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Statistics Finland

Mini-Presentation for SPPI on

Data Processing, Hosting and Related Activities (ISIC 6311) with Emphasis on Cloud Computing

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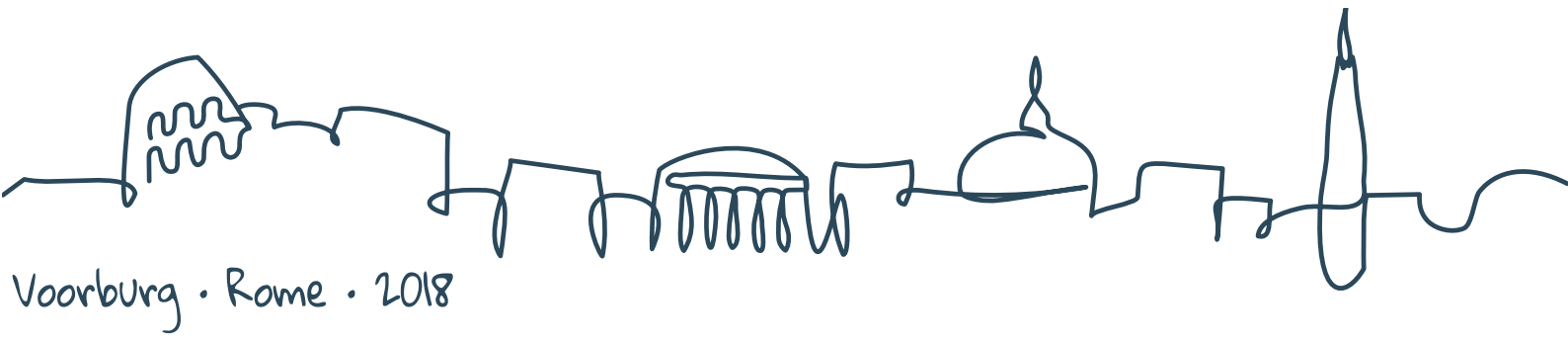


1. Description and Characteristics of the Industry

1.1. Definition of the Industry

Definition of the Service

This paper focuses on data processing, hosting and related activities with an extra emphasis on cloud computing. According to the International Standards Industrial Classification of All Economic Activities (ISIC), Rev. 4, class 6311, Data processing, hosting and related activities, includes the following services: provision of infrastructure for hosting, data processing services and related activities, specialized hosting activities such as streaming services, application hosting and web hosting. An important characteristic of web hosting service is the promise of a secure and reliable site and Internet connections that can be quickly scaled to accommodate variations in traffic use. Frequently, consulting, customization and systems integration are part of the package. Applications are frequently e-commerce related and enable on-line storefronts, shopping carts and catalogues with advanced and complex features such as order processing, fulfilment, procurement, invoicing, transaction processing, customer relational management and back-end database and data warehouse integration and migration services.[1]

Furthermore, application service provisioning and general time-share provision of mainframe facilities to clients are included. This industry also comprises establishments providing data entry services and data processing activities such as complete processing of data supplied by clients and generation of specialized reports from data supplied by clients.

As mentioned above, also streaming services are included in this industry. Based on the discussion and notes[2] from the 32nd Meeting of the Voorburg Group on Service Statistics, the IT portion of streaming on a fee basis is classified to ISIC 6311, Data processing, hosting, and related services, which links to Central Product Classification (CPC) 83159, Other hosting and IT infrastructure provisioning services. Establishments offering these services provide only the infrastructure without controlling the content.

In the Statistical Classification of Products by Activity (CPA 2015) the class 63.11, Data processing, hosting and related services, is comprised of two categories and five subcategories which are shown in the Table 1.

[1] Eurostat, (2015)
[2] Murphy, J. (2017)

TABLE 1.
Class 63.11 in Statistical Classification of Products by Activity (CPA 2015)

CPA	Name
63.11	Data processing, hosting and related services
63.11.1	Data processing, hosting, application services and other IT infrastructure provisioning services
63.11.11	Data processing services
63.11.12	Web hosting services
63.11.13	Application service provisioning
63.11.19	Other hosting and IT infrastructure provisioning services
63.11.2	Advertising space or time in Internet
63.11.20	Advertising space or time in Internet

Classification Issues

It should be noted that several information and communication services often overlap. Especially, many units classified to the following groups produce many of the services as their main or secondary activity: 582 Software publishing, 620 Computer programming, consultancy and related activities and 631 Data processing, hosting and related activities; web portals. For example, a quarter of the output of enterprises classified to class 6311 comes from computer programming, consultancy and related services (group 620) in Finland in 2016 (Statistics Finland, Business Services Statistics, 2016).

Furthermore, the classification of different data processing, hosting and related services on a product level is rather challenging. There might be difficulties for the reporting units to classify their services correctly in the above-mentioned industries. For example, designing the structure and content of a web page and/or of writing the computer code necessary to create and implement a web page is classified to CPA 62.01.11, IT design and development services for applications. Instead, service contracts where the design and development of a web page is bundled with the hosting of the web page belongs to class 63.11.12, Web hosting services.

Especially, as it comes to increasingly popular cloud computing services, it might be difficult to classify these services because they are not yet explicitly defined in the classification. There are different kinds of cloud products which are discussed in more detail in section 1.3, such as Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS) and Infrastructure-as-a-Service (IaaS). There are different views, how to classify these services. For example, Eurostat Task Force “Price and volume measures for service activities” suggests that: “The supply of SaaS should be classified with other software: CPA 58.2 (Software publishing services). PaaS is most likely CPA 62.01 (Computer programming services) while IaaS is CPA 63.11.1 (Data processing, hosting, application services and other IT infrastructure provisioning services)”.

From another point of view, PaaS and IaaS might both belong to 63.11 class. In particular, it might be problematic to determine a suitable subcategory for SaaS: it could be classified to either 58.29.40 Online-Software or 63.11.13 Application service provisioning in the CPA classification. Usually, provision of a leased software belongs to class 63.11. If the service provider has copyrights

for a software, the activity could be classified to publishing activities e.g. 58.29, Software publishing. Altogether, this classification issue seems to need more discussion.

1.2. Market Conditions and Constraints

Key Figures of Industry

Based on Structural Business and Financial Statement Statistics, enterprises in ISIC 6311, Data processing, hosting and related activities, generated a total of EUR 1.4 billion (≈ $1.6 billion) in turnover in 2016. The share of industry turnover was about 0.4 percent of total turnover in the Finnish business sector. The following table shows number of enterprises, employees and turnover in small and micro, medium-sized and large enterprises.[3]

TABLE 2
Number of enterprises, employees and amount of turnover in ISIC 6311 in Finland, 2016

	Number of enterprises	Number of employees	Turnover (€ million)
Micro and small enterprises	341	901	213
Medium enterprises	21	1138	275
Large enterprises	16	1768	955
TOTAL	**378**	**3 807**	**1 442**

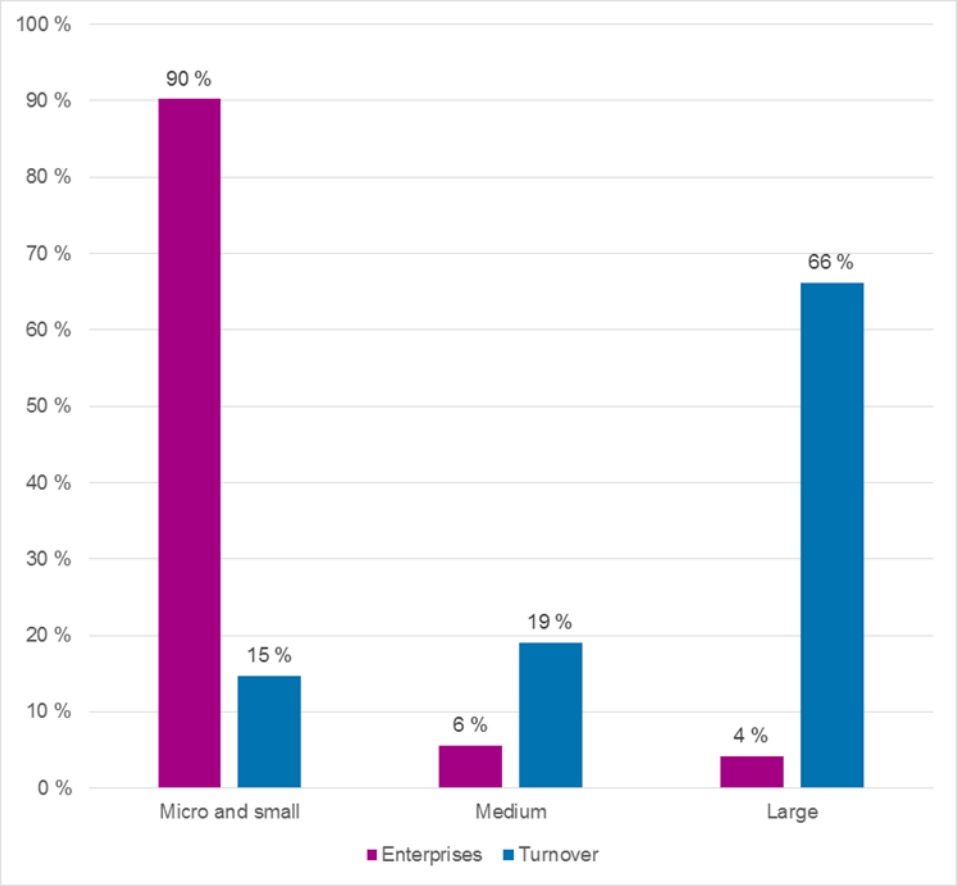
Source: Statistics Finland, Structural Business and Financial Statement Statistics, 2016

Industry Concentration

As shown in the following figure, micro and small enterprises account 90 percent of number of enterprises, whereas they only earn about 15 percent of industry turnover. Large enterprises earn the biggest share of the industry turnover, over 66 percent. It seems that data processing, hosting and related activities is rather concentrated industry according to the data and the used size classification.

[3] The size of enterprises are defined as follows: "The category of micro, small and medium-sized enterprises (SMEs) is made up of enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million. Within the SME category, a small enterprise is defined as an enterprise which employs fewer than 50 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 10 million. Within the SME category, a microenterprise is defined as an enterprise which employs fewer than 10 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 2 million."
Source: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32003H0361&qid=1534483798458, accessed August 18, 2018.

FIGURE 1
Industry concentration in ISIC 6311 in Finland in 2016



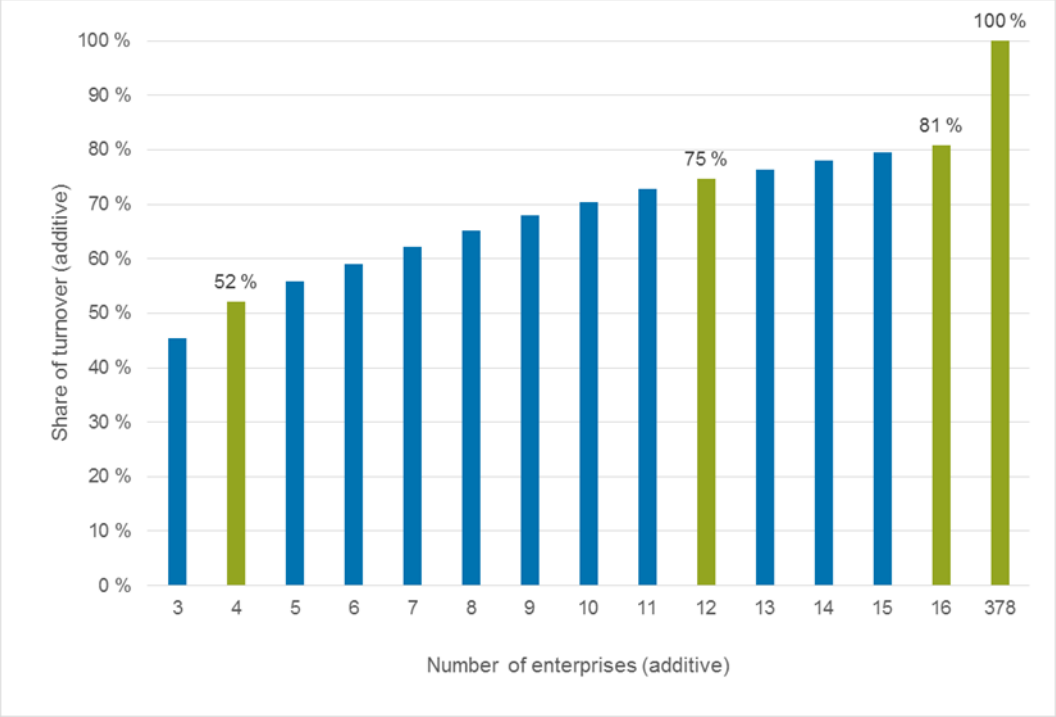
Source: Statistics Finland, Structural Business and Financial Statement Statistics, 2016

The additive turnover of enterprises sorted by size is shown in Figure 2. There are four enterprises generating over 52 percent of total turnover in the industry. The top 16 enterprises earn about 81 percent of industry turnover. Some enterprises earn high turnover with relatively small[4] amount of employees. On the whole, the industry is highly concentrated when considering only turnover.

[4] They have less than 250 employees which was the definition for a large enterprise earlier in the paper.

FIGURE 2

Industry concentration in ISIC 6311 in Finland in 2016, enterprises sorted by size based on their turnover, additive (%)



Source: Statistics Finland, Structural Business and Financial Statement Statistics, 2016

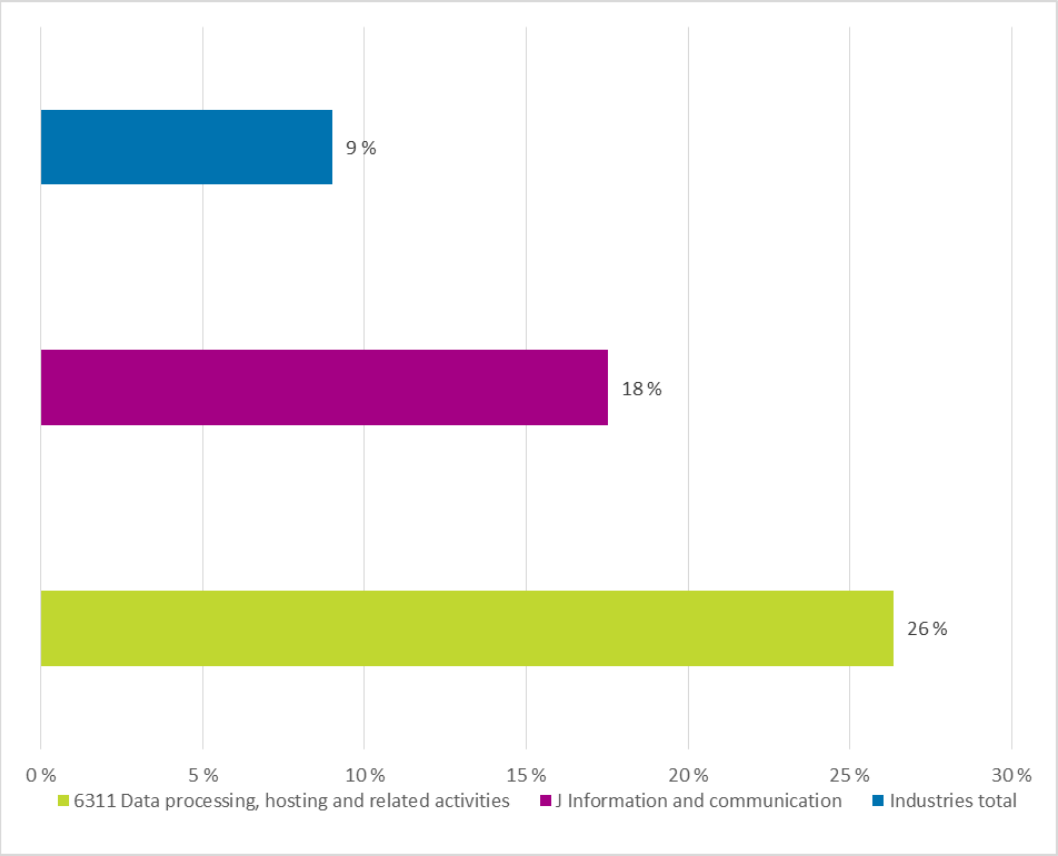
Profitability

The profitability of the industry, measured in operating margin (per cent)[5], was higher than the average of all industries in Finland in 2016. As shown in the Figure 3, operating margin was about 9 percent on average in all the industries, whereas in ISIC section J, Information and communication, it was nearly 18 percent and in class 6311, Data processing, hosting and related activities, it was over 26 percent.

[5] Operating margin reflects the company's operating profit before depreciation and financial items. Operating margin (per cent) is calculated by dividing operating margin by operating income.

FIGURE 3

Operating margin, per cent, industries total, ISIC section J and class 6311 in Finland in 2016



Source: Statistics Finland, Structural Business and Financial Statement Statistics, 2016

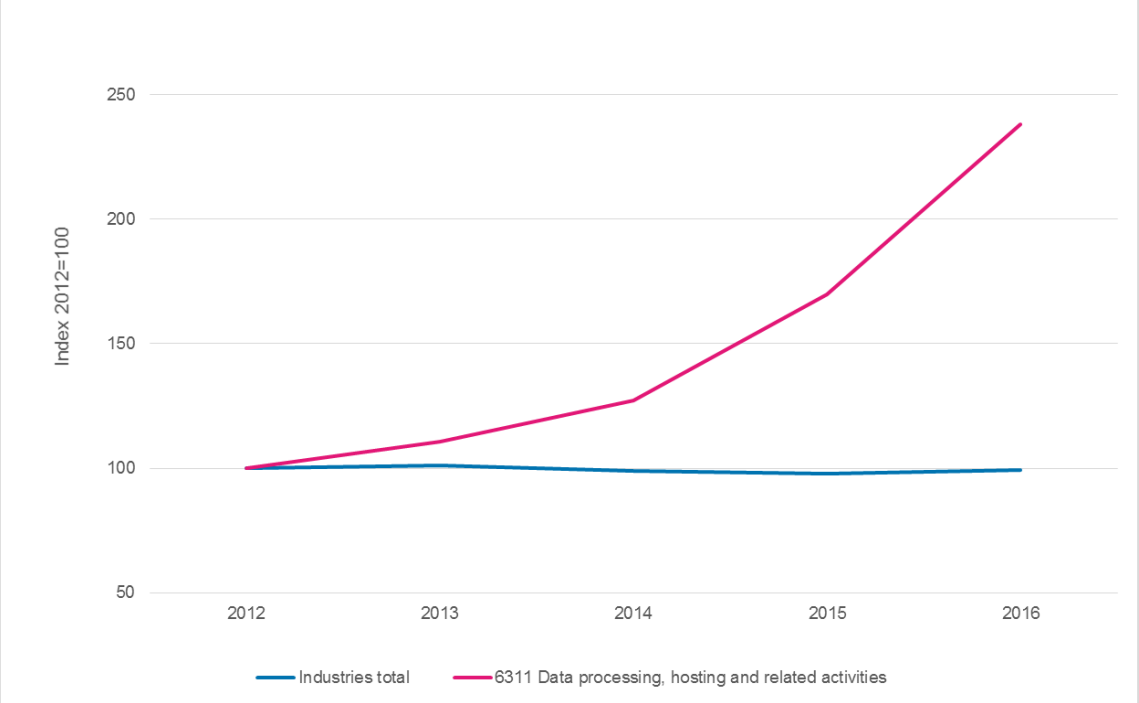
Market Trends

Data processing, hosting and related activities have grown significantly in recent years. The industry has a strong positive trend over the period 2012-2016 (see the Figure 4). The industry turnover more than doubled during that period. It rose from €605 million in 2012 to over €1.4 billion in 2016. Especially growing cloud computing business might explain the rapid growth of industry turnover. There are some global enterprises which have established data centers in Finland such as Google.

The importance of cloud computing is expected to grow even more in the future. It is closely related to the development of communication technology like 5G mobile network technology. 5G, i.e. high-performance wireless communications platform, enables fast and smooth access to the internet for devices, services and systems.[6] Thereby, the quality and efficiency of, for example, industrial processes can be enhanced with real-time cloud services which are located in data centers.

[6] Source: https://www.viestintavirasto.fi/en/spectrum/5gmomentumecosystem.html, accessed July 17, 2018

FIGURE 4
Development of turnover, industries total and ISIC 6311 in Finland in 2012-2016 (2012=100)



Source: Statistics Finland, Structural Business and Financial Statement Statistics, 2016

Based on the report of Copenhagen Economics[7] (2017), Finland has several factors needed by the data center industry. The advantages include good international communications and a stable environment. It is also strengthened by favorable conditions, such as the climate and good availability of energy and water. In addition, there are plans to construct a digital bridge between Europe and Asia via the Northeast Passage, so called ”Arctic Connect”. This could attract more data centers to Finland.

1.3. Specific Characteristics of the Industry

Cloud Computing

Definition of Service

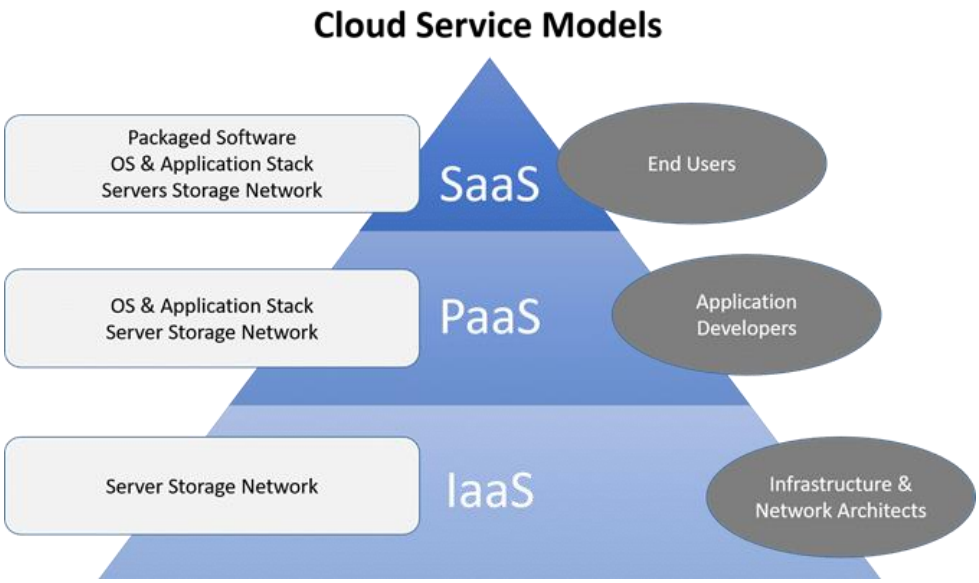
Cloud computing is a relatively new but rapidly growing service. Probably there is no commonly agreed definition for cloud computing. For example Microsoft defines it as follows:

> *“Simply put, cloud computing is the delivery of computing services — servers, storage, databases, networking, software, analytics and more — over the Internet (“the cloud”). Companies offering these computing services are called cloud providers and typically charge for cloud computing services based on usage, similar to how you are billed for water or electricity at home.”*

[7] Report on “Finland’s economic opportunities from data centre investments”.

Basically, the users of cloud computing services do not necessarily need to buy hardware and software, for example, to save files. They can access their data wherever they are via the Internet. There are different types of service models in cloud computing as depicted in the following figure:

FIGURE 5
Cloud service models



Source: https://www.uniprint.net/en/7-types-cloud-computing-structures/, accessed July 17, 2018

As shown in the Figure 5, the service delivery models are hierarchical. Each type of service model offers users specific features and functionalities like levels of control, flexibility, and management:

Firstly, IaaS, i.e. Infrastructure-as-a-Service, offers the basic building blocks for cloud IT. The users of IaaS can access automated and scalable environments which include for example networks, databases and data storage space. IaaS allows the highest level of flexibility and management over resources for users compared to PaaS and SaaS. For example Amazon Web Services (AWS) can be regarded as IaaS.

Secondly, PaaS, i.e. Platform-as-a-Service, includes more features than IaaS allowing users to concentrate on the development of the application. PaaS offers the underlying infrastructure like operating systems, resource procurement, capacity planning, software maintenance and other runtimes. Google App Engine and Microsoft Azure are examples of PaaS.

Thirdly, SaaS, i.e. Software-as-a-Service, is the most commonly used business model in cloud computing. SaaS offers a complete product and the user has the lowest level of flexibility compared to the other two models. A SaaS provider hosts and maintains the servers, databases and code which constitute an application. In many cases, SaaS refers to end-user applications like web-based email application. Basically, SaaS replaces traditional on-device software. Gmail, Google Docs, Dropbox and Office 365 are examples of SaaS.

Besides the three service models, there are also other kinds of services available in the markets. These other services include, for instance, database as a service (DBaaS), storage as a service (STaaS), security as a service (SECaaS) and test environment as a service (TEaaS).

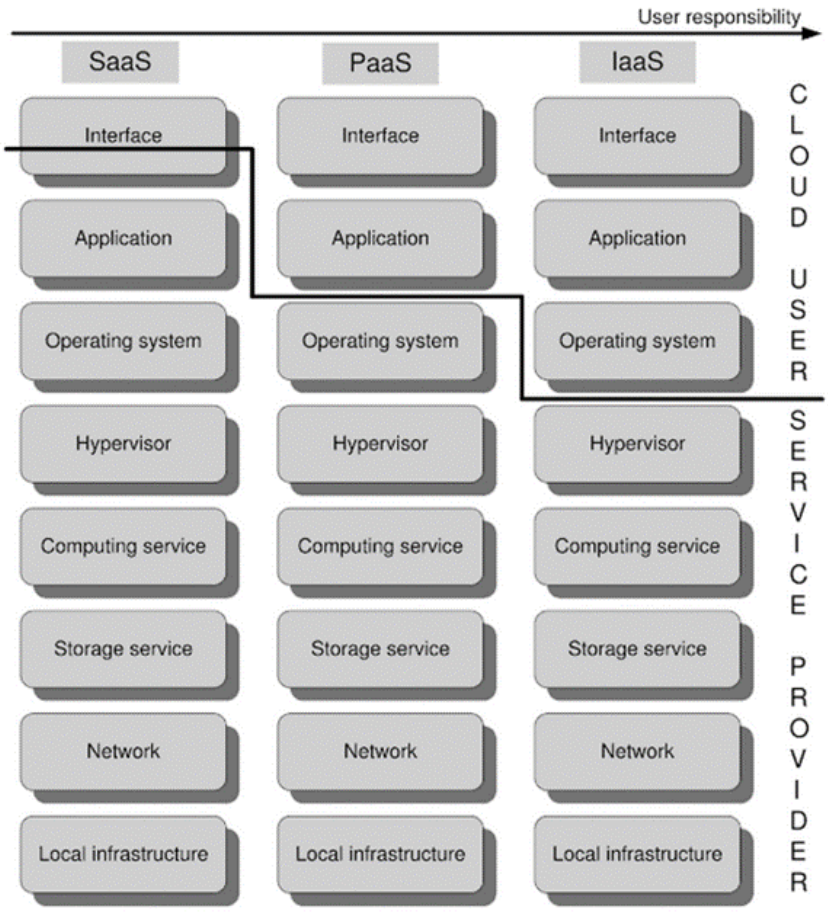
Cloud computing services can also be grouped according to the way the services are deployed. The following types can be listed: private cloud, community cloud, public cloud and hybrid cloud. For example, in the case of private cloud, the infrastructure is operated only for an organization, whereas the public cloud is available to the general public so a user purchases a service from the same servers as other service providers.[8]

Many providers of cloud computing services are global enterprises and the provider and the user of the cloud service can easily be located in different countries; it may even not be exactly clear to the user which unit exactly provides the service and where the supplier is located. Amazon, Google and Microsoft are well known examples of providers of cloud computing services.[9]

The following figure depicts how the responsibilities are divided between the cloud user and the cloud service producer.

[8] See, for example, pages 8-9 in Marinescu, D. (2016), for more information.
[9] Source: European Commission, final report of the task force “Price and volume measures for service activities” (2018).

FIGURE 6
Responsibilities between a user and the provider



Source: Marinescu, D. (2016)

From the aforementioned three service models, SaaS allows the least control on the cloud resources for the user. The user is only partially responsible for the interface. PaaS allows the user more control than SaaS while the user can control both the interface and the application. IaaS includes the most responsibilities for the user than the other two while the user is responsible for all the events occurring while running the application.

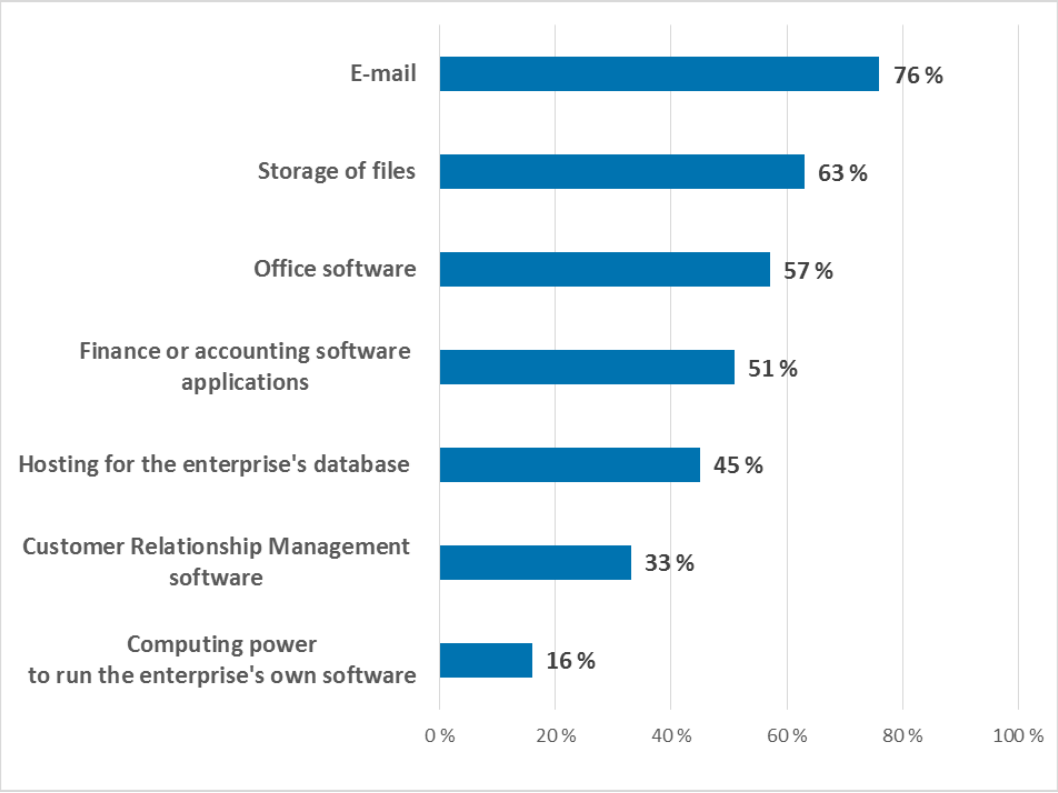
Type of Users of the Services

Cloud computing services are generally purchased by both corporations and private households. Corporations use all three types of services depending on their needs. IaaS is mainly used by full-time developers, network architects or large-scale enterprise customers, whereas PaaS is aimed especially for application developers and SaaS for users of cloud applications. Private households use mostly SaaS.

Based on figures of Use of Information Technology in Enterprises statistics, 66 percentage of Finnish enterprises buy cloud computing services used over the internet. The enterprises, which utilize cloud computing services, use them mostly for e-mails (76 percent) and storing of files (63 percent) from the services which are inquired in the questionnaire. Also, office software (57

percent), finance or accounting software applications (51 percent), hosting of the enterprise's database (45 percent) and Customer Relationship Management software (33 percent) are rather common uses of cloud services.

FIGURE 7
Commonly used cloud services in Finnish enterprises in 2017



*Source: Statistics Finland, Use of I*nformation Technology in Enterprises, 2017

In Finland, cloud computing services are the most commonly used in the information and communication industry, 87 percent of businesses, and the least in transport and storage industry where 45 percent of businesses used these services in 2017. Use of cloud services is more typical in large companies[10] (86 percent) than in smaller companies (59 percent).

Public clouds were used by the majority of cloud-based companies, 52 percent of all enterprises, in Finland in 2017. The prevalence of usage varies from 37 percent in the transport and storage industry to 76 percent in the information and communications industry. The private cloud was used only by 21 percent of Finnish businesses. In many industries, the use of private clouds is relatively low, with the exception of the information and communications industry where 46 of enterprises use private cloud services.

Private households use cloud services especially for storage of files. Based on the Use of Information and Communications Technology by Individuals statistics, 34 percent of population

[10] Large companies are defined here as companies employing more than 100 people and small companies employing 10 to 19 people.

stored their files in to a cloud server in Finland in 2017. People between the ages of 16 and 24 use the most (58 percent) and people between the ages of 75 and 89 use the least (4 percent) cloud services.

2. Measurement of SPPI

2.1. General Framework

In Finland, the Producer Price Index for Services (SPPI) is compiled on a product basis following the product classification, CPA 2015 (CPA Ver. 2.1), which is the European Union's Statistical Classification of Products by Activity. In other words, the index describes development in the prices of certain types of services irrespective of the main industry of the enterprise.

The Finnish SPPI includes the prices of services provided by enterprises to other enterprises and the public sector (Business to Business, BtoB), to households (Business to Consumers, BtoC) and to all end users (Business to All, BtoAll).

Statistics Finland has published SPPI for CPA 63, Information services, since 2005. More detailed level indices for Information services are confidential. The index is used as a deflator for National Accounts and Index of Services Production (ISP).

Rapid development of information services requires constant update of the index as well. Especially, cloud computing services should be covered better in the Finnish SPPI.

2.2. Measurement Issues

Statistics Finland's Business Register and Business Services Statistics are used as the sampling frame for the Producer Price Index for Services. The Business Register contains data on the industry and turnover of enterprises. Business Services Statistics describe the structure of turnover and services produced in certain branches of industry providing business services. In the case of CPA 63, the products and enterprises are sampled from Business Services Statistics.[11] However, there are some restrictions in the availability of data in CPA 63 because product level data for information services (ISIC 63) are only available in four digit level in Finland.

Product-specific indices have been designed independent of each other and the used sampling method varies by service. Depending on the service, data suppliers have been selected by applying PPS (Probability Proportional to Size) sampling or judicious sampling, or by combining judicious and probability-based sampling. In the case of CPA 63, PPS sampling is used.

Services whose prices are surveyed quarterly are selected in co-operation with data providers. The objective is that the examined services would be as representative as possible and could be monitored as well as possible. The following criteria are used in selecting the services to be monitored:

[11] Source: Producer Price Index for Services 2010=100, Handbook for Users, accessed July 19, 2018

- The service is as representative as possible. It generates a significant share of the enterprise's turnover.
- The service describes as well as possible the average price development of the services belonging to the same service entity.
- A price concerning a certain unit (e.g. number or day) and quality can be quoted regularly by quarter (or less frequently) for the service. The price must be comparable between statistical reference quarters.

The lower level weights of indices are based on enterprises' turnover and their breakdown by service groups. The used data on turnover are either data reported by the enterprises themselves on turnover received from services within the industry concerned or data on turnover obtained from the Business Register or from the Business Services Statistics (turnover by service groups, i.e. CPA classification). The upper level weights are obtained from the National Accounts' supply and use tables.

SPPI is calculated with the Laspeyres price index formula.[12] First, geometric means are calculated for service product entities, or main groups, of each enterprise from price ratios (= current price/previous quarter's price) deduced from individual service products. These micro indices are combined into product-specific and total index by weighting each micro index with its own weighting coefficient. Thus, the size of the impact on the index from changes in the prices of individual enterprises and services varies.

In the case of missing prices, imputation methods are employed. The missing prices of products are imputed by means of other corresponding products or the price development in the service group. Imputation is based on the assumption that the price development of a certain service is the same as that of corresponding services. Permanently missing services are replaced with new service products as soon as possible.

2.3. Description of Pricing Methods and Criteria for Choosing the Method

Price Determining Characteristics of the Service

The following list[13] includes some of the factors which influence prices of cloud computing:

Initial costs, i.e. the amount of money that the service provider spends to buy resources.

Lease period, i.e. the period in which the customer will lease resources from the service provider. Usually, longer subscription periods are offered for lower unit prices.

Age of resources, i.e. the age of the resources used by the cloud provider. The older the resources, the lower their financial value is.

[12] Statistics Finland will have an annual chain linked index in the future, starting from statistical year 2019.
[13] Al-Roomi, Al-Ebrahim, Buqrais & Ahmad (2013)

Cost of maintenance, i.e. the costs that the cloud provider faces when maintaining and securing the cloud.

Location, prices may vary geographically depending on where the server is located. The proximity of a data center reduces latency (here: the measure of the time lag between sending and receiving information). Running of applications and delivering of other cloud-based services is faster compared to a situation where the data has to travel farther to be processed at a distant data center.

Quality of Service, QoS, refers to the type and characteristics of a service. It is the set of technologies and techniques offered to the user, such as the availability of service, data privacy, scalability, the power of the processor, the amount of RAM, and the amount of disk space allocated and operating system.

Typical Pricing Methods

There are more flexible pricing models in cloud computing services than in traditional models.[14] Every cloud provider has its own pricing scheme which may complicate the measurement of prices for statistical purposes. Some providers use a fixed pricing model, whereas some use a dynamic or market-dependent pricing model.

Fixed pricing models include, for example, the following:

Pay-as-you-go pricing charges users according to the amount of resources they use measured in time or quantity. For example, Amazon Web Services/Simple Storage Service (S3) is charged per GB of storage or per data transferred in GB.

Subscription means that the customer pays a fixed amount of money to access the service for a certain period of time, usually a month or a year. For example, in Microsoft Azure some of the charges are monthly basis for database.

Hybrid pricing is a combination of pay-per-use and subscription. Google App Engine is an example of a hybrid pricing model in which price is monthly based but after a certain limit the service will be charged on a per GB basis and the processing power on an hourly basis.

List prices are also used in cloud computing.

Dynamic pricing models include, for example, the following[15]:

Cost-based pricing is a method in which the price is set by adding a profit on top of the cost.

Competition-based pricing denotes a method in which the user is charged based on competitors' prices.

Customer-based pricing sets the price according to the amount the user is prepared to pay.

[14] Mazrekaj, Shabani & Sejdiu (2016)
[15] Al-Roomi, Al-Ebrahim, Buqrais & Ahmad (2013)

Some services, especially SaaS used by private households, are free of charge up to a certain limit. For example, Gmail offers 15GB and Dropbox 2GB of free storage. After exceeding the limit, users are typically charged a flat fee monthly or yearly. In the case of IaaS, pay-as-you-go pricing is more typical.

As mentioned in section 1.2, the profitability of the industry is rather high on average. Therefore, it is especially important that profit margin is also included in the observed prices when measuring output prices for statistical purposes. The profit margin can fluctuate depending on business conditions and competition.

In the Finnish SPPI, the most used pricing method is a subscription/contract pricing, such as monthly fee, or pay-as-you-go pricing. In addition, hedonic pricing models are possible to use for cloud services but Statistics Finland has not used them for these services.

2.4. Evaluation of Comparability of Price Data with Output Data

SPPI for information services (CPA 63) is published, as mentioned in section 2.1, only on a two-digit level. This level of detail is also required by the European Union Short-term business statistics regulation (STS). More detailed breakdowns would be useful for deflation and other use. This would require further development of SPPI.

For calculations of Index Services Production (ISP) and Trend Indicator of Output (TIO), there is a challenge related to the timing of SPPI: The SPPI is published in Finland quarterly on the 24th day of the month after the statistical reference quarter or on the following weekday. In contrast, ISP and TIO are produced monthly, which brings challenges to the use of the SPPI in deflation. Therefore, it is necessary to distribute quarterly data to monthly level, i.e. interpolate, and predict the latest missing data, i.e. extrapolate. Linear interpolation is used for all services in the interpolation of price indices. The default method used in the extrapolation of price indices is the extrapolation method that in the previous month or quarter has produced the best estimate. The used extrapolation methods are: ARIMA model, AR model and carrying the value of the previous quarter forward.

3. Evaluation of Measurement

There are many challenges to measure the price development of data processing, hosting and related activities such as cloud computing. The cloud computing is a growing field of activity which is also changing rapidly.

As described in section 1.3, there are many kinds of services and business models in cloud computing activities. It is essential to stay up to date and understand what kind of services emerges in the market. First of all, it is important to find a solution for the classification issues discussed in section 1.1. Furthermore, the sample and the price collection should be updated whenever needed. Alternative price collection methods might be preferable for this kind of technically advanced industry.

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