jobs. • The accumulated cost savings for public administrations for the EU28+ in 2020 are forecasted to equal 1.7 bn EUR¹⁹⁸. • Open data can help unlock \$3 trillion to \$5 trillion in economic value annually across seven sectors (Education, Transportation, Consumer products, Electricity, Oil and gas, Health care, Consumer finance)¹⁹⁹.
Related Terms	<ul style="list-style-type: none"> • Open Government Data • Open Science Data • Open Knowledge • Linked Open Data
Source(s) of Documentation	<ul style="list-style-type: none"> • <i>Interviews</i> • Gartner recognizes Open Data Governance as key to building a smart city²⁰⁰.

¹⁹⁶ Open data Charter, <http://opendatacharter.net/>

¹⁹⁷ World Data Center System (18 September 2009). "About the World Data Center System". NOAA, National Geophysical Data Center.

¹⁹⁸ European Data Portal, Benefits of Open Data, <https://www.europeandataportal.eu/en/using-data/benefits-of-open-data>

¹⁹⁹ McKinsey Global Institute - James Manyika, Michael Chui, Diana Farrell, Steve Van Kuiken, Peter Groves, and Elizabeth Almasi Doshi, (October, 2013), Open data: Unlocking innovation and performance with liquid information, <http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/open-data-unlocking-innovation-and-performance-with-liquid-information>

²⁰⁰ Open Data Governance Is Key to Building a Smart City (3, September 2015), <https://www.gartner.com/doc/3124418/open-data-governance-key-building>

21.2 Impact Assessment

Open Data	
Identifier	TT#7
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Enhanced government transparency, accountability and democratic control – Impact measurement of policies. • Enhanced public participation and engagement. • Self-empowerment/ capability to make better decisions in citizens’ life. • Improved or new private products and services. • Improved efficiency and effectiveness of government services. • Technological innovation and economic growth by enabling third parties to develop new kinds of digital applications and services. • New knowledge from combined data sources and patterns in large data volume. • Acceleration of rate of scientific discovery by better access to data. 	<ul style="list-style-type: none"> • No well-defined standards. • Lack of data validation mechanisms regarding their veracity and completeness. • Collecting, 'cleaning', managing and disseminating data are typically labour- and/or cost-intensive processes. • Additional processing is often needed by targeted end-users (analysis, apps, etc.). • Little incentives to invest in the processing required to make data useful.
Opportunities	Threats
<ul style="list-style-type: none"> • Promote birth of open data driven business ventures. • Stimulate interagency benchmarking and learning. • Enable an evidence-based approach to policy making. • Allow open and citizen-driven innovation. • Generation of new business services around open data. 	<ul style="list-style-type: none"> • Further advantage already privileged groups (e.g. a small elite of technical specialists or those who can afford to employ open data) -Increase the digital divide and social inequality, unless approached right. • Concern that open data will be misinterpreted, if analysed without the input of the researchers who collected the data. • Potential of open data misuse.
Relevant Needs	<p>Individuals’ needs:</p> <ul style="list-style-type: none"> • Transparent and participative access to public sector services • Environmental amicability <p>Businesses’ needs:</p> <ul style="list-style-type: none"> • Stimulate entrepreneurial and start-up culture • Easy access to public sector information <p>Governments’ needs:</p> <ul style="list-style-type: none"> • Lean bureaucracy • Digitization • Rework the trust deficit • Participative democracy

Open Data	
	<ul style="list-style-type: none"> • Accessible public sector information
Potential uses / applications/ services	<ul style="list-style-type: none"> • Open data portals • Open Health Records • Public Transport Data • Geospatial data and services • Financial Data Services
Existing solutions / products / services	<ul style="list-style-type: none"> • EU Open Data Portal, http://data.europa.eu/euodp/en/data • Public Data portal, http://publicdata.eu/ • Policy Compass Portal, http://www.policycompass.eu • WatchUK, CitaDel, Public Contracts http://public-contracts.nexacenter.org/, Open Coesione²⁰¹ (to monitor how EU money is spent) http://www.opencoesione.gov.it/ , Visual OPML²⁰² (to make available employment data through innovative interfaces) • RES (Research and Education Space) project to improve access to public archives for use in education²⁰³. • 3cixty initiative of the Innovation Action Line Digital Cities, a powerful platform of websites and apps that helps compare and combine information about events, places and transport in a one stop shopping window²⁰⁴. • Good Basic Data for Everyone” initiative in Denmark²⁰⁵ • Publicspending.net²⁰⁶

22 Open Government

22.1 Analysis

Open Government	
Identifier	TT#7

²⁰¹ <http://www.opencoesione.gov.it/>

²⁰² <http://visual.opmltorino.it/>

²⁰³ <https://bbcarchdev.github.io/res/>

²⁰⁴ <http://www.eitdigital.eu/conference/exhibition/3cixty/>

²⁰⁵ http://www.eurogeographics.org/sites/default/files/BasicData_UK_web_2012%2010%2008.pdf

²⁰⁶ <http://publicspending.net/greece/home>

Open Government	
Type	Trend – the origins of open government arguments can be dated to the time of the European Enlightenment and debates about the proper construction of a then nascent democratic society.
Description	
<p><i>Open Government</i> stands for the governing doctrine which holds that citizens have the right to access the documents and proceedings of the government to allow for effective public scrutiny and oversight. In its recent development, it holds ties with the theory of open source governance, which advocates the application of the free software movement to democratic principles, enabling interested citizens to get more directly involved in the legislative process.</p> <p>Overall, Open Government is widely seen to be a key hallmark of contemporary democratic practice and is often linked to the passing of freedom of information legislation²⁰⁷.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Freedom of the press • Freedom of information legislation
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • N/A
Related Terms	<ul style="list-style-type: none"> • Open source governance • Government 2.0 / Gov 2.0 • Participative Government
Source(s) of Documentation	<ul style="list-style-type: none"> • <i>Interviews and focus groups</i> • E-government policies across the world dictate the adoption of Gov 2.0 principles as key components of an open government. Notable examples include the <i>UK Digital Strategy</i> and the <i>EU Digital Agenda</i>. The <i>2009 US Open Government Directive</i> identifies "transparency, participation, and collaboration" as the key principles of an open government, and requires US agencies to, among other things, publish government information online, release high-value datasets in open formats on Data.gov, and create an Open Government website.

²⁰⁷ Wikipedia – Open Government, https://en.wikipedia.org/wiki/Open_government

22.2 Impact Assessment

Open Government	
Identifier	TT#8
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Transparency and accountability of governance. • Citizens' engagement. • Reduced incidents of government corruption, bribery and malfeasance. • Wider access to information. 	<ul style="list-style-type: none"> • Organisational and legal reforms needed. • High costs for maintenance • No well-defined business model for exploitation
Opportunities	Threats
<ul style="list-style-type: none"> • Offering the means for private companies, civil society, government organisations and crucially individuals to self-organise and create value. • Novel ways for access to public information. • Entrepreneurship support. • Transparency enhancement. • New business models for Public Sector. 	<ul style="list-style-type: none"> • Technical and financial challenges. • Concerns on citizens' privacy. • Data prone to misinterpretation and manipulation.
Relevant Needs	<p>Businesses' needs:</p> <ul style="list-style-type: none"> • Easy access to Public Sector information (open data) <p>Governments' needs:</p> <ul style="list-style-type: none"> • Civil servants as a community of change
Potential uses / applications/ services	<ul style="list-style-type: none"> • Access to procurement and financial data • Cross country data analysis • Fiscal management • Transport and Traffic data • Cultural and Education Services • Smart City Applications
Existing solutions / products / services	<ul style="list-style-type: none"> • European Data Portal²⁰⁸ • Portal de la transparencia (Gobierno de Espana)²⁰⁹ • CKAN²¹⁰ • Policy Compass²¹¹

²⁰⁸ <https://www.europeandataportal.eu/>

²⁰⁹ <http://transparencia.gob.es/>

²¹⁰ <http://ckan.org>

²¹¹ <http://www.policycompass.eu>

23 (Service) Personalization

23.1 Analysis

Personalization	
Identifier	TT#9
Type	Trend, based on the continuous effort of software to adapt to the needs of its users and accommodate their most important needs, taking advantage of various personal data and preferences which are shared by individuals publicly in the Web2.0 or privately with the software system application.
Description	
<p>Personalization, sometimes also referred to as advanced, user-centric customization, consists of tailoring a service or a product to accommodate specific individuals, sometimes tied to groups or segments of individuals, taking in most of the cases also the context in mind as well. A wide variety of organizations use personalization to improve customer satisfaction, digital sales conversion, marketing results, branding, and improved website metrics as well as for advertising. Personalization is a key element in social media and recommender systems²¹².</p> <p>In the public sector, personalization goes hand in hand with the provision of public services to citizens and businesses at the ultimate level of automation (Level #5 - Personalized Transaction)²¹³, where eGovernment systems are in a position to pre-fill fields of the service applications, as well as to recommend and suggest services which are of need to the applicant, based on various criteria and possible life events.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Web personalization • Customer satisfaction • Advertising • Marketing • Branding • Sales
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • N/A for services personalization, however market surveys suggest that personalization is a key driver in retail.
Related Terms	<ul style="list-style-type: none"> • Customization • Mass personalization • Adaptive hypermedia

²¹² Wikipedia – Personalization, <https://en.wikipedia.org/wiki/Personalization>

²¹³ Koussouris, S.; Tsitsanis, A.; Gionis, G.; Psarras, J. (2010). Designing Generic Municipal Services Process Models towards eGovernment Interoperability Infrastructures

Personalization	
Source(s) of Documentation	<i>Interviews</i>

23.2 Impact Assessment

Personalization	
Identifier	TT#9
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> Offering a better customer experience/Improving customer satisfaction. Improving customer/user retention. Enabling time and money savings for the user – preventing redundant work. Providing more targeted (filtered) information. 	<ul style="list-style-type: none"> Higher cost. Anonymity may be preferred. Lack of relevance. Can create a “filter bubble” that prevents people from encountering a diversity of viewpoints beyond their own.
Opportunities	Threats
<ul style="list-style-type: none"> Improving the effectiveness of public services. Reducing errors. Enabling time and money savings for citizens. Linking life events and real-time needs with services Potential of using data from a user’s personal social graph. Fighting digital divide. 	<ul style="list-style-type: none"> Increasing system complexity. Increasing service provisioning costs. High Privacy and Ethical concerns.
Relevant Needs	<p>Individuals’ needs:</p> <ul style="list-style-type: none"> Inclusive well-being and health <p>Businesses’ needs</p> <ul style="list-style-type: none"> Lessen complexity Stimulate entrepreneurial & start-up culture Technology implementation Agile and participative public sector
Potential uses / applications/ services	<ul style="list-style-type: none"> Personalized services for citizens. More targeted services to citizens. Personalized education (provide an education experience adapted to personal necessities, preferences or context information). Recommendation mechanism to assist citizens in identifying the proper applications/services for addressing a

Personalization	
	<p>specific need.</p> <ul style="list-style-type: none"> • Geolocation and personalization settings to provide the desired public service according to location and previous user behaviour. • Recommending user related public services according to user profile, occupation, marital and financial status, involving news feeds, notifications and alerts, reminders in user calendars with regard to deadlines on their obligations and rights as individual citizens and business owners. • Single sign-on access to cross-organizational services in a personalized fashion. • Consolidation of citizen data, cadastral information, etc.
Existing solutions / products / services	<ul style="list-style-type: none"> • Google Optimize 360²¹⁴ • Barilliance - Saas Personalisation for Ecommerce²¹⁵ • Rich Relevance²¹⁶ • Pureclarity - Ecommerce Personalisation²¹⁷ • Bunting Website Personalisation²¹⁸ • Personyze²¹⁹

24 Policy Making 2.0

24.1 Analysis

Policy Making 2.0	
Identifier	TT#10
Type	Trend, based on the advances of relatively new information and communication technologies in the fields of visualization, modelling, simulation, opinion mining, etc. for supporting decision making in public policies.
Description	

²¹⁴ <https://www.google.com/analytics/optimize/>

²¹⁵ <https://www.barilliance.com/website-personalization/>

²¹⁶ <http://www.richrelevance.com/>

²¹⁷ <http://www.pureclarity.com/>

²¹⁸ <https://getbunting.com/>

²¹⁹ <http://www.personyze.com/>

Policy Making 2.0	
<p><i>Policy Making 2.0</i>, refers to the set of methodologies and technological solutions, aimed at innovating policy making. Its scope goes well beyond the “policy adoption” notion typical of eParticipation, and encompasses all phases of the policy cycle. The common denominator of the wide set of methodologies and sets it encompasses (e.g. agent-based models, systems thinking, social network analysis, big data analyses, persuasive technologies, etc.) is that they use technology in order to design more effective public policies and share a common approach in taking account and dealing with the full complexity of human nature.</p> <p>Overall, Policy Making 2.0 is a new term to express in more understandable terms the somehow technical notion of “ICT for governance and policy-modeling” and allows all stakeholders to participate to the decision making process²²⁰.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Policy Making
Related Market Potential/Forecasted Growth	<p>There is no definite market for Policy Making 2.0, however the main technological building blocks of the trend show a significant increase in terms of their market. Indicatively:</p> <ul style="list-style-type: none"> • Data visualization applications market 4.12 bn USD and is expected to reach 6.99 bn USD by 2020²²¹. • Social Network Analytics are expected to grow to 5.4 bn USD by 2020 from 1.6 bn USD in 2015²²².
Related Terms	<ul style="list-style-type: none"> • Government 2.0 / Gov 2.0 • Open Government • eGovernment
Source(s) of Documentation	<i>Interviews</i>

24.2 Impact Assessment

Policy Making 2.0	
Identifier	TT#10

²²⁰ CROSSOVER project, Policy-Making 2.0 – Definition, <http://debategraph.org/Details.aspx?nid=228979>

²²¹ Mordor Intelligence (2016). Data Visualization Applications Market - Future of Decision Making - Trends, Forecasts and the Challengers (2016 - 2021)

²²² MarketsandMarkets (2016). Social Media Analytics Market by Type, Applications (Customer Segmentation & Targeting, Multichannel Campaign Management, Competitor Benchmarking, Customer Behavioral Analysis, & Marketing Measurement), Vertical, Region - Global Forecast to 2020

Policy Making 2.0	
SWOT Analysis	
Strengths <ul style="list-style-type: none"> • Enabling all stakeholders to participate in the decision/policy making process. • Citizen engagement and democratic participation. • Enabling citizens to offer a set of unique skills and competencies (as provided by participating citizens) that government cannot acquire or can do so at high cost. • Enabling governments to acquire feedback on planned or implemented policies. • Enabling the civil society to act a watchdog for government. 	Weaknesses <ul style="list-style-type: none"> • Changes in legislation needed. • High cost of implementation. • Not guaranteed participation of stakeholders involved. • Existence of bias – results and outputs may represent just a sample of the society.
Opportunities <ul style="list-style-type: none"> • More participative policy formulation. • Higher alignment between societal needs and policies implemented. • Enablement of learning processes. • Non-discriminatory participation in policy making. • Transparency support. 	Threats <ul style="list-style-type: none"> • Neglecting citizen's opinions • Manipulation of user groups and/or specific resolution by organised communities • One-Off approaches, not sustained • No clear Policy Making 2.0 strategy • High costs in data/information curation
Relevant Needs	Individuals' needs: <ul style="list-style-type: none"> • Transparent and participative access to Public Sector services • Environmental Amicability Governments' needs: <ul style="list-style-type: none"> • Rework the trust deficit
Potential uses / applications/ services	<ul style="list-style-type: none"> • Online platforms to gather feedback on citizens' experience as users of public services. • "Citizens for the citizens" platforms. • Governmental blogs, wikis, etc. • Open Simulation platforms
Existing solutions / products / services	<ul style="list-style-type: none"> • 2050 Pathways Analysis²²³ • UrbanSIM²²⁴ • GLEAM²²⁵ • C-ROADS²²⁶ • Arbeitsmarktmonitor²²⁷

²²³ <https://www.gov.uk/guidance/2050-pathways-analysis>

²²⁴ <http://www.urbansim.com>

²²⁵ <http://www.gleamviz.org>

²²⁶ <https://www.climateinteractive.org/tools/c-roads/>

²²⁷ <https://arbeitsmarktmonitor.arbeitsagentur.de>

25 Sentiment Analysis

25.1 Analysis

Sentiment Analysis	
Identifier	TT#11
Type	Trend, based on NLP, statistics, text analysis and computational linguistics, fuelled by the rise of social networks and blogs.
Description	
<p><i>Sentiment Analysis</i> (also known as <i>Opinion Mining</i>) refers to the use of natural language processing, statistics, text analysis and computational linguistics, to identify and extract subjective information in source materials. Sentiment analysis aims to determine the attitude of a speaker or a writer with respect to some topic or the overall contextual polarity of a document. The attitude may be his or her judgment or evaluation, affective state (that is to say, the emotional state of the author when writing), or the intended emotional communication (that is to say, the emotional effect the author wishes to have on the reader). In simple words, sentiment analysis is the process of computationally identifying and categorizing opinions expressed in a piece of text, especially in order to determine whether the writer's attitude towards a particular topic, product, etc. is positive, negative, or neutral^{228, 229}.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Marketing • Customer service
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • The global text analytics market has a potential to reach 6.5 bn USD by 2020, registering a CAGR of 25.2% during 2014-2020²³⁰.
Related Terms	<ul style="list-style-type: none"> • Opinion mining • Text analytics • Natural Language Processing (NLP)
Source(s) of Documentation	<i>Interviews</i>

²²⁸ The Algorithmia Guide to Sentiment Analysis, <http://developers.algorithmia.com/guides/sentiment-analysis/>

²²⁹ Wikipedia-Sentiment analysis, https://en.wikipedia.org/wiki/Sentiment_analysis

²³⁰ PR Newswire, Text Analytics Market is Expected to Reach USD 6.5 Billion by 2020 - Allied Market Research, <http://www.prnewswire.com/news-releases/text-analytics-market-is-expected-to-reach-65-billion-by-2020---allied-market-research-288040851.html>

25.2 Impact Assessment

Sentiment Analysis	
Identifier	TT#11
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Identify big picture trends with regard to a particular topic. • Filter through mass quantities of content and identify the specific content that needs attention. • Enable public relations monitoring and reputation management. • Analyse competition – set benchmarks or probe for competitor weaknesses. • Allow to determine marketing strategy, improve chances of campaign success, enhance customer service. • Predict future trends and behaviour (if accurate). 	<ul style="list-style-type: none"> • Large and relevant data sample needs to be mined (so that outliers are diluted in the aggregate) – Cannot be relied upon for small data samples. • Inaccurate results due to ignorance of context, sarcasm or irony - it is still up to humans to parse the fine nuances of human language. • Not able to analyse historical tendencies of the individual commenter. • Different features or aspects of the same issue may generate different sentiment responses. • Multiple languages support is needed in order to obtain accurate results for large sections of the world.
Opportunities	Threats
<ul style="list-style-type: none"> • Identify the citizens’ sentiment on public policies and/or public services. • Improve the quality and efficiency of public policies and/or public services. • Anticipate and (proactively) manage citizens’ complaints or forthcoming protests. • Identify behaviour patterns (e.g. corruption). 	<ul style="list-style-type: none"> • Manipulation of citizens perceptions. • “Big brother” control over society as a result of tracking citizens’ opinions. • Privacy and Ethical Issues • Online Data is not always representative of society due to digital divide
Relevant Needs	Governments’ needs:
	<ul style="list-style-type: none"> • Rework the trust deficit • Participative democracy • Civil servants as a community of change
Potential uses / applications/ services	<ul style="list-style-type: none"> • Election results prediction (identifying political sentiment in blogging, microblogging and social media posts). • Establish a taxonomy of critical keywords and combine it with organisations’ structures data, so as to allow departments to better formulate outgoing messages, target specific audiences for those messages and agilely respond to citizens’ complaints. • Combine social media posts and geo-tagged information to reveal patterns of malpractice or corruption.

Sentiment Analysis	
Existing solutions / products / services	<ul style="list-style-type: none"> • Anlzer Analytics Engine²³¹ • Alchemy API (Sentiment Analysis API)²³² • TheySay Sentiment Analysis API²³³ • Applause Mobile Sentiment Analysis²³⁴

26 Smart Workplace

26.1 Analysis

Smart Workplace	
Identifier	TT#12
Type	Trend, powered by IoT technologies, automation and collaboration solutions.
Description	
<p>A <i>Smart or High Performance Workplace</i> is a physical or virtual environment designed to make workers as effective as possible in supporting business goals and providing value. Such a workplace results from continually balancing investment in people, process, physical environment and technology, to measurably enhance the ability of workers to learn, discover, innovate, team and lead, and to achieve efficiency and financial benefit^{235, 236}.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Business sector
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • The total market size of the smart and connected offices market is expected to reach \$43.31 bn by 2020 at an estimated CAGR of 10.70% from 2014 to 2020²³⁷. • More than 50% of all IoT devices will be used in workplace by 2021²³⁸.

²³¹ <http://www.anlzer.com>

²³² <http://www.alchemyapi.com/products/alchemy/language/sentiment-analysis>

²³³ http://www.theysay.io/sentiment-analysis-api/?gclid=CjwKEAiA17LDBRDElqOGq8vR7m8SJAA1AC0_gLhQWT142TOe3trjeg21nScCv9qk9V6Jte9_VspsbBoCNMjw_wcB

²³⁴ <https://www.applause.com/mobile-analytics/>

²³⁵ Gartner IT Glossary, High Performance Workplace, <http://www.gartner.com/it-glossary/high-performance-workplace>

²³⁶ TechRepublic, Gartner Hype Cycle: Exploring the leading-edge technologies for a digital business, <http://www.techrepublic.com/article/gartner-hype-cycle-exploring-the-leading-edge-technologies-for-a-digital-business/>

²³⁷ Markets and markets, "Smart Office / Smart Workplace Market - Global Forecast to 2020", <http://www.marketsandmarkets.com/PressReleases/smart-connected-offices.asp>

Smart Workplace	
Related Terms	<ul style="list-style-type: none"> • Smart Workspace • Smart Office • Smart Workforce • Smart Collaboration • Remote Working • Internet of Things
Source(s) of Documentation	<i>Focus groups</i>

26.2 Impact Assessment

Smart Workplace	
Identifier	TT#12
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Efficiency and productivity. • Greater employee commitment. • Competitive advantage. • Higher degree of collaboration. • Multiple channels of communication. 	<ul style="list-style-type: none"> • High setup costs. • Skilled personnel/employees required.
Opportunities	Threats
<ul style="list-style-type: none"> • Better work-life balance. • Higher environmental sustainability. • Public services closer to citizens needs • Spin-Out/Off opportunities for Public Sector 	<ul style="list-style-type: none"> • Resistance to change. • Bureaucracy • Privatisation of Public Assets
Relevant Needs	<p>Individuals' needs:</p> <ul style="list-style-type: none"> • Modern workplaces • Equal employment opportunities <p>Businesses' needs</p> <ul style="list-style-type: none"> • Talent acquisitions and retention
Potential uses / applications/ services	<ul style="list-style-type: none"> • Silo-busters (tools transcending organizational boundaries to enable teams to solve problems and generate ideas across work silos). • Police-messenger similar to WhatsApp to enhance communication, data

²³⁸ Orbis Research, Global Smart Workplace Market 2016-2021 Research Study, <https://www.linkedin.com/pulse/global-smart-workplace-market-2016-2021-research-study-simone-kendle>

Smart Workplace	
	protection and privacy among police officers.
Existing solutions / products / services	<ul style="list-style-type: none"> Slack, intra-office messaging service²³⁹ iVivaCloud solution²⁴⁰

27 Social Networking

27.1 Analysis

Social Networking	
Identifier	TT#13
Type	Trend, based on Web 2.0 technologies.
Description	
<p><i>Social Networking</i> refers to act of establishing online many-to-many human connections for the purposes of sharing information with the network or subsets thereof²⁴¹, and is based on computer-mediated technologies that make up an online environment allowing the creation, consumption, promotion, distribution, discovery, and sharing of content (e.g. information, ideas, career interests and other forms of expression) via virtual communities and networks²⁴². The common features of social networking applications or social media are that they are interactive web 2.0 internet based applications, involving the creation of service-specific user profiles and leveraging user-generated content, and facilitating the development of online social networks. Essentially, social media are web-based services that allow individuals construct a public or semi-public profile within a bounded system, articulate a list of other users with whom they share a connection, and view and traverse their list of connections and those made by others within the system²⁴³.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> Internet Communication Advertising, Marketing Gaming E-commerce

²³⁹ <https://www.technologyreview.com/s/600771/10-breakthrough-technologies-2016-slack/>

²⁴⁰ <http://www.ivivacloud.com/>

²⁴¹ Gartner IT Glossary – Social networking, <http://www.gartner.com/it-glossary/social-networking/>

²⁴² Gartner IT Glossary – Social Media, <http://www.gartner.com/it-glossary/social-media/>

²⁴³ Wikipedia – Social media, https://en.wikipedia.org/wiki/Social_media

Social Networking	
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> Out of 3 bn internet users globally (nearly 45% of the world's population), 2.1 bn people have social media accounts and 1.7 bn people are active social media users²⁴⁴.
Related Terms	<ul style="list-style-type: none"> Social media Web 2.0
Source(s) of Documentation	<i>Interviews</i>

27.2 Impact Assessment

Social Networking	
Identifier	TT#13
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> Improving individuals' sense of connectedness with real and/or online communities. Effective communication (or marketing) tool for corporations, entrepreneurs, non-profit organizations, including advocacy groups and political parties and governments. Building reputation and bringing in career opportunities and monetary income. Popularity, outreach. Virality. Ease of use. Immediacy. Integration on mobile devices. 	<ul style="list-style-type: none"> Negatively impacting social skills due to the absence of face-to-face contact and interaction. Affecting mental and physical health - links found between heavy social media use and depression, sleep deprivation, addictive behaviours, etc. Becoming a factor of distraction and a way to waste time for many users. Enabling behaviours, like cyberbullying, online harassment and "trolling". Scepticism around the reliability of user-generated content. Huge debate on the ownership of the content on social media platforms. Privacy concerns - data captured without the user's knowledge or consent through electronic tracking and third party applications. Potential of data and information collected for third party use.
Opportunities	Threats
<ul style="list-style-type: none"> Higher participation opportunities. Promotion of a distributed environmental sensitivity. Personalised Services. Novel communication channels. 	<ul style="list-style-type: none"> Exclusion of people with no social media profiles or no access to web services or even technology illiterates. Citizen data being collected for law enforcement and governmental

²⁴⁴ Search Engine Journal, The Growth of Social Media v 3.0 [Infographic], <https://www.searchenginejournal.com/growth-social-media-v-3-0-infographic/155115/>

Social Networking	
<ul style="list-style-type: none"> • Online information/data sourcing opportunities. • Crowdsourcing enabler. 	<ul style="list-style-type: none"> • purposes. • Privacy and Ethics concerns.
Relevant Needs	<p>Individuals' needs:</p> <ul style="list-style-type: none"> • Transparent and participative access to Public Sector services • Environmental Amicability <p>Governments' needs:</p> <ul style="list-style-type: none"> • Rework the trust deficit
Potential uses / applications/ services	<ul style="list-style-type: none"> • Usage of social media to represent the public sector – Social media as vehicles for increased transparency of an agencies actions, e.g. use of the micro-blogging service Twitter to inform journalists and professional groups and direct them to longer updates on a government's website • Social media enhanced idea exchange platforms for local issues. • Social-media enhanced platforms enabling governments to consult citizens on policy issues. • Consultation platforms for government employees/Private networks for government employees enabling the exchange of ideas and experiences.
Existing solutions / products / services	<ul style="list-style-type: none"> • Facebook page for civil servants in the U.S.A • Digital Pioneers (Netherlands)²⁴⁵ • NASA Virtual CoLab²⁴⁶

28 Wearables

28.1 Analysis

Wearables	
Identifier	TE#15
Type	Wearable technology is an extension of ubiquitous computing. It is based on the advances of mobile, Bluetooth and wireless interfacing and networking, and in particular

²⁴⁵ <https://www.kl.nl/en/projects/digital-pioneers/>

²⁴⁶ <https://appel.nasa.gov/2008/06/01/nasa-colab-creating-a-space-for-participatory-exploration/>

Wearables	
	WPAN and WBAN specifications.
Description	
<p><i>Wearables</i> (wearable computers and interfaces) are miniature electronic devices that are designed to be worn on the body, such as a wrist-mounted screen or head mounted display, to enable mobility and hands-free/eyes-free activities²⁴⁷.</p> <p>Wearable computers are especially useful for applications that require more complex computational support, such as accelerometers or gyroscopes, than just hardware coded logic. One common feature of wearable computers is their persistence of activity. There is constant interaction between the wearable and user, so there is no need to turn the device on or off. Another feature is the ability to multi-task. When using a wearable computer, there is no need to stop what one is doing to use the device; its functionality blends seamlessly into all other user actions. These devices can be used by the wearer to act as a prosthetic. It may therefore be an extension of the user's mind or body²⁴⁸.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Sensory integration (help people see better or understand the world better) • Health care monitoring systems • Mobile devices • Military and Defence
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> • CCS Insight predicts that wearable technology market increase its volume from 123 million units in 2016 to 411 million units in 2020. This corresponds to a rise of the market value from \$14 bn in 2016 to \$34 bn in 2020²⁴⁹. • Gartner, Inc. forecasts that 274.6 million wearable electronic devices will be sold worldwide in 2016, an increase of 18.4 percent from 232.0 million units in 2015. Sales of wearable electronic devices will generate revenue of \$28.7 bn in 2016. Of that, \$11.5 bn will be from smartwatches²⁵⁰.
Related Terms	<ul style="list-style-type: none"> • Wearable technology • Wearable computers • Body-borne computers • Wearable interfaces • Wearable devices • Internet of Things

²⁴⁷ Gartner IT Glossary – Wearable Computer, <http://www.gartner.com/it-glossary/wearable-computer/>

²⁴⁸ Wikipedia - Wearable computer, https://en.wikipedia.org/wiki/Wearable_computer

²⁴⁹ Forbes, Wearable Tech Market To Be Worth USD 34 Billion By 2020, <http://www.forbes.com/sites/paullamkin/2016/02/17/wearable-tech-market-to-be-worth-34-billion-by-2020/#5b39b2f03fe3>

²⁵⁰ Gartner (2016). Gartner Says Worldwide Wearable Devices Sales to Grow 18.4 Percent in 2016 (Press Release) <http://www.gartner.com/newsroom/id/3198018>

Wearables	
Source(s) of Documentation	Wearables appear at the peak of Gartner’s “Hype Cycle for Emerging Technologies, 2015” ^{251, 252} .

28.2 Impact Assessment

Wearables	
Identifier	TE#15
SWOT Analysis	
Strengths	Weaknesses
<ul style="list-style-type: none"> • Convenience of use (hands-free). • Personal safety improvement. • Health and fitness tracking - Real-time monitoring and information provision to health providers. • Ensuring better engagement with the environment. • Endless possibilities for connectivity with other devices. 	<ul style="list-style-type: none"> • Expensive. • Not as widely accepted- • Heat and precipitation can damage wearable devices. • Power management (constrained power reserves-short battery life) and heat dissipation issues affecting the quality and trust of the devices. • Not widely accepted – awkward for some.
Opportunities	Threats
<ul style="list-style-type: none"> • Improved service personalisation • Retrieval of sensory information about individuals • Compensating disabilities or supporting elderly people in public services/buildings. • Providing info in sites of interest through VR or augmented reality. 	<ul style="list-style-type: none"> • Invading privacy of other people. • Potential misuse of private (biometric/physiological/health) data. • Risk of hacking and thus misusing wearable devices.
Relevant Needs	<p>Individuals’ needs:</p> <ul style="list-style-type: none"> • Inclusive well-being and health • Modern workplaces <p>Governments’ needs:</p> <ul style="list-style-type: none"> • Civil servants as a community of change
Potential uses / applications/ services	<ul style="list-style-type: none"> • Wrist computers • Smart watches • Digital glasses
Existing solutions / products / services	<ul style="list-style-type: none"> • VitalConnect Band Aid (wearables to check health vitals)²⁵³

²⁵¹ Gartner (2015). Hype Cycle for Emerging Technologies, 2015, <https://www.gartner.com/doc/3100227>

²⁵² Gartner (2015). Hype Cycle for the Internet of Things, 2015, <https://www.gartner.com/doc/3098434>

Wearables	
	<ul style="list-style-type: none"> • Medical Wearable Solutions Eyeforcer²⁵⁴ • Rooti Labs Limited W/Me2²⁵⁵ • Cardio family of products²⁵⁶ • Biovotion AG monitoring platform²⁵⁷

29 Virtual Reality

29.1 Analysis

Virtual Reality	
Identifier	TE#16
Type	Technology evolving from advancements in Computer Graphics, Cognitive Intelligence and Human Computer Interaction
Description	
<p><i>Virtual Reality (VR)</i> provides a computer-generated 3D environment that surrounds a user and responds to that individual's actions in a natural way²⁵⁸. It refers to computer technologies that use software to generate realistic images, sounds and other sensations (e.g. smell, vibrations, etc.) that replicate a real environment (or create an imaginary setting), and simulate a user's physical presence in this environment, by enabling the user to interact with this space and any objects depicted therein using specialized devices (e.g. display screens, projectors, goggles, headsets or head-mounted displays, gloves, etc.) VR actually brings the user into the digital world by cutting off outside stimuli. In this way user is solely focusing on the digital content²⁵⁹.</p>	
Mainstream Domains of Application	<ul style="list-style-type: none"> • Entertainment/Video games • Education & training • Engineering • Archaeology • Architecture/ Urban design

²⁵³ <http://www.vitalconnect.com/news/vital-connect-uses-band-aid-like-wearable-strip-to-monitor-your-vital-signs>

²⁵⁴ <http://medicalwearablesolutions.com/devices/>

²⁵⁵ <https://www.rootilabs.com/index.html?en#/wme2/begin?en>

²⁵⁶ <https://www.getqardio.com/about-us/>

²⁵⁷ <http://www.biovotion.com/>

²⁵⁸ Gartner IT Glossary – Virtual Reality, <http://www.gartner.com/it-glossary/vr-virtual-reality/>

²⁵⁹ Wikipedia – Virtual reality, https://en.wikipedia.org/wiki/Virtual_reality

Virtual Reality	
Related Market Potential/Forecasted Growth	<ul style="list-style-type: none"> The virtual reality market is expected to grow from USD 1.37 bn in 2015 to USD 33.90 bn by 2022, at a CAGR of 57.8% between 2016 and 2022²⁶⁰. Total revenue for VR is projected to increase from \$5.2 bn in 2016 to over \$162 bn in 2020. Software will be a notable revenue source, growing more than 200% year-over-year in 2016. Hardware shipments of VR devices alone will increase from 2.2 million in 2015 to 20 million in 2018. Furthermore, there is an excessively high demand for VR headsets, gaming, and video entertainment platforms²⁶¹. The market for immersive virtual reality systems is expected to cross 2 bn market by 2021²⁶².
Related Terms	<ul style="list-style-type: none"> Artificial reality Immersive multimedia Computer-simulated reality Human Computer Interaction Virtual Worlds
Source(s) of Documentation	Virtual Reality appears in Gartner's Hype Cycle for Emerging Technologies, 2015 (Sliding Into the Trough) ²⁶³ , whereas it is considered, according to Deloitte's Tech Trends 2016 Report, as one of the eight trends that are likely to disrupt businesses in the months to come ²⁶⁴ . It further shows up in the list of the top 9 technology trends for 2016, compiled by the IEEE Computer Society ²⁶⁵ .

29.2 Impact Assessment

Virtual Reality	
Identifier	TE#16
SWOT Analysis	

²⁶⁰ Markets and markets, "Virtual Reality Market - Global Forecast to 2022", <http://www.marketsandmarkets.com/PressReleases/ar-market.asp>

²⁶¹ Advanced MP Technology, The Growth of Virtual Reality, <http://www.advancedmp.com/the-growth-of-virtual-reality/>

²⁶² Mordor Intelligence, Immersive Virtual Reality Market - Market Potential Estimation and Possible Competitive Landscape – Forecasts, Trends and Analysis (2016 – 2021), https://www.mordorintelligence.com/industry-reports/immersive-virtual-reality-market?gclid=CjwKEAiAg5_CBRDo4o6e4o3NtG0SJAB-IatYjYO2Lc_qyKA8ZLi4mQofM0UwSEj1KTacGs6uBzptBoCIq3w_wcB

²⁶³ Gartner (2015). Hype Cycle for Emerging Technologies, 2015, <https://www.gartner.com/doc/3100227>

²⁶⁴ Deloitte (2016). Tech Trends 2016, <https://www2.deloitte.com/global/en/pages/technology/articles/tech-trends.html>

²⁶⁵ Computing Now (IEEE Computer Society), Top Technology Trends for 2016 <https://www.computer.org/web/computingnow/trends/Top-Technology-Trends-2016>

Virtual Reality	
Strengths <ul style="list-style-type: none"> • Simulating the real world – realistic scenarios • Stimulus Control and Consistency. • Immersive experience. • Convenience-remote engagement, also saving time and money. • Safe Testing and Training Environment - modelling complex task-performance behaviours, many of which carry life-or-death risks in real-world learning. • Cuing Stimuli to Support “Error-Free Learning”. • Self-Guided Exploration and Independent Practice. • Real-Time Performance Feedback. • Gaming Factors to Enhance Motivation. • Patient rehabilitation. • Innovative and enjoyable. 	Weaknesses <ul style="list-style-type: none"> • High price. • Technical challenges (e.g. platform compatibility). • Interface-related challenges (cables impeding movement, poorly designed instruments causing fatigue and an unsettling feeling of enclosure). • Prolonged use side-effects (sickness, headache, vertigo, nausea, disorientation etc.). • Individuals having a hard time deciphering what is real and what is virtual. • Faulty training results in case of poor models of the real world.
Opportunities <ul style="list-style-type: none"> • Virtual Public Sector Environments. • Public organizations employees training. • Citizen’s Training. 	Threats <ul style="list-style-type: none"> • Risk of not wide use and acceptance. • High investments costs. • Health threats.
Relevant Needs	Individuals’ needs: <ul style="list-style-type: none"> • Experiential education and training • Environmental Amicability • Modern Workplaces Businesses’ needs: <ul style="list-style-type: none"> • Talent acquisitions and retention Governments’ needs: <ul style="list-style-type: none"> • Recruitment, training (and IT Literacy) • Resource optimization
Potential uses / applications/ services	<ul style="list-style-type: none"> • Virtual tours on Museums • rescue teams training • Citizens training for crisis situations • Oculus Rift²⁶⁶
Existing solutions / products / services	

²⁶⁶ <https://www.oculus.com/>