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Voices behind indicators for welfare and healthcare in Finland

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Abstract

The voices of different kinds (i.e., stated or unstated expectations of the entities) affect the functioning of the systems. Voices of authorities (VoA), processes (VoP) and shareholders (VoS) are seen in controls interacting with an environment. Therefore, control-related indicators are prescriptive, and they provide expectations for the functioning of the systems. In the study, the entity-related approach of the voices (VoA, VoP, and VoS) adapted to formalize rules for the evaluation metadata of the KUVA and SOTKANET indicators the meaning of which is to control welfare and health in Finland. The KUVA indicators are meant to control especially cost-effectiveness. The region classifications of the KUVA and SOTKANET indicators used to figure out whether responsible information providers (VoP) and information consumers (VoA and VoS) can be established. When 15 region classifications mapped within the voices by the nine rules the result of which was that nine region classifications mapped within VoA, three within VoS, and two within VoP. The main information providers are municipalities and hospital districts and municipalities. Despite our metadata-based KUVA and SOTKANET content research, without the deployment instructions of the indicators, the municipalities and other service providers do not get a complete picture of how the authorities and shareholders see them and what is expected of them, i.e., control-related cost-effectiveness will not be transparent.

Keywords: compliance, control, functional domain, value chain activity

Introduction

Modern healthcare leadership theories (e.g., Triple Aim [1], 4P [2] and Value-Based Healthcare [3]) emphasize the data significance within the decision making. Continuous measurement supports enterprise strategy utilization and is based on a selected set of indicators [4], which are describing the health care service system performance, resource consumption and the outcome.

Analytics generate value for decisions either retrospectively or predictively. The healthcare industry produces large amounts of data for processes, diagnostics, record keeping, administrative purposes and ensuring the care continuum with detailed documentation. [5] Documentation digitalization provides a new way to utilize the data for secondary use. In addition to the primary purpose, the data is used for leadership, development, quality assurance and research.

The Euro Health Consumer Index (EHCI) is used to rank the healthcare systems of the 35 European countries. The ECHI is composed of 46 indicators of six sub-disciplines. The ECHI 2018 ranked the Finnish healthcare system within the sub-disciplines (the Finnish score/the maximum score of the sub-discipline) as

follows: patient rights and information – 113/125, accessibility – 150/225, outcomes – 278/300, range and reach of services provided – 120/125, prevention – 101/125, and pharmaceuticals – 78/100. Finland is the European champion of the outcomes sub-discipline the interpretation of which is "Finland does well in value-for-money healthcare". However, there are some identified areas (e.g., long waiting times, limited dental care, and high out-of-pocket payment for prescription drugs) for improvement in the Finnish healthcare system. Nowadays, private healthcare supplements to public healthcare. The Euro Health Consumer Index (EHCI) 2018 claims that the Finnish "public payers and politicians traditionally were less sensitive to "care consumerism" than in other affluent countries" without the definition of care consumerism. [6]

There are more than 3000 SOTKANET indicators containing statistical information on welfare and health in Finland [7]. The National Institute for Health and Welfare (THL) published in March 2019 a new set of common indicators (KUVA) to be used in health and welfare service management, service quality assessment, cost, effectiveness and productivity monitoring. The published indicators were the result of the project for the basis of knowledge regarding regional, welfare and healthcare reform during the years 2017 - 2018. The project was carried out to ensure the THL capability to fulfil the changing requirements through the reform. Despite the reform discontinued at Mach 2019 the indicators and corresponding data browsing tools (e.g., the Tietoikkuna.fi service) was published [20]. The KUVA indicators were mainly designed for the discontinued regions, welfare and healthcare reform. The main aims for the KUVA indicator set are the following [8]:

- renew the THL data production process
- provide comprehensive and up to date the data source for neutral assessment
- provide data for national and regional data needs

Nowadays, the care units have self-control themselves and the municipalities should ensure the proper functioning of the care units. The municipalities report to regional government agencies which are reporting to the national supervisory authority the rights of which allow suspending activities. There seems to be a need for controlling systems the triggers of which are even escalated to corresponding representatives of the supervisory authority. For example, compliance will be ensured within mechanisms (e.g., regular audits and policies for reporting breaches) and measures (e.g., training)[9], documents and information are required to provide during the service production without delay, i.e., the formation of the documents and other information during the production of the service can be verified ex-post [10].

In general, enterprises control their capabilities based on regulatory environments [11]. Governing bodies are accountable for several issues that are related to each other. For example, the concept 'mesh of management' [12] launched to illustrate the combinations of environmental issues, practices, resources and technologies. However, the management mesh covers only one organization whereas public services require a holistic approach where parts of the value streams provided by several organizations interrelate and interact controlled manner to fit for use (i.e., warranty that concerns non-functional properties) and fit for purpose (i.e., utility that concerns functional properties). A value stream is defined to be the "series of steps an organization undertakes to create and deliver products and services to consumers" [13] or "the series of steps that an organization uses to build solutions that provide a continuous flow of value to a customer" [14]. Whether, the system of enforcement for public services requires controls by authorities, processes and shareholders, then control-related indicators have to be related to monetary valuation or non-monetary valuation.

Welfare and healthcare results are difficult to compare statistically between different regions or organizations. The population age structures may be different. It means that the comparison is possible without any bias. Thus, different standardization methods are developed. Health problems and service demand are often related to age. The age-related standardization is used to enable the comparison of regional or organizational health-related phenomena, like mortality or health service demand, by a comparable way. The age-related stand-

ardization is always based on the standard population. The phenomena on hand are calculated for the age groups and then the calculations by the group are adjusted with the transposed standard results. It is essential to notify; the transpositions change between different populations and transpositions should be recalculated between the materials. It is possible to do the age standardization either by direct or indirect way. The direct standardization requires both the results by the age groups and the population age structure. The subgroup results are transposed to the population and the results, index values, are calculated. The indirect standardization requires only data about the population-level results. Based on the population results, the subgroup estimate is calculated and the expected and observed results are calculated. The standardize ratio is possible to use to compare different subgroups from different regions. [15].

In healthcare, the different risk calculations are widely used to estimate the risk the situation is getting more difficult. Mortality, getting some disease, status worsening, readmission or prolonged hospital stay are often used. Based on the risk it is possible to standardize the results with the same methodology as the standardized mortality ratio discussed above. [16,17]. It is necessary to remember the effect of the changing population as well the changing practices on the results.[16]. Thus, the risk calculation formulas are essential to recalibrate on a regular basis.

The key element of the indicator comparability is high and solid quality of the used data as well as the quality of calculations. The source data quality is possible to improve by training the staff registering the data [18], using automated data collection methods [16] and centralized calculations.

In this study, the entity-related approach of the voices of authorities, processes and shareholders described in our previous study [19], adapted to formalize rules for evaluations of the indicators for welfare and healthcare in Finland [8] (Section Material and methods). Moreover, the formalized rules are applied in the context of the indicators for welfare and healthcare in Finland (Section Results). Finally, we are discussing the control effects of the indicators.

Material and methods

The voices of a different kind (i.e., stated or unstated expectations of the entities) affect the functioning of the systems. First, we present voices of authorities, processes and shareholders (Section Common Controls, Entities and Voices) that are seen in controls interacting with an environment. The section illustrates that the data entity is accessed and updated through services. [20]. Second, we present categorizations (Section KUVA, Sotkanet.fi and Tietoikkuna.fi) of the KUVA and SOTKANET indicators.

Common controls, entities and voices

Governance of different kinds (e.g., architecture, corporate and IT) are used to ensure that business is conducted properly [21]. Governances are practices or institutionalized best practices by which entities and their relationships are managed and controlled at an enterprise-wide level. The TOGAF content meta model provides a feature set (i.e., entities and their relationships) that can be either explicitly (e.g., the Government Wide Enterprise Architecture, GWEA) or implicitly (e.g., JHS 179 Enterprise architecture planning and development) mapped on artefacts [22]. The following entities of the TOGAF 9.2 content meta-model are fulfilled mainly based on the definitions of the ISO Online Browsing Platform [23], the Oxford University Press [24]:

- *Actor*. External or internal person, organization, or a system that initiates or interacts with activities.
- *Driver*. A factor (external or internal) that contributes to an outcome or result. For example, changes in regulations or compliance rules.
- *Goal*. A statement of the intended outcome or result.
- *Course of Action*. Statements of purposes to the operation way.

- *Function*. A purpose (or an activity) intended for a person and/or thing to deliver business capabilities
- *Control*. A decision-making step (e.g., business logic or governance gate) for process execution. Business (or domain) logic describes the sequence of operations to carry out the business rule that manipulate data entities. Governance gates are decisions between stages [25] or phases of the process to verify process phases where some form of regulatory or compliance sign-off is required.
- *Process*. A flow of control between or within functions, processes, and/or services performed by roles and/or organization units to achieve a specified outcome (e.g., products).
- *Event*. An organizational state change triggered from inside or outside the organization.
- *Service*. An element of behavior defined for business, information systems, and platforms to provide specific functionality in response to commands or requests.
- *Data Entity*. An encapsulation of data as a recognized thing.
- *Contract*. An agreement that establishes functional and non-functional (e.g., privacy and security) parameters for interactions between consumers and providers of the service.
- *Measure*. An indicator or factor to determine success or alignment with goals.

Some of the entities (e.g., contract and control) have to be related properly at the architecture level to ensure compliance with authority documents (e.g., regulations, internal and external standards). There are common controls frameworks such as the Common Controls Framework (CCF) by Adobe, the Unified Compliance Framework (UCF) and the Common Security Framework (CSF) by HITRUST. Each common control framework takes into the consideration authority documents (e.g., COBIT, HIPAA, ISO/IEC 27001 and NIST). However, the UCF is the most comprehensive with over 800 documents and the UCF compliance dictionary [26,27] are grouped by IT impact zones (e.g., Leadership and Highfields).

The common controls are used to illustrate requirements or obligations that are derived from the authority documents (e.g., regulations and standards) and are controlled by the same party of parties (i.e., by the authorities). Controlled voices represent controls affecting to functional domains and, in addition representing different stakeholder requirements and the need [19]. The Voice of the Authority (VoA) is stated requirements that are adapted to the common controls. The Voice of the Shareholder (VoS) is stated requirements that are adapted to the corporate controls. The corporate controls concern governance of different kinds (e.g., architecture, corporate and IT) that are used to ensure that business is conducted properly at the enterprise-wide level. Furthermore, corporate controls are in accountabilities and responsibilities, as well in the statements of corporate strategy [28]. The variation of the process is based on either common cause (a.k.a., noise, chance causes, non-assignable causes, natural patterns, random effects, and random errors) or special causes (a.k.a., signals, sporadic causes, assignable causes, unnatural patterns, systematic effects, and systematic errors). The Voice of the Process (VoP) is a term used to describe whether the process is under control and what kind of causes are attached to individual measurements. A common cause is a part of natural variation. A special cause needs to be addressed with. We use the term process control is used to illustrate variation ranges (e.g., lower and upper control limits) and individual results that are plotted above and below the average of the process.

The governing body (e.g., a board of directors) is accountable for the performance and conformity of the enterprise. The process owners conduct the course of action. The entities the definition of which contain the effects of authorities and governing body are the source entities (Table 1). The service is governed and measured by the contract where both the Voice of the Authority and the Voice of the Shareholder are in the attributes of the contracting entity.

Table 1. Exemplifying enterprise entities vs. VoA, VoS and VoP.

Source Entity	Relationship	Target Entity	Authorities	Governing bodies	Process owners
Driver	creates	Goal	VoA	VoS	
Goal	is realized by	Course of Action		VoS	
Course of Action	influences	Function		VoS	
Function	is realized by	Process			VoP
Control	ensures the correct operation of	Process	VoA	VoS	
Function	Is bounded by	Service	VoA	VoS	
Contract	governs and measures	Service	VoA	VoS	
Service	is realized by	Process			VoP
Event	is resolved by	Actor, Process, Service	VoA	VoS	VoP
Data Entity	Is accessed and updated through	Service			VoP
Measure	sets the performance criteria for	Service	VoA	VoS	
Measure	sets the performance criteria for	Objective	VoA	VoS	
Objective	realizes	Goal		VoS	

Table 2. Sotkanet.fi completion or production over time.

Completion or production	Number of indicators
Completion in 2019	14
Completion during 2020-2023	18
Completion during 2024-2025	56
In production	443
Total	**531**

The Voice of the Authority and the Voice of the Shareholder affect processes via the contract and control as well as the course of action, for example, by process limits. At the operational level, the event is meaningful because it is resolved, for example, by the actors (i.e., a person, organization, or system) that initiate or interact with the activities of the processes.

KUVA, Sotkanet.fi and Tietoikkuna.fi

We analyzed the KUVA excel [29] the content of which is 531 indicators within their descriptions, completion or production, dimensions, sets of functions, data source, purposes, information providers, information consumers, and justification for the choice of the indicator. 443 indicators are already in the Sotkanet.fi service and 88 indicators are new ones (Table 2).

The dimensions of the KUVA indicators illustrates main purposes of the indicators. Moreover, the KUVA excel contains some other purposes such as being a part of the regional or municipality well-being report, monitoring of regional development and being factors of state subsidies. However, 450 indicators do not have other purposes than dimensional ones. It is observable that

one indicator might belong to 1-3 dimensions and 1-3 sets of functions. Therefore, the numbers of the KUVA indicators per dimensions or per sets of functions are indicative.

One indicator may have four levels for information providers (V=national, M=regional, K= municipality, P=service provider) the combinations of which differ. Furthermore, one indicator may have five levels for information consumers (V=national, M=regional, K= municipality, P=service provider, A=customer) the combinations of which differ. We manipulated the KUVA excel by combining labels of the information providers (Appendix table 5) and labels of information consumers (Appendix table 6). The numbers of the indicators per the different combinations of the information providers (Appendix table 7) and per the different combinations of the information consumers (Appendix table 8) as well as their cross table (Appendix table 9) illustrate the main meaning of the KUVA indicators (i.e., to provide data for national and regional data needs).

The KUVA indicators were originally intended for social welfare and healthcare reform the regions of which are the whole country (the level of which is national, V), region (the level of which is regional, M) and municipality (the level of which is a municipality, K). Moreover, the KUVA indicators are intended for the customers (the level of which is customer, A) and service providers (the level of which is provider, P). The levels of the KUVA indicators are mapped into the voices of the authorities (VoA), processes (VoP) and shareholders (VoS) based on the information providers of the indicators. There are different combinations of the information providers (Table 3). The levels of the information providers and voices (Table 3) and the levels of the information consumers and voices are mapped by the following rules:

- IF V THEN VoA
- IF P THEN VoP
- IF M or K THEN VoS

Table 3. Information providers and voices.

Information providers (rows) and voices (columns)	**VoA**	**VoP**	**VoS**
V+M	179		179
V+M+K	269		269
V+M+P	14	14	14
V+M+K+P	69	69	69
Column total	**531**	**83**	**531**
Information consumers (rows) and voices (columns)	**VoA**	**VoP**	**VoS**
V+M	379		379
V+M+A	8		8
V+M+K	54		54
V+M+K+A	4		4
V+M+P	19	19	19
V+M+P+A	53	53	53
V+M+K+P	12	12	12
V+M+K+P+A	2	2	2
Total	**531**	**84**	**531**

The voice of the shareholder does not distinct form the voice of the authority (VoA). Furthermore, there seem to be only a few indicators that illustrate the voice of the process (VoP). Therefore, we adapt to the regions of the Sotkanet.fi service where the values of the indicators are related to the codes of the indicators and the codes of the regions. We collect the identifiers of the KUVA indicators from the Tietoikkuna.fi service. Then we use the Sotkanet REST API [31] (=>API calls https://sotkanet.fi/rest/1.1/regions and https://sotkanet.fi/rest/1.1/indicators) to download the normalized region classifications of the indicators (Maa - whole country, Maakunta - region, Sairaanhoitopiiri - hospital district, Kunta - municipality, Aluehallintovirasto - area for the regional state administrative agency, Nuts1 - Mainland Finland/Åland, Erva - university hospital special responsibility area, Suuralue - major region, Seutukunta - sub-region, Eurooppa - European, Pohjoismaat - Nordic countries, EU15, EU25, and EU25) and organizations of the indicators.

If the indicator exists then it is important to know the identifier of each indicator (ID) in the Sotkanet.fi service because there is more information, for example, about classification, data content, data source, years, update frequency, interpretation, and restrictions. The indicators have the normalized region classifications in the Sorkane.fi service. However, the values of the indicators have been mapped within the codes of the regions in the Sotkanet.fi service. Each municipality has regions to which the municipality belongs:

- Five (5) major regions [32]
- Two (2) NUTS 1 [32]
- 19 regions [33]
- 70 sub-regions [34]
- 21 hospital districts (SHP) [35]
- Five (5) university hospital special responsibility area (ERVA) [36]
- Seven (7) are as for the regional state administrative agency (AVI) [37]
- 16 centers for Economic Development, Transport and the Environment (ELY) [38].

It is not possible to identify the information providers of the indicators based on the normalized region classifications. However, we will figure out whether the normalized region classification illustrates the voices of the authorities, processes and shareholders better than the information providers and information consumers of the KUVA excel.

Results

The metadata of the SOTKANET indicators contain the organization and normalized region category. The organization illustrate the owner of the indicator (Appendix table 10). Most indicators are established by the Institute for Health and Welfare.

The normalized categories of the SOTKANET indicator illustrate regions (Appendix table 11). Most indicator values are assigned to the different regions without the knowledge of the responsible information providers as well as without the primary sources of the raw data that have been used to aggregate the providable information.

Without the detailed information of the indicators (e.g., data content, data source, interpretation, and restrictions), the normalized region classifications can be cross-tabulated to gain insights into the value of the indicators across different regions. There are several combinations of the normalized region classifications in the Sotkanet.fi service. When the number of the classifications are tabulated within the normalized region classifications (Appendix table 12), we realized that the municipalities and hospital districts are behind most of the indicators.

There seems to be two main representatives of the service providers, municipalities and hospital districts, that represent the voice of the process. The rest of the classifications are mapped (Table 4) with the voices of the authorities and shareholders by the following rules:

- IF EU15 OR EU20 OR EU27 OR European OR Nordic countries THEN VoA
- IF whole country THEN VoA
- IF NUTS1 THEN VoA
- IF major region THEN VoA
- IF sub-region THEN VoA
- IF region THEN VoS
- IF AVI THEN VoS
- IF ERVA THEN VoS.

Table 4. Region classifications and voices.

Region classification	Sotkanet.fi	Tietoikkuna.fi	VoA	VoP	VoS
whole country	2856	406	x		
region	2850	431			x
SHP	2619	412		x	
municipality	2617	345		x	
AVI	2541	324			x
Nuts1	2526	308	x		
ERVA	2503	322			x
major region	2362	280	x		
sub-region	2310	265	x		
European	40	1	x		
Nordic countries	35		x		
Eu25	31		x		
Eu27	29		x		
Eu15	18		x		
(empty)	1				

Discussion

Some of the KUVA and SOTKANET indicators are based on the authority documents (e.g., regulations) which means that both information providers, assessors, and even information consumers have been explicitly defined in the authority documents. However, some authorities are the assessors, and some are the payers. Further, many authorities have both roles (i.e., assessor and payer) the meaning of which is that the authorities are responsible for both monetary valuation and non-monetary valuation. Analogically to the proxy social, that refers the assessors as the decision-makers without the payer roles [39], the proxy society requires the proxy authorities as the assessors without the payer roles and with the responsibilities concerning the standardized valuation practices. The proxy authorities will interoperate within the payers having monetary and/or non-monetary responsibilities or other authorities having non-monetary responsibilities. With or without the proxy authorities, the standardized valuation practices have to derive from the motivation elements (e.g., drivers and goals). Ideally, the drivers are based on the interoperable common controls the one meaning of which is to enable data diffusion.

Motivation. Motivation contains elements such as a driver, assessment, and goal [40]. The drivers and goals guide defining, designing and developing the indicators or metrics for enterprise leadership on all organizational levels. The drivers are derived partly from the common controls and partly from the requirements of different kinds such as the shareholders' ones. The concontrols of different kinds ensure the correct operation of the processes. Therefore, when the indicators are used to controlling and leading the operations at the national level, the same indicators should be available at the local level more detailed and higher frequency. The ideal situation within hierarchical welfare and healthcare monitoring system is to produce the data at the lowest possible organizational level (customers or service providers) and aggregate the data to the next levels (regional ones). Nowadays most of the used source data is sent from regional operators to national administration using the administrative care reports [41]. It is essential to harmonize the data for benchmarking and comparison purposes as well as look after the data usability for different aggregate levels. The continuous assessment of results, needs, processes, and quality is essential when developing anything. According to Stange and colleagues [41] "the metrics can

help and hurt the necessary development". The successful building and continuous use of the indicators can help the organizations to focus on the current situation and lead the learning to a new evolutionary stage [41]. The indicators turn the concept features (i.e., volume, size, ratio, performance, and quality) as numbers. Both direct measures but also indirect measures are important. The direct measures describe the phenomena (e.g., the hospitalization episodes for home care patients) and the assessments of the phenomena influence directly. Indirect indicators describe the phenomena (e.g., drug abuse) with a secondary measurement (e.g., drug concentration in wastewater). The well-defined and well-described metrics serve both authority and the service provider data need. However, there is a risk to increase the data management workload of health care professionals because of the increased statistics compilation [42]. The increased workload is due to the information system definition but also the definition of the statistics. In the case of the statistics compilation, the form is becoming to be more important than the subject itself. In the ideal situation, the statistics are generated directly from treatment documentation without any additional tasks because of the statistics compilation.

Interoperable common controls. The common controls [28] set the minimum level for the obligations and requirements based on the authority documents. There are some frameworks (e.g., CCF, HITRUST, and UCF) to ensure compliance with authority documents. However, valuation practices from the authority documents to production are needed within semantic and technical compatibility [43]. For example, the European Interoperability Framework (EIF) to promote the meaningful and understandable information of the digital public services in the EU [44]. The EIF addresses legal, organizational, semantic and technical issues. The most meaningful issue is the legal one due to its conceptual effects on other issues. Furthermore, the common controls are adapted from the legal items.

Data diffusion. Modern leadership theories ([1-3]) emphasize data diffusion. Service value streams require continuous improvements within feedbacks triggers, and other issues that require continuous attention, are established based on the observed data. However, public controls (e.g., the KUVA and SOTKANET indicators) are usually attentive and they are based on retrospective indicators concern events and productions that have been looked back. There might be some forecasts (e.g., population projections for forthcoming years) that have been used with some coefficients to predict the values of the indicators concerning the likelihoods of events and productions (i.e., predictive aspect). Moreover, the different scenarios around the resources help to optimize productions (i.e., prescriptive aspect). However, the indicators or insights from data that affect forthcoming events and productions are needed, which means amplified, augmented or even autonomous decision-making systems. The comprehensive maturity model simplifies the current analytics adoption and improves the analytics benefits ([45-47]). Despite the healthcare and welfare are characterized to be an information-intensive business [34] having a strong scientific tradition the advanced analytical methods with the big data solutions have not proceeded as expected. The McKinsey Global Institute (MGI) has executed twice, 2011 and 2016, the reviews of the data and analytics capabilities in Europe and the USA [48]. The public and healthcare sector was the laziest to utilize the new practices, only 30 per cent of the potential highlighted was captured five years earlier. The result is not supporting the general assumption of healthcare as the information-intensive business, but it is supporting the assumption that healthcare is slow to implement the new technology [49]. The difference between the early adopters and later majority as well the laggards according to Roger's innovation theory is increased. Both the scientific and professional discussion over the big data is handling more chances than the challenges [50]. Despite the slower diffusion rate of the healthcare big data, big data and advanced analytics have significant potential at different levels of healthcare [5]. The commonly shared indicators and metric definitions will improve the realizations parallel with the big data solutions decreasing the data harmonization work.

The KUVA excel contains some other purposes such as being a part of the regional or municipality well-being report, monitoring of regional development and being

factors of state subsidies. Actually, those other purposes are meaningful when the control panel or dashboard will be built for the service providers and other responsible actors. However, it is not clear how the different indicating interests of the different authorities or shareholders (e.g., Ministry of Finance) are collected and combined to get views of the municipalities or other actors. Without the detailed information of the indicators (e.g., data content, data source, interpretation, and restrictions) and without the deployment instructions of the indicators at least all discussed issues (i.e., motivation, interoperable common controls, and data diffusion) will not be fulfilled. Moreover, despite our metadata-based KUVA and SOTKANET content research, we realized that some of the key elements regarding both quality and costs are missing. According to current care guidelines [51], the diagnostic procedures, imaging, pathology, and chemistry, are necessary. Chronic disease, like type 2 diabetes, treatment requires regular follow up with appointments and laboratory tests as well as the fundus of the eye photography [51]. In addition, unnecessary diagnostic tests increase treatment costs [52]. Despite the KUVA aims to emphasize the used data quality, there were no specific indicators for data quality. It is obvious when the source data is generated for the operational use of the intended use of the data items is changed when data are joined to statistical compilation [53]. Incomplete and erroneous data decrease the used data value, statistical significance, and usability for further use [16,54].

Conclusion

The entity-related approach of the voices (VoA, VoS, and VoP) adapted to formalize rules for the evaluation of the KUVA excel and the evaluation of the KUVA and SOTKANET indicators. The Voice of the Authority (VoA) refers to the common controls, the Voice of the Shareholder (VoS) refers to the corporate controls, and the Voice of the Process (VoP) is a term used to describe whether the process is under control.

The KUVA excel manipulated to figure out the levels of the information providers and voices (Appendix able 12) as well as the levels of the information consumers and voices. There are four levels for information providers (V=national, M=regional, K= municipality, P=service provider) the combinations of which differ. Further, there are five levels for information consumers (V=national, M=regional, K= municipality, P=service provider, A=customer) the combinations of which differ. The information providers and consumers mapped within the voices by the simple three rules. However, we realized that the numbers of the VoA and VoS indicators do not distinct and there are relatively few VoP indicators. Therefore, we collected the identifiers of the completed KUVA indicators from the Tietoikkuna.fi service and compared the normalized region classifications of the KUVA and SOTKANET indicators to figure out whether the normalized region classifications illustrate the voices better than the information providers and information consumers of the KUVA excel.

There are several combinations of the normalized region classifications in the Sotkanet.fi service. The normalized region classifications cross-tabulated to gain insights into the value of the indicators across different regions. When the number of the classifications are tabulated within the normalized region classifications, we realized that the municipalities and hospital districts are behind most of the KUVA and SOTKANET indicators. Therefore, we specified nine rules and used them to map the normalized region classifications of the indicators (whole country, region, hospital district, municipality, area for the regional state administrative agency, Nuts1, university hospital special responsibility area, major region, sub-region, European, Nordic countries, EU15, EU25, and EU25) within the voices: nine classified regions within VoA, three within VoS, and two within VoP.

The usability of the KUVA excel is not straightforward due to the missing identifiers and unclear organizations behind the indicators. Therefore, the information links of the indicators in the Tietoikkuna.fi service have to be used to figure out the detailed information of the indicators in the Sotkanet.fi service. The main responsibility of the indicators (i.e., the organizations of the indicators) refer to the information consumers instead of the clear understanding of the information providers in the Sotkanet.fi service. Furthermore, the values of the indi-

cators are assigned to the different regions without the knowledge of the responsible information providers as well as without the primary sources of the raw data that have been used to aggregate the providable information.

Conflict of interest

Petteri Mussalo, no conflicting of interest. Virpi Hotti, no conflicting of interest. Hanna Mussalo, no conflicting of interest.

References

[1] Berwick DM, Nolan TW, Whittington J. The Triple aim: care, health, and cost. Health Aff (Millwood). 2008 May-Jun;27(3):759-69. https://doi.org/10.1377/hlthaff.27.3.759

[2] Flores M, Glusman G, Brogaard K, Price ND, Hood L. P4 medicine: how systems medicine will transform the healthcare sector and society. Per Med. 2013;10(6):565-576. https://doi.org/10.2217/pme.13.57

[3] Nordin P, Kork AA, Koskela I. Value-based healthcare measurement as a context for organizational learning: Adding a strategic edge to assess health outcome? Leadership in Health Services 2017;30(2):159-170. https://doi.org/10.1108/LHS-10-2016-0053

[4] Kaplan RS, Porter ME. How to solve the cost crisis in health care. Harv Bus Rev. 2011 Sep;89(9):46-52, 54, 56-61 passim.

[5] Raghupathi W, Raghupathi V. Big data analytics in healthcare: promise and potential. Health Inf Sci Syst. 2014 Feb 7;2:3. https://doi.org/10.1186/2047-2501-2-3

[6] Bjornberg A, Phang AY. Publications – Health Consumer Powerhouse - Euro Health Consumer Index 2018. Health Consumer Powerhouse; 2019 [Cited 15.6.2019]. Available from: https://healthpowerhouse.com/media/EHCI-2018/EHCI-2018-report.pdf

[7] National Institute for Health and Welfare. Sotkanet.fi, Statistical information on welfare and health in Finland. The Finnish Institute for Health and Welfare; 2005–2019 [Cited 31.3.219]. Available from: https://sotkanet.fi/sotkanet/en/index.

[8] Ketola E. Sote-tietopohjan kehittämishanke. Helsinki: THL; 2019 [Cited 31.3.2019]. Available from: http://thl.fi/fi/web/sote-uudistus/tietopohja-ja-arviointi.

[9] European Data Protection Board. Guidelines of the European Data Protection Board. Office of the Data Protection Ombudsman; 2019 [cited 31.3.2019]. Available from: https://tietosuoja.fi/en/guidelines-of-the-european-data-protection-board.

[10] FINLEX. Ajantasainen lainsäädäntö: Laki julkisen hallinnon tietohallinnon ohjauksesta 10.6.2011/634 FINLEX; 2011 [Cited 31.3.2019]. Available from: https://www.finlex.fi/fi/laki/ajantasa/2011/20110634.

[11] GRC 20/20 Research, LLC. Common Controls Hub Innovations Break New Ground – Innovation in Regulatory Intelligence for Compliance Management. October 2015 [Cited 31.3.2019]. Available from: http://ucf.unifiedcompliance.com/downloads/presos/2015-10-27_Rasmussen_Isaacs_CCH_Innovations.mp4-

[12] Agutter C, England R, van Hove S, Steinberg R. VeriSMTM - A service management approach for the digital age. Zaltbommel: Van Haren Publishing; 2017 [Cited 31.3.2019]. Available from: https://www.vanharen.net/shop/amfilerating/file/download/file_id/367/

[13] ITIL Foundation. ITIL 4 edition. Norwich, UK: The Stationery Office TSO; 2019.

[14] Scaled Agile Inc. Value Streams. Scaled Agile Framework. Scaled Agile Inc.; 2018 [Cited 31.3.2019.] Available from: https://www.scaledagileframework.com/value-streams/.

[15] Tilastokeskus. Tilastokoulu, väestötieteen perusteet. Helsinki: Tilastokeskus; 2019 [Cited 1.7. 2019]. Available from: https://tilastokoulu.stat.fi/verkkokoulu_v2.xql?course_i

d=tkoulu_vaesto&lesson_id=8&subject_id=9&page_type=sisalto.

[16] Reinikainen M, Mussalo P, Hovilehto S, Uusaro A, Varpula T et al. Association of automated data collection and data completeness with outcomes of intensive care. A new customised model for outcome prediction. Acta Anaesthesiol Scand. 2012 Oct;56(9):1114-22. https://doi.org/10.1111/j.1399-6576.2012.02669.x

[17] Lane-Fall M, Neuman MD. Outcomes measures and risk adjustment. Int Anesthesiol Clin. 2013 Fall;51(4):10-21. https://doi.org/10.1097/AIA.0b013e3182a70a52

[18] Arts DGT, De Keizer NF, Scheffer G. Defining and improving data quality in medical registries: A literature review, case study, and generic framework. J Am Med Inform Assoc. 2002 Nov-Dec;9(6):600-11. https://doi.org/10.1197/jamia.M1087

[19] Mussalo P, Hotti V, Mussalo H. Voices of Authorities and Shareholders Affect Voices of Processes. In: Li H, Pàlsdottir A, Till R, Suomi R, Amelina Y (Eds). Well-Being in the Information Society. Fighting Inequalities. WIS 2018. Communications in Computer and Information Science 2018;907:88-100. https://doi.org/10.1007/978-3-319-97931-1_7

[20] Mussalo P, Hotti V, Kirjanen A, Lauronen H, Holopainen J et al. Common controls driven conceptual leadership framework. FinJeHeW 2018;10(1):89-101. https://doi.org/10.23996/fjhw.68821

[21] The Open Group. The TOGAF® Standard, Version 9.2, a standard of The Open Group. The Open Group; 2018 [Cited 13.5.2018]. Available from: http://pubs.open-group.org/architecture/togaf9-doc/arch/index.html.

[22] Makola D, Hotti V. Critical Success Factors for Adopting Enterprise Architecture Metamodels in the Health Sector: Literature Review. Journal of Health Informatics in Africa 2013;1(1):127-132. https://doi.org/10.12856/JHIA-2013-v1-i1-43

[23] ISO Online Browsing Platform (OBP). ISO 22300:2018 (en) Security and resilience - Vocabulary. ISO; 2018 [5.5.2018]. Available from: https://www.iso.org/obp/ui#iso:std:iso:22300:ed-2:v1:en.

[24] Oxford University Press. English Dictionary, Thesaurus, & grammar help, Oxford Dictionaries. Oxford University Press; 2018 [Cited 5.5.2018]. Available from: https://en.oxforddictionaries.com/.

[25] Cooper RG. Stage-gate systems: A new tool for managing new products. Business horizons 1990;33(3):44-54. https://doi.org/10.1016/0007-6813(90)90040-I

[26] Network Frontiers LLC. Unified Compliance. Network Frontiers LLC; 2019 [Cited 13.5.2018]. Available from: https://www.unifiedcompliance.com/.

[27] Network Frontiers LLC. Unified Compliance: What is the difference between an Implied, Mandated, and an Implementation Control? Network Frontiers LLC; 2015 [Cited 31.3.2019]. Available from: http://support.commoncontrolshub.com/hc/en-us/articles/204278525-What-is-the-difference-between-an-Implied-Mandated-and-an-Implementation-Control-.

[28] De Ana FJ, Umstead KA, Phillips GJ, Conner CP. Value driven innovation in medical device design: A process for balancing stakeholder voices. Ann Biomed Eng. 2013 Sep;41(9):1811-21. https://doi.org/10.1007/s10439-013-0779-5

[29] Sosiaali- ja terveysministeriö. Sosiaali- ja terveydenhuollon kustannusvaikuttavuuteen on luotu yhtenäinen mittaristo. Sosiaali- ja terveysministeriö 19.3.2019 [Cited 9.4.2019]. Available from https://stm.fi/artikkeli/-/asset_publisher/sosiaali-ja-terveydenhuollon-kustannusvaikuttavuuteen-on-luotu-yhtenainen-mittaristo.

[30] National Institute for Health and Welfare. Data Window, trial version 0.1.3. National Institute for Health and Welfare; 2019 [Cited 9.4.2019]. Available from: https://proto.thl.fi/tietoikkuna/en/#/chart?previousView=chart.

[31] Terveyden ja hyvinvoinnin laitos (THL). Sotkanet REST API. Terveyden ja hyvinvoinnin laitos (THL); 2019 [Cited 9.4.2019]. Available from: https://yhteistyotilat.fi/wiki08/pages/viewpage.action?pageId=27557907.

[32] Tilastokeskus. Tilastokeskus - Luokitukset - NUTS 1-3, 2016. Helsinki: Tilastokeskus; 2016 [Cited 5.9.2019]. Available from: https://www.stat.fi/meta/luokitukset/nuts/002-2018/index.html.

[33] Tilastokeskus. Tilastokeskus - Luokitukset - Kunnat 2019 / Maakunnat 2019 - Luokitusavain. Helsinki: Tilastokeskus; 2019 [Cited 5.9.2019]. Available via . http://www.stat.fi/meta/luokitukset/kunta/001-2019/kunta_mk.html.

[34] Tilastokeskus. Tilastokeskus - Luokitukset - Kunnat 2019 / Seutukunnat 2019 - Luokitusavain. Helsinki: Tilastokeskus; 2019 [Cited 5.9.2019]. Available from: http://www.stat.fi/meta/luokitukset/kunta/001-2019/kunta_sk.html.

[35] Tilastokeskus. Tilastokeskus - Luokitukset - Kunnat 2019 / Sairaanhoitopiirit 2019 - Luokitusavain. Helsinki: Tilastokeskus; 2019 [Cited 5.9.2019]. Available from: http://www.stat.fi/meta/luokitukset/kunta/001-2019/kunta_sp.html.

[36] Sosiaali- ja terveysministeriö. Sairaanhoitopiirit ja erityisvastuualueet. Helsinki: Sosiaali- ja terveysministeriö; 2017 [Cited 5.9.2019]. Available from: https://stm.fi/sairaanhoitopiirit-erityisvastuualueet.

[37] Aluehallintovirasto. Kuntaluettelo aluehallintovirastojen toimialueista. Aluehallintovirasto; 2019 [Cited 5.9.2019]. Available from: https://www.avi.fi/web/avi/kuntaluettelo.

[38] Elinkeino- liikenne- ja ympäristökeskus. Kuntaluettelo ELY-keskusten toimialueista. Elinkeino- liikenne- ja ympäristökeskus; 2018 [Cited 5.9.2019]. Available from: https://www.ely-keskus.fi/web/ely/kuntaluettelo.

[39] Tsuchiya A, Watson V. Re-Thinking 'The Different Perspectives That can be Used When Eliciting Preferences in Health'. Health Econ. 2017 Dec;26(12):e103-e107. https://doi.org/10.1002/hec.3480

[40] The Open Group. Welcome to the ArchiMate® 3.0.1 Specification, an Open Group Standard. The Open Group; 2017 [Cited 9.4.2017]. Available from: https://pubs.opengroup.org/architecture/archimate3-doc/.

[41] Stange KC, Etz RS, Gullett H, Sweeney SA, Miller WL et al. Metrics for assessing improvements in primary health care. Annu Rev Public Health. 2014;35:423-42. https://doi.org/10.1146/annurev-publhealth-032013-182438

[42] Toikkanen U. Kirjaamisen osuus työajasta kasvaa. Lääkärilehti Ajankohtaista 31.8.2018, 35/2018 vsk 73, p. 1858–1861 [Cited 3.5.2019]. Available from: https://www.laakarilehti.fi/ajassa/ajankohtaista/kirjaamisen-osuus-tyoajasta-kasvaa/?public=fed6c7e8550c0c81bbc0fbe2fd64b786.

[43] Avillach P, Coloma PM, Gini R, Schuemie M, Mougin F et al. Harmonization process for the identification of medical events in eight European healthcare databases: The experience from the EU-ADR project. J Am Med Inform Assoc. 2013 Jan 1;20(1):184-92. https://doi.org/10.1136/amiajnl-2012-000933

[44] European Commission. European Interoperability Framework – Implementation Strategy. European Commission; 2017 [Cited 9.4.2019]. Available from: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52017DC0134&from=EN

[45] Comuzzi M, Patel A. How organisations leverage Big Data: A maturity model. Industrial Management & Data Systems 2016;116(8):1468-1492. https://doi.org/10.1108/IMDS-12-2015-0495

[46] Jain P. What is your organization's Analytics Maturity? Forbes; Jun 22, 2012 [Cited 4.9.2019]. Available from:https://www.forbes.com/sites/piyankajain/2012/06/22/what-is-your-organizations-analytics-maturity/.

[47] Sanders D, Burton DA, Protti D. The Healthcare Analytics Adoption Model: A Framework and Roadmap. Salt Lake City, Utah, USA: Health Catalyst; 2016. 10 p.

[48] Henke N, Bughin J, Chui M, Manyika J, Saleh T et al. The Age of Analytics: Competing in a Data-Driven World. McKinsey Global Institute; 2016.

[49] Wilson B, Athanasiou D. The value of healthcare information technology: A practical approach to discussing and measuring the benefits. Journal on Information Technology in Healthcare 2008;6:389-399.

[50] Clarke MA, Moore JL, Steege LM, Koopman RJ, Belden JL et al. Health information needs, sources, and barriers of primary care patients to achieve patient-centered care: A literature review. Health Informatics J. 2016 Dec;22(4):992-1016. https://doi.org/10.1177/1460458215602939

[51] Tyypin 2 diabetes. Käypä hoito -suositus. Suomalaisen Lääkäriseuran Duodecimin, Suomen Sisätautilääkärien yhdistyksen ja Diabetesliiton Lääkärineuvoston asettama työryhmä. Helsinki: Suomalainen Lääkäriseura Duodecim; 2018 [Cited 31.3. 2019]. Available from: https://www.kaypahoito.fi/hoi50056#K1

[52] Vegting IL, Van Beneden M, Kramer MH, Thijs A, Kostense PJ, Nanayakkara PW. How to save costs by reducing unnecessary testing: Lean thinking in clinical practice. Eur J Intern Med. 2012 Jan;23(1):70-5. https://doi.org/10.1016/j.ejim.2011.07.003

[53] Foshay N, Kuziemsky C. Towards an implementation framework for business intelligence in healthcare. Int J Inform Manage 2014;34(1):20-27. https://doi.org/10.1016/j.ijinfomgt.2013.09.003

[54] Cook JS, Neely PA. Business intelligence for healthcare: A prescription for better managing costs and medical outcomes. In: Information Resources Management Association (USA). E-Health and Telemedicine: Concepts, Methodologies, Tools, and Applications. Vol. 3. IGI Global; 2016. p. 1506-1529. https://doi.org/10.4018/978-1-4666-8756-1.ch076

Appendix

Appendix table 1. First sets of functions and their indicators (names of the sets of the functions from [30].

Set of function	Number of indicators
Adult population health risks and service demand	47
Living conditions	7
Emergency care	8
Specialised care	50
Coordination of welfare and health promotion and expert work	6
Services for the elderly	61
Services for children, young people and families	97
Mental health services	37
Primary health care, outpatient and inpatient care	71
Basic information	6
Services for substance abusers	18
Social welfare and health care, general	29
Oral health	28
Social services for working age people and measures to support employment	39
Services for the disabled	27
Total	**531**

Appendix table 2. First dimensions and their indicators (names of the dimensions from [30].

First dimension	Number of indicators
Service need	111
Welfare and health	34
Integration	11
Costs	83
Use of services	143
Quality, safety and customer-oriented approach	68
Basic information	14
Availability	38
Sosio-economic and regional differences in service availability	4
Effectiveness	3
Freedom of choice	18
Equality and vulnerable customer groups	4
Total	**531**

Appendix table 3. Second dimensions and their indicators. Observe that there is one own dimension (participation and rights) and the 'basic information' dimension is not included.

Second dimension	Number of indicators
Service need	7
Welfare and health	40
Integration	3
Costs	1
Use of services	7
Quality, safety and customer-oriented approach	7
Availability	3
Sosio-economic and regional differences in service availability	2
Effectiveness	8
Freedom of choice	2
Equality and vulnerable customer groups	21
Participation and rights (osallistuminen ja oikeudet)	3
(empty)	427
Total	**531**

Appendix table 4. Third dimensions and their indicators.

Third dimension	Number of indicators
Service need	1
Welfare and health	8
Integration	1
Quality, safety and customer-oriented approach	2
Effectiveness	4
Equality and vulnerable customer groups	1
(empty)	514
Total	**531**

Appendix table 5. Information providers before manipulation.

Label of the information providers	Manipulated label
V+M	V+M
V+M+(P)	V+M+P
V+M+(P)+K	V+M+K+P
V+M+K	V+M+K
V+M+K+P	V+M+K+P
V+M+P	V+M+P
V+M+P+K	V+M+K+P
V+M= 4 vuoden välein	V+M
V+M=4 vuoden välein	V+M
V+M=4.vuoden välein	V+M
V-M	V+M
(tyhjä)	V+M

Appendix table 6. Information providers after manipulations.

Information providers	Number of indicators
V+M	179
V+M+K	269
V+M+K+P	69
V+M+P	14
Total	**531**

Appendix table 7. Information consumers before manipulations.

Label of the information consumers	Manipulated label
	V+M
V+M	V+M
V+M+A	V+M+A
V+M+K	V+M+K
V+M+K+A	V+M+K+A
V+M+P	V+M+P
V+M+P+A	V+M+P+A
V+M+P+A+K	V+M+K+P+A
V+M+P+K	V+M+K+P
V+M+P-A	V+M+P+A
V+M-P	V+M+P

Appendix table 8. Information consumers after manipulations.

Information consumers	Number of indicators
V+M	379
V+M+A	8
V+M+K	54
V+M+K+A	4
V+M+P	19
V+M+P+A	53
V+M+K+P	12
V+M+K+P+A	2
Total	**531**

Appendix table 9. Information consumers and information providers.

Information consumers (rows) and providers (columns)	V+M	V+M+K	V+M+K+P	V+M+P	Row total
V+M	134	190	46	9	379
V+M+A	3	5			8
V+M+K	9	43	2		54
V+M+K+A		4			4
V+M+P	4	2	8	5	19
V+M+P+A	29	11	13		53
V+M+K+P		12			12
V+M+K+P+A		2			2
Column total	**179**	**269**	**69**	**14**	**531**

Appendix table 10. Organizations and their indicators in the Sotkanet.fi service and the Tietoikkuna.fi service (19.7.2019).

Organization	Sotkanet.fi	Tietoikkuna.fi
Institute for Health and Welfare	1822	309
Statistics Finland	961	58
Social Insurance Institution of Finland	192	44
Statistical Office of the European Communities	38	
Finnish Centre for Pensions	13	2
Nordic Committee on Social Security Statistics	8	
Finnish Institute of Occupational Health	8	
Organisation for Economic Co-operation and Development	7	1
Ministry of Employment and the Economy	7	5
Emergency response centre agency	5	5
Finnish Cancer Registry	5	5
Fimea and Kela	4	4
Finnish Centre for Pensions and Social Insurance Institution of Finland	4	3
Housing Finance and Development Centre of Finland	3	1
National Land Survey of Finland	2	2
Ministry of Finance	2	
National Supervisory Authority for Welfare and Health	1	
Patient Insurance Centre	1	
The Finnish Dental Association	1	
Nordic Centre for Social and Welfare Issues	1	
Finnish Medical Association	1	1
Total	**3086**	**440**

Appendix table 11. Classifications of the indicators.

Normalized classification	Region classification	Sotkanet.fi	Tietoikkuna.fi
Maa	whole country	2856	406
Maakunta	region	2850	431
Sairaanhoitopiiri	hospital district	2619	412
Kunta	municipality	2617	345
Aluehallintovirasto	area for the regional state administrative agency	2541	324
Nuts1	Mainland Finland/Åland	2526	308
Erva	university hospital special responsibility area	2503	322
Suuralue	major region	2362	280
Seutukunta	sub-region	2310	265
Eurooppa	European	40	1
Pohjoismaat	Nordic countries	35	
Eu25	Eu25	31	
Eu27	Eu27	29	
Eu15	Eu15	18	
(tyhjä)	(empty)	1	

Appendix table 12. Number of the classified indicators in the Sotkanet.fi service.

Normalized region classifications	1	2	3	4	5	6	7	9	Total
Europe	9		2	29					40
EU25			2	29					31
EU27				29					29
EU15			2	16					18
Nordic countries	10		13						23
Whole country	132	127	99	115	12	40	42	2289	2856
Nuts1	4			46	103	43	41	2289	2526
Major region			4		6	22	41	2289	2362
Sub-region						9	12	2289	2310
Region		107	74	161	109	68	42	2289	2850
AVI		5		46	109	61	31	2289	2541
ERVA		3	25	1	103	51	31	2289	2503
SHP		13	86	115	6	68	42	2289	2619
Municipality	1	3	9	160	97	46	12	2289	2617

Appendix table 13. Number of the classified indicators in the Sotkanet.fi service.

Normalized region classifications	1	2	3	4	5	6	7	9	Total
Europe	9		2	29					40
EU25			2	29					31
EU27				29					29
EU15			2	16					18
Nordic countries	10		13						23
Whole country	132	127	99	115	12	40	42	2289	2856
Nuts1	4			46	103	43	41	2289	2526
Major region			4		6	22	41	2289	2362
Sub-region						9	12	2289	2310
Region		107	74	161	109	68	42	2289	2850
AVI		5		46	109	61	31	2289	2541
ERVA		3	25	1	103	51	31	2289	2503
SHP		13	86	115	6	68	42	2289	2619
Municipality	1	3	9	160	97	46	12	2289	2617