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ITU-T Focus Group on Data Processing and Management to support IoT and Smart Cities & Communities

Technical Specification D5

Data economy: commercialization, ecosystem and impact assessment

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The procedures for establishment of focus groups are defined in Recommendation ITU-T A.7. ITU-T Study Group 20 set up the ITU-T Focus Group on Data Processing and Management to support IoT and Smart Cities & Communities (FG-DPM) at its meeting in March 2017. ITU-T Study Group 20 is the parent group of FG-DPM.

Deliverables of focus groups can take the form of technical reports, specifications, etc., and aim to provide material for consideration by the parent group in its standardization activities. Deliverables of focus groups are not ITU-T Recommendations.

Technical Specification D5

Data economy: commercialization, ecosystem and impact assessment

Summary

This Technical Specification specifies data commercialization, data ecosystem enhancement and data economy impact assessment as a number of key pillars comprising data economy. Various relevant topics that support data economy for these key pillars are defined in this Technical Specification.

Acknowledgements

This Technical Specification was researched and principally authored by Okan Geray (Smart Dubai Office) under supervision of Gyu Myoung Lee (Korea, Rep.of).

Additional information and materials relating to this Technical Specification can be found at: www.itu.int/go/tfgdpm. If you would like to provide any additional information, please contact Denis Andreev at tsbfgdpm@itu.int.

Keywords

Data economy; data commercialization; data ecosystem; data economy impact assessment.

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Data economy: commercialization, ecosystem and impact assessment

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Data economy: commercialization, ecosystem and impact assessment

1 Scope

The scope of this Technical Specification includes digital data; (i.e. data stored and processed in digital electronic media). Hence, non-digital data (e.g. data stored in non-electronic media such as paper, etc.) are beyond the scope of this document.

Additionally, this Technical Specification excludes economic activities conducted by a single organization (private or public) which collects and processes its own data to create benefits for itself. That is, it excludes economic activities where data is created, stored, processed and used by the same organization.

The scope of the Technical Specification includes economic activities where data value chain activities as a whole incorporate more than one organization; and hence either entail monetization through data exchange as a commercial transaction or through data exchange as a non-commercial transaction for indirect economic impact (benefit).

Specifically, this Technical Specification covers the following:

- Data value chain and data ecosystem stakeholders identification;
- Data commercialization and data economy business model examples;
- Data ecosystem enhancement;
- Data economy impact assessment.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Technical Specification. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Technical Specification are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Technical Specification does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T L.1400] Overview and general principles of methodologies for assessing the environmental impact of information and communication technologies

[ITU-T L.1410] Methodology for environmental life cycle assessments of information and communication technology goods, networks and services

[ITU-T L.1430] Methodology for assessment of the environmental impact of information and communication technology greenhouse gas and energy projects

[ITU-T L.1440] Methodology for environmental impact assessment of information and communication technologies at city level

[ITU-T Y.4905] Smart sustainable city impact assessment

3 Definitions

3.1 Terms defined elsewhere

These Technical Specifications use the following terms defined elsewhere:

3.1.1 greenhouse gas (GHG) [ISO 14064-1:2018]: Gaseous constituent of the atmosphere, both natural and anthropogenic, that absorbs and emits radiation at specific wavelengths within the

spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds. GHGs include carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF6).

3.1.2 greenhouse gas emission [ISO 14064-1:2018]: Total mass of a GHG released to the atmosphere over a specified period of time.

3.1.3 organization [ISO 14064-1:2018]: Company, corporation, firm, enterprise, authority or institution, or part or combination thereof, whether incorporated or not, public or private, that has its own functions and administration.

3.1.4 ICT companies [ITU-T Y.4901]: Companies that provide products and/or services with respect to information and communication technologies.
3.1.5 city [ITU-T Y.4900]: An urban geographical area with one (or several) local government and planning authorities.
3.1.6 smart sustainable city [ITU-T Y.4900]: A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects.

3.2 Terms defined in this Technical Specification

None.

4 Abbreviations and acronyms

These Technical Specifications use the following abbreviations and acronyms:

AI Artificial Intelligence

DPM Data Processing and Management

EIA Environmental Impact Assessment

GDP Gross Domestic Product

GHG Greenhouse Gas

GVA Gross Value Added

ICT Information and Communication Technology

IOM Input Output Model

IoT Internet of Things

NGO Non-governmental Organization

SDO Standards Development Organization

SIA Social Impact Assessment

SSC Smart Sustainable City

5 Conventions

None.

6 Data Ecosystem & Value Chain

6.1 Data in Economic Activities

Data driven economic activities are becoming prominent by enabling creation, collection, storage, distribution and use of digital data, among others. Traditional economic activities rely on goods and services. In general, economic activities entail input of resources (e.g. raw materials) which are transformed through production processes into products (in the form of goods and services) referred to as outputs.

Goods are tangible, can be stored and usually used or consumed after production. On the other hand, services are intangible, and generally hard to store and hence tend to be consumed at the same time as they are produced.

Data today acts as both an input (as raw material) to various economic activities as well as an output. It exhibits interesting characteristics reminiscent of both goods and services. In other words, data is intangible; however, it can be stored and its consumption tends to happen after production.

Data obtained from consumers (e.g. consumer data), businesses (e.g. private sector data) and government organizations (e.g. public sector data) among others take the form of input resources to economic activities and value is created by transforming them into economic output in the form of goods and services. Hence, data becomes driver of various economic activities in different sectors. It yields direct and indirect benefits in the form of generating additional revenues as well as creating efficiencies in an economy (e.g. in the form of cost savings).

Data Origin describes the type of source from which the data originally comes from. Some possible values are [b-Schomm]:

- **Internet data** is obtained directly from a publicly available online resource in Internet.
- **Self-Generated data** originates from individuals and organizations who have means of generating data by themselves, e.g., manual curation of a specific dataset.
- **User interactive data** includes data that users have to provide an input before they can retrieve any resulting data, e.g. flight arrival data.
- **Community data** is based on a wiki-like principle. The restrictions as to who can participate and contribute are in general quite low.
- **Government data** is a recent development, where governments avail huge amounts of data they capture and process publicly available.
- **Authority data** is data that comes directly from an authority responsible in a given domain, e.g. stock exchanges providing the stock market data for stock prices.

Data Access describes the mechanism by which data is received from data providers (suppliers) by data consumers. Some examples are [b-Schomm]:

- **APIs (Application Programming Interfaces)** are used to provide language and platform independent programmatic access to data over the Internet.
- **Downloads** are one of the most convenient ways to access a data set, because anyone can access by using a Web browser.
- **Specialized Software clients** are usually proprietary and given to the user by a vendor that also offers the data set(s). While this approach does have disadvantages (implementation and maintenance expense, dependency issues, etc.), there are some scenarios in which the concept is beneficial to the customer; for example, providing readily available solutions or granting access to real-time data.
- **Web Interfaces** display the data to customers directly through Internet.

Data output describes formats in which data can be obtained. The following are examples of data outputs [b-Schomm]:

- **XML** is a widely established standard for data transfer and representation which is human and machine-readable.

- **CSV/XLS** Structured data can be provided in a tabular format, thus it is logical to use a table file format.
- **JSON** is similar to XML but a little more lightweight and also used as a data transfer format. Data is represented as text in key-value pairs.
- **RDF** is a method commonly used for information resources. It uses a subject-predicate-object scheme for resources.
- **Report** When data is analysed, formatted and aggregated, the output can be deemed as a report. The main difference in this category is that the customer may not be exposed or have access to the underlying raw data.

6.2 Data Value Chain

It is important to identify various, potentially commercial, value adding activities related to data, which is commonly referred to as data value chain. In other words, each and every activity in the value chain identified can potentially be monetized.

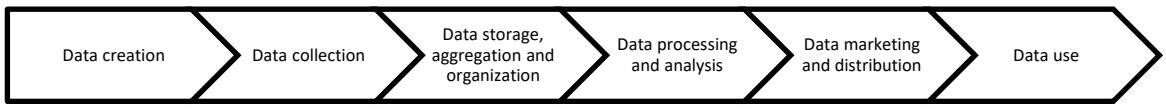
Value created from data consists of the following core data related activities:

- Data creation
- Data collection
- Data storage, aggregation and organization
- Data processing and analysis
- Data marketing and distribution
- Data use.

On the other hand, following support activities contribute directly or indirectly to value creation from data:

- Data laws, regulations and policies
- Data security and privacy related services
- ICT connectivity and infrastructure services
- Data skills enhancement services.

Data Core Activities



Data Support Activities

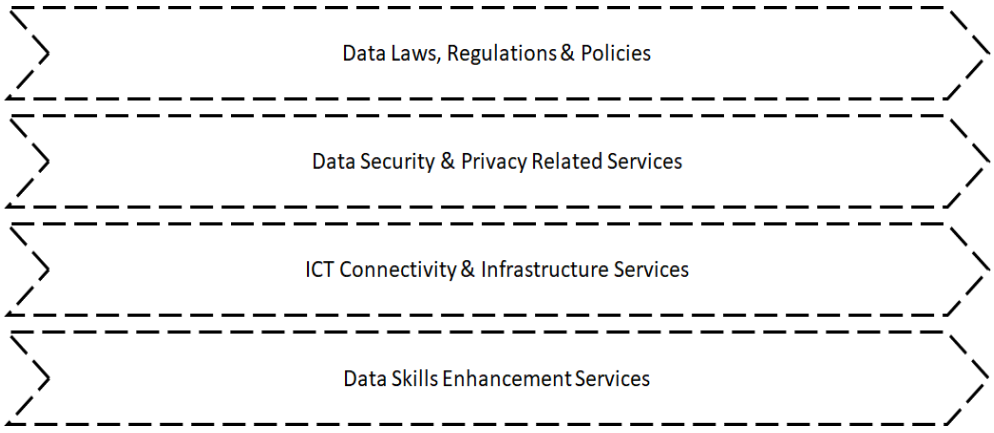


Figure 1: Data Value Chain

An organization can conduct one or more activities in the data value chain shown in Figure 1. For example, an open data portal provider can collect, store and aggregate open data and can also provide various analyses and data processing tools.

In some cases, even multiple entities or organizations can participate in a single activity in the data value chain. For example, multiple government (public sector) organizations can create and collect various datasets, which then get aggregated and stored in an open data portal. Similarly, consumers in aggregate can create significant amounts of consumer data to be collected by online service providers (e.g. social media companies). These are just some non-exhaustive examples to illustrate the concept.

6.3 Explanation of Data Value Chain activities

Data creation: This activity includes creation (actual formation) of data. Data can be created by consumers (individuals), organizations (public, private sector and others) and even by machines (e.g. sensors or IoT data).

Data collection: This activity includes collection (gathering and assembling) of data created by the previous activity of data creation. Sources of data collection may include extraction of data from information systems, browsers, competitions, contracts, cookies, loyalty schemes, mobile apps, online surveys, etc. Data can be collected by consumers, organizations and machines.

Data storage, aggregation and organization: This activity includes the storage, aggregation and organization of collected data. It is an intermediate step between data collection and related processing and analysis. It enables availability of data over time and also enhances access to it.

Data processing and analysis: This activity includes processing and analysing as well as creating further value and insights from data stored and organized by the previous activity. It can include one or more datasets. It can be done by consumers, organizations and machines.

Data marketing and distribution: This activity includes marketing and distributing data (raw data as well as processed and analysed data) for use by its end consumers. It can include one or more datasets.

Data use: This activity includes using (consuming) data for a certain purpose. Data can be used for more than one purpose in some cases. For example, speeding data can be collected to issue traffic fines for exceeding speed limit in a city (primary or direct purpose). However, the same data can also be used together with traffic accident data to identify speeding related traffic accidents and to potentially reduce traffic accidents (secondary or indirect purpose). Data can be used by consumers, organizations and machines.

Data support activities complement and supplement above core data activities and therefore help in enhancing value of data and / or provisioning of data.

Data laws, regulations and policies: This activity includes formulation and enforcement of data related laws, regulations and policies in a jurisdiction (in some cases policies might be applicable to one or more organizations rather than an entire jurisdiction).

Data security and privacy services: This activity includes provisioning of data related security and privacy services for implementing and enforcing data laws, regulations and policies in a jurisdiction or data policies in an organization.

ICT connectivity and infrastructure services: This activity includes provisioning of ICT connectivity and infrastructure services for implementing data value chain activities. It includes services of telecommunications operators (e.g. mobile network operators, ISPs), cloud based service providers, data centre service providers, etc.

Data skills enhancement services: This activity includes provisioning of data skills enhancement services. It includes among others data related programs, degrees, certificates, courses of professional training organizations, academia, educational institutions, etc.

6.4 Data Ecosystem Stakeholders Identification

Even though value is created through activities in the data value chain, there is a rich set of stakeholders in data economy. Some stakeholders are involved in commercial (flows of funds related) activities (e.g. ad networks, ad exchanges, etc.) throughout data value chain despite the fact that they may be transparent to data creators and data consumers.

Data can trigger flows of funds among various stakeholders involved in data value chain activities. Data commercialization and business models section will discuss and illustrate some of these funds flows. In general, data economy can enable:

- direct commercialization of the data itself (e.g. monetization of data sets themselves);
- indirect commercialization of data (e.g. advertising revenues related to online consumer data);
- indirect efficiencies achieved through data resulting in cost savings (e.g. reduction of energy consumption through analysis of consumption data may enable cost savings).

Following is a non-exhaustive list of stakeholders involved in data economy along with a preliminary categorization:

- **Data creator, collector and aggregator**
  - Consumers (individuals), organizations (public and private including NGOs, etc.) and machines (e.g. IoT devices such as sensors)
  - Online search engines
  - Online websites, mobile apps, e-commerce sites
  - Content owners (data owners)
  - Open data portals
  - Data marketplaces
- **Advertising organization**
  - Ad networks
  - Ad exchanges
  - Ad agencies
  - Retargeters
  - Advertisers
- **Data related services provider**
  - Payment providers
  - Data management platform providers
  - Data processing and analysis tools providers
  - Data processing and analysis services providers
  - Telecommunications services providers
  - Data security and privacy services providers
- **Regulatory organization**
  - Sector specific organizations (e.g. energy, mobility, health, education, etc. regulatory bodies, councils, etc.)
  - Data regulatory agencies
- **Data skills**
  - Data related labour force in economy
  - Academia
  - Data related training and skills enhancement providers
- **SDO**
  - Data related standards development organizations (SDOs)

Table 1 below defines and briefly explains each stakeholder, indicating its category and data value chain activities it is most probably involved in.

Table 1 – Stakeholder type, definition, category and value chain activities

Stakeholder Type	Definition	Category	Data Value Chain Activities
Ad exchange	A marketplace / platform that enables participants to buy and sell ads	Advertising organization	Data marketing and distribution
Content Owners	An entity that owns the rights to content and can be watched, listened or read online	Data creator, collector and aggregator	Data creation
Ad agency	A company that develops, plans, and manages advertising on behalf of advertisers	Advertising organization	Data marketing and distribution
Ad network	A company that matches advertising demand to aggregated advertising inventory	Advertising organization	Data marketing and distribution
Retargeter	A company that advertises for a product / service shown specifically to a consumer who has previously expressed interest in, or intent to purchase it	Advertising organization	Data marketing and distribution
Advertisers	A company that purchases advertising to promote its brand, content, and goods and services.	Advertising organization	Data marketing and distribution
Open data portal	A portal that provides access to Open data; i.e. data that anyone can access, use and share. Open data portals provide data in a common, machine-readable format and license it. The license permits (or defines the rules) for processing data, including transforming, combining and sharing it	Data creator, collector and aggregator	Potentially all data core activities

Stakeholder Type	Definition	Category	Data Value Chain Activities
	with others, even commercially.		
Data marketplace	A data marketplace is an electronic marketplace whose main product is provisioning of data and / or related services around data.	Data creator, collector and aggregator	Potentially all data core activities
Online search engine	An online software system that is designed to search for information on the World Wide Web. The information may be a mix of web pages, images, and other types of files.	Data creator, collector and aggregator	Potentially all data core activities
Online website	An online website is a website publicly accessible over Internet which is a collection of related web pages, including multimedia content, typically identified with a common domain name, and published on at least one web server.	Data creator, collector and aggregator	Potentially all data core activities
Payment providers	A company that facilitates financial transactions to make a payment.	Data related services provider	ICT Connectivity & Infrastructure Services
E-commerce site	A website that enables users to purchase goods and services using an electronic platform.	Data creator, collector and aggregator	Potentially all data core activities
Mobile app	A mobile app is a computer program designed to run on a mobile device such as a phone/tablet or watch.	Data creator, collector and aggregator	Potentially all data core activities
Data Management Platform	A platform that enables advertisers, ad agencies, etc. to manage customer data and facilitate ad targeting (enables	Data related services provider	ICT Connectivity & Infrastructure Services

Stakeholder Type	Definition	Category	Data Value Chain Activities
	purchasing ad space, etc.).		
Data processing and analysis tools providers	Organizations that provide tools for processing and analyzing data.	Data related services provider	Data processing and analysis
Data processing and analysis services providers	Organizations that provide services for processing and analyzing data (the providers use various tools and provide data processing and analyses as a service)	Data related services provider	Data processing and analysis
Telecommunications services providers	Organizations that provide telecommunications services to enable data communication (data transport).	Data related services provider	ICT Connectivity & Infrastructure Services
Data security and privacy services providers	Organizations that provide a range of services to enhance the value of data by enhancing its security and privacy.	Data related services provider	Data security & privacy related services
Sector specific organizations	Organizations pertaining to a sector (or an industry) and composed of its members addressing various issues jointly. It may include sector bodies, agencies, councils, associations, etc.	Regulatory organization	Mainly Data laws, regulations & policies
Data regulatory agencies	A regulatory agency (also regulatory authority, regulatory body or regulator) responsible for exercising autonomous authority over data activities in a regulatory or supervisory capacity. It can be a public authority or government agency.	Regulatory organization	Data laws, regulations & policies

Stakeholder Type	Definition	Category	Data Value Chain Activities
Data related labor force in economy	Total labor pool in economy related to data activities indicated in the data value chain.	Data skills	Related to one or more data value chain activities
Academia	Institutions providing data related formal education programs or conducting data related research.	Data skills	Data skills enhancement services
Data related training and skills enhancement providers	Professional training institutes and other organizations providing data related training courses, programs, etc.	Data skills	Data skills enhancement services
Data related standards development organizations	Organizations whose primary activities are developing, coordinating, promulgating, revising, amending, reissuing, interpreting, or otherwise producing data related technical standards.	SDO	Data laws, regulations & policies

7 Data Commercialization

Increased pace of digitization across the globe has concomitantly increased the significance of data and data related activities. Data has become an important ingredient for organizations enabling innovation.

Individuals (consumers) and organizations routinely provide and exchange information while interacting and consuming online. This collected massive amount of information is commercially valuable and is enabling new business models to emerge.

Data can be sold and purchased (i.e. traded or commercially exchanged) just like raw materials in the form of goods and services.

Data can be directly or indirectly monetized; it can be an organization's main or supplementary offering. Data Monetization, as a term, is rather new but it has been used as a synonym for generating money with data.

In this context, data commercialization is the process of creating commercial value from data, and may encompass various activities, including but not limited to, monetization, valuation, pricing, licensing, distribution, marketing and sales.

7.1 Data Monetization

The term 'monetization' in broad terms is defined as the utilization of something of value as a source of profit[1]. On the other hand, academic literature offers a wider definition for 'monetization' i.e. it

[1] Source: Merriam Webster.

may entail generation of money or revenue [b-Najjar] [b-Woerner]. Therefore, Data Monetization is not solely about profit yielding but encompasses a wider definition from the perspective of monetary transaction. Data Monetization entails a source of positive, incoming money flow through data exchange.

Hence, a transaction needs to take place in which something of value is ultimately exchanged or converted into money. Furthermore, the transaction requires at least two parties who participate in this exchange. The transaction also entails a party's willingness to buy a good or service and another party's willingness to sell it for a certain mutually agreed amount of money. Thus, both parties must have similar valuation of this good or service, otherwise the transaction will not occur. Consequently, the laws of demand and supply are also present in the action of monetization.

[b-Gartner] has identified two distinct ways how an organization may generate revenue and monetary value with data: namely, the direct and indirect ways. The direct revenue generation means that data is traded or sold and therefore monetary value is produced through a transaction. In the indirect revenue generation data is utilized and refined to produce new information, services or products that are sold or traded. Therefore, in the indirect way the key is in leveraging data and generating monetary value with refining data to something else that is valuable. Apart from [b-Gartner] distinction, Data Monetization can be an organization's core or non-core business. Naturally, Data Monetization's position in an organization's portfolio of business lines may vary depending on how much an organization focuses on this business activity.

An organization can sell or trade data or its derivatives. On the other hand, [b-Woerner] has identified 'wrapping' as an additional way to monetize data. Wrapping refers to an organization wrapping information or data around its core product or service, primarily to differentiate itself from competitors in the market. Hence, data wrapping is associated with Data Monetization that is not an organization's core business. Wrapping may make a product or service more attractive to the customers if it fulfils some kind of customer need in the form of information. Furthermore, wrapping may lead to greater value and thus greater revenue generation [b-Woerner]. Thus it seems evident that Data Monetization is rather a diverse phenomenon in terms of how data can be used in business to generate revenue.

Note: Data Monetization is not limited to data trading but revenue may also be generated with information-based products or services. As [b-Woerner] argues, the term "information-based products or services" may refer to various offerings with different complexity levels. Thus, an information-based product or service can be raw data, processed data, etc. Therefore, it seems that Data Monetization is not, in reality, limited to transactions related to only data, but it is rather a hypernym for generating revenue from data or information-based products or services. This is in alignment with [b-Gartner] definition of indirect and direct Data Monetization as well.

Hence, Data Monetization includes positive incoming money flow with and out of data and data-derived and information-based products and services. Thus, the definition and point of view on Data Monetization is expanded from data to also its derivatives, which means that an organization can, for instance, derive and refine its data to other products that are then, in turn, sold forward, generating revenue for the organization. This broadens the scope of distinct business and monetization models as part of Data Monetization.

7.2 Data Valuation

Data can be treated as an asset (or as capital) and therefore can be associated with a value.

Data capital is one of the most important assets of digital or online businesses; however, the concept can be expanded to other public and private sector organizations as well. Data is more than just a record; it is raw material for creating novel types of value.

Valuation Exercise: One can take a market value perspective for data (the internal value of data to an organization is excluded as indicated in the scope of this Technical Specification). Intrinsically, data as representation may have no value.

The value is created when data is put to use or interpreted in a context; that is, when utilized through a use case. Hence, the use case contextualizes the data and also allows attaching a value to it. The value can be determined by assuming the data consumer's perspective which is further down the value chain. The consumer perspective allows framing and putting data in a usage context by the consumer.

Note: The valuation method described in this Technical Specification is one alternative among other potential ones.

Value is created either by increasing revenues or by reducing costs for an organization. Revenue increase can take the form of identifying sources for:

- Novel customers (in existing or new markets)
- Additional revenues from existing customers (e.g. product / service enhancements, cross-selling, upselling, etc.).

Cost reduction can take the form of identifying sources for:

- Reducing expenditures in core and/or support activities of an organization
- Operational efficiencies by eliminating a portion of existing expenditures (e.g. readily available customer data may reduce market research costs, supplier and related products data may reduce procurement costs[2]).

Revenue increase(s) and/or cost reduction(s) can be quantified and turned into monetary value through careful assessment. One can also take a discounted cash flow approach and determine the market value of data by calculating an organization's market value with and also without the data separately. The difference would be the market value of the data for that organization.

Therefore, given a use case, the total market value of data can be calculated by summing up the incremental market value of data for all applicable organizations in a market.

Number of Potential Customers: It is also important to note that there can be one or multiple (even several) potential customers for the data whose market value is determined through a valuation exercise. For example, certain data might be consumed either by a monopolistic organization in its industry or by a single public sector organization, limiting its potential market to a single consumer. On the other hand, data can potentially be consumed by a competitive market or a market segment with multiple organizations (e.g. companies) in it.

The number of targeted customers may potentially affect the data price (discussed in the next clause) since the market value of data might be shared among several customers.

Valuation Discrepancy: As indicated earlier, data value depends on the use case considered. This inherently introduces a challenge as well as an opportunity. The challenge is to identify potentially applicable all use cases for a given data set(s) which may not be straightforward in all cases[3]. The opportunity, on the other hand, is that since multiple use cases might be applicable for a given data set(s), its value will increase with each use case.

Hence, given a data set(s), the total market value of data can be calculated by summing up the market values of data for all applicable use cases (assuming full independence or mutual exclusivity among them).

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[2] The list can be extended substantially as there is a significant number of sources for expenditures in a given organization.

[3] In some cases, applicable new use cases can be discovered subsequent to initially identified one(s).

7.3 Data Pricing

Data markets are to a large extent unregulated today. One of the challenges in these emerging data markets is establishing an accepted methodology for determining data prices. Current data pricing strategies vary widely, some driven by the seller, with limited visibility into the value assessment and cost of producing the data. It is important to note that the maturity and the efficiency of data markets will certainly play a critical role in achieving fair prices.

In reality, several parameters can be utilized to determine price of data. Below is a potential non-exhaustive list that can be utilized in Data Pricing [b-Heckman]:

- Value-based parameters (entails value of data as perceived by the consumer or as envisaged by the data provider):
    - The value of the data to create efficiencies for its consumers (e.g. saving time, effort, or money)
    - The Return On Investment (ROI) for the data consumer
    - Risk exposure – Anonymous data (sanitized so as to avoid personally identifiable information; private data could potentially be priced higher)
    - Data exclusivity – incorporates whether the data is provided on an exclusive or non-exclusive basis
    - Level of ownership – data purchase (entails transfer of ownership), data leasing (e.g. permission to use for a fixed time) or data licensing (e.g. permission for prescribed use for a jointly agreed purpose)
    - Willingness to pay
- Qualitative parameters (entails various other characteristics of the dataset):
    - Period (timeframe) of the data for which it is available
    - Reliability of the data
    - Brand recognition of the data provider (and/or creator)
    - Precision and correctness of the data
    - Complete availability of the data – missing fields for certain data elements, etc.
    - Structure of the data – format aspects such as plain text, streaming data, tabular datasets, etc.
- Cost based parameters:
    - Cost of creating and collecting the data
    - Cost of data storage, bandwidth, and various other DPM costs
    - Cost of additional data processing (e.g. data analytics, data aggregation, report generation)
    - Delivery scheme – one-time, periodic, or continuous basis.

The operational value of data (which is the cost of producing the data by the seller) can be easily determined from the marginal cost of creating, storing, and sharing the data. This is the minimum price that a seller can charge to cover the total cost of creating and providing the data. The market value of data is mostly determined through value-based parameters, which may pose challenges to quantify and model.

Following pricing mechanisms can be applied for data:

- Free (e.g. publicly available open data)
- Freemium (Freemium business models combine free services and premium services. Certain datasets are made available to customers for free, and specific datasets are delivered for a fee.)
- Pay per Use (use of dataset(s) is metered, and data consumers are charged when they use them)
- Subscription (customers sign up for periodic access to dataset(s))
- Others (e.g. flat-rate for dataset(s), promotional pricing such as buy one get one free or bundled pricing, combination pricing mixing various above mechanisms, etc.)

7.4 Data Licensing

Dataset(s) can be licensed to allow reusing and/or reselling data. Data License constitutes a legally binding agreement between the Licensor and the Licensee and includes the license terms and conditions.

Licensor creates (in some cases collects and aggregates) and maintains the data. Licensee obtains legal rights for using the licensed data from the Licensor. Data license agreement can contain several clauses potentially addressing the below issues, among others:

- Term of the license (time duration) and termination rights
- Exclusivity
- Transferability
- Permitted actions (e.g. reproduction, further usage, displaying, etc.)
- Availing it to other parties
- Security and data protections measures and obligations
- Ownership
- Attribution
- Intellectual property rights
- Updates to data and derivatives
- Payment and data fees
- Commercial usage limitations and terms
- Limitations of liabilities

Some commonly used data licensing schemes include public domain, creative commons (comprising different types of licensing under creative commons), open data commons, community data licensing, etc. Licensor can include various terms and conditions in the license agreement which constrain data with respect to above mentioned issues.

Hence, data licensing plays an important role in data commercialization by setting the rules, permissions as well as limitations regarding dataset(s).

7.5 Data Distribution Channel

Data distribution channel includes all organizations and intermediaries through which a data set is availed until it reaches its consumer.

It can include, among others, the digital channels of the organization (e.g. a company website) that created or aggregated the data (e.g. open data portal, data marketplace).

Hence, the owner of the data can determine which distribution channel or channels will be used to provide the data. In some cases, a single distribution channel may be selected, but in some cases multiple distribution channels can be used for availing data.

Commercial factors, including distribution channel costs, as well as others such as related terms and conditions may play a role in determining the appropriate mix of distribution channel(s).

7.6 Data Marketing

It is quite important to create awareness for data set(s) and to incentivize its usage[4]. Hence, organizations availing data (e.g. owners, intermediaries, etc.) can conduct various marketing activities to create awareness and to convey its value proposition to potential consumers of data.

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[4] In this Technical Specification, data marketing includes creation of awareness and incentivization of usage activities. In different contexts, marketing includes other activities such as data pricing, data distribution channel(s) selection. However, on purpose those are segregated to emphasize their importance.

These activities may include, among others, digital as well as offline marketing. Digital channels such as popular websites, social media sites, open data portals, etc. may be used for that purpose. In some cases, offline marketing through face-to-face activities can also be used (e.g. corporate data being marketed through such activities).

Data marketing can also include various promotion activities to incentivize usage. Data set prices can be changed to boost targeted usage. E-mail marketing campaigns, usage surveys, etc. can be conducted.

7.7 Data Sales

Data set(s) are sold to data consumers (customers) through distribution channels. Data sales includes all the activities to fulfil an order. In other words, receiving, processing and delivering an order is part of data sales.

Order processing also entails payment for the data set (if commercial). Digital payment types may need to be incorporated to process the order (e.g. credit card payment, online direct debit, etc.).

Similarly, order delivery includes activities to deliver data set(s) to a customer. The delivery can be done digitally (e.g. ftp transfer, online downloading of data) or through semi-digital channels (e.g. physical delivery of data set(s) in an encrypted USB).

Note: This deliverable has excluded other potential business processes such as order cancelation, customer support, dispute resolution, etc.

8 Data Commercialization & Business Models

Data provided and exchanged by consumers, organizations, and machines create an enormous potential for commercial value creation. In this context, new business models have emerged (and are still emerging) stemming from data creation, collection, aggregation, storage and processing. New types of market players, such as specialist intermediaries, have emerged assuming new roles for advertising or data related insights generation. More generally, data is being used to:

- Enhance the advertising and promotion of products and services
- Enable enhancements to existing products and services or their profitability
- Innovate new products and services utilizing data.

For example, online consumer data is used to increase advertising efficiency by understanding customer needs, better matching of advertising buyers and sellers, and customizing and personalizing products and services. Online advertisement spend is gradually replacing traditional bricks-and-mortar advertising spend. The ability to target and retarget online users has contributed to this shift.

8.1 Business Models for Online Customer Data

Several business models for online customer data already exist. Below are some prominent non-exhaustive business models in online customer data economy [b-Analysys]:

- Targeted Advertising Business Model
- Retargeting
- Personalisation and recommendations
- Data intermediation and sale of customer insights

[b-Analysys] includes various data and funds flows for the above mentioned business models in the online customer data economy.

8.2 Business Models for Organizational Data

In addition to online customer data, data belonging to organizations (both public and private sector organizations) have also enabled novel business models. Organizational data when utilized in a context, referred to as use case, may yield commercial value. Business models described in this section illustrate commercial value creation through organizational data.

Marketplaces

Internet has changed how individuals and organizations access and consume data. Due to ample availability of storage and processing options in Internet, data is increasingly being provided over Internet. In this context, data marketplaces have become quite important to enable provisioning and exchange of data.

Economics in general regards marketplaces to be the physical or virtual realization of markets. On the other hand, markets are the specific places where the interactions of buyers and sellers lead to exchange of goods and services (e.g. determine the price and the quantity of a good or service) [b-Stahl].

In contrast, the term marketplace for a given product (good or service) is the explicit actual place of encounter in terms of time and location where buyers and sellers conduct transactions, i.e., it provides the location, facilities and supporting mechanisms for trading. Hence, the difference between a market and a marketplace is a matter of abstraction. A marketplace is the infrastructure (physical or virtual realization) that enables the abstract concept of a market [b-Stahl].

Essentially, markets serve three main functions [b-Stahl]:

1. The market as an institution defines the rules that govern the behaviour of the participating entities.
2. The market is comprised of all market-based transactions. The transactions are composed of four main phases:
    a. the information phase where participating entities gather information on products and form concrete exchange intentions in the form of bids and offers;
    b. the negotiation phase where negotiations occur on the product, the contract terms, and the price with the intention of reaching an agreement;
    c. the transaction phase where the agreement is executed and the exchange takes place; and
    d. the after-sales phase where customer service is provided for improved customer satisfaction.
3. Markets are a pricing mechanism through which buyers and sellers interact to determine prices of exchanged products.

Data Marketplaces as an Example of Electronic Marketplaces

Based on the definitions above, electronic markets are based on electronic medium whereby transactions are handled through digital communication and transaction infrastructure. The three main market functions defined above; namely institution, transaction, and pricing mechanism, remain intact on electronic markets.

An electronic marketplace is the concrete agency or infrastructure that allows participants to meet and perform the market transactions through an electronic medium.

A data marketplace is an electronic marketplace whose main product is provisioning of data and / or related services around data. Data marketplaces offer a digital electronic infrastructure which allows customers to upload, browse, download, buy and sell machine-readable data.

Important Note: Despite meeting the above criteria, government agencies or non-governmental organizations (NGOs) providing free data are not deemed as data marketplaces because provisioning

and exchange of data is not their core business. They publish data as an auxiliary activity and are not interested in finding a commercial business model for it [b-Stahl].

Decentralized Data Marketplaces

Privacy, confidentiality and trust concerns may hinder organizations to share their data in a centralized marketplace (e.g. in an open data portal). Also, immature data markets and the fragmented nature of data available in disparate organizations and the extensive differences in terms of demanded and supplied data may potentially act as barriers for centralizing data.

Hence, decentralized marketplaces provide an alternative for addressing such concerns and federate data from several sources rather than centralizing it. Mechanisms such as tokenization and monetization can be applied to enable data exchange commercially.

Data Based Commercial Applications

The use of licensed data can enable ICT companies, entrepreneurs and start-ups to develop their own commercial products and services generating revenue. These services can be in the form of web-based services, mobile apps, etc. The end consumers of these commercial applications are individuals and businesses in most cases.

Data can be licensed through:

- Open data portals,
- Data marketplaces, and
- Peer-to-peer data provisioning arrangements.

The commercial application provider utilizes the licensed data and creates a new product or service by adding further value on top of the licensed data.

Smart City Use-Case Specific Commercial Solutions

This business model entails providing commercial solution(s) to a city public sector organization regarding a specific use case (or potentially a few use cases) by a private sector organization. The use case incorporates utilizing data as a key enabler and intends to solve or address an urban challenge or problem. The implemented solution may include use of IoT (Internet of Things) devices such as sensors, actuators, related data processing infrastructure and platforms.

These solutions are acquired through traditional procurement processes of city public sector organizations. They are funded mostly through public finances (e.g. city public sector organization budget).

Hence, the commercial solution provisioning for smart city use case(s) constitutes a business model. It creates an opportunity either for existing ICT solution providers or for start-ups through encouraging entrepreneurship.

Public Private Partnership (PPP)

In broad terms, PPP refers to public and private sector organizations working together to exploit synergies through innovative use of resources and management knowledge to achieve goals of both organizations (e.g. build-operate-transfer arrangements). PPPs vary depending on the degree of ownership of assets, capital expenditures and risk bearing investments (e.g. innovation investments, etc.). PPPs in general tend to have the following characteristics:

- A long term agreement related to the provision of a public service (city related)
- Private company receives a revenue stream from city public sector organization budget or from user charges or a combination of both which transfers risk to the private organization based on agreement
- Private company in most cases make an investment in the venture
- City public sector organization tends to contribute to the investments as well as share risk

- At the end of the agreement associated assets revert to city public sector organization

City public sector organizations may find it difficult or challenging to build and operate DPM platforms. Earlier introduced data value chain activities entail data related skills and competences which city public sector organizations may not necessarily possess. In such cases, city public sector organizations may opt to capitalize on PPP arrangements as a viable alternative. The partners involved in PPP may turn it into a commercially viable venture by jointly formulating a business plan and target revenue schemes from data related services. Data related services may include, among others, collecting and provisioning of data, processing and analysing data, generation of new algorithms (e.g. artificial intelligence based algorithms) to address urban problems.

8.3 Other Innovative Business Models

Given the significant potential of data, other novel business models can emerge in due course. The abundance of IoT data, data marketplaces, data sharing arrangements, etc. can potentially catalyse proliferation of new business models. Similarly, application and enhancement of data analytics and data processing techniques and methods (e.g. AI) will potentially give rise to novel successful commercial business models.

Another emerging business model is data trust. Data trust entails creation of intermediaries with fiduciary responsibilities between data trustees and trustors which provide independent stewardship of data. It has disclosure and governance obligations that provide privacy controls while achieving data aggregation and anonymity for data commercialization. The trustees assume a legally binding role for data issues considering the interests of beneficiaries (similar to commercial banks' aggregation function for household savings with fiduciary responsibilities through well-defined regulations).

Data driven innovation will play a critical role in attaining additional innovative business models.

9 Data Economy & Data Ecosystem Enhancement

Data economy exists in a broad context and is influenced by several factors which directly and indirectly shape or impact it. These factors may be considered peripheral; however, they tend to affect how various DPM activities are in reality conducted.

The term data ecosystem is used to include all other value adding peripheral and non-specific factors. More specifically, the following comprise the data ecosystem in this Technical Specification:

a. Data Laws, Regulations and Policies
b. Data Standards
c. Data Skills
d. Data R&D Programs
e. Data Entrepreneurship
f. Data Economy Financial Incentives
g. Data Platforms.

Sections 9.1 to 9.7 discuss these briefly and address their relevance to overall data economy.

9.1 Data Laws, Regulations and Policies

Data laws, regulations and policies determine and shape various actions regarding data processing and management. However, there are differences among laws, regulations and policies.

More specifically, data laws and regulations can be thought of as data rules promulgated by legally authorized bodies such as a government agency or an appropriating agency. They both are enforced to the full authority of the law; and violations of both may incur penalties (e.g. fines, imprisonment).

However, laws go through a legislation process before being enacted as laws; but regulations are created by an authorized agency (e.g. government) and do not have to go through the legislation process. In some cases, regulations are formulated to implement a given law.

On the other hand, policy is a deliberate system of principles to guide decisions and achieve certain intended outcomes. Policies are generally adopted by a governance body within an organization[5]. In a broader form, a policy is a plan of action adopted or pursued by an individual, government, organization, business, etc.

Hence, DPM organizations and authorized agencies can formulate data laws, regulations and policies within their jurisdictions, where applicable. Each of the three can be considered as an alternative (or potentially viable) instrument (or tool) to guide DPM activities within a jurisdiction. They can also be used to complement each other. For example, a government agency can issue a data law (e.g. California consumer privacy act, Dubai data law) which governs data processing and management within a state or city jurisdiction; or similarly a company can issue a data policy which governs data processing within the company itself.

Data laws, regulations and policies can address one or more of the following general data issues (among others):

- Data and data rights ownership – who owns data and data rights, rules for transferring or delegating ownership, etc.
- Data classification and metadata – how data is classified and categorized, what metadata is used for the actual data (e.g. administrative, structural, descriptive metadata6)
- Data protection and security – who is authorized to process data and for what purposes, how integrity and accuracy is maintained, how to store, archive and dispose data, how to secure data to achieve confidentiality, integrity and availability.
- Data privacy – if personal data can be stored or collected, how or whether data can be shared (exchanged) with other parties (e.g. anonymization, pseudonymization).
- Data transparency and consent – whether there is transparent access to who uses the data and for what transactions, whether there is informed and explicitly expressed consent of what (personal) data moves to whom, when, and for what purpose from the owner of the data.
- Data commercialization – how data is monetized, licensed, distributed, marketed, sold, etc. and related guidance and restrictions as well.

As data economy grows and matures, each jurisdiction by itself or through collaboration with other jurisdictions (locally, regionally or globally) may formulate regulations and policies [b-G20] balancing the preservation of the rights of individuals, encouragement of competition and innovation in data economy, and enabling free flow of trusted data (via interoperability mechanisms). Competition authorities (e.g. agencies, commissions, bureaus) may define appropriate markets in data economy to stimulate competition within their jurisdictions. Various competition boosting laws / regulations can be formulated or applied in the context of data economy if deemed necessary (e.g. anti-trust laws).

On the other hand, public sector procurement regulations (and private sector procurement policies) may encourage and, in some cases, may mandate data related clauses to use procurement as a lever to boost data economy. Stipulations pertaining to, among others, openness, accessibility, sharing, standards compliance, and interoperability of data may help boost data economy.

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[5] Source: Wikipedia

[6] https://en.wikipedia.org/wiki/Metadata

Existence of data laws, regulations or policies may enhance trust in DPM systems. They would define and shape the landscape in which DPM activities take place. Therefore, they play an important role in the overall data ecosystem.

9.2 Data Standards

Data standards ensure consistency through documented agreements in terms of potentially how data is formatted, described, structured, stored, processed, shared (exchanged), used, managed and interpreted. Data standards enable compatibility and interoperability among DPM systems.

Standards have several benefits as they:

- provide efficiency through reduction in requisite overhead (in the absence of data standards),
- enable further innovation by capitalizing on existing data standards,
- avoid proprietary solutions and implementation decisions which in due course may become excessively inefficient as the needs for compatibility and interoperability arise.

Hence, SDOs formulate various data standards to address these needs. Data standards can be industry specific (e.g. healthcare data standards) as well as industry neutral (e.g. generic open data standards) depending on the context and actual need.

Data standards play an important enabling role in boosting data economy and the overall data ecosystem since multiple stakeholders partake in them. Having commonly agreed standards catalyse and enable collaboration and cooperation among different stakeholders involved in DPM and allow them to adopt a unified language and provide various shortcuts for DPM innovation and solutions implementation.

9.3 Data Skills

DPM techniques have the potential to spur innovations that can transform and disrupt various industries and sectors in economy. The proliferation of data as a result of digitization and automation efforts, deployment of information systems, IoT based systems, machine to machine communication, etc. is enabling unprecedented possibilities for DPM. Businesses that use data effectively are increasing their output and productivity7.

However, capitalizing on DPM opportunities also require DPM skills availability. Lack of DPM skills such as data specialist and data science skills may hamper achieving potential economic, social and environmental benefits provided by DPM.

More specifically, some of the requisite skills and competencies required from DPM include, among others:

- Solving structured as well as unstructured problems by utilizing data,
- Collecting and making sense of data, drawing insights from it,

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[7] Brynjolfsson, E., L.M. Hitt and H.H. Kim (2011), "Strength in numbers: How does data driven decision making affect firm performance?", Social Science Research Network (SSRN), 22 April, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1819486.

Bakhshi, H., A. Bravo-Biosca and J. Mateos-Garcia (2014), "Inside the datavores: Estimating the effect of data and online analytics on firm performance", Nesta, March, www.nesta.org.uk/sites/default/files/inside_the_datavores_technical_report.pdf, accessed 25 May 2015.

Bakhshi, H. and J. Mateos-Garcia (2012), "Rise of the datavores: How UK businesses analyse and use online data", Nesta, November, www.nesta.org.uk/sites/default/files/rise_of_the_datavores.pdf, accessed 13 May 2015.

- Performing data analytics and quantitative reasoning (i.e. mathematics, statistics and to a certain extent database management skills),
- Demonstrating creative and social intelligence.

Ensuring sustainable availability of DPM skills has implications for the formal education system as well as life-long learning systems. A strong foundation in STEM (science, technology, engineering and mathematics) skills including statistics, computer science, coding, etc. would be helpful. However, domain knowledge and a broad understanding of legal issues such as privacy, property rights, etc. would also be helpful among others.

In addition to above mentioned specialized data skills, it is also important to address data user skills availability. Basic literacy around using and manipulating data is also important as data becomes pervasive in many activities in the economy.

Following is a list of some example action items that can be potentially taken by cities and nations to enhance their DPM skills availability:

- Changing curricula in the formal education system to incorporate some of the aforementioned skills and competencies in existing courses and degrees
- Creating new degrees around DPM skills (e.g. Master of Science in Data Science)
- Creating internships and placement programs for DPM
- Providing workplace and professional DPM training programs
- Taking MOOC (Massive Open Online Courses) and providing incentives for them
- Providing DPM challenges, actual projects, etc. to encourage on the job learning and training
- Organizing DPM related contests, competitions, awards, etc.
- Provide platforms to exchange knowledge among DPM practitioners and interested candidates.

The list above may be extended to include other targeted action items depending on each jurisdiction's particular challenges and opportunities regarding DPM skills demand and supply. The timing of skills needs also is an important factor in formulating an appropriate mix of the above action items (e.g. short-term skills deficit versus long-term sustainability).

9.4 Data R&D Programs

DPM is a relatively novel field which encompasses a wide blend of topics ranging from data processing & management, data trust and security to data commercialization and governance. Each and every topic potentially entails a large number of research and development areas.

In this deliverable data commercialization and data economy were discussed to a certain extent. However, several open research questions exist for these topics. For example, no widely accepted data valuation and data pricing schemes exist for datasets; similarly impact assessment for DPM initiatives is a relatively novel field and will require further research and modelling techniques to be developed. These examples can be extended to various other topics within the confines of DPM.

As these simple examples illustrate, DPM in its entirety poses several research questions which will necessitate further development. Therefore, cities and nations can formulate their own DPM challenges and priority areas by engaging their stakeholders and then undertake research and development (R&D) programs to address them.

R&D programs will allow not only addressing particular challenges but will also help build DPM skills and knowledge for the long term which can in due course be tapped into. Government, academia and private sector can collaborate closely to identify and conduct R&D programs regarding DPM. Specific funds can be allocated for R&D programs reflecting particular DPM needs and priorities. Institution and project-based R&D funds can be created.

Multidisciplinary DPM related R&D programs can be funded to incentivize collaboration among multiple institutions and the industry. Social, economic and environmental objectives and missions such as climate change, sustainability, economic growth, etc. can be addressed by specific R&D programs utilizing DPM.

Knowledge gained through R&D programs have spillover effects into other domains as well and can potentially be commercialized in due course resulting in economic value. R&D programs will enhance research as well as innovation capacity in DPM.

9.5 Data Entrepreneurship

Innovation will be quite important in DPM as it is a relatively novel field with stupendous potential. Start-ups and new businesses are known to adopt new technologies in an agile manner and apply them to real life contexts by assuming the requisite risks and rewards for it.

Hence, encouraging DPM entrepreneurship and providing a rich environment conducive to innovation will be crucial. Demand-side policies and approaches can help DPM entrepreneurship flourish. Public sector driven whole-of-government approaches such as smart city strategies, AI strategies and policies, IoT strategies, etc. create ample demand for DPM and tend to also catalyse private sector investment in those fields including start-up activities. Similarly, industry boosting (vertical) strategies may also help create demand for DPM entrepreneurs (e.g. Industrial IoT strategies).

It is important to create a business environment that fosters DPM start-ups and expansion of new firms. Therefore, it would be helpful to reduce DPM firms' entry and exit barriers to flourish innovation. Easing and simplifying regulations and administrative burdens for starting a DPM business would help reduce barriers to entry. Similarly, reducing burdens on exit (e.g. through bankruptcy laws, merger and acquisition laws, etc.) would also avoid discouragement for starting a DPM business since start-ups tend to have high uncertainty for their chances of survival.

Start-ups can also be supported by incubators and accelerators. They both offer ways and opportunities for entrepreneurs to grow their businesses, and also increase their chances of attracting capital (e.g. from venture capital firms). Accelerators accelerate existing companies' growth, whereas incubators help incubate new, and mostly disruptive, ideas to turn them into a viable business model and a new company. Usually, accelerator programs have a fixed timeframe, whereas incubators tend to operate without a set schedule. Both schemes provide mentorship and business acumen in addition to various technical assistance and facilitation of financing.

Innovation in DPM will be essential in ensuring its sustainability and growth as a promising economic sector. In this context, entrepreneurship may act as a major supporting pillar to data economy.

It is important to note that in some cases data owners' ability to process and create value from data may be lesser than data non-owners' (e.g. entrepreneurs, start-ups, etc.) ability to create and enhance value from it resulting in an asymmetric risk. This risk can potentially be mitigated through different means such as commercial negotiations, legal agreements. data sharing regulations, etc.

9.6 Data Economy Financial Incentives

A financial incentive is a monetary benefit to motivate or encourage certain behaviours or actions. Since data economy is a relatively new field, financial incentives can be utilized to encourage investment in it by organizations, companies, entrepreneurs, etc.

Existence of policies to ensure access to finance would assist data economy. A healthy financial sector would be desirable in general. DPM start-ups and entrepreneurs as new entrants tend to face financial restrictions due to lack of successful business history and uncertainty in the valuation of their assets. Therefore, mature venture capital markets, and the securitisation of DPM innovation assets (e.g. IP) might be key sources of their finances. Seed capital and start-up financing by angel funds and networks would be beneficial.

Below is a list of non-exhaustive financial incentives that can potentially be utilized to encourage data economy (below may be applied to general finances of DPM companies or alternatively to their R&D specific investments as well):

- Tax breaks,
  - Tax exemption,
  - Tax deduction,
  - Tax credit,
  - Tax holidays,
  - Capital allowances and adjustments in capital gains taxes,
- Reduced loan rates,
- Public private partnerships,
- Investment subsidies,
- Reductions in miscellaneous contributions (expenditures such as pension fund, health insurance, etc.).
- Cross-border DPM services trade regimes,
- Cross-border tax treaties, foreign tax credits, etc. to encourage sales of cross-border DPM services.

Aforementioned list of financial incentives is a potential list and needs to be scrutinized and tailored based on the particular needs of each jurisdiction and its specific economic condition, structure and priorities.

9.7 Data Platforms

Data platforms are centralized systems for, among others collecting, aggregating, analysing and processing large sets of data. They provide connectivity and DPM capabilities by architecting and implementing DPM related ICT infrastructure, solutions and services.

The main advantage of the availability of data platforms is the readily available DPM solutions which enable:

- Core business focus (as opposed to building a DPM platform from scratch and then implement the business solution),
- Cost savings through economies of scale (especially beneficial for start-ups and SMEs that cannot afford to invest in data platforms due to their financial limitations),
- Reduced implementation times (circumventing the need for DPM infrastructure and services implementation),
- Scalable and flexible availability of DPM services,
- Democratization and commoditization of DPM services.

Examples of data platforms include public and private cloud solutions for DPM among others. There is a multitude of diverse data platforms providing different capabilities (e.g. public cloud platforms, infrastructure and platform as a service, big data solutions, AI solutions, IoT DPM capabilities, etc.).

Data platforms' availability has the potential to expedite and also encourage DPM solutions availability; which in turn acts as an enabler and catalyser for data economy.

10 Data Economy Impact Assessment

Data initiatives have a multitude of impacts. It is quite significant to identify and asses this impact. Identification and assessment of impact will allow better risk mitigation, initiatives planning, setting and managing expectations with stakeholders, well-informed budgeting, and benefits realization among others. This will also help in communicating DPM initiatives.

It is important to take a broad perspective and assess the impact of data initiatives. International Association for Impact Assessment (IAIA) defines impact assessment as "the process of identifying the future consequences of a current or proposed action". Impact assessment can help owners of DPM initiatives as well as their stakeholders determine the extent of impact for their data initiatives. It can be used to identify and circumvent the negative and unintended impacts while capitalizing on and enhancing the positive and sustainable impacts further.

Ex-ante impact assessment: Ex-ante impact assessment entails conducting a prospective analysis of what the impact of Data economy policies and DPM initiatives might be. In general, it intends to inform data economy policymakers and DPM initiative owners for the potential future consequences.

Ex-post impact assessment: Ex-post impact assessment entails conducting a retrospective analysis of what the impact of Data economy policies and DPM initiatives have been. It also permits evaluating whether intended consequences are attained or not.

In general, it would be beneficial to compare ex-ante and ex-post impact assessments to compare and contrast their results. Discrepancies would allow taking course correcting actions and also identification of lessons learnt.

Data economy impact in this document will be assessed along the social, economic and environmental dimensions.

10.1 Social Impact Assessment

Social impact assessment (SIA) identifies and analyzes the data related issues which impact people and their lives as well as the society at large related to DPM initiatives. Social impact specifically captures issues related to what people think, require, and wish as well as their concerns and aspirations among others related to DPM initiatives. It is important to indicate that social impacts can be experienced both in perceptual or in real sense, or both (unlike environmental impacts which are experienced in real sense).

Social impacts can be assessed through a well-planned inclusive process by involving and engaging DPM stakeholders. DPM initiatives purposely and also inadvertently introduce changes in people's lives by utilizing ICT and data related technologies.

Social impact refers to consequences of DPM initiatives to people and the society at large. It also includes cultural impacts of DPM initiatives involving changes to the norms, values, and beliefs that guide and rationalize their cognition of themselves and their society.

Social impact may involve one or more of the following areas (depending on selected DPM initiative):

- lifestyle –how people conduct their lives and interact with each other on a daily basis;
- culture – the common beliefs, traditions, etc.;
- community – joint communal aspects;
- participation and engagement – the degree to which people engage and participate in DPM initiatives;
- health and wellbeing – impact of DPM initiatives on people's health and overall well-being;
- personal freedom – includes cases where people experience violation of their civil liberties including, but not limited to, security, general freedom, and privacy;
- fears and aspirations – overall security and safety concerns at the individual, family and collective communal levels.

Social Impact Assessment (SIA) incorporates assessing various social ramifications, both positive and adverse, of DPM initiatives. It helps identify various social issues and risks associated with DPM initiatives beforehand.

SIA aims to increase the gains of DPM initiatives while also reducing their potential undesirable implications, more specifically the social ones.

For example, open and shared government data allows for engagement and collaboration between a range of stakeholders: within the public sector; between public and private sector entities; and between the government and the citizens of a country. Citizens' use of open data enables them to become better informed in government matters and in decision-making. This can lead to further impacts for the government including enabling greater transparency, accountability and strengthened public debate. In doing so, it may also enhance citizens' satisfaction and happiness. Open government data also has the opportunity to improve citizens' quality of life, by enabling them to make more informed decisions. Residents and visitors can use open data to make more informed decisions and better choices in many aspects of their lives including finance, healthcare, education, and transportation. This can "enhance the quality of their lives. Parents can access information on school performance, teacher absence, use of IT and other factors to support their decision making about where to send their children to school. This information leads to happier citizens and that there will be a wider societal impact as schools are encouraged to improve performance which could then increase educational attainment [b-Cucos]. Installed transponders on city buses enabled individuals to locate the buses in real time which, in turn, increased ridership by 12 per cent and reduced congestion in the city (as less people chose to drove) [b-Manyika] .

New disruptive and emerging technologies may press existing businesses to reduce employment opportunities leading to social resistance (e.g. Artificial Intelligence algorithms applied to data may potentially replace human beings). Solving mobility issues (e.g. traffic congestion reduction) through DPM techniques may make people feel better living in their communities and cities. Reducing greenhouse gas (GHG) emissions through air quality data processing and management may enhance the health and the well-being of individuals. Leading edge data skills may be scarce and may pose a skills divide in the labor force for employment which may create a certain level of anxiety. Unconsented sharing and usage of consumer data may cause security and privacy concerns and may adversely impact trust and confidence in them if not addressed properly.

On the other hand, economic prosperity and new job opportunities may have positive impacts on people and communities in the city. Rising living standards and disposable income may render city residents more confident about themselves and about their futures; alleviating their job security concerns. People can empower themselves and enhance their well-being through various means in their city lives. These are some non-exhaustive examples to illustrate the concept.

SIA ensures that DPM initiatives:

1. consider and envisage important social issues;
2. include stakeholders' engagement;
3. undertake a well-defined impact assessment approach.

The actual SIA for a given DPM initiative would be a comprehensive list regarding the specific DPM related issues.

10.2 Economic Impact Assessment

Economic impact assessment identifies and analyzes the economic effects and contributions of DPM. Economic impact can be viewed in terms of aggregate economic activity, Gross Value Added

(GVA)8 or Gross Domestic Product (GDP), productivity, wealth, personal income, jobs and labor force among others. DPM and data economy initiatives can qualitatively and quantitatively analyze economic impacts.

The extent to which different types of data create economic value is to some extent dependent on the make-up and the consumer and business behaviour of its economy within that context. For example, if a certain sector or industry is a small portion of an economy, the importance of data relating to it is relatively much lower.

Top-down and bottom-up economic impact assessment: Economic impact can be assessed either through a top-down or a bottom-up approach. Top-down assessment looks at overall changes in the economy and selected key economic variables (e.g. GDP, GVA, etc.) and seeks to understand the extent to which those economy-level changes can be attributed to data economy policies or DPM initiatives. Top-down economic impact assessment can be done through econometric modelling with a measure of the data economy policies or DPM initiatives as one explanatory variable, alongside a range of other variables that could explain the changes being observed in the selected key economic variables.Naturally, there is a need to have sufficient number of data points for each of the vaiables to apply such econometric models. Furthermore, and perhaps most importantly, it is often difficult to establish a cause and effect relationship between the data economy policies or DPM initiatives and changes observed in the macroeconomic impact measure.

Bottom-up approach based on a theory of change of how the inputs and activities associated with a DPM policy or intervention ultimately lead to end impacts in the economy. The relationships between impacts and the DPM policy or intervention are often complex, therefore describing the relationship between an input, activity, outputs / outcomes and impacts is key. This can be done through the use of a logic model which is a systematic and visual way of presenting the interactions between inputs, activities and impacts. Elements of this logic model can then be quantified and/ or monetized to build up to an estimate of the end impacts attributable to the DPM policy or intervention. This approach requires the collection of more data than an econometric modelling, top-down approach, and therefore can require greater resources to implement. However, it provides a greater level of granularity of the factors driving the end impacts and so provides more detailed insights into how impacts are generated and the levers to impact that can be pulled to attain more significant end impacts.

One commonly used approach is the Leontief input model for assessing economic impact [b-Leontief]. The following is excerpted from ITU-T Y.4905 Recommendation “Smart Sustainable Cities Impact Assessment” and applied to the DPM context. Leontief model estimates economic impacts at direct, indirect, and induced levels:

- Direct impacts arise from direct expenditures associated with DPM initiatives (e.g. DPM related goods and services procurement and implementation, additional DPM skills needs, etc.).
- Indirect impacts arise from the suppliers of DPM initiatives procuring goods and services and recruiting new employees (i.e. creating new DPM related employment) to meet the DPM initiatives demand.
- Last, but not the least, induced impacts include disbursements stemming from the additional income in DPM initiatives involved households (households that received extra earnings due to DPM initiatives and spend it on various other items). Induced impacts are spill-over impacts to various sectors in the economy.

The indirect and induced impacts are in general called secondary impacts.

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8 GVA is defined as “the value of output less the value of intermediate consumption; it is a measure of the contribution to GDP made by an individual producer, industry or sector” [b-OECD2].

In this approach, data economy assesses economic impacts by the Leontief Input Output Model (IOM) [b-Leontief1] which describes a simplified view of the economy if the Leontief Input Output Model (IOM) is available.

The main objective of IOM is to estimate the level of production for each of several types of goods or services in an economy. More specifically, it is used to estimate how a change in demand for one sector effects the entire economy. Input-Output tables in IOM organize the business sector of an economy in terms of which sectors produce what outputs and which ones uses what inputs. In essence, it is a matrix of inputs and outputs in an economy. IOMs help in estimating how an increase in demand for a product of one sector could impact other sectors and the economy as a whole.

In other words, IOMs are used to construct Input-Output multipliers which can be used to estimate the economic impacts of incremental spending in an economy [b-Miller]. Hence, direct multipliers measure direct impacts which are changes that occur in businesses that would initially receive expenditures and revenue as a direct consequence of the DPM initiatives. On the other hand, indirect multipliers measure indirect impacts stemming from changes in activity for suppliers of businesses related to DPM initiatives. Induced multipliers measure induced impacts stemming from shifts in spending on goods and services as a consequence of changes to the payroll of the directly and indirectly affected DPM initiatives related businesses (i.e. they constitute additional household income, sometimes also referred to as consumer surplus).

10.3 Environmental Impact Assessment

Environmental impact assessment (EIA) is an analytical process that systematically examines the possible environmental consequences of the implementation of projects, programmes and policies [b-OECD1]. Hence, in this deliverable environmental impact captures anticipated effects and consequences of DPM policies and initiatives on water, energy, emissions, air, land, waste and in general on urban natural environment and resources (in a city). EIA allows a comprehensive impact assessment going beyond the social and economic impacts discussed in the previous sections.

Environmental impact intends to assess one or more of the following areas (depending on selected DPM initiative):

- water – its usage and consumption and also potential loss (e.g. water supply leaks); planning for water sources, water availability, and also measuring and enhancing water quality;
- energy – its usage and consumption and also potential loss (e.g. energy transmission leaks); planning for energy sources (e.g. energy mix in terms of renewables) and energy availability;
- emissions – the extent to which greenhouse gas (GHG) emissions are affected and its impact on climate change;
- air quality – how DPM initiatives affect the particulate matters in the air and affect air pollution;
- waste – changes in waste collection, treatment, disposal, recycling, etc.;
- resilience – prevention or preparation for natural disasters (flooding, earthquakes, fires, landslides, etc.);
- land and soil – changes in land use and allocation, soil quality and quantity;

  biodiversity – the extent to which biological diversity is affected in terms of species, specifically on endangered and protected species, flora, fauna and landscape changes;

The environmental impact types can be summarized into following categories:

1. Efficiency,
2. Availability,

3. Cleanliness,
4. Diversity.

Each type is briefly discussed below.

Efficiency: DPM initiatives may create environmental resources efficiencies by conserving them or by reducing their consumption. Resources such as water and energy can be conserved by taking targeted actions for reducing their consumption. For example, consumption data can be used to adjust tariffs for shaping resources demand; it can also be used for disincentivizing high consuming households and businesses through various measures (e.g. creating awareness, avoiding high consumption appliances, etc.). Similarly, DPM based IoT solutions can be deployed to detect resource transmission leaks (e.g. water and electricity transmission leaks) and can help in mitigating such resource draining occurrences.

Important Note: Efficiencies in resources such as water and energy will also result in economic impact, which can be quantified separately under the economic impact.

Availability: DPM initiatives can enhance the availability of resources and municipal services such as waste collection. DPM based IoT solutions can detect water and electricity supply interruptions more effectively (e.g. detecting supply failure locations more precisely as well as their reasons). Hence, by utilizing data, supply interruptions can be fixed more rapidly, leading to enhancements in resource availability for consumers.

Similarly, waste collection can be enhanced by circumventing the need for collecting partially filled waste-bins through IoT based sensors and their deployment across the cities. This will have a dual benefit of reaching more areas with the same waste collection resources by creating efficiencies (e.g. trucks, staff, etc.) and in turn, will increase the availability of access to waste collection as a basic municipal service.

Cleanliness: DPM initiatives can enhance the purity and cleanliness of environmental resources such as water and air. Air and water pollution are both potential hazards to human health. DPM based solutions can measure contamination in terms of various chemicals and particles in both water and air and can guide targeted mitigation measures. Air quality also includes electromagnetic radiation and noise. DPM based solutions can detect whether certain thresholds have been reached and even surpassed and can also help in identifying sources.

Diversity: DPM initiatives can help in enhancing the diversity of environmental resources. More specifically, they can help in identifying new fresh water sources by using geological data. They can also help in diversifying energy sources into more renewable and clean energy forms. Similarly, data can be collected on biodiversity in urban areas to ensure preservation of existing diversity.

10.4 Scoping Boundaries for Data Economy Impact Assessment

This section is based on the scoping boundaries defined in ITU-T Draft Recommendation "Smart Sustainable Cities Impact Assessment" [ITU-T Y.4905] and applied to the DPM context. This clause provides general guidance on how impact can be assessed for DPM initiatives. A number of DPM initiatives may be implemented with distinct scopes. It is important to determine the impact assessment boundaries and apply a well-defined process.

Initially, the time horizon for impact assessment should be determined prior to conducting impact assessment. More specifically, the data economy impact assessment should clearly indicate the timeframe for assessment with a well-defined initial and completion time. Impacts should be identified for this timeframe.

Data economy boundaries in this Draft Technical Specification consist of three types:

- geographical,
- initiative, and

- impact.

Boundaries establish the scope of the data economy impact assessment as defined in this Technical Specification.

Geographical Boundary:

Impact assessment should determine the geographical boundary (i.e. the actual physical or territorial boundary) for which the impact assessment will be conducted. As examples, an entire community, city or nation boundaries may be used or a different geographical boundary may be selected for impact assessment (e.g. a subset of administrative boundaries).

DPM initiatives may impact beyond their immediate location of implementation. Hence, it is important to consider suitable spatial boundary for identifying DPM initiatives impact.

DPM Initiative(s) Boundary:

It is important to determine the scope of DPM initiative(s) for which the data economy impact assessment will be conducted.

One or more DPM initiative(s) may be included as part of the impact assessment or a portion of an initiative as well.

Various factors such as size, dependencies, complexity, and implementation timeframes may be used as possible factors to consider in selecting which DPM initiative(s) to incorporate in the data economy impact assessment.

Impact Type Boundary:

It is essential to decide which of the three main impact types will be incorporated in the data economy impact assessment; i.e. social, economic and environmental.

In general, an all-encompassing approach can be taken and all three aforementioned impact types can be included in the data economy impact assessment. That is, social, economic and environmental perspectives will be included during the impact assessment.

Various stakeholders can be consulted to initially assess potential impacts for the DPM initiatives. Consultation with government officials, related businesses, NGOs and also selected individuals and community members might help identify which impact type(s) to include for data economy impact assessment.

Baselining for DPM impact assessment

Baselines should be determined before conducting a data economy impact assessment.

Baselining refers to identification of initial status against which future impacts will be predicted. Impact assessment starts from the baseline and estimates further impacts which will potentially occur as a consequence of implementing scoped DPM initiative(s).

Hence, the scoped DPM initiative(s) when implemented will change the baseline and will give rise to new impacts. Data economy impact assessment should try to factually and correctly estimate these changes within the scoped boundaries of DPM initiative(s).

Field research and analyses for DPM impact assessment

The required research and analyses, both quantitative and qualitative, for assessing data economy impact should be determined.

Data economy impact assessment can utilize various research tools and techniques such as targeted engagements including individual interviews, focus groups, online surveys, etc. The results obtained from research should be collected and processed for further analysis. Research results will help in understanding various issues and will also aid in reaching evidence-based conclusions. Quantitative

modelling techniques can be used if requisite data is available and the scope of impact analysis requires such (e.g. econometric analysis).

Impact assessment should clearly identify appropriate stakeholders who will be involved during research and analyses.

In certain impact assessments, third-party organizations (e.g. research companies) can assist in terms of conducting research.

Both primary and secondary data sources may be utilized during the impact assessment. Public and private sector organizations, NGOs, members of the community and various key individuals may perform as data sources.

Data sources, data collection techniques and the data itself should be recorded and available for verification and audits, where needed. The quality of data is quite important as it will directly influence the accuracy and the validity of the research results.

Resource requirements should be planned and requisite resources (e.g. human and financial) should be allocated to ensure the success of field research and analyses.

Impact evaluation and mitigation

Subsequent to conducting the impact assessment, potential impacts will be identified. It is also crucial to identify the relative importance of each potential impact to determine potential mitigation measures.

These measures may avoid, accept, reduce or minimize undesirable and possibly harmful (risky) potential impacts while preserving and increasing desirable and favourable ones. Following measures can be considered for mitigation of potential impacts:

i. ***Accept impacts:*** the potential impacts can be agreed and possibly tolerated in some cases. Hence the DPM initiative(s) can be implemented.

ii. ***Reduce impacts***: the potential adverse impacts can in some cases be reduced by taking targeted actions. For example, policies and regulations may eliminate concerns of individuals, organizations and communities related to data in certain cases. Training and reskilling programs may boost the skills of existing labor force and may also create new employment opportunities diminishing resistance to DPM initiatives (if any).

iii. ***Monitor impacts:*** the potential impacts are closely watched and monitored during the implementation of the DPM initiative(s). Actual outcomes may necessitate taking further mitigation actions. Adverse impacts, if they occur, may trigger such actions.

iv. ***Avoid impacts:*** in exceptional cases DPM initiative(s) may be abandoned due to identified adverse impacts which critically obstruct their implementation. Prior to abandoning DPM initiative(s), various alternatives for reducing or monitoring impacts should be considered.

On the other hand, desirable (favourable) impacts act as a strong lever to highlight and convey the positive aspects of DPM initiatives to their stakeholders. They can facilitate easier funding for them.

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