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## Article

# Measuring digitalization: Key metrics

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## MEASURING DIGITALIZATION – KEY METRICS

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**Abstract:** The article covers an analysis of metrics used to measure digitalization activities. Five main levels are analyzed – moving from the metrics of the digital economy to society, industry, enterprise, and clients. The study is based on leading public and commercial metrics used for the evaluation of the digital progress. The similarities and differences between key performance indicators on each level are discussed, forming a set of conclusions on the scope and maturity of various measurement systems and potential improvement options.

**Keywords:** digitalization, digital metrics, digital key performance indicators (KPI), benchmarking, digital economy, digital society, digital industry, digital enterprise, digital client, digital investment.

### 1 Introduction

Widespread digitalization of organizations and their business models is one of the strongest trends reshaping the global economy of today. The drive to digitize processes is fuelled by a strong assumption of achieving higher overall organizational performance and building competitive advantages, equally important for both survival and growth (Peppard, J., 2016).

Efficiency improvements are expected across all dimensions of the profit and loss statement: revenue generation (new clients, new sales, higher cross-sell ratio, and lower churn), improved costs (automated processes, straight-through-processing, shorter processing times), and better risk management (improved scoring by using precise and timely data, less operational issues, advanced risk modeling) (Fernández-Olano, et al., 2015; Rutkowsky, et al., 2015; Gottlieb, Willmott, 2014; Desmet, et al, 2015).

According to the research of McKinsey, companies investing in digital solutions are expecting to deliver annual growth and cost efficiencies of 5–10% or more in the next 3–5 years (Catlin, et al., 2015). Digitalization benefits for the society<sup>1</sup> are highly expected by the governments.

The work of the European Commission embraces the potential offered by the digitalization as assumed in the Digital Agenda pillar of the Europe 2020 strategy (European Commission, 2016).

The Digital Agenda asks for a stronger leveraging of the potential of information and communication technology (ICT) in order to foster innovation, economic growth, and progress by focusing on:

- achieving the digital single market,
- enhancing interoperability and standards,
- strengthening online trust and security,
- promoting fast and ultra-fast Internet access for all,
- investing in research and innovation,
- promoting digital literacy, skills, and inclusion.

Positive impacts of digitalization are already seen in various industries, where digital leaders outperform their peers (Westerman, et al., 2012; World Economic Forum, 2016).

The consolidation of digitalization benefits is also clearly visible on the macroeconomic level, resulting in job creation, innovation, and economic growth (El-Darwicheet, et al., 2012), as well as increasing the efficiency of public service and administration (Deloitte Access Economics, 2015).

Expectation of benefits from digitalization sparks a plethora of investments programs in private companies (Weiss, Sachdeva, 2016; Caldo, et al., 2014) or public organizations and governments (Digital India, 2015). Flow of capital is also seen by the dy-

<sup>1</sup> The European Union aims to achieve benefits in (1) climate change, through partnerships with emitting sectors; (2) managing aging population, through eHealth and telemedicine systems and services; (3). digitization of content, through European; and (4) intelligent transport systems (European Commission, 2016).

dynamic development of venture funding, especially in the FinTech industry, where in 2015, the global investment amounted to 19.1 billion USD, with continued strong inflows in 2016 (Miller and Wong, 2016).

As appealing as it may seem, digitalization is not a sea free from navigational problems. Organizations involved in digitalization face multiple issues related mainly to the (Fernández-Olano, et al., 2015; Gottlieb and Willmott, 2014):

- 1) prioritization of investments (needs exceed available funding), and
- 2) understanding the true value of digital (measurable results and clarity of business cases).

For both issues, it is critical that for ex-ante and ex-post implementation of digital solutions, a set of metrics is developed and managed in order to evaluate the tangible (or other) benefits and assure their proper measurement. In this respect, the famous words of R. Kaplan remain very valid: “what you measure is what you get”(Kaplan and Norton, 1992). This notion is reflected in the new perspective of the Organization for Economic Co-operation and Development (OECD) on the digital economy, with a new measurement agenda and a call for new statistical

and reporting tools (OECD Publishing, 2014). OECD’s view is converted into the following goals:

- improve the measurement of investments in ICT and its link to macroeconomic performance,
- define and measure skills needed for the digital economy,
- develop metrics to monitor issues of security, privacy, and consumer protection,
- promote the measurement of ICT for social goals and the impact of the digital economy on the society,
- invest in comprehensive, high-quality data infrastructure for measuring impacts,
- build a statistical quality framework suited to exploiting the Internet as a data source.

The view of OECD as a growth-oriented entity with global reach can be easily projected downwards onto the situation of individual industries and enterprises. At the same time, digitalization measurement systems implemented by lowest-level organizations can provide valuable upward feedback, showing how atomic microeconomic results contribute to the overall macroeconomic development.

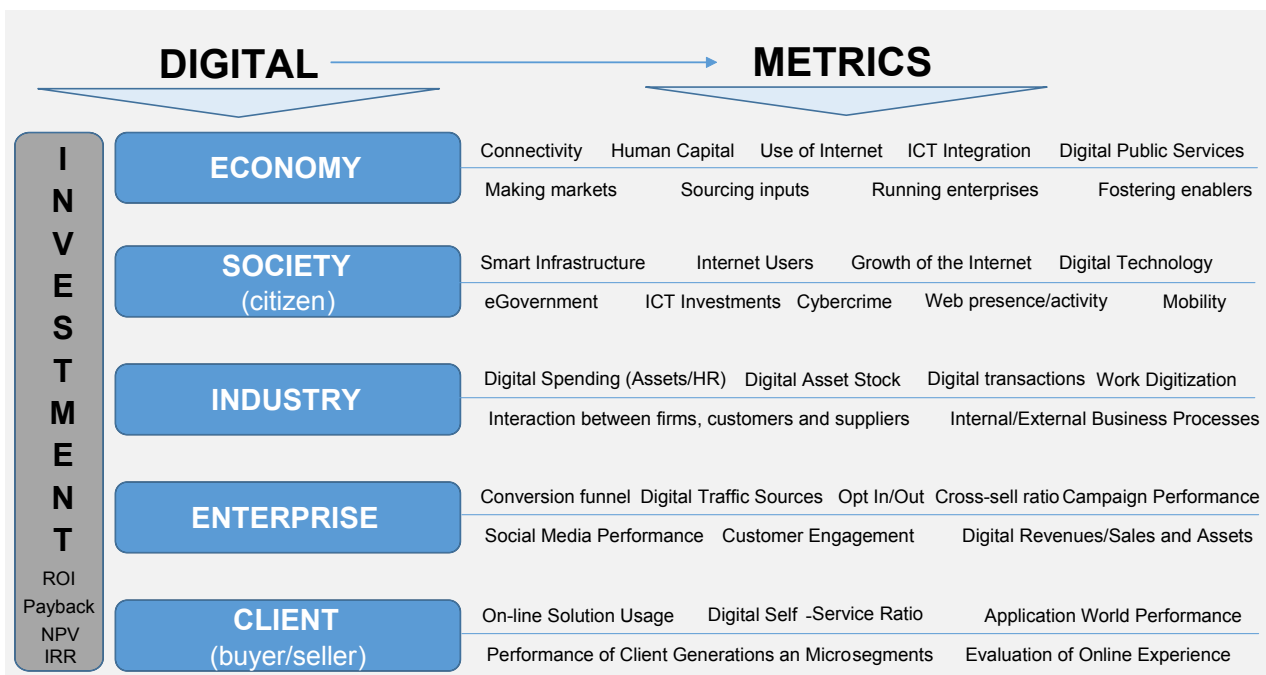


Figure 1. Digitalization dimensions and their primary metrics (source: own work)

The purpose of this article is to look at what digitalization metrics are defined and used by various participants of the economy and what lessons or improvement actions can be proposed to enhance the digitalization measurement systems. The study is based on literature sources and on-site research with selected European universal banks.

The following levels of digitalization with samples of relevant metrics are covered (Fig. 1).

## 2 Digital Economy Metrics

It is commonly viewed that the term “digital economy” was introduced by Don Tapscott in his publication: *The digital economy: promise and peril in the age of networked intelligence* (Tapscott, 1997).

The term “digital economy” describes an economic system where the usage of ICTs is widely spread, embracing the:

- 1) base infrastructure (e.g., high-speed Internet access, computing power, security services),
- 2) e-business (business models with high utilization of ICT for front- and back-office functions), and
- 3) eCommerce (usage of the ICT in business-to-business (B2B), business-to-consumer (B2C), and consumer-to-consumer (C2C) transactions).

### 2.1 Digital Density Index (DDI)

Oxford Economics and Accenture developed jointly a Digital Density Index (DDI) measuring how digital technologies impact the economic growth (Macchi, et al., 2015).

The ultimate aim of DDI is to guide further investments of both the public and business community in order to stimulate economic development. The DDI contains 50 indicators grouped into 4 activity areas and 18 groups of metrics (Table 1).

Table 1. Measurement framework of the Digital Density Index  
(source: Macchi, et al., 2015)

Activity area	Description and metrics	
1. Making markets	Increasing digitalization of existing markets and creation of new digital markets. Recognition that existing markets are becoming increasingly digital and new markets are being created through digital means.	
<i>Metrics:</i>	<ul style="list-style-type: none"> <li>• Customer activity cycle</li> <li>• Digitally contestable markets<sup>2</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Interfirm collaboration</li> </ul>
2. Sourcing inputs	Use of digital technologies to source and/or use factors of production. Degree to which digital technologies change the lifecycle of sourcing these factors for the business.	
<i>Metrics:</i>	<ul style="list-style-type: none"> <li>• Plant, property, equipment</li> <li>• Labor</li> </ul>	<ul style="list-style-type: none"> <li>• Finance (capital, liquidity)</li> </ul>
3. Running Enterprises	Business use of digital technologies and activities to execute key business functions.	
<i>Metrics:</i>	<ul style="list-style-type: none"> <li>• Technology process</li> <li>• Strategy process</li> <li>• Human capital/talent</li> </ul>	<ul style="list-style-type: none"> <li>• Business model</li> <li>• Innovation</li> <li>• Research and development (R&amp;D) spending</li> </ul>

<sup>2</sup> Contestable market is a market where new entrants face costs similar to those of established firms and where, on leaving, firms are able to recoup their capital costs, less depreciation. Consequently, it is not possible for established firms to earn above normal profit as this will be eroded by the entry of new firms, or, alternatively, the mere threat of such new entry may be sufficient to ensure that established firms set prices that yield them only a normal profit return. Collins Dictionary of Economics, 4th ed. Pass C., B. Lowes, B., Davies, L. 2005.

Table 1. Measurement framework of the Digital Density Index, cont.  
(source: Macchi, et al., 2015)

Activity area	Description and metrics	
4. Fostering enablers	Changes in institutional and socioeconomic environments to facilitate digitalization.	
<i>Metrics:</i>	<ul style="list-style-type: none"> <li>• Organizational flexibility</li> <li>• Connectivity</li> <li>• Attitudes in society</li> </ul>	<ul style="list-style-type: none"> <li>• Government spending</li> <li>• Ease of business</li> <li>• Long-term regulatory outlook</li> </ul>

The metrics are used to compose an overall score (0–100) for activity areas reflecting the digital pro-

file of a country’s economy in a benchmark view with other economies (Fig. 2):

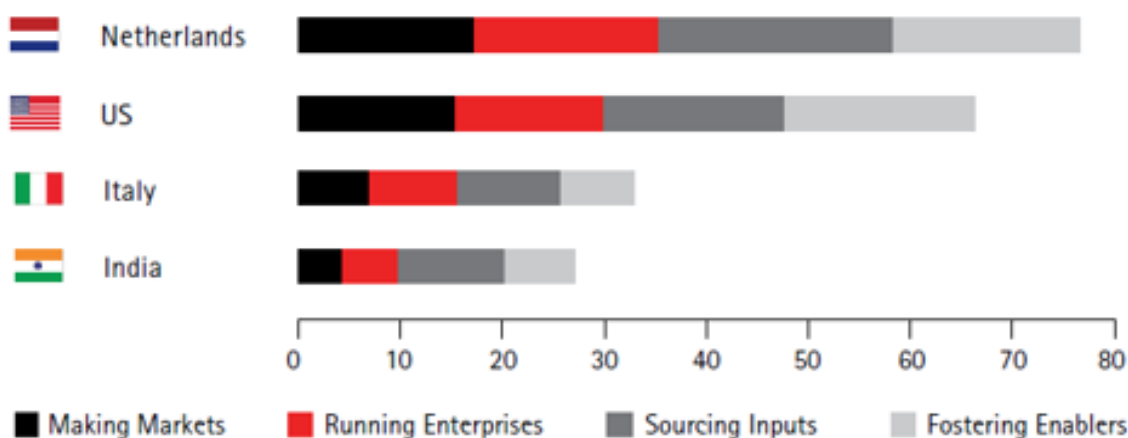


Figure 2. Sample Digital Density Score of selected economies – activity areas  
(source: Macchi, et al., 2015)

A deep dive on the country level elaborates on the country’s performance in each group of metrics. An example of the “Fostering enablers – Ease of busi-

ness” metric shows maturity levels and country performance (Fig. 3).

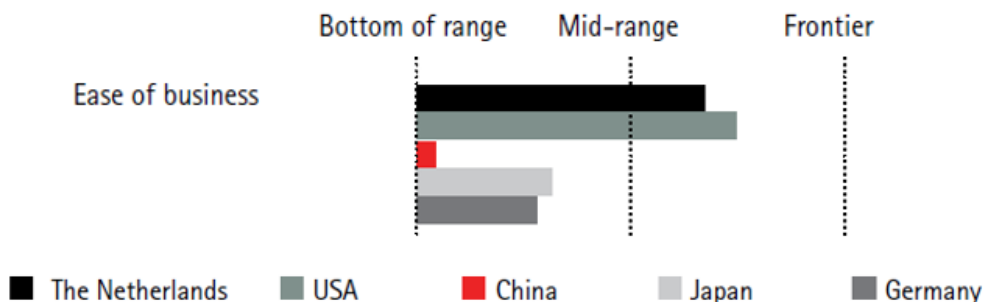


Figure 3. Digital Density Scores of selected economies: detailed metrics for the “Fostering enablers”  
(source: Macchi, et al., 2015)

## 2.2 Digital Economy and Society Index (DESI)

Within the framework of "Europe 2020 Strategy", the European Commission introduced a performance measurement system to track the evolution of the EU member states in digital competitiveness (European Commission, 2016).

The Digital Economy and Society Index (DESI) is a composite index that contains five primary measure areas (Table 2).

Both the DDI and DESI reflect an attempt to capture factors of high impact on the competitiveness of local economies in the global (or internal EU)

context. The results of the benchmarking can be used to study the best practices in use by the top performing digital economies, to be qualified for a potential reuse in other geographies.

The DDI is strongly market/economy oriented, while the DESI includes a view on both economic and social factors, such as human capital potential and usage of ICT by the population. DESI provides an important differentiation by analyzing the eGovernment as a separate category and allowing to measure the efficiency of public investment in the digitalization.

Table 2. Digital Economy and Society Index – activities and metrics  
(source: European Commission, 2016)

Activity area	Description and metrics
1. Connectivity	<ul style="list-style-type: none"> <li>• The deployment of broadband infrastructure and its quality. Access to fast broadband-enabled services is a necessary condition for competitiveness.</li> </ul>
<i>Metrics:</i>	<ul style="list-style-type: none"> <li>• 1a Fixed Broadband <ul style="list-style-type: none"> <li>– 1a1 Fixed BB Coverage</li> <li>– 1a2 Fixed BB Take-up (usage)</li> </ul> </li> <li>• 1b Mobile Broadband <ul style="list-style-type: none"> <li>– 1b1 Mobile BB Take-up</li> <li>– 1b2 Spectrum</li> </ul> </li> <li>• 1c Speed <ul style="list-style-type: none"> <li>– 1c1 NGA Coverage (&gt;24Mb/s)</li> <li>– 1c2 Subscriptions to Fast BB</li> </ul> </li> <li>• 1d Affordability <ul style="list-style-type: none"> <li>– 1d1 Fixed BB Price</li> </ul> </li> </ul>
2. Human capital	<p>Skills needed to take advantage of the possibilities offered by a digital society.</p> <p>Such skills go from basic user skills that enable individuals to interact online and consume digital goods and services to advanced skills that empower the workforce to take advantage of technology for enhanced productivity and economic growth.</p>
<i>Metrics:</i>	<ul style="list-style-type: none"> <li>• 2a Basic Skills and Usage <ul style="list-style-type: none"> <li>– 2a1 Internet Users</li> <li>– 2a2 Basic Digital Skills</li> </ul> </li> <li>• 2b Advanced Skills and Development <ul style="list-style-type: none"> <li>– 2b1 ICT Specialists</li> <li>– 2b2 STEM (science, technology, engineering, math) graduates</li> </ul> </li> </ul>

Table 2. Digital Economy and Society Index – activities and metrics, cont.  
(source: European Commission, 2016)

Activity area	Description and metrics
3. Use of Internet	<p>Variety of activities performed by citizens already online.</p> <p>Such activities range from consumption of online content to modern communication activities or online shopping and banking.</p>
<i>Metrics:</i>	<ul style="list-style-type: none"> <li>• 3a Content <ul style="list-style-type: none"> <li>– 3a1 News</li> <li>– 3a2 Music, Videos and Games</li> <li>– 3a3 Video on Demand</li> </ul> </li> <li>• 3b Communication <ul style="list-style-type: none"> <li>– 3b1 Video Calls</li> <li>– 3b2 Social Networks</li> </ul> </li> <li>• 3c Transactions <ul style="list-style-type: none"> <li>– 3c1 Banking</li> <li>– 3c2 Shopping</li> </ul> </li> </ul>
4. Integration of information technology	<p>Digitization of businesses and their exploitation of the online sales channel.</p> <p>By adopting digital technology, businesses can enhance efficiency, reduce costs, and better engage customers, collaborators, and business partners.</p> <p>Furthermore, the Internet as a sales outlet offers access to wider markets and potential for growth.</p>
<i>Metrics:</i>	<ul style="list-style-type: none"> <li>• 4a Business digitization <ul style="list-style-type: none"> <li>– 4a1 Electronic Information Sharing</li> <li>– 4a2 RFID</li> <li>– 4a3 Social Media</li> <li>– 4a4 eInvoices</li> <li>– 4a5 Cloud</li> </ul> </li> <li>• 4b eCommerce <ul style="list-style-type: none"> <li>– 4b1 SMEs Selling Online</li> <li>– 4b2 eCommerce Turnover</li> <li>– 4b3 Selling Online Cross-border</li> </ul> </li> </ul>
5. Digital public services	<p>Digitization of public services, focusing on eGovernment.</p> <p>Modernization and digitization of public services can lead to efficiency gains for the public administration, citizens, and businesses alike as well as to the delivery of better services for the citizen.</p>
<i>Metrics:</i>	<ul style="list-style-type: none"> <li>• 5a eGovernment <ul style="list-style-type: none"> <li>– 5a1 eGovernment Users</li> <li>– 5a2 Pre-filled Forms</li> <li>– 5a3 Online Service Completion</li> <li>– 5a4 Open Data</li> </ul> </li> </ul>

### 3 Digital Society Metrics

The digital society can be described as a society in which the usage of ICT is common across demographic parameters of the population. Digital citizens function in the digital economy using the available digital public and commercial infrastructure for conducting life activities.

The measurement of society digitalization is a part of the DESI presented in the previous chapter. A similar approach is reflected in the OECD's digital economy measurement system comprising "indicators traditionally used to monitor the information society" (Macchi, et al., 2015, p.3). In the context of this paper, it is important to note that OECD aims at (Macchi, et al., 2015):

- 1) reviewing the current set of internationally comparable ICT indicators,
- 2) exploiting the potential of existing official statistics and experimenting with new metrics,
- 3) identification of data gaps, and
- 4) discussing the data infrastructure needed to measure ICT diffusion and impacts, including tools for analysis of large data sets.

The OECD digital metric system can be generally mapped onto the DESI areas, providing additional key performance indicators (KPIs) or more details for the metrics already indicated in DESI. Proposed mapping and important additional OECD metrics (vs DESI) are shown in Table 3.

Table 3. Digital Economy and Society Index – activities and metrics  
(source: European Commission, 2016)

OECD activity area – description and selected additional metrics versus DESI	
1.	<p>Smart infrastructure (DESI: Connectivity):</p> <ul style="list-style-type: none"> <li>• availability of fiber optics,</li> <li>• average download speeds,</li> <li>• connectivity costs (outside of the primary broadband connection): ICT devices (e.g., laptop, tablet, desktop), ICT applications, people using smartphones.</li> </ul>
2.	<p>Internet users (DESI: Human capital):</p> <ul style="list-style-type: none"> <li>• number of activities performed online per person,</li> <li>• digital natives: age of first Internet access, Internet usage by students at school and outside,</li> <li>• usage of parental controls and Web filters,</li> <li>• ICTs in schools: Internet connectivity, computer use for practicing, drilling, mathematics, and foreign languages,</li> <li>• online course usage (e.g., word processor, spreadsheet, programming),</li> <li>• computer use at work (simple, advanced, no use),</li> <li>• people who believe that they have sufficient ICT skills to find new jobs.</li> </ul>
3.	<p>The growth of the Internet (DESI: Use of Internet):</p> <ul style="list-style-type: none"> <li>• online purchase analytics (e.g., travel, music, books, food, ticketing),</li> <li>• usage per type of operation (e.g., e-mail, product information, news, social networks, eBanking, eGovernment, eCommerce (buy and sell), gaming, audio, video, travel, accommodation, Web radio, Web TV, telephone, software download, job search, medical services, content creation),</li> <li>• average Wikipedia views (fixed and mobile connectivity),</li> <li>• YouTube views of domestic content,</li> <li>• top Web sites by type (e.g., search engine, social network, media content, portal, reference/encyclopedia, news, eCommerce, eBanking, blogging),</li> <li>• search for health information,</li> <li>• number of domestic Internet domains.</li> </ul>



Table 3. Digital Economy and Society Index – activities and metrics, cont.  
(source: European Commission, 2016)

OECD activity area – description and selected additional metrics versus DESI	
4.	<p>Digital technology (DESI: Integration of the digital technology):<sup>7</sup></p> <ul style="list-style-type: none"> <li>• trust in cross-border eCommerce,</li> <li>• number of applications considered “standard” on the mobile phones,</li> <li>• overall number of applications,</li> <li>• usage of data analytics and big data, data-mining-related scientific articles,</li> <li>• average data storage cost,</li> <li>• innovation (R&amp;D activity and intensity, innovative enterprises in ICT manufacturing and services, engagement in in-house ICT manufacturing),</li> <li>• patents related to digitalization (ICT related, radicalness of patents, ICT industrial designs, and ICT trademarks),</li> <li>• labor productivity in ICT,</li> <li>• cost of genome sequencing,</li> <li>• security measures used for authorization and authentication (strong/weak, offsite backups, intrusion detection systems, tokens, biometrics),</li> <li>• number of ICT security issues,</li> <li>• acknowledging security issues – changes to browser settings,</li> <li>• number of issues on client data protection.</li> </ul>
5.	<p>eGovernment services (DESI: Digital public services):</p> <ul style="list-style-type: none"> <li>• problems in using eGovernment services (technical issues with portals, outdated information, no support for digital solutions).</li> </ul>
6.	<p>Other metrics (not explicitly specified in DESI):</p> <ul style="list-style-type: none"> <li>• weight of the digital economy in the overall economy (measured by GDP, number and performance/size of ICT companies, new entrants on the ICT market, global trade, gross exports),</li> <li>• ICT investments (capital inflows, investment as a percentage of GDP, value added of ICT, venture capital investments),</li> <li>• digital IQ (graduates in ICT, researchers in ICT).</li> </ul>

The DESI index is used by the EU members states for the EU progress reporting and also as a base framework for more detailed studies of digital development on the country level. For example, in Poland, the Ministry of Digital Affairs<sup>3</sup> prepares a comprehensive report on the “information society” (Szymanek, 2015) by using DESI metrics as well as additional KPIs that provide very important insights (Table 4).

A study of DESI and OECD shows that both sets of metrics are mutually supplementary: a number of KPIs are shared, while other metrics are distinctive per set. Also, there are differences in definitions and attributes (analytical dimensions). Both DESI and OECD cover several aspects of the digital economy and society, without clear borders between these dimensions or their strict hierarchy. The digital citizen is not evaluated separately, but rather as a part of a larger category of “Internet users.”

<sup>3</sup> Ministry of Digital Affairs – Ministerstwo Cyfryzacji i Administracji, <http://mc.gov.pl>

Table 4. Additional insights – information society metrics in the Polish economy  
(source: Szymanek, 2015)

<p>Group of additional insights in the Polish information society reporting:</p> <ul style="list-style-type: none"> <li>• internet users – new versus regular, Internet illiteracy, Internet skills versus computer skills, competencies of “digital natives,”</li> <li>• cybercrime protection,</li> <li>• client considerations/fear while using digital solutions,</li> <li>• integration services offered by eGovernment (API, open platforms, reporting),</li> <li>• running of useful eGovernment Web sites/portals (with traffic justifying the investment),</li> <li>• enterprises with Web presence,</li> <li>• internet advertising versus Internet sales,</li> <li>• purchasing versus Internet sales,</li> <li>• ICT usage in public administration: <ul style="list-style-type: none"> <li>– promoting ICT usage in public administration,</li> <li>– implementing ICT in public administration,</li> <li>– internal process digitalization in public administration,</li> <li>– external process digitalization in public administration,</li> <li>– level of user centricity in public administration ICT,</li> </ul> </li> <li>• promotion of citizen and enterprise mobility.</li> </ul>
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#### 4 Digital Industry Metrics

For the purpose of this paper, the term “digital industry” is defined as the application of digitalization in any type of industry. It is, therefore, not limited to the ICT/new technology sector that produces digital solutions, but it covers all manufacturing or service delivery where such digital solutions are used.

One of the most prominent examples of metrics that are used to measure the digital state of industries is proposed in the McKinsey Global Institute (MGI) Industry Digitalization Index (Manyika, et al., 2015). The index covers three groups of metrics:

- 1) assets,
- 2) usage, and
- 3) labor,

for which detailed KPIs are defined in Table 5.

Another example of a measurement system is the Industry Digitalization Index (IDI), which is derived from the data collected in the Eurostat databases (Friedrich, et al., 2011). The IDI contains data on

company usage of the digital infrastructure, grouped into four dimensions:

- digital input (procurement process digitalization),
- digital processing (internal and external process integration, enterprise resource planning (ERP), customer relationship management (CRM), internal data sharing, external electronic data exchange with business partners and the public sector, upstream and downstream supply chain management/SCM),
- digital output (sale process digitalization),
- infrastructure (level of advancement of the ICT function in the industry, Internet connectivity).

In comparison to the economy and society metrics, the methods used to diagnose the industries emphasize the process component, with an internal and external view.

Process digitalization is measured in conjunction with the ICT system infrastructure, especially with the usage of established, integrated solutions such as the ERP or CRM.

Table 5. Metrics included in the MGI Industry Digitalization Index  
(*source*: Manyika, et al., 2015, p.30)

Group	Detailed metrics
Assets	<ul style="list-style-type: none"> <li>• Digital spending: <ul style="list-style-type: none"> <li>– hardware spending (share of total expenditures spent on ICT hardware, e.g., computers and servers),</li> <li>– software spending (share of total expenditures spent on software, e.g., enterprise resource planning (ERP) software),</li> <li>– telecommunications spending (share of total expenditures spent on telecommunications, e.g., broadband access and mobile data services),</li> <li>– IT services spending (share of total expenditures spent on IT services, e.g., IT consulting and IT architecture and implementation).</li> </ul> </li> <li>• Digital asset stock: <ul style="list-style-type: none"> <li>– hardware assets (share of total assets made up of ICT hardware, e.g., computers and servers),</li> <li>– software assets (share of total assets made up of software, e.g., purchased software licenses),</li> <li>– connected equipment (share of equipment embedded with digital connections, e.g., oil rigs outfitted to transmit data on yield),</li> <li>– data storage (data stored per firm, measured in terabytes, for firms with at least 1,000 employees).</li> </ul> </li> </ul>
Usage	<ul style="list-style-type: none"> <li>• Transactions: <ul style="list-style-type: none"> <li>– digital transactions (share of payments and transfers, both from consumers to businesses (C2B) and from businesses to other businesses (B2B) made through digital means, e.g., payments via ACH or wire).</li> </ul> </li> <li>• Interactions between firms, customers, and suppliers: <ul style="list-style-type: none"> <li>– digital external communications (composite score based on share of firms reporting benefits from using social technologies to interface with customers and share of firms reporting benefits from using social technologies to work with partners),</li> <li>– digital customer service (composite score based on average number of customer service chats per month and share of total contact center calls routed by automated systems, i.e. integrated voice response (IVR) or automated speech recognition (ASR) technology).</li> </ul> </li> <li>• Business processes conducted internally: <ul style="list-style-type: none"> <li>– digitized back-office processes (composite score based on the adoption of enterprise resource planning (ERP) software (e.g., SAP, Oracle) across the industry, and share of firms reporting that technology is very integrated into employees' daily activities),</li> <li>– digitized front-office processes (composite score based on the adoption of customer relationship management (CRM) software across the industry and digital marketing (e.g., e-mail, banner, and search engine advertisements) expenditures, as an estimated share of total marketing expenditures),</li> <li>– product development software intensity (intensity of software usage in product development process, e.g., for computer-assisted design).</li> </ul> </li> </ul>

Table 5. Metrics included in the MGI Industry Digitalization Index, cont.  
(source: Manyika, et al., 2015, p.30)

Group	Detailed metrics
Usage	<ul style="list-style-type: none"> <li>• Market making: <ul style="list-style-type: none"> <li>– digitally enabled markets – extent to which digital platforms are being used to connect supply with demand, calibrated using the relative size of digital bid-ask or auction-based markets (in terms of users, transactions, and/or revenues).</li> </ul> </li> </ul>
Labor	<ul style="list-style-type: none"> <li>• Digital spending: <ul style="list-style-type: none"> <li>– hardware spending on workers' ICT hardware, for example, computers and server expenditures per full-time-equivalent employee (FTE),</li> <li>– software spending per worker, for example, enterprise software license expenditures per FTE,</li> <li>– telecommunications spending per worker – telecommunications (e.g., broadband access, mobile data service) expenditures per FTE,</li> <li>– IT services spending per worker – IT services (e.g., IT consulting and IT architecture and implementation) expenditures per FTE.</li> </ul> </li> <li>• Digital capital deepening: <ul style="list-style-type: none"> <li>– hardware assets per worker – ICT hardware assets (e.g., servers and computers) per FTE,</li> <li>– software assets per worker – software assets (e.g., worker software licenses) per FTE.</li> </ul> </li> <li>• Digitization of work: <ul style="list-style-type: none"> <li>– share of tasks that are digital (time-weighted share of worker tasks involving digital tools or processes, e.g., tasks requiring workers to input information via tablet, conduct online research, or perform analyses with spreadsheet software). Based on a search for digital keywords (e.g., data, computer, software) in a publicly available database of worker tasks,</li> <li>– share of jobs that are digital (digital jobs, e.g., computer and information systems managers, hardware engineers, telecommunications equipment installers and repairers as a share of total jobs).</li> </ul> </li> </ul>

## 5 Digital Enterprise Metrics

The level of a single enterprise digitalization can be measured with industry metrics presented in the previous section. However, there is a large additional measurement area that is not covered explicitly by the IDI. Additional KPIs describe the status and performance of eCommerce and digital customer dialog in an enterprise. Core KPIs of this type include:

- conversion funnel (users/visitors  $\Rightarrow$  leads  $\Rightarrow$  prospects  $\Rightarrow$  clients/wins) and cost (cost per lead/prospect/client),
- traffic sources (organic, paid search/affiliate networks/referrals, direct, e-mail, social media),
- opt-in/out level and dynamics,
- email/SMS performance (bounce/delivery rate, sharing, open rate, click-through-rate (CTR), cost per lead (CPL), lead quality (LQ), and name to marketing qualified lead (MQL) conversion),
- public and eCommerce Web sites (bounce/drop-off rate, page views per visit/total, ad capture/impressions, CTR, cost-per-impression (CPI), cost-per-click (CPC), new sessions, time on (sub)-site, CPL, LQ),

- content quality (white-book downloads, newsletter/info-service sign-ups),
- subscription service performance (free trial to subscription rate),
- social media volume and performance (sharing and tagging, Facebook likes and lead conversion, Twitter followers, promoted tweet cost/success, YouTube subscribers, LinkedIn followers, Instagram followers, Google+ circled-by, Pinterest pinning),
- media performance (social, digital and traditional) number and quality of publications,
- customer engagement (Client Satisfaction Index, mystery shopper results, Net Promoter Score (NPS), churn and retention levels),
- campaign and digital channel return on investment (ROI) and revenue share in total,
- client cross-sell ratio,
- sales and revenue per digital client and revenue share in total.

The presence of the above enterprise metrics in the economy/society and industry measurement systems is limited, despite their purely digital nature.

## 6 Digital Client Metrics

In the course of research on the topic of enterprise digitalization metrics, the author collected information on the practical application of digital KPIs in sample financial institutions.

Banks are at the forefront of digital transformation, engaging in highly competitive struggle internally within the financial sector and externally with FinTech/venture capital corporations as well as with non-financial players making more bold attempts at capturing financial services' market share (e.g., Bitcoin/Blockchain, Apple Pay, Google Wallet). From this point of view, digitalization is a key to the survival and growth of current and future business models on the banking market.

A case study, sourced via interviews with Chief Digital Officers and collection of KPIs, was conducted on five universal banks operating in the European Union (EU). The goal was to understand what KPIs

and dashboards were used for regular tracking of the progress of digitalization.

In comparison to all the measurement systems presented already in the paper, the following conclusions can be drawn from practices in the sample banks:

- a number of base metrics are in line with the economy/society/industry/enterprise views, for example, digital solution users (gross and net), Web site activity tracking, and social media performance,
- there are several groups of KPIs specific to the banking sector, for example,
  - usage of online solutions:
    - logins per day/month (time of day analysis, session duration),
    - number/volume of transactions per session/in time series,
    - customer login journey (origination patterns),
    - most frequently used functionalities,
    - hardware technological platform used, with change history (iOS, Android, Windows),
    - software platform used (system, browser type),
    - origination IP for security tracking purposes,
  - product sales(volumes), revenues, and profitability of digital clients,
  - self-service ratio via digital solutions in sales and after sales per product and channel,
  - business activity generated via the mobile and stationary channels,
  - app-world performance (downloads of applications per platform, rankings/stars and feedback, application updates,
  - share of contact campaign records processed via digital channels,
- banks are highly detailed with respect to digital performance in client segments via:
  - observance of client generations (e.g., Baby Boomers, X, Y, Z),
  - microsegmentation into profiles (e.g., via digital activity preferences),

- tracking of consent for marketing communication (opt-ins/opt-outs),
- online experience client satisfaction polls,
- digital business cases are subject to close monitoring against their planned business benefits.

In summary, we may note that in the sample case studies, the banks created yet another measurement category related to the “Digital Client.”

This perspective is relevant for all client-centric business models, but it could also find numerous uses in the eGovernment and public administration. It allows to understand client behaviors/preferences as well as usability of functions provided in the online solutions.

Moreover, banks are highly aware of the necessity to assure the proper ROI from digital investments, paying special attention to business cases and their ranking.

## 7 Digital Investment Metrics

Case studies conducted in the banks univocally point towards the mandatory measurement of digital investments also in their strict financial sense.

Taking into account the needs for digitalization, the pipeline of digital investment is usually larger than ICT budget capacity, which calls for prioritization of initiatives according to their business attractiveness.

According to the research of Adobe, based on a poll run in 2015 with 648 senior corporate marketers across the digitally dynamic Asia-Pacific/APAC region, the reality of digital investments is burdened with dilemmas (Adobe and CMO Council, 2015):

- 66% said digital was enabling greater opportunities for the business,
- 79% were planning to increase digital budgets, while only 2% declared a decrease,
- 37% declared spending 10–24% of budget on digital and 13% would spend more than 50%, at the same time:
- 50% claimed digital efforts were stalled by budgets,

- 39% declared digital investments were difficult to justify by the inability to make a business case for spending.

The relative pessimism linked to budgets and business cases stems from the nature of digital projects: frequently, they deal with disruptive innovations and new business models for which there is limited or no past performance data and management heuristics.

The costs and benefits reach across multiple dimensions that need to be linked together in the evaluation process. Moreover, some performance characteristics are not easily quantifiable with the known KPIs (e.g., client value, loyalty, social media score, positive or negative impacts on other processes).

The uncertainty of business case development needs to be addressed via standard business case methods (including, among others, the calculation of net present value (NPV), internal rate of return (IRR), payback period (PB), Return on Investment (ROI) equipped with more sophisticated methods of evaluating current and future cash flows from digital processes.

It is important to develop digital performance metrics in parallel with the business case and to assure their on-going measurement to understand whether expected benefits are being delivered.

## 8 Conclusions

The study of digitalization metrics covered in this paper allows to draw several conclusions that can be used by researchers and digitalization managers in commercial and public organizations:

- 1) Significant effort was invested in the development of metrics for digitalization. However, the level of standardization in metrics definition and calculation is moderate, calling for further harmonization and detailing to allow precise absolute measurement and benchmarking. This is highly relevant within single economic communities/markets with the goal of increasing their competitiveness by sharing best digitalization practices and properly targeting investments.

- 2) Measurement systems on all levels (from economy down to client) share/duplicate selected KPIs (e.g., related to the digital processes, infrastructure, or usage) in a different context, but each system has additional differentiating focus areas. When operating on a given level, it is suggested to explore other levels for potential reuse of KPIs.
- 3) The overall number of digital KPIs already exceeds 100 items raising a problem of selecting the best metrics to monitor with limited control budgets (cost of data acquisition and processing). Further work should be conducted to select the metrics with the highest descriptive/statistical potential to pronounce the development of digital performance.
- 4) The economy, society, and industry levels of metrics have no clear borders and share a number of KPIs. For the sake of clarity, the classification of measures on these levels should be more specifically referred to macroeconomic, social, or microeconomic dimensions.
- 5) In the technical view, current metrics are Internet centric. The perspective of a digital citizen or digital client is dispersed and limited and could be extended, especially with the use of micro-segmentation and stronger demographic/behavioral profiling. In other words, the measurement system should be both technologically oriented (Internet centric) and focused on the end consumer of digitalization effects (client centric).
- 6) Although process approach is strongly reflected in the digital industry metrics, there is no clear and dominant approach to measuring the digitalization levels of processes. A detailed process scoring system should be introduced within industry benchmarking or in the analysis and design of eGovernment development.
- 7) It is important to develop digital performance metrics in parallel with the business case and to assure their on-going measurement to understand whether expected benefits are being delivered.

Taking into account the complexity and broad scope of digital KPIs discussed in the paper, it becomes apparent that digital measurement systems require the usage of advanced data collection and processing.

Digitalization is, therefore, strongly linked to data management and analytics, acting both as an enabler (feeding new digital processes with proper information) and a control mechanism (measuring the results).

Although already quite comprehensive, the universe of digital measures will continue to expand, looking into more features and insights of digital economies, societies, industries, enterprises, and clients.

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