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A Meta Study of 26 "How Much Information" Studies: Sine Qua Nons and Solutions

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This article compares 26 "How Much Information" (HMI) studies according to several sine-qua-non components: geographical scope, actors and sectors covered, products observed, their stocks and flows, raw and target indicators, nomenclatures, and concepts of information. Typical weaknesses are identified. After a short summary of the lessons from the 50 years of history of national accounting (used in economics), this work suggests that the main indicators and methodology of HMI studies be standardized in accordance with the logic of Systems of National Accounts (SNA), resulting in a kind of Standard System of National Information Accounts (SSNIA). Interests of all nations would then be reflected in such a process of standardization.

What is the "Whole Stuff"? An Introduction

Considerable research carried out during the last four decades has been aimed at quantifying the amount of information produced, consumed, accumulated, stored, or distributed in a society or region. The authors of these studies—Bohn, Short, and Lane (2009), Bounie (2003), CISCO (2009, 2011), de Sola Pool et al. (1983, 1984), Dienes (1986, 1992a, 1992b, 1994a, 1994b, 2010), Erdész (1983), Gantz et al. (2007, 2008), Gantz and Reinsel (2009, 2010, 2011), Hilbert et al. (2011), Hilbert and López (2012a, 2012b), Ito (1981), Lesk (1997), Lyman and Varian (2000, 2003), Neuman, Park, & Panek (2009), Short, Bohn & Baru (2011), Tomita (MPT) (1975), and Varga (1986)—recognized that in macro level technological and economic processes in which information products are components, the information they carry behaves like a fluid regardless of its carriers. They understood that information flows, stocks may be studied, and the results may be useful for businesses, governments, and the public in that they report on surveys and their outputs are statistics: censuses or accounts.

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This meta study reviews and compares the different approaches taken in the aforementioned studies. The result contours a model—a system with its components— and points toward a "How Much Information" (HMI) science consisting of the macro statistics of information stocks and flows. HMI science can be seen as macro statistics of societal reproduction of information. Its ingredients are inherently similar to those of macro statistics of economic stocks and flows whose statistics are standardized by the 50-year-old System of National Accounts (SNA) of the United Nations (UNSD, 2009a). SNA is the internationally agreed standard set of recommendations on how to compile measures of economic activity. The SNA describes a coherent, consistent, and integrated set of macroeconomic accounts in the context of a set of internationally agreed concepts, definitions, classifications, and accounting rules. The SNA is the intellectual framework, with a collection of huge national databases for the description of world economy that has been in daily use for decades by industry, government, and people (UNSD, 2002).

2. Different Components of HMI Studies

2.1. The Scope of the HMI Studies

The geographical scope of the recent HMI studies—in accordance with the interest of the authors and their clients—extends to individual countries, groups of countries (OECD and EU), the whole world, or to regions (in Japan).

2.2. Actors

Mostly, information flows as a result of actions of people, their organizations, and machines. Actors are the active elements and terminals of information-related processes. Actors may be *elementary* (physical, with mostly physical flows between them) or *complex*. The elementary actors are *individuals* and *devices*. Devices are connected to each other and/or to the environment by *channels* and are separated by *interfaces.* Their flows can be technically defined as *traffic. Integrated devices* contain embedded devices, channels, and interfaces.

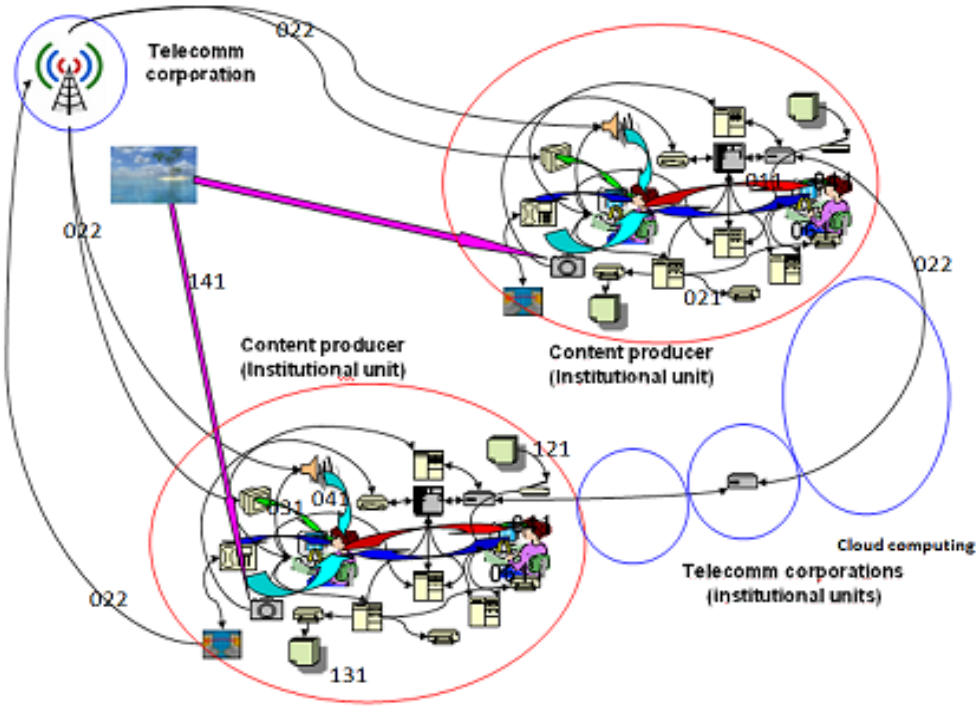

Figure 1. Physical flows of information within and between organizations.

When assessing device → human and human→ device flows, it is useful to conceptualize internal cognitive units of individuals—like eyes, ears, and so forth—as devices that are responsible for the levels of human cognition. These levels can correspond to the methods of conversion to bitmap, compressed, and txt files as described by Lyman and Varian (2000).

For political, economic, and sociological reasons, the individuals and devices in a society are embedded into larger complex units like institutional units. Institutional units may own, contain, employ, hire, and use elementary units. Institutional units are the terminal points to both economic and information flows; they are the binding elements between accounts for economic value and volume of information.

Complex units may be households, enterprises, government agencies, and corporations among others. The figures for the indicators of the complex units can be aggregated from those of elementary units. In the aggregation, stocks are additive, flows are usually not.

Most HMI studies do not provide exact definitions for the units they would like to cover.

SNA defines the concept of residence of units, which may be adopted to define *domestic* and *rest-of-the-world* sectors. Transborder data flows are covered to a lesser extent by HMI studies Saito et al., 1983; Ziming, 2004.

The figures obtained in a census for information flows heavily depend on the interfaces of units that have been defined. For instance, if a country is considered a complex actor, its internal domestic traffic must be neglected, and it is the international traffic only that counts as its information flow. A number of HMI studies ignore or do not define actors clearly and heavily simplify input/output production chains.

2.3 Sectors

Sectors may be used to define the scope of a survey, or to define the targets to be analyzed. Statistical institutes define standard official sectors. Nonresident units constitute the mostly ignored rest-of-the-world sector. Table 1 compares the kinds of sectors included in various HMI studies. (We will do the same for other characteristics in subsequent tables in this article.)

Table 1. Sectors (Classes of Actors) to be Described by Various Studies.

Source	***Sectors***
UNSD 2009a	Corporations, general government, nonprofit institutions serving households, households, rest of the world
Tomita, 1975	Country (Japan)
de Sola Pool, 1984	Countries (U.S. ,Japan)
Dienes, 1993	Country (Hungary), private, state, rest of the world
Dienes, 1994a (Methodology)	Regions, nations/countries, organizations, individuals, government units, corporations, nonprofit institutions, employees, ethnic and language communities, rest of the world
Dienes, 1994b	Country (U.S.), governments, corporations, households, rest of the world
Lesk, 1997	World

Lyman & Varian, 2000, 2003	World, U.S.
Bounie, 2003	U.S., Europe households
Neuman, 2009	U.S. households
CISCO, 2009,2011	World, countries, regions, businesses, residential, consumers, mobility
OECD, 2009 methodology	Content sector, digital content sector
Gantz et al., 2007–2011	World, individuals, enterprises
Bohn & Short , 2009	Country (U.S.) households
Dienes, 2010	Country (Hungary), individuals, non-individuals, employees
Short et al., 2011	World, enterprises
Hilbert & López, 2011	World

Several HMI studies extend to standard households or corporations sectors. Nonstandard sectors may be desirable for special HMI purposes. Population in several countries, particularly large countries, is divided by language, ethnic, and other factors, which can be classified as subsectors in HMI studies. Rights of employees to use employer's information (trade secrets) and rights of employer to use employee's information (patents, copyright, privacy) are subject to conflicts and regulation; therefore, employees may constitute a subsector in HMI studies.

2.4 Measurement Units

2.4.1 Data versus information. Braman (1990) was the first to collect and compare several definitions of "information" in social sciences. The intention here is simply to compare the ways that concepts of data and information were handled in previous HMI studies.

Information is "any symbol, signal or image having a meaning for either a sender or the receiver" (Tomita, 1975, p. 342), "data that have been organized and communicated as flows of data" (Porat, 1977, p. 19). Bohn & Short (2009) state that information "is a subset of data" (p. 7). Hilbert & López (2012b) attempt to adopt Shannon's (1948) theory in which information is a measure of uncertainty in a set of certain random communication situations. In my personal opinion, information in HMI studies—in an actual situation, and for somebody—should be understood as data on a carrier, which, if used, modify one's beliefs concerning something.

Data "are artificial signals, intended to convey meaning", being artificial "because they are created by machines" and data are outputs of devices in Bohn & Short 2009 (p. 10). For Short et al., (2011), data represent "the lowest level of abstraction from which information and knowledge are derived" (p. 9).

Dienes (1992, 1994a) means that it is not information itself in HMI studies that is considered as a resource or a product, but the goods and services (including the rendering of nondurable signals) that carry/convey information by carrying recorded, standard uniform signals.

2.4.2 Conversion and conversion rates. The most outstanding difference between the SNA and HMI studies is in how they value flows and stocks. The valuation of economic flows and stocks in the SNA has been based upon general substitutability for money, that is, in the opportunity for selling. In digitally oriented HMI studies, it is based upon general substitutability of an analog record for a digital record, upon the opportunity of digital rerecording or digital remake.

The elementary places to store one yes/no signal on a digital product (please see the terms later) are called "physical bits" (or "binary digits," according to Hilbert & López, 2012a, b). The number of bits recorded on/in carriers is termed *the volume of information that the carrier carries.* What is known is that a given carrier at a given moment carries a given volume of information. For studies in real terms, the operating system of the reader/writer device keeps an inventory of where the stores reserved for data are, and it also provides data on their actual size.

For HMI purposes and for various non-digital media, figures expressed in "raw units," (like metric ton of books produced annually in a country) are to be converted to common units. Conversion rates, that is, densities of information on a carrier (e.g., Mbit/metric ton of books, Mbit/sec of satellite TV broadcasting) are defined by the following: (a) "converting what" (the raw indicator expressed in raw units); (b) "converting how" (conversion procedures); and (c) "converting to what" (unit of the target indicator).

For several kinds of products, for example, books, there are more sources of raw data, such as official industrial statistics, international trade statistics, cultural statistics, industrial associations, registries, ISBN agency, and so forth, and these are not functionally equivalent. Booklets and course books may or may not be included in the figures, the date of their output may be different in the printing factory, and at the publisher end, the books printed for a foreign publisher may or may not be included in the figures and so forth

Some other studies use word, hour, and character measures, but they are partial, not universal, because these units cannot be used thoroughly for information stocks and flows through each media and because their definition is difficult. Hour units are meaningless for measuring the volume of works like a poem or Picasso's output. A length of plain text does not show the sentence trees or its deep structure, without which the text is meaningless. Universal application of (8-bit) bytes—when several other kinds of chunks of data are used in telecommunication—does not seem purposeful.

Table 2. Units of Measure Adopted in the HMI Studies

Source	***Unit of Measure***
UNSD, 2009a	Monetary units of the country
Tomita, 1975	"As is" words
de Sola Pool et al., 1984	"As is" words
Varga, 1986	"As is" hours
HCSO, 1990	"As is" bits for digital products or calculated for nondigital products, as if digitized as is usual at the time
Dienes, 1992a	de Sola Pool et al., 1984
Dienes, 1992b	HCSO, 1990
Dienes, 1994a	Dienes, 1992b
Dienes, 1994b	HCSO, 1990
Lesk, 1997	"As is" bytes
Lyman & Varian, 2000, 2003	Scanned, "Compressed-as-usually" text terabytes
Bounie, 2003	Lyman & Varian, 2000
Neuman, 2009	de Sola Pool et al., 1984
CISCO, 2007–2011	As measured/estimated bits

Gantz et al., 2007–2011	As measured bits
Bohn & Short, 2010	Hours, words, and bytes, "as if transmitted"
Dienes, 2010	HCSO, 1990
Short et al., 2011	"As is" bytes of capacity
Hilbert & López, 2011	Calculated "as if digitized and compressed optimally" bytes

Several authors calculate the number of "as is" compressed or uncompressed bytes/bits without assuming any additional compression, because statistics—as much as possible—should reflect the facts. Volume of information carried/conveyed by analog signals on/in information- and non-information goods and services is equal to the volume of binary storage capacity that is:

- needed to record (input) these signals at the average level of technology available at the moment of the account;
- in a digital form so that the record will be sufficient to reproduce the signal to ensure that the reproduction would allow its equivalent use with the original by the end-user.

Hilbert and López (2011) calculate the volume of a digital equivalent to an analog product *as if it would be digitized and optimally compressed* The HMI studies, which are to measure capacities, may adopt an assumed, optimal lossless compression.

Bohn & Short (2010) use "bandwidth," which is defined as the rate at which compressed information is transmitted over the link between the originator and the consumer. It is desirable that the best fitting measure of information density on carrier be adopted in the HMI studies, from related indicators as bit rate, bandwidth, throughput, and so forth. Assumption of transmission is not reasonable when digital (long-range or interdevice) transmission does not occur.

The SNA provides measures in real terms and volume measures, taking into account price changes. Similarly, when analyzing time series, the stocks and flows of analog goods and services are to be revaluated (Dienes, 1992b; Hilbert & López, 2011, 2012a, 2012b), relating them to the actual technical level of digital recording/remaking/transmission of a fixed reference year.

2.5. Products, Information Products

Durable or nondurable elementary signals in or on various media are produced, processed, transferred, used, and consumed in packages. Kinds of technical packages have been defined by the technology of production (for bytes, files, SMS messages, IP packages, print pages) or by their distribution and use in the institutional units (e.g., the size of books, cameras, and mobile phones, each under the influence of the marketplace).

Economic products are "actual packages" that are determined by technical and economic factors in the process of exchange. In the SNA, product is a bound term: An economic product is something that is the result of productive processes. In HMI studies, information products whose production, consumption, or other flows (as well as stocks) were to be measured, have been defined in various ways and at varying level of exactness. This article will present the alternatives that HMI studies have considered and will continue to face when defining products.

2.5.1 Intangible works consisting of ideas versus tangible information goods and services. A drama or a poem that is viewed as a work, like Poe's "The Raven," exists in several tangible durable or nondurable and digital or non-digital material exemplars, as well as in intangible copies in the creator's and users' brains. When speaking about a work, people refer to mental brain representations. The work itself is not an information good, such as a CD or the radio waves of a broadcast; those may be only its embodiments on or in various durable media.

2.5.2 Durable versus nondurable. Products and non-produced assets can be durable or nondurable. Durable products (e.g., CD, book) are the information and information-carrying goods that can produce knowledge in the human brain. Goods and produced human knowledge can be accumulated and stored. They are persistent in that they can be consumed long after their inventory or supply ends, and for a long time, they can become fixed assets. Services (broadcast, Internet), on the other hand, cannot be accumulated and stored, their stocks cannot be recorded, and they are consumed immediately.

Table 3. Kinds of Products Studied by the Authors of HMI Studies and Defined in the SNA.

Sources	***Kind of Products***
UNSD 2009a	"Goods" are physical produced objects for which a demand exists, over which ownership rights can be established, and whose ownership can be transferred from one institutional unit to another by engaging in transactions on markets. (p. 96) "Services" are the result of a production activity that changes the conditions of the consuming units or facilitates the exchange of products or financial assets. (p. 631)
Erdész, 1983	Goods and services were not distinguished.
de Sola Pool et al., 1984	Goods and services were not distinguished.
Varga, 1986	Goods and services were not distinguished.

HCSO, 1990	Goods, services, human information.
Dienes, 1992a	Pool et al., 1984
Dienes, 1992b	"Information goods should be goods in the SNA . . . which are to carry information . . . " "The supply of durable and nondurable signals, together with repair of information goods, will be defined as information services." (p. 10)
Dienes, 1994a, 1994b, 2003,	Information goods are durable tangible physical objects: "- that have been intentionally created to carry or convey information (their principal function); - over which ownership rights can be established; and - whose ownership can in principle be transferred." (p. 137) "Reparation, transformation or mending of information goods, creation of durable signals on or in non-information goods so that no new good will be created and supplying non-durable signals are *called information service*." (p. 139) Information goods and services are together called "information products." (p. 54) Produced human knowledge (Introduced, but non-defined.)
Lesk, 1997	Goods and services are not distinguished.
Lyman & Varian, 2000, 2003	Goods and services are not distinguished, kinds of products are called "type of content."
Bounie, 2003	Goods and services are not distinguished.
Neuman, 2009	Goods and services are not distinguished.
CISCO, 2007, 2008, 2010	CISCO collects data or calculates estimates for the "traffic": the quantity of bits carried in the frame of various telecomm services between service providers and subscribers.
Gantz et al., 2008	Goods and services are not distinguished.
Bohn & Short, 2010	Goods and services are not distinguished.

Dienes, 2010	Dienes, 1994a
Short et al., 2011	Goods and services are not distinguished.
Hilbert & López, 2011	Goods and services are not distinguished.

2.5.3 Products to carry information or products actually carrying information. Paintings and inscriptions on and inside buildings, even on such things like pencils, light bulbs, or eggs are good examples of *durable signals* on or in *non-information goods.* T-shirts, cars, and houses may carry information, but that is not their function. None of the HMI studies attempted to measure the amount of durable signals on or in noninformation goods and *occasional signals*, such as when one points at a person or a thing.

2.5.4 Commodities versus non-commodities. In the SNA, a *commodity* is a market good or service. The bits-impulses in the traffic between enterprise servers to be counted (see Dienes, 1992, 1994; Short et al., 2011; studies and oral communications in Tomita, 1975) obviously are not commodities.

2.5.5 Originals and copies. Several HMI studies contain data for originals and copies. The source of definition may be international copyright law, SNA, or a special definition for HMI purposes. International law of intellectual property does not extend to several information products like chats, internal management databases, and so forth. Lyman & Varian (2000, 2003) call the originals "unique information." The concept of unique information can be related to that of "non-redundant" information.

2.5.6 Media, kinds of carriers of products. Several authors classify the information products that they studied by media, that is, magnetic, optical, paper, air, and so forth. Lyman & Varian (2000) adopt the term "media" for various kinds of information products, as well as for kinds of information carriers.

2.5.7 Traditional versus digital (information) products, digitized versus non-digitized products, electronic content-products versus the rest of the products. Digital and non-digital products may substitute for each other; therefore, any HMI study that attempts to understand the processes of entering the new digital era should extend to both. According to the broad definition of OECD, if taken verbatim, *non-digitized products* should include all kinds of digital information goods, for example, DVDs. The still debatable OECD term of *electronic content product* is assumed to refer to products of the electronic content sector.

2.5.8 Specific kinds of information products. Nomenclatures of information goods and services can be used to define the scope of an HMI study, or the selected classes can be characterized as targets. The

nomenclature of information products in HMI studies has not been standardized, and various authors adopted various classifications, as shown in Tables 4, 5, and 6.

Nomenclatures of information products are not coherent, mainly because international statistical organizations have difficulties keeping up with rapid technical development. At present, comprehensive HMI studies cannot be based exclusively on standard international or national classifications—ISIC, SITC, CPC, HS, COFOG, and COICOOP—because several products, including the most important services on the net, are not included there.

Table 4. Nomenclatures for Identification and Classification of Information Activities, Goods, and Services.

Sources	***Nomenclatures***
UNSD, 2009a	Activities of units: ISIC, foreign trade SITC, harmonized nomenclature
Erdész, 1983	Standard UNESCO
de Sola Pool et al., 1984	Own
Varga, 1986	Standard UNESCO
HCSO, 1990	Standard Hungarian official statistical
Dienes, 1992	Standard Hungarian nomenclatures (ITJ, SZJ, TEÁOR), international standard UNESCO, media research companies
Dienes, 1994a methodology	UNESCO, ITU, own
Dienes, 1994b	U.S. official statistical nomenclatures, nonstandard nomenclatures
Lesk, 1997	Own
Lyman & Varian, 2000, 2003	Own
Bounie, 2003	Own
Neuman, 2009	Own
CISCO, 2009,,2011	Proprietary

Gantz et al., 2007–2011	Proprietary
Bohn & Short, 2010	Own
Dienes, 2010	Hungarian official industrial, cultural, and telecomm statistical nomenclatures, nomenclatures of national industrial associations and media research companies
Short et al., 2011	Own
Hilbert & López, 2011, 2012a, 2012b	Own

Technical classifications, combined with the classification of economic transactions, may provide a solution to identify standard lists of kinds of information products.

HMI studies mostly exclude "dark information"—the information built into microchips that are embedded in non-information devices, even if this "out of user control" information will prevail and define the not-so-distant future (Hilbert & López, 2011; Short et al., 2011).

Table 5. Classes of Information Goods Studied Individually by Various HMI Authors.

Sources	***Goods***
Tomita, 1975	Mail, direct mail, newspapers, books, magazines, advertising literature, phonograph records, music tapes, outdoor advertising (billboards, etc.)
de Sola Pool et al., 1984	Records and tapes, books, magazines, newspapers, first-class mail, direct mail, telephone directories, mailgrams. No pictures are considered.
Erdész, 1983	Books, journals, newspapers, movies, tapes, and records
Varga, 1986	Books, journals, newspapers, movies, tapes, and records
Dienes, 1992a	Records and tapes, books, magazines, newspapers, mail

Dienes, 1992b	Newspapers, magazines, books (including telephone directories), posters, postmarks, banknotes, flyers, postcards, maps, other print and paper-based home and office documents, mail, records, photographic industrial and cinematographic roll and sheet film (positive and negative), photos, drums, tapes, cassettes, hard disk drives, floppy disks, telex messages, telegrams, fax messages.
Dienes, 1994a Methodology	Recorded ROM, RAM, hard disk- and paper-based media, digital and analog magnetic media, films
Dienes, 1994b	Human consumable: paper-based, other. Machine consumable: videocassettes, records and audiocassettes, magnetic tapes and reels, diskettes, hard disks, films, other
Lesk, 1997	Computer stores: optical and magnetic disk, magnetic tapes, maps, photos, movie films, sound recordings, prints
Bounie, 2003	Books, serials, personal and office documents, films, photographic films, vinyl, CD, DVD, magnetic cassettes, hard disks, floppies, microprocessors and memory cards, flash memory, PDA
Lyman & Varian, 2000, 2003	Newspapers, magazines, books (including telephone directories), paper-based home and office documents, mail, records, photographic industrial and cinematographic roll and sheet film (positive and negative), photos, records, magnetic cassettes, hard disk drives, floppy disks, optical disks,
Neuman, 2009	Newspapers, magazines, books (including telephone directories), mail, records, records, magnetic cassettes, CD, VCR, DVD, DVR, portable audio, videogames
CISCO, 2007	Nothing: Only broadband Internet and IP traffic in the frame of various telecom services
Bohn & Short , 2009	Newspapers, magazines, books, recorded music
Short et al., 2011	Nothing: "Data at rest" excluded.
Dienes, 2010	Newspapers, magazines, books, print and paper-based home and office documents, mail, records, cinematographic roll and films, records, magnetic tapes, cassettes, hard disk drives, floppy disks, optical disks, semiconductor memory

Hilbert & López, 2011	Hard disk, DVD Blue-ray, digital tape, CD & minidisk, portable disks, memory cards, mobile phones, PDAs, videogames, others, floppy disks, digital cameras and camcorders, internal chip cards, video analogs, print photos, audiocassettes, photo negatives, Cine films, vinyl LPs, TV episodes on film, X-ray films, TM film, newsprint, other paper and print, books

Most HMI studies ignore human consumable information services like public education.

Table 6. Classes of Information Services Studied by Various Authors.

Author	Services Covered
Takasaki & Ozawa 1983	Fixed public and private (household and corporations) phones, mobile phones, wire and wireless phones, public and private telegraph, radio, television, wire broadcast, cable television, lectures, education, entertainment, outdoor advertising, face-to-face conversations outside the home.
de Sola Pool, 1984	Radio and TV broadcasting, cable TV, movies, education in the classroom, telephones, data communications
Erdész, 1983	Radio and TV broadcasting, movie (or theatre) libraries and publishers' services, concerts, other cultural services, public education
Varga, 1986	Radio and TV broadcasting, movies (or theatre) libraries and publishers' services, concerts, other cultural services, public education
Dienes, 1992a	Radio and TV broadcasting, cable TV, movies, education in the classroom, fixed phone, telex, telegraph
Dienes, 1992b	Spectator sports, theatres, museums, concerts, cultural and entertainment services, movies' services (feature films, documentaries), education (primary, secondary, and tertiary), courses, courts' services, information services of police and public prosecutors, local and central government (administration and legislation) services, information services of social security, engineering services, financial services, business services, legal services, fixed phone services (voice), radio programming (originals), TV programming (originals), terrestrial radio broadcasting, TV broadcasting, cable TV programs (originals), cable TV distributing services, audio and audiovisual display of sound or visual records and programs
Dienes, 1994a Methodology	Telecommunication, broadcasting, services of financial intermediaries, publishing houses, education, R&D, spectator sports, movies, theatres, museums, other kinds of entertainment, TV shows and supplying radio programs (displaying services), personal

	communications, human knowledge, writing, keyboarding, mouse input.
Dienes, 1994b	Human consumable: Education, personal communication, TV and radio displaying, writing, reading, phone, cultural services, entertainment. Machine consumable: TV and radio broadcasting, cable TV, TV and radio programming (originals), education
Lesk, 1997	Cinema, broadcasting, sound, telephony
Lyman & Varian, 2000	Internet, phone, broadcast services
Lyman and Varian, 2003	Internet, phone, broadcast services
Bounie, 2003	Radio and TV broadcasting, PC, Internet content and web hosting, market software, games software, piracy software
Neuman, 2009	Terrestrial and satellite broadcasting, cable TV, terrestrial and satellite radio broadcasting, theatrical motion picture, wireline, cellular, IM phone services, dial-up, broadband, WiFi Internet services
CISCO, 2007-2010	Broadband Internet and IP traffic in the frames of mobile, cable, and wired telecomm services: Internet video to PC, to TV, VoIP, video communications, gaming, P2P, Web/Data
Gantz et al., 2007-2011	Cloud services, "big data" services
Bohn & Short, 2009	Cable TV SD (Standard Definition), over-air TV SD, Cable TV HD (High Definition), over-air TV HD, satellite SD, satellite HD, mobile TV, other TV (delayed view), Internet video, satellite radio, movies in theaters, AM radio, FM radio, fixed-line voice, cellular voice, high-end computer gaming, computer gaming, console gaming, handheld gaming, Internet (including e-mail, offline programs, LAN, WiFi)
Dienes, 2010	Theatres, museums, concerts, cultural and entertainment services, movie services (feature films, documentaries), education (primary, secondary, and tertiary), fixed and mobile phone services (voice, SMS, Internet), fixed and mobile data services, radio programming (originals), TV programming (originals), terrestrial and satellite radio broadcasting, TV broadcasting, cable TV programs (originals), cable TV distributing services, cable TV Internet services, computer mediated flows, manual creation of digital data (keyboarding, mouse input, audio and audiovisual display of works

Short et al., 2011	Processing services of servers: completing various kinds of transactions
Hilbert & López, 2011	Communication services: digital and analog satellite, terrestrial, cable, TV, analog and digital radio, GPS, fixed and mobile voice phone, mobile data, Internet services, letters, newspaper delivery, paper-based advertising. Computation services by personal computer, videogame console, server and mainframe, supercomputer, pocket calculator, mobile phone/ PDA, digital signal processor, microcontroller, graphic processing unit.

2.5.9 Volume of resources spent for production of products, versus volume of products. While Short et al. (2011) measured the volume of *information work* of servers—what has been spent for some products—the rest of the HMI studies (in and overt or latent way) measured the *volume of products.* Hilbert and López (2011a) measure processing capacity. This might be conceptualized as capacity of units to provide "digital processing services" or capacity of "machine work." Volume of work spent for products and volume of products themselves seem to be useful in describing reproduction of information, and this has analogs in SNA.

2.6 Stocks, Kinds of Stocks, Assets.

According to our use here, which follows SNIA, the term *stocks* relates to information products held at a point in time and to the volume of information they carry.

Stocks are not defined overtly in the HMI studies, except in Dienes (1992b, 1994b). In the SNA, in the broad sense, the term refers to the set of economic values available in any capacity, at any given moment, minus liabilities. This is the "store," "storage" meaning which covertly has been adopted by several HMI studies, attempting to measure the volume of available capacity of information machines or volume of stored data. Figure 2 visualizes information stocks and flows according to SNA and SNIA.

An account should take into consideration stocks of all goods, anywhere, and accounted in any capacity. The main kinds of stocks are shown as round circles at the left (beginning of year) and right sides (end of year) of Figure 2. For instance, stocks of books in bookshops will be considered as information products for resale, while those of libraries as fixed information assets.

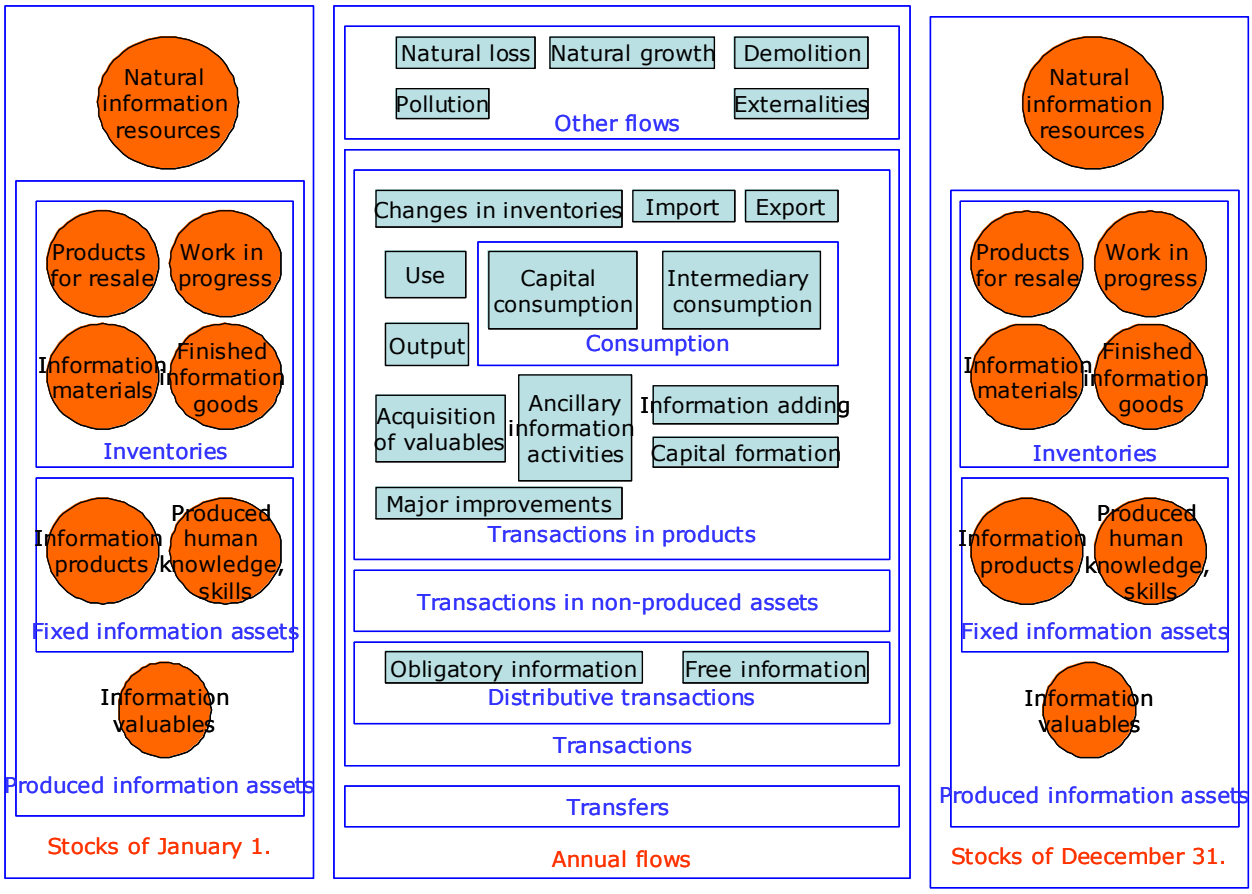

Figure 2. Information assets and flows of institutional units in the SNIA (simplified).

Information assets have been defined as produced information assets and natural information resources. *Produced assets* (stocks in sensu lato) are *fixed information assets*, *inventories* (information materials and supplies, commercial information commodities for resale, finished, own-made information products, and semi-completed information products, i.e., work in progress), and *information valuables*. Natural resources include *produced human knowledge and skills*. These have been depicted in Figure 2.

Among HMI studies, Dienes (1986, 1994a, 2010) and Lesk (1997) provided estimations for size, natural growth, and loss of stocks of human knowledge. Braman's genetic assets have not been studied as yet.

2.7. Physical Information Flows and Information Flows between Institutional Units

Table 7 details the classification of physical flows, some of which are illustrated in Figure 1.

Table 7. Classification of Flows and Their Codes by Kinds of Terminals of Flows and Kinds of Channel.

The codes refer to those presented in Figure 1

Channel	Endpoints of the flows	Intraorganization	Interorganization
Audio	From individual to individual: speech	011	012
Visual	From individual to individual: gestures		
Electronic	From device to device: messaging, signaling	021	022
Visual	From device to individual: displaying	031	032
Audio	From device to individual: playing	041	042
Audio	From individual to device: voice commanding	051	052
Motor	From individual to device: keyboarding, mousing, screen-touching, various kinds of manual input	061	062
Motor	From individual to media: handwriting	071	072
Audio	From individual to media: sound recording	081	082
Visual	From product to individual: seeing, reading	091	092
Audiovisual	From product to individual: viewing	101	102
Visual etc.	From product to individual:	111	112
More	From product to device: reading	121	122
More	From device to product: magnetic, optical and other kinds of recording	131	132
More	From outer world (reality) to device: measuring, recording	141	142

Most HMI authors fail to define the generic concept of "flow" exactly; they interpret it in various ways, but almost each of them, latently, adheres to the basic everyday sense of the word (Table 8.). The flows that are related to technical and economic "packages" and to institutional units are usually not defined and distinguished in HMI studies.

Table 8. Definitions of Flows, Economic and Information Flows.

Sources	***Definitions***
Wordnet, 2011	*Flow*, *flowing*: the motion characteristic of fluids (liquids or gases) • is a kind of change of location, travel *Flow*, *flow rate*, *rate of flow*: the amount of fluid that flows in a given time *Flow, stream*: the act of flowing or streaming; continuous progression • is a kind of motion, movement
UNSD, 2009 (p. 39)	"Economic flows reflect the creation, transformation, exchange, transfer or extinction of economic value; they involve changes in the volume, composition, or value of an institutional unit's assets and liabilities. Mirroring the diversity of the economy, economic flows have specific natures as wages, taxes, interest, capital flows, etc., that record the ways in which a unit's assets and liabilities are changed. Economic flows consist of transactions and other flows." "A transaction is an economic flow that is an interaction between institutional units by mutual agreement or an action within an institutional unit that it is analytically useful to treat like a transaction, often because the unit is operating in two different capacities. The value of an asset or a liability may be affected by economic flows that do not satisfy the requirements of a transaction. Such flows are described as 'other flows.' Other flows are changes in the value of assets and liabilities that do not result from transactions. Examples are losses due to natural disasters and the effect of price changes on the value of assets and liabilities."
Tomita, 1975	Information flows to be covered by the census: (a) There must be a transfer of information from one point to another, therefore excluding transfers inside a single communication system, such as a standalone computer. (b) The flow must be intentional, unwilled signs, i.e., acts that can be interpreted as signals like body language are excluded. (c) Both the sender and receiver must be either a human or a machine working directly to a human will, as described by Duff 2004.

Dienes, 1994a	*Information flow* is defined here as an action, whose object, instrument or source is an information good or a signal. (p. 45) Information flows are processes that reflect the creation, transformation, exchange, transfer or extinction of volumes of information." (p. 53)
Lyman & Varian, 2003	Latent defined flow is production: "Communication flows through four electronic channels: radio and television broadcasting, telephone calls, and the Internet." (p. 9)
Bounie, 2003	"Flow" of a product stands for its (industrial) production or sales.
Bohn, Short, & Lane 2009	"Our definition emphasizes 'flows' of data—data in motion. We count every flow that is delivered to a person as information." (p. 10)
Dienes, 2010	In accordance with the SNA, a process can be called an information flow, if and only if it results in the changing of the volumes of information assets, or what is termed a change in the state of "informedness" of participant institutional units.
Short et al., 2011	"We define *enterprise server information* as the flows of data processed by computer servers as inputs plus the flows delivered by servers as outputs." (p. 8)

With indicators of flows, we measure changes in volume of information over a period of time.

In the central part of Figure 2, various kinds of annual flows are plotted as boxes. For instance, the embedding of parts and accessories (like recorded chips) will be accounted as productive information consumption. The annual flow of books from printing factories or publishers—where they may be recorded as finished information goods—to bookshops will be accounted as their output. The flow from bookshops to libraries may qualify information capital formation.

The most important kinds of flows are those which can be conceptualized under the SNA umbrella terms of production and consumption.

Various non-defined (but related) terms are used to identify the activity of calling the various kinds of products into existence—create, produce, make, supply, write, compile, translate, prepare, print, and so forth—and to identify the conversion to figures in bit units of the raw data for sales, output, or turnover or supply used. This indicates that these concepts can be standardized in harmony with SNA.

Table 9. Various Authors' Definition of Creation, Production, Output, and Supply.

Source	***Definition***
UNSD, 2009a	"*Production* is an activity, carried out under the responsibility, control and management of an institutional unit that uses inputs of labor, capital, and goods and services to produce outputs of goods and services a) *Gross value added* is the value of output less the value of intermediate consumption. b) *Net value added* is the value of output less the values of both intermediate consumption and consumption of fixed capital." (p. 95) "Thus *output* is defined as the goods and services produced by an establishment, a) excluding the value of any goods and services used in an activity for which the establishment does not assume the risk of using the products in production, and b) excluding the value of goods and services consumed by the same establishment except for goods and services used for capital formation (fixed capital or changes in inventories) or own final consumption." (p. 105)
Tomita, 1975	*Supply* refers to the information transmitted by the sender regardless of whether or not the information is read or otherwise consumed at the other hand.
de Sola Pool et al., 1984	"The concept of *volume of words supplied* starts with the publisher, or producer or letter writer, and asks how much he puts out that is available to the audience, whether or not the audience members choose to attend it." (p. 5)
Dienes, 1992b	". . . the volume of information conveyed by all copies of all information goods and services (durable and non-durable signals) and human knowledge of all individuals produced within a 'period dt' will be denoted by *P(dt)* [italics added] shortly called *gross information production.*" (p. 43)
Dienes, 1994a	"*Information production sensu lato* is an activity carried out under the control and responsibility of an institutional unit that uses inputs of labor, capital and goods and services to produce outputs of goods and services carrying information, including those products, whose destination was other than carrying information, like printed T-shirts classified as a piece of cloth, or the price tagged boxes of chocolates. Instead of information production s.l. the production of information goods and services is accounted." (p. 31) "*Information production* can be defined as an activity in which an institutional unit consumes inputs of goods, services and human knowledge (including those that are treated as "labor" and "capital" in SNA) to produce information outputs. Of those goods and services volumes of information goods and services will be recorded in the bit-accounts of SNIA." (p. 143)

	Information output of an establishment is the goods and services that carry or convey information produced within that establishment and that become available for use outside the establishment. (p. 148) "*Information added,* gross at an economic unit i, can be defined in accordance with the SNA (1993) as its information output, minus *intermediate information consumption*, due to the production of information goods and services." (p. 205) "*Net information added* can be obtained as the difference between information added gross and fixed information capital consumption." (p. 205) "*Gross information supply* of a unit is the volume of information conveyed by *all copies* of information goods and services supplied by him; either produced, or acquired in other transactions." (p. 147)
Lyman & Varian, 2000	"We have identified production of content by media type . . ." (p. 3) "Yearly U.S. and world production of originals and copies for the most common forms of information media." (p. 1)
Lyman & Varian, 2003	"The various forms of information produced around the world . . . and stored in some form for posterity." (p. 2)
Gantz et al., 2007	"(digital) information created, captured, and replicated." (p. 1)
Gantz et al., 2008	"(digital) information created, captured, or replicated." (p. 1)
Dienes, 2010	Dienes 1994a
Short et al., 2011	Processing, output, no generic definition

Consumption and use of information are the second among the popular processes favored in HMI studies. Table 10 shows the definitions found in HMI studies.

Table 10. Definition of Consumption and Information Consumption in the SNA and Various HMI Studies.

Source	***Defintion***
UNSD, 2009a	"*Consumption of goods and services* is the act of completely using up the goods and services in a process of production or for the direct satisfaction of human needs or wants. The activity of consumption consists of the use of goods and services for the satisfaction of individual or collective human needs or wants." (p. 184)
Tomita, 1975	The amount of information actually consumed
de Sola Pool et al., 1984	"The concept of *words consumed* focuses on the reader or viewer, or listener, and asks what he or she takes in." (p. 5)
Dienes, 1992a	de Sola Pool et al., 1984
Dienes, 1992b	"Under consumption of a copy of an information good or service its reversible or irreversible physical disappearance (annihilation or transformation) will be understood either as a consequence of repeated usage or building it into some good (like embedding, e.g., firmware chips)." (p. 49) "*Use of information goods and services* (shortly *information use*) is understood as occurrence of a physical access to them for their copying for recording, modifying or for any other purpose." (p. 56)
Dienes, 1994a	Dienes, 1992b
Neuman, 2009	Demand, consumption
Bohn & Short, 2010	The quantity of data is accounted as information (consumption) each time consumers use it.

In the SNA (economic) *consumption* and *use* are synonyms. However, when a work or a book is used for reading, it obviously will not be physically consumed, and law regulates use only and not consumption of tangible and less tangible information goods. Therefore, as Dienes, in his SNIA (1994a), has suggested, it is desirable to distinguish consumption from use in HMI studies.

Overwhelmed already by useless, even harmful texts and pictures, de Sola Pool et al. (1984) tried to define "useful" information. His classification of information products to work and live is an embryonic formulation of *final and productive consumption* of an information good or service in SNA. The

entertainment versus non-entertainment dichotomy is an attempt to distinguish between *final information consumption* and *information capital formation* of SNIA.

Table 11. Kinds of Consumption in the HMI Studies.

Source	***Definition***
UNSD, 2009a	"Household *actual final consumption* consists of the consumption goods and services acquired by individual households." (p. 184)
Tomita, 1975	Uses made of communications: information for work, for living, entertainment
de Sola Pool et al., 1984	Information for work, information for living; entertainment, nonentertainment
Dienes, 1992b	Productive and final information consumption, waste, information capital formation
Dienes, 1994a	Productive and final information consumption, waste, information capital formation
Dienes, 1994b	Productive and final information consumption
Short et al., 2011	Work information, consumer information

For HMI studies, it seems to be straightforward to lend and modify the SNA definitions for intermediate and final consumption.

In Dienes (1994a), *information export and import* is defined as export and import of all goods and services carrying information. *Transborder flow of information* consists of information export and imports, plus transborder information transfer and the *information externalities of economic transactions*, like the overspilling of broadcasting and mobile phone services.

3. Discussion

3.1. What Are the Typical Problems of the HMI studies?

After reading this article, and particularly if one reads the studies themselves, the reader could be convinced that there are typical problems with the studies, including the following:

1. Lack of clear concepts and definitions, of agreement in the content of terms, of concerted classes, data for the main industries of economy, government sector, human knowledge, and information in the censuses.

2. Diverseness of the indicators.

3. The indicators do not constitute a coherent system, which covers all information activities and all kinds of information assets and flows.

4. Overall oversimplification of situations.

5. Several HMI studies are documented to a lesser degree than is necessary.

So far, only a single book (Dienes, 1994a) published online is available on the methodology of HMI studies, which contains generic definitions for a whole system that could constitute the skeleton of all calculations. Elimination of the methodical weaknesses just mentioned (and those not mentioned) is doubtlessly a necessary task for HMI-ers. The benefits of a standardization of HMI methodologies should at least include the following:

1. This will open the way toward an agreed upon, SNA-like intellectual vehicle, that provides both a worldview and a compass for policy making, following the steps of the founding fathers of SNA, and which would replace the systems like ITU 2010a, b.

2. Meanwhile, a new science of statistical measuring of the societal reproduction of information in various countries can gain shape and space. The main, practical and long-range objective of the work could be the elaboration of a Standard System of National Information Accounts (or SSNIA) manual, like UNSD (2009).

3. The new indicators, being harmonious with economic terms, should spur the interest of governments, industries, the economy, and the people.

The fundamental concepts of HMI studies to come—existing elements of which are freedom of speech, of intellectual property, of privacy, and of access to government information—will penetrate society and may lend new impetus to economies, similarly to what occurred at the dawn of the industrial society when the codification of a new generic law replaced the law of guilds.

3.2. Some Lessons Learned From the Experience with the Older Brother SNA

1. SNA and its creators were able to make the world more described, known, controllable, and controlled.

2. The founders gave birth to a new branch of science and a new industry. In the course of national planning and situation assessment, national governments worldwide rely on SNA quarterly data.

Also, a standard methodology of political analyses has been consolidated (UNSD, 2002, 2009b), which, of course, does not exclude innovative nonstandard approaches.

3. Several new application areas have emerged, as well as the methodology of add-ins with new satellites (UNSD, 2011a).

4. That the first version of SNA in 1963 served its users for 30 years indicates that even such a sophisticated worldwide system as the world economy can be described in a stable way, if the will persists to do so.

5. In the past 50 years, the methodology of development and apparatus of official statistical standards consolidated.

6. One-sided use and publication of SNA data is a caveat. A major part of the arsenal that SNA provides has never (or only sporadically) been used. It is the GDP that is favored by UNSD, HCSO, policy makers, the press and the people.

7. Sometimes overaggregation due to conscious misleading or to an overly scientific manner makes the situation dull for users of the statistics.

8. Inclination of statisticians and politicians toward standard statistics when a nonstandard approach would be better.

9. International statistics and statistical methodology may be a tool in the hands of the leading powers.

3.3 Summary and Two Steps Forward

The *IJoC* special section presents an opportunity for HMI practitioners and outsiders to show that the work of different parties done over the past decades is not a collection of totally contradictory and conflicting ideas, and that there is a perspective to standardize the methodology and to define coherent and rich accounts that reflect the system of societal reproduction of information. The final objective of the science that may emerge from HMI studies should be the understanding of the macro processes of this system in geographical units, in language, or in other communities. The main, practical and long-range objective of the methodological work can be the elaboration of an SNA/SNIA-like intellectual vehicle—a Standard System of National Information Accounts (SSNIA) that serves as a worldview and compass in domestic and international policy making for national legislations and administrations, enabling central governments to make top-down decisions in the interests of electors versus those of lobbyists of different traditional and digital industries and of international players.

Two initial steps should be taken:

1. Collect experience with increasingly more indicators and from several countries for which the demand exists. (There are several alternatives for HMI studies, for which a simplified overview of opportunities is presented in this study.)

2. Launch a collective international effort to develop a Draft SSNIA, like Bellini et al., 2001, in which the demands of information accounting toward the SNA community can be formulated.

The objectives of those who order statistics justify not only the definitions but also all details of the survey methodology. It is hoped that participants in the effort be fueled by the desire to engineer the best ways to make better world.

References

Bellini, F., Braunstein, Y., Clavero, G.M., Deistler, M., Dienes, I., Jellema, T. et al. (2001). *European standard system of information accounts*. Project proposal of research consortium submitted to the 5th Programme of the EU. Retrieved from http://infostat.hu/publikaciok/00-partb.pdf

Bohn, R., Short, J., & Lane, P. (2009). *How much information? Report on American consumers*. Retrieved from http://hmi.ucsd.edu/howmuchinfo.php

Bounie, D. (2003). *The international production and dissemination of information*. Retrieved from http://ses.telecom-paristech.fr/bounie/documents/Recherche/Annex.pdf

Braman, S. (1990). Defining information: An approach for policymakers. *Telecommunications Policy 13*(3), pp. 233–242.

CISCO Systems Inc. (2009). Cisco visual networking index: Forecast and methodology, 2010–2015. Retrieved from http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-481360_ns827_Networking_Solutions_White_Paper.html

CISCO Systems Inc. (2011). Entering the zettabyte era. Retrieved from http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/VNI_Hyperconnectivity_WP.html

de Sola Pool, I. (1983, August 12). Tracking the flow of information. *Science*, *221*(4611), 609–613. doi: 10.1126/science.221.4611.609

de Sola Pool, I., Inose, H., Takasaki, N., & Hurwitz, R. (1984). *Communications flows: A census in the United States and Japan*. New York: Elsevier Science.

Dienes, I. (1986). Magnitudes of the knowledge stocks and information flows in the Hungarian economy (in Hungarian). InJ. Szabó (Ed.), *Tanulmányok az információgazdaságról* (pp. 89–101). Budapest, Hungary: KSH-OMIKK. Retrieved from http://infostat.hu/publikaciok/86-nagysr.pdf

Dienes, I. (1992a). A comparative analysis of communications flow in Hungary, the United States and Japan. In I. Dienes (Ed.), *Proceedings of the third conference"Information economy and policy"* pp. 19–30). Budapest, Hungary: NJSZT. Retrieved from http://infostat.hu/publikaciok/91-desola.pdf

Dienes, I. (1992b). Knowledge stocks and information flows in Hungary 1945–1990. An implementation of the system of national information accounts and its application to policy assessment and policy making. Appendix i-ii–iv, 196 pp., Supporting material, p. 61. Retrieved from http://infostat.hu/publikaciok/92-snia-jav-20110926.pdf

Dienes, I. (1992c). *Information balances of Hungary 1975–90* (in Hungarian). Paper presented at the Information Economy, Information Policy Conference, Budapest. Retrieved from http://infostat.hu/publikaciok/91-eload.pdf

Dienes, I. (1993). Towards a system of national information accounts. *Proceedings of the XXI Telecommunications Policy Research Conference*, Solomons, Maryland. Retrieved from http://infostat.hu/publikaciok/93-solomonsprez.pdf

Dienes, I. (1994a). National accounting of information. Reference Manual of SNIA, Version 1.1. Manuscript, Berkeley, Budapest, Hungary. Retrieved from http://infostat.hu/publikaciok/94-ssniav.pdf

Dienes, I. (1994b). Accounting the information flows and knowledge stocks in the U.S. Preliminary results. Presentation at the University of California, Berkeley. Retrieved from http://infostat.hu/publikaciok/94-berkeleyreport.pdf

Dienes, I. (2002). How much information? Chapters from the history of the accounting of information flows and knowledge stocks. Retrieved from http://infostat.hu/publikaciok/02-fulbright.pdf

Dienes, I. (2003). World-wide information balances—Information balances of Hungary 1990–2002 (in Hungarian). *Proceedings of the VIII National John von Neumann Congress, 2003*, Budapest, 145–168. Retrieved from http://infostat.hu/publikaciok/03-neumannkuld.pdf

Dienes, I. (2010a). National accounting of information. Reference Manual of SSNIA, Version 1.2. Manuscript, 370 pp. Budapest, Hungary.

Dienes, I. (2010b). Twenty figures illustrating the information household of Hungary between 1945 and 2008 (in Hungarian). Retrieved from http://infostat.hu/publikaciok/10_infhazt.pdf

Duff, A. S. (2004). The past, present, and future of information policy. *Information, Communication & Society*, *7*(1), 69–87.

Erdész, T. M. (1983). A birdview review of cultural services in Hungary: Viewing at computerization (in Hungarian). Manuscript, Budapest.

Gantz, J. F., Reinsel, D., Chute, C., Schlichting, W., McArthur, J., Minton, S. et al. (2007). The expanding digital universe. [IDC white paper]. Retrieved from http://www.emc.com/collateral/analyst-reports/expanding-digital-idc-white-paper.pdf

Gantz, J. F., Chute, C., Manfrediz, A., Minton, S., Reinsel, D., Schlichting, W. et al. (2008, March). The diverse and exploding digital universe [IDC white paper]. Retrieved from http://www.emc.com/collateral/analyst-reports/diverse-exploding-digital-universe.pdf

Gantz, J. F., & Reinsel, D. (2009). As the economy contracts, the digital universe expands. [IDC multimedia white paper]. Retrieved from http://www.scribd.com/doc/15748837/IDC-Multimedia-White-Paper-As-the-Economy-Contracts-the-Digital-Universe-Expands

Gantz, J. F., & Reinsel, D. (2010, May). *The digital universe decade—Are you ready?* Retrieved from http://www.emc.com/digital_universe

Gantz, J. F., & Reinsel, D. (2011). Extracting value from chaos. Retrieved from http://idcdocserv.com/1142

Hilbert, M., & López, P. (2011, February 10). The world's technological capacity to store, communicate, and compute information. *Science 1*, *332*(6025), 60–65. doi: 10.1126/science.1200970

Hilbert, M., & López, P. (2012a). How to measure the world's technological capacity to communicate, store and compute information? Part I: Results and scope. *International Journal of Communication*, *6*, (This Special Section.)

Hilbert, M., & López, P. (2012b). How to measure the world's technological capacity to communicate, store and compute information? Part II: Measurement units, statistical lessons, and conclusions. *International Journal of Communication*, *6*, (This Special Section.)

Hungarian Central Statistical Office (HCSO). (1990). Information balances of Hungary in natural units (in Hungarian). Internal report, Budapest.

Ito, Y. (1981). The Yohoka Shakai approach to the study of communication in Japan. In G. C. Wilhoit & H. de Bock (Eds.), *Mass communication review yearbook, Vol.2* (pp. 671–698) Beverly Hills, CA: SAGE Publications.

International Telecommunication Union (ITU). (2010a). *Monitoring the WSIS targets. A mid-term review 2005–2015*. World Telecommunication/ICT Development Report 2010. Geneva, Switzerland. Retrieved from http://www.uis.unesco.org/Communication/Documents/WTDR2010_e.pdf

International Telecommunication Union (ITU). (2010b). *Measuring the WSIS targets—A statistical framework*. ITU. Geneva, Switzerland. Retrieved from http://www.itu.int/dms_pub/itu-d/opb/ind/D-IND-MEAS_WSIS-2011-PDF-E.pdf

Lesk, M. (1997). How much information is there in the world? Retrieved from http://www.lesk.com/mlesk/ksg97/ksg.html

Lyman, P., & Varian, H. R. (2000). *How much information?* Retrieved from http://www2.sims.berkeley.edu/research/projects/how-much-info/

Lyman, P., & Varian, H. R. (2003): *How much information?* Retrieved from http://www.ischool.berkeley.edu/files/images/hmi2003.gif

Neuman, W. R., Park, Y. J., & Panek, E. (2009). *Tracking the flow of information into the home: An empirical assessment of the Digital Revolution in the U.S. from 1960–2005*. University of Michigan, Ann Arbor.

OECD. (2009). Guide to measuring the information society. Directorate for Science, Technology and Information. DSTI/ICCP/IIS(2005)6/FINAL Retrieved from http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DSTI/ICCP/IIS%282010%295/FINAL&docLanguage=En

Porat, M. U. (1977). *The information economy: Definition and measurement*. Washington, D.C., Office of Telecommunications. Retrieved from http://www.eric.ed.gov/PDFS/ED142205.pdf

Saito, T., Inose, H., & Kageyama, S. (1983). A comparative study of the mode of domestic and transborder information flows including data. *Information Economics and Policy*, *1*(1), 75–92.

Shannon, C. (1948). A mathematical theory of communication. *Bell System Technical Journal*, *27*, 379–656. doi:10.1145/584091.584093

Short, J. E. Bohn, R.E., & Baru, C. (2011). *How much information? 2010 report on enterprise server information* (Background Technical Working Paper No. 1). University of California, San Diego, (Global Information Industry Center at the School of International Relations and Pacific Studies) Retrieved from http://clds.ucsd.edu/sites/clds.sdsc.edu/files/pubs/ESI-Report-Jan2011.pdf

Takasaki, N., & Ozawa, T. (1983). Analysis of information flow in Japan. *Information Economics and Policy*, *1*(2), 177–193.

Tomita, T. (1975). The volume of information flow and the quantum evaluation of media. *Telecommunication Journal*, *42*(6), 339–349.

UN Department of Economic and Social Affairs, Statistics Division. (UNSD). (2002). *Handbook of national accounting. Use of macro accounts in policy analysis studies in methods series: F, No. 81*. ST/ESA/STAT/SER.F/81. Retrieved from http://unstats.un.org/unsd/pubs/gesgrid.asp?id=278

UN Statistical Division (UNSD). (2009a). European Commission, International Monetary Fund, Organization for Economic Co-operation and Development, United Nations, World Bank. *System of National Accounts 2008*. New York, p. 722. Retrieved from http://unstats.un.org/unsd/nationalaccount/docs/SNA2008.pdf

UN Statistical Division (UNSD). (2009b). *Methodology of UN national account main aggregates database*. Retrieved from http://unstats.un.org/unsd/snaama/methodology.pdf

UN Statistical Division (UNSD). (2011a). *Tourism satellite account: Recommended methodological framework series: F, No. 80*. Retrieved from http://unstats.un.org/unsd/pubs/gesgrid.asp?id=255

Varga, A. E. (1986). The development of cultural activities in Hungary in the past 25 years as reflected by the data (in Hungarian). In J. Szabó (Ed.), *Tanulmányok az információgazdaságról* [Studies on information economy]. OMIKK-KSH, Budapest: ISBN 9635924879.

Ziming L. (2004). Transborder information flow through human movement: implications for professional interactions. *The International Information & Library Review*, *36*(1), 39–45.