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Organizational sustainability to support Trusted Smart Statistics: Istat's experience

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Abstract. The datification processes have driven National Statistical Institutes (NSIs) to explore new data sources with the goal of enhancing the quality of statistical information. The creation of innovative statistical products, known as Trusted Smart Statistics (TSS), necessitates new production processes that integrate with traditional methods, maintaining levels of relevance, quality, and trust.
To facilitate this transition in statistical production, NSIs must embark on change management initiatives involving all organizational dimensions engaged in statistical processes. In the scientific debate, sustainability has assumed a broad connotation. This paper delves into the organizational aspect, viewing sustainability as a paradigm that encompasses all organizational areas and their interactions crucial to supporting the shift to new statistical production models, without compromising traditional practices.
The paper explores the path taken by Istat in this direction, the organizational solutions implemented, the benefits realized, and investments in research and innovation initiated years ago on new data sources, aligning with developments in the European statistical community. Istat has been at the forefront of big data experimentation in Europe for over a decade, implementing a modernization program and establishing research infrastructures. Istat took a significant step by founding the TSS Center to guide organizational adaptation at technological, methodological, legal, communication, and human resources levels toward the new production system.

Keywords: Sustainability, trusted smart statistics, organization, Istat

1. Introduction

This paper describes the path followed by the European Statistical System and the Italian Statistical Institute (Istat) in responding to changes brought about by the ongoing digital transformation. It focuses on the new business models necessary to support the production of new statistical products, the Trusted Smart Statistics created with the use of the new data sources and therefore made possible by the developments resulting from the digitalisation. The organizational adjustments undertaken by Istat, necessary for implementing a new production model capable of integrating big data into its processes, will be described, considering the approach associated with organizational sustainability.

When used in the context of typical complex organizations like Istat, the term organizational sustainability refers to a holistic paradigm. When determining a strategic target, it's important to identify all organizational structures that are involved, outline the steps that each one needs to take, and encourage ongoing interaction between these structures to guarantee coherence and uniformity in reaching the shared goal. Henry Chesbrough argues that technological advancements force organizations to change because business models must be responsive to changes in external contest [1]. The concept of Business Model Innovation [2]. according to which organizations innovate by leveraging their available internal capabilities and resources, therefore without initial investments in terms of human and financial resources, is a model that Istat took inspiration from to

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begin investing in the TSS field. The decision to establish the Center TSS or a new governance structure to drive TSS projects resulted from various organizational changes within Istat. These changes began in 2016 with the initiation of the modernization program and the establishment of research and innovation infrastructures to support, structure, plan, and guide investments in research and innovation towards a more meaningful utilization of new data sources. The TSS Center is designed to bring together various structures and leverage diverse skills for a collective project. The objective is to contribute to the Institute's innovation and informational advancements, without compromising current production.

The paper is divided into 7 sections; after the introduction, Section 2 provides an overview of the digital transformation and its impact on the institutional role of NSIs. We describe the opportunities arising from new data sources and address the challenges NSIs are facing in the new and increasingly competitive statistics production scenario. Section 3 outlines the guidelines advocated by Eurostat to steer the transition towards a statistical production model that moves from an experimentation phase with Big Data to a production phase of Trusted Smart Statistics. In Section 4, we highlight how TSS have redefined the role of citizens, who, from a citizen science perspective, become both producers and consumers of information. TSS places humans at the center, fostering a new era of digital humanism. The following paragraph instead examines the impacts of TSS on the internal organization of the NSIs and how organizational sustainability is embodied in new business models to ensure the preservation of the quality, reliability, and relevance of official statistics. Finally, Section 6 is dedicated to exploring Istat's organizational and strategic response to the opportunities presented by datafication, with a focus on the TSS Center created to support, guide and monitor the development of projects in the TSS field. The last pharagraph provides the Istat's outcomes and comparison between its experiences and those of CBS Statistics Netherlands and the Office for National Statistics.

2. Digital transformation: opportunities and risks in National Statistics Institutes

The last decades have been characterised by profound transformations that have led to significant changes due to the increasing availability of data and interaction with extraordinary technological innovations. Digitalisation has exponentially stimulated data production and the *datafication* of society [3]. The diffusion of smart devices in many areas of daily life has led to the generation of increasingly granular data both from a spatial and temporal point of view, which represent increasingly stimulating sources for public and private organisations. The digital revolution has created a new environment and a new ecology. It has changed our culture in a profound and significant way. All these changes represent not only a digital, but also an actual ontological revolution [4]. This means that the digital revolution has caused a shift in the approach, in the interpretations, representations, and understandings of reality. Indeed, Information and Communication Technologies (henceforth ICTs) are changing the nature and the meaning of reality. To understand the scope of such a change, we need to understand how they interconnect with and influence our lives [5]. ICTs represent new systems of relation to the world: they have become "*environmental forces*" that create and transform our realities, our interactions, and our very existence. The capillarity of information technologies, thanks to the diffusion of computers, smart devices, and the development of the internet and digital platforms, have consequences on people's behaviour and on the way in which they communicate, inform themselves, and shape their beliefs. All of these factors contribute to a transformation that exceeds digitalisation and brings about a *revolution of meaning* [6]. This causes a significant process-change that requires a rethinking and radical redefinition of concepts, procedures, business, and management models in social, political, and economic contexts [6], as well as within NSIs. Society, politics, the environment, and, in the context of this paper, statistics as well, are all areas that need to be redefined after the advent of digital technologies. This is what Floridi calls, as we have seen, an *ontological revolution*: the digital revolution re-ontologises modernity (that is, it modifies its nature) and "*re-epistemologises*" it (it modifies the ways it is understood). ICTs restore ontology to the world and transform it, they erode the barriers between the real world, both offline and online, so as to allow an irreversible integration between the physical and digital aspects of reality [4]. The blurring of the boundaries between online and offline life makes it so that we are continuously connected to each other, surrounded by intelligent objects that are capable of interacting with us. It changes the way we make purchases, work, learn, take care of our health, have fun, and cultivate our relationships. It changes our modes of interacting with the informational, legal, financial, and political fields: the

network becomes a cultural device, "*a place of society, that is how it should be conceived, not simply as a space that lies outside of it*" [7]. It is becoming progressively difficult to separate the relational moments that happen through traditional means from those that happen through technologically determined processes. And it is in this new environment that we should contextualise new data sources and the role they play, both within the information ecosystem and within the NSIs.

The digital transformation has also led scholars to re-evaluate the role of statistical institutes as institutional subjects, as they contribute significantly to the development of democracy through the production and dissemination of official statistics to support public decisions. NSIs are key players within the knowledge ecosystem because they contribute significantly to strengthening scientific communication and to weakening phenomena such as disinformation and the infodemic. Official statistics perform a public service because data are a collective good, a public good. The recent event of the pandemic has taught us that good data allows us to make more effective, timely, and citizen-friendly decisions.

NSIs have understood the potential of new data sources for statistical purposes. Big data make our society measurable, they represent a knowledge infrastructure and an opportunity to enrich one's information-offer and respond to the needs of a changing world. Mariana Kotzeva, Director General of Eurostat, emphasised the ability of European statistical institutes to meet the challenges of the digital transformation at the opening of the XIII National Statistic Conference in July 2018. She argued that "*Official statistics measure life and, when life changes, official statistics change, too. Statistics follow the life*". NSIs are aware of the potential offered by new data sources, which allow for the production of more timely and granular statistics both in terms of time and space. Thanks to these new sources, it is possible to satisfy new information needs, to analyse and describe emerging phenomena that would not, otherwise, be observable with traditional statistic's tools [8].

The world of NSIs is erroneously perceived as a static world with its own rules and specific processes, characterised by strict quality criteria. The world changes as does the way of doing statistics. We went from a pre-datafied world, in which the efforts of the NSIs were focused on data collection, specifically surveys and censuses – which have been, for years, the main source of data – to a world of huge data archives [9]. From this enormous corpus of available data, coming from a multiplicity of different sources, NSIs must extract reliable information, as suggested by Weinberger in 2011 when he stated that "*Information is to data what wine is to the vineyard: something delicious that was extracted and distilled*" [10].

In the pre-datafied world, NSIs held a monopoly on statistical activity. The only alternative to official statistics was no statistics. Nowadays, NSIs are one of many data-producing entities within the complex information ecosystem. Various actors on the public and private sectors are producing new data and offering alternative statistical viewpoints on new phenomena.

NSIs are competing with these other statistics producers and must maintain and strengthen their institutional role while, when producing statistics from new data sources, guaranteeing the same levels of quality, relevance, accuracy, and reliability that are typical of traditional statistics.

In a context where the amount of information available to users is increasing, only the recognition of data quality, and of the institutional role of those who produced them, can allow citizens, businesses, and decision makers to effectively navigate in an increasingly crowded information ecosystem.

The relevance of statistical information, its timeliness, and usability are essential for building a relationship of trust with their users. The answer that official statistics can offer their users (be them citizens, businesses, stakeholders) is represented, as we will see later, by the so-called *Trusted Smart Statistics*, an expression coined by Eurostat to indicate the most mature phase of the production of big data statistics.

3. The European strategy on New Data Sources: from big data to TSS

At the European level, the new production model for official statistics involves a greater integration of traditional methods with data from administrative sources and with big data: a holistic approach that aims to provide users with new, more effective, and efficient tools.

The two main actions, taken by Eurostat, the Statistical Office of the European Union, to encourage this change were the Scheveningen Memorandum of 2013 [11] and the Bucharest Memorandum of 2018 [12].

The Scheveningen Memorandum formalised the need for all European statistical institutes to consider big data sources as new sources for official statistics, launching experimental projects aimed at understanding how to exploit the potential of big data.

It has officially inaugurated a strategic and tactical use of large masses of data for statistical purposes and launched complex activities of experimentation and innovation to explore the potential of big data and begin research on suitable methodologies to exploit such potential, as well as defining complex tools to evaluate data quality and indicators.

The memorandum represented a fundamental phase in the process of adopting new research and data production paradigms. We moved from a "traditional" model based on the NSI' direct data-acquisition to a new model based on the integrated use of administrative data, survey data, and big data.

NSIs in Europe, through their participation in the European Statistical System Network (henceforth ESSnet) projects, have: (*i*) launched intense experimentation activities both on techniques and methodologies to exploit the potential of new data sources; (*ii*) studied the legal and regulatory aspects related to privacy constraints and compliance with the standards of official statistics; (*iii*) evaluated the organisational impacts deriving from the new production model of statistics.

The ESSnet projects were launched at the Directors General of the National Statistical Institutes (hereafter DGINS)[1] meeting held in Palermo in September 2002. On that occasion, the Directors of the NSIs expressed the need to find synergies, harmonise and disseminate practices in the European Statistical System. Thus, the first ESSnet project, the Big Data I, started in 2013, soon followed by the ESSnet Big Data II.

The proposal that emerged from the Palermo meeting was to create a tool dedicated to accepting the challenge of using Big Data in official statistics; this tool is represented by the projects of the Centres and Networks of Excellence (now ESSnet), in order to bring together skills distributed among the different NSIs and develop specific actions to benefit the entire system. Indeed, an ESSnet project is "*a network of different ESS organisations that aims to deliver results that can be beneficial for the entire European Statistical System*".

The goal is to take advantage of the cooperation synergies of some Member States in order to share expertise and save costs in solving common problems of European interest. Spreading results and knowledge also to non-participating partners, for the benefit of the whole ESS, is an essential feature of ESSnet projects.

[1]The DGINS Conference was created on 15 July 1953 in Luxembourg; is held once a year with the aim of discussing an important topic related to the statistical programme or methods and processes for the production of European statistics.

For many years, the development of the use of new data sources has been at the centre of the European NSIs 'agenda. Eurostat, through its role of coordinator of NSI' activities, facilitates and contributes to innovative planning and implementation activities in full compliance with the codes that regulate the production and dissemination of official statistics. Indeed, Eurostat has led the development of the Big Data Action plan and related roadmap that is a strategic document that contains the response of European statistics to the ongoing datafication process, as well as foreseeing the actions to be taken to implement the Scheveningen Memorandum. The Roadmap represents a shared and coherent framework that contains, starting from the analysis of the single initiatives launched so far, plans for the launch of future initiatives needed for the development of a more mature use of new data sources.

Within the European Statistical System, following the Scheveningen Memorandum and the consequent Big Data Action Plan and Roadmap, a large number of NSIs have undertaken initiatives related to the study of the advantages and challenges pertaining the use of new data sources and data science techniques in official statistics. During the period the European Statistical Program 2014–2020 was in effect, the NSIs, including Istat, collaborated, within the ESSnet Big data I and II, to conduct projects, develop technical knowledge and capabilities, initiate implementation plans, produce experimental statistics, and develop national strategies. Eurostat has actively contributed to these activities both in the planning and in the implementation phases towards the innovation of official statistics.

The second fundamental act sanctioned by Eurostat in October 2018 was the Bucharest Memorandum on "*Official Statistics in a datafied society (Trusted Smart Statistics)*", which specifies in detail the defining aspects and the European path towards Trusted Smart Statistics. The Bucharest Memorandum has therefore contributed to enhancing and formalising the contribution of big data in terms of validity, accuracy, and reliability of their outputs. Compared to the Scheveningen Memorandum, which marked the beginning of the coordinated exploration of big data in official statistics, the Bucharest Memorandum acknowledges the achievements of that first phase (2013–2018) and identifies priorities to further develop the European statistical system in a data-driven society, towards the so-called Trusted Smart Statistics, whose meaning will be defined in the next paragraph. The Bucharest Memorandum favoured the launch of two new projects: the ESSnet Towards Trusted Smart Statistics and the ESSnet Smart Sur-

veys. Unlike the previous Big Data I and II, which were oriented towards experimentation and research, these projects are more focused towards the production of real official statistics in the new context of using Big Data sources.

3.1. On 'Smart' and 'Trusted'

The term Trusted Smart Statistics was proposed by Eurostat to represent the evolution of traditional statistics and was officially adopted by the European Statistical System in the Bucharest Memorandum on October 12, 2018 during the 104th DGINS conference. It refers to multi-source and multi-output statistical production systems that use innovative technologies to flexibly integrate new big data sources into statistical production. The reliability of statistics, to which the term *trusted* refers, is closely linked to the reliability of the institution that produces them. It is based on: (i) compliance with standards for data processing and privacy; (*ii*) the infrastructures that enable data processing (*iii*) methodological characteristics; (iv) quality guarantee of the entire production processes.

The reference to a concept as important as 'trust' is due to the changes "*of meaning and sense*" introduced by the digital transformation, discussed in the previous paragraphs. Historically, the NSIs have always had full control of the entire statistical production process because it took place internally, from the data collection phase to the dissemination of the statistics produced. The internal management of the processes allowed the NSIs to guarantee truthfulness, quality, and robustness of the data collected, of the methodologies applied, and of all the standards necessary to define 'official' the statistics produced. Since statistics have been produced with new data sources, they have used data collected and held by subjects external to the NSIs (e.g. mobile phone network operators, etc.). However, it is necessary to continue to maintain the same quality levels and the same characteristics that allow us to ensure the official nature of the statistics produced and the trust that users have with respect to the institutional role of the NSIs and the statistics they release. In a context in which the amount of information available to users is increasing, it is only the recognition of data quality and the institutional role of those who produce them that can allow users to orient themselves in an increasingly crowded information ecosystem.

'Smart' means based on smart personal devices, typically smartphones, but not only. The production of smart statistics involves a continuous interaction with the respondent and with his or her personal devices [11]. The data can be provided actively, which means explicitly by the respondent (for example via answers to questions or images acquired on request by an app) or passively, that is collected in the background by the device's sensors (for example via accelerometer, GPS etc.).

4. TSS' external impact on NSIs: decision makers and citizen science

The datification process is one of the most significant aspects of the digital transformation that impacted all of us in recent years. The devices that we wear and that surround us produce a massive amount of data that we must learn to understand, read, and select in order to obtain knowledge to apply to the understanding and interpretation of the phenomena that surround us as well as, hopefully, in our daily actions.

That it even if each of us, often unconsciously and by being constantly connected, consumes and contributes to the production, distribution, and sharing of information. We are immersed in that stage of society that Manuel Castells [13] calls *mass self-communication*: the users of the network are also the producers of information, thus emancipating themselves from traditional institutions. Each one of us is "public in public", that is we are no longer immersed in the internet, but we are part of it, we are connected publics, we are information activators and, thanks to the role of technologies, disseminators of information [14]. From this point of view, TSS give a new role to citizens. The big data produced by citizens make society measurable, they put humans at the centre, create a new digital humanism [15], and can create citizen statistics thanks to new processes institutionalised by the new social infrastructure represented by digital technologies.

If we look at this phenomenon with the approach of citizen science, we can see that TSS become the product of a trust-based exchange between citizen and NSIs. Citizens become, through their daily online and offline actions, "measurable": they are data producers and statistical users at the same time. That is because citizen science considers citizens as an active part in the production of data (the so-called citizen data) and enhances their involvement in scientific research, as well as in information and knowledge production processes. Citizens are engaged in statistical production and provide a concrete contribution to specific phases of the process. This is a significant change. In the pre-

datafication era, or in the era of "traditional" statistical products, citizens were just respondents: they provided answers to questionnaires designed upstream by the NSIs. In the digital world, citizens turn from simple respondents to co-producers of data – sometimes unknowingly – thanks to the new habits, behaviours, and daily practices introduced by the digital revolution. To seal this collaboration, the statistical institutes should define a social pact with the citizens that allows them to take data from them in exchange for useful information. Such a pact must include citizens in the statistical process and define the purpose of data collection and the benefits that data suppliers can derive from it. The pact must be based on precise rules and citizen-centred, so as to respect citizens' rights, first of all that of privacy.

Being aware of living in an interconnected system has significant impacts not only on citizens/ respondents' behaviour, but also on their expectations: does it make sense to be interviewed if the data can be easily found across many sources? Thus, on the one hand, the so-called statistical burden can be greatly reduced, but, on the other, data acquired through direct questions can be integrated with other "passive" data, automatically generated by sensors installed on smartphones, GPSs, home automation devices and the like. Such citizen involvement in statistical production processes is necessary to strengthen trust in NSIs and in official statistics, both mentioned several times throughout this paper. Recent studies on strategic communication and reflections on possible strategies to combat disinformation also suggest that "*participation in civil and social life is associated with higher levels of trust in institutions*" [16]. In this regard, TSS and smart surveys are valuable tools because they allow new methods of participation, collaboration and horizontal power exchanges with a double advantage: citizen involvement allows Public Administrations to decrease the possibility of litigation and increase accountability and recognition of their institutional role. This suggests to us that the future of official statistics depends not only on working with new digital technologies or data sources and on the development of new methods, but also on rethinking relations with citizens and establishing new interactions with them, allowing the growth of social trust which, in sociology, is the glue holding groups together and the invisible engine driving social progress. In general, it is very difficult to explain to people that there may be a discrepancy between their personal experience and what the official statistics show. In order to arrive to the human story of each citizen, to make the data feel closer to their daily and personal experiences, detailed data are especially useful. These are often distributed by geographical area or subgroups so that, in this sense, new data sources and, consequently, TSS, represent an opportunity for all statistical institutes that must not be missed.

In this process, however, it is essential for NSIs to maintain unchanged the quality, reliability, and strength of their products.

The character of timeliness and temporal and spatial granularity of TSS will enable policy makers to make more effective decisions based on much richer data than those produced with traditional statistics. TSS enable decision makers to have more timely access to data and statistics across different sectors. Up-to-date statistics also enable decision makers to implement government policies with more accurate spatial detail. For decision makers, being able to use these new statistical products is an extremely significant opportunity because TSS offer knowledge of various social aspects at a territorial level, able to bring institutions closer to citizens. These new statistical products allow knowledge of elements relating to a territory that can certainly help policy makers to govern it better, to respond more effectively to citizens' needs, and to strengthen that link between institutions and civil society, which has progressively deteriorated in recent times. The availability of real-time and comparable statistics at the European level has become crucial to enable policy makers to make decisions and support effective and timely corrective measures. This was testified by the recent Covid-19 pandemic, which revealed the usefulness of these data sources also as a tool to combat the spread of fake news and disinformation.

5. TSS' internal impact on NSIs: organizational sustainability

The release of the first outputs obtained with big data, experimental statistics, the comparison between the different NSIs in the European Statistical System within the ESSnet projects, has allowed us to develop the awareness that using new data sources not only requires technical skills and more powerful IT infrastructures, but also investments in the various sectors that structure the individual organisations. At the European level, we have seen taking root the belief that the evolution of official statistics towards more complete, rapid, transversal but still accurate and solid analyses can be achieved not only through administrative sources but also through data generated by sources of various nature. These are offered by the numerous subjects that

supply digital and telecommunication services, which will have to be entrusted with a complementary role. Indeed, the new data sources will integrate and not replace the pre-existing ones: the consolidated components of statistical systems will not be eliminated, rather expanded and improved by the new ones. In other words, as Fabio Ricciato, Albrecht Wirthmann and Martina Hahn suggest [17], we must think of data sources as an innovative fuel and of statistical systems as an engine: the new fuel cannot be fed into the pre-existing engine and the statistical systems have to develop a new type of engine, whose operating principles will differ from the pre-existing ones and adapt to the characteristics of the new data fuel [17].

TSS therefore represent a cultural change, a new vision: they are the result of introducing innovation – also experienced thanks to the ESSnet projects – into the processes.

TSS represent the implementation and institutionalisation, within the NSIs, of new processes made possible by everything that has happened outside of the Institutes themselves. To be accepted the same way of official statistics, TSS need to adopt innovative paradigms and a different set of technical, organisational, and legal tools to guarantee compliance with the principles and objectives of official statistics, as defined by the Italian and European codes.

As with other socio-technological systems, the change does not concern only the dimensions of technology and ITs, but also happens at the human level as it involves processes, organisation, communication of regulations and practices. For example, new data sources require the following new methodological approaches: (i) to transform raw data into statistical information and concepts; (*ii*) to use data that were not designed and collected for statistical purposes; (*iii*) to overcome issues of coverage; (*iv*) to integrate new data sources with traditional ones.

In such a complex framework, in order to sustain confidence in the new statistical products, it is necessary to develop a coherent set of legal, organisational, methodological, and technical conditions in order to ensure a high level of reliability and quality throughout the entire production process. In our opinion, the rethinking of the organisational structure must refer to the principle of organisational sustainability. As it is known, sustainability means meeting the needs of the present generation without compromising those of the future generation. Organisational sustainability therefore implies a necessary re-engineering of organisational and transversal processes, essential to support NSIs towards the production of TSS, and a readjustment of all organisational components to the new operating paradigms, preserving outputs' quality, relevance, and strength and the normal functioning of the individual Institutes.

To ensure the transition to a TSS production system in complex and highly interconnected structures such as those of the NSIs, it is necessary to reorganise the processes of each individual organisational dimension because a change in each of them inevitably impacts all the other dimensions involved. The complexity of this organisational adjustment consists precisely in allowing all the components to evolve in a coherent, coordinated, and, therefore, sustainable manner and in directing their adjustments and investments towards a common goal. It is necessary to adopt a systemic and holistic approach, capable of moving all of the dimensions involved in the same direction. As we will see in the following paragraphs, the concept of organisational sustainability in Istat is represented by the Center for TSS.

6. Istat's experience: the Center for Trusted Smart Statistics

As we know, since 2013 Istat has assumed an active role in Europe for the experimentation and production of new outputs, also through academic and not academic international collaborations and partnerships. Istat is now in transitioning from a 'playground' phase, needed to understand the potential and limits of Big Data sources and the methods necessary to deal with them, to a phase of mature use of these sources. After the adoption of the Bucharest Memorandum on Trusted Smart Statistics an internal reflection began in Istat on how to govern this innovation process. An agile solution was chosen to support the new TSS system and ensure interdepartmental and transversal participation in the experimentation of new data sources and the release of the first innovative outputs. Indeed, the organisational model of the TSS System is based on the continuous interaction among all the interdisciplinary skills of the Institute and makes it possible to overcome organisational fragmentation and favour collaborations between the various structures of Istat.

In order to monitor the adjustment of individual organisational dimensions, Istat has implemented a monitoring and guidance framework aimed at measuring the organisational maturity of the individual components of the *new* Trusted Smart Statistics as a production system. This tool will support the monitoring phases of actions

implemented by Istat's individual organisational structures, both at the strategic and operational level, aimed at building the TSS system.

With a resolution of the President of Istat in December 2020, the Center TSS was instituted. It was appointed the task of enhancing the experiences previously carried out at the international, European, and national level regarding the integration of big data in official statistics. The TSS Center is an agile organisation, whose interdepartmental character allows it to overcome organisational fragmentation. It represents the point of connection and monitoring of all activities aimed at building the new production system.

The reasons underlying the establishment of the TSS Center and the activities assigned to it are consistent with the evolution of the context external to Istat and with the programming envisioned by Eurostat for 2020–2027 and by UNECE, which aims to enhance and capitalise the results achieved with the ESSnet Big Data I and II.

The TSS Center comprises a Steering Committee, which includes the Institute's top management, and a technical-scientific secretariat, which represents an operational and supervision body with specific tasks regarding the experimentation, industrialisation, and production of TSS. The Secretariat is the point of connection and monitoring of all organisational, technical, and methodological activities during the production of TSS.

The TSS Center has the task, as expressly stated in its establishment resolution, to favour the creation of a new production system for TSS that is completely integrated with the Institute's data acquisition, production, and dissemination infrastructure, and especially with the Integrated System of Registers and with current research. The TSS Center oversaw the preparation of and monitors the three-year 2021–2024 Roadmap for TSS, which we will discuss in the next paragraph. The organisation chart of the TSS Center and the main functions of its bodies are shown in the Fig. 1.

At the organisational level, the TSS Center has the task of designing a sustainable organisational structure to help and support the individual components of Istat to work in a systemic, coherent, and synergistic way. The goal is to create a new Trusted Smart Statistics production system. This means that, consistently with the organizational sustainability approach, each organisational dimension is involved in updating current business model processes: legal, methodological, communicative, strategic planning, human resources, and skills development.

In order to monitor the adjustment of individual organisational dimensions, Istat has implemented a monitoring and guidance framework aimed at measuring the organisational maturity of individual components of the "new" Trusted Smart Statistics production system. This tool will support the monitoring phases of actions implemented by Istat's individual organisational structures, both at the strategic and operational level, aimed at building the TSS system.

6.1. Roadmap

Through a participatory process involving all the Institute's structures, the TSS Center produced a strategic document called "Roadmap for the production of Trusted Smart Statistics. Years 2021–2024",[2] which guides the implementation of the operational actions necessary to build the Institute's path towards the new production system. The document represents a reflection on which projects are a priority in TSS and on the transversal activities necessary to support them. The Roadmap therefore develops in two distinct levels. First of all, a strategic level elaborated according to a top-down approach, which directly involved the managers of the production structures. Building on the European programming of the Eurostat Strategic Plan 2020–2024 [18] and on what was programmed at the Institute level, this level highlights some strategic projects to be implemented via new sources when deemed particularly promising and capable of having an impact on issues of relevance. Secondly, the Roadmap develops in an operational level, which more directly involves the transversal structures with a bottom-up approach, which allows to highlight the support actions needed to develop management-defined priority projects.

With a top-down approach, new statistical outputs were therefore identified and associated with the objectives and actions needed to ensure their achievement. The infrastructure to support production was defined building on considerations regarding the following areas:

- IT and methodological investments.
- Organisational processes (planning, data collection...).
- Human resources (training, skill development...).
- Partnerships and rules (privacy, procurement...).
- Identification of new communication paradigms.

The supporting actions indicated in the above areas are subjected to biannual monitoring to verify achievements and consistency with the final objectives. Reading these indicators is facilitated by a dedicated framework which will be described later.

Table 1
Classification of Big data sources

Source	Data
Smart personal data	Mobile phones
	Electronic Payment Transactions
Smart systems	Scanner data
	Smart meters data
	Satellite pictures
	Traffic sensors
	Ship detection sensors (AIS)
Web intelligence	Data from digital booking platforms (e.g., data from flights, hotels, travel)
	Company websites' data
	Online job vacancies
Smart surveys	App data/personal devices' sensors
Web relations	Twitter data

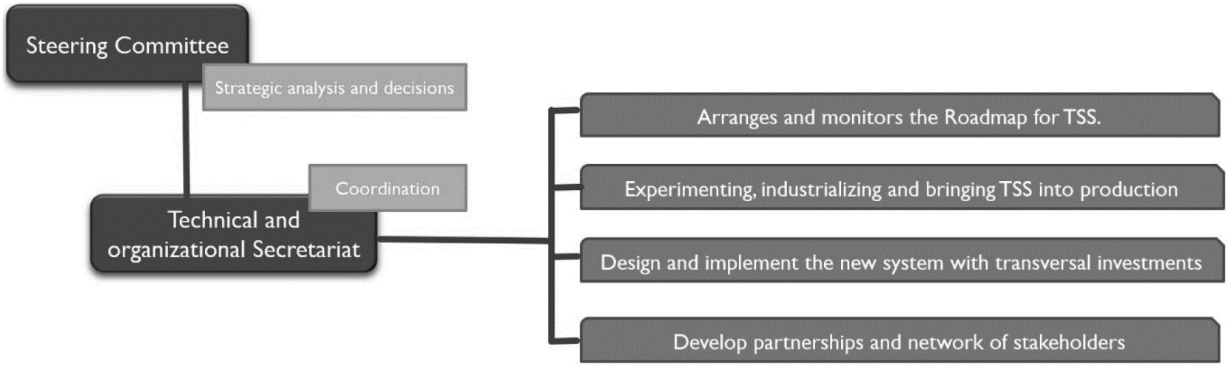

Fig. 1. Organigram and functions of the TSS Center.

Selecting the Roadmap's priority projects involved the management of the thematic departments of the Institute. First, by carrying out an initial recognition of the projects relating to TSS in place in the Institute and present in the National Statistical Program.[3] The activities in progress have been grouped into five main strands by source type (web intelligence, smart systems, smart surveys, smart personal data, web relations), as shown in Table 1.

The Board of the production sectors, on the basis of various qualitative criteria reported in Table 2, has chosen to include specific projects defined as priorities and included in Table 3.

Once the production projects had been defined, the individual structures – shown in Fig. 2 – were called to identify, each for its own area of competence, the actions necessary to implement them. What emerged

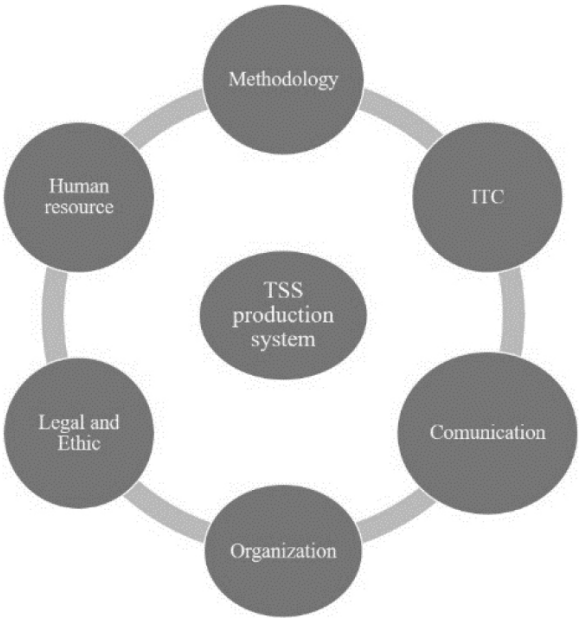

Fig. 2. Organisational dimensions contributing to the creation of the TSS system.

[2]Istat internal document.

[3]The National Statistical Program is a regulatory act. It is based on art. 13 of the Legislative Decree n. 322 of 1989 and its additions and it establishes the statistical surveys of public interest to be entrusted to the National Statistical System, as well as their related information objectives.

Table 2
Criteria to prioritise TSS

MACRO-CRITERIA (to prioritise TSS)	Criteria
Enrichment of statistical production (Information enrichment. Source characteristics. Potential for official statistics Output's. Development stage)	An emerging phenomenon of high priority for users/policy makers
	Makes it possible to access new information that cannot be deduced from other sources (direct surveys or administrative archives) already used by Istat
	Data granularity with respect to available sources
	Timeliness of data with respect to available sources
	Reliability of the source in general and over time
	Degree of coverage of the source with respect to the phenomenon under study
	Potential to become an official statistical product or to create an intermediate product / advance knowledge
	Generation of Experimental Statistics
	Experimental Statistics were generated or Official Statistics are in production
	Projects with a high degree of completion
Methodological and research advancements	Integration into the SIR (impact on the registers' production system)
	Integration into the current survey system (e.g. Smart survey)
	Does not require ad hoc methodological investments (cost of methodological investment)
	Consistency with international projects
Technological advancements	Platform available for use (IT investment costs)
	Does not require developing ad-hoc applications (IT application investment costs)
Data collection advancements and general direction	Reduction of respondents' information load by reducing data acquired from direct surveys
	Advantages in terms new sources' access/acquisition costs compared to data collection costs
	Easy definition of institutional and commercial agreements
	Projects require a contractual commitment

Table 3
Priority TSS projects

Data sources	Projects
Smart systems	Accidents' rate indicators according to road arc and extension from Open Street maps data
	Consumer price index with the use of scanner data
	Shipping and harbour use statistics by means of Automatic Identification Systems (AIS)
	Land cover classification with the use of satellite images (Sentinel-2)
Web Intelligence (public data) – ad hoc scraping	Statistics on vacancies and skills sought by companies
Web Intelligence	Price indexes enriched with company sites' information
	Statistics on the identification and characterisation of the Smart Specialisation Strategy (S3) dimension of companies
	Estimate of the kilometres covered by vehicles on national roads from the Big data source 'Autoscout' by means of web-scraping
	Web-scraping on 'agriturismi'
Smart personal data (private)	Electronic transactions for statistics and macroeconomic forecasts
Smart personal data	Methodological elements for the analysis of people's mobility by means of Big Data
	Use of smart meters for updating the Basic Registry of Individuals and the Permanent Census of Population and Housing, and for energy consumption monitoring.
Web relations (private data)	Use of electronic billing data
	The war in Ukraine through Twitter data
	Social Mood on Economy Index
	Statistics on gender stereotypes and safety
	Hate speech on immigration on Twitter data

was a catalogue of activities whose monitoring allows us to verify the implementation state of each of the new statistical outputs included in Table 3.

6.2. *Implementation of a monitoring framework*

The Technical Organisational Secretariat was responsible for identifying the support actions necessary for the realisation of the priority projects included in the Roadmap and reported in Table 3. The Secretariat also developed a set of actions functional to the development of the priority projects selected in the sectors:

- Methodological.
- IT.
- Legal (privacy, ethics...).
- Human resources.
- Communication and dissemination.
- Organisation.

A monitoring framework has been developed to monitor the progress of production projects and the necessary support actions. The framework is also useful to report on the progresses achieved and, above all, to highlight critical issues, which aspects are more solid, and/or what are the chances of improvement.

The matrix was designed by taking into account all the actions that each organisational structure has indicated as necessary for the strategic planning indicated by the Roadmap. These were aggregated in two large blocks. The first group includes "Soft/Human level" actions, which can be identified in all kinds of organisational support. The second, "Methods and Technologies/Hard Skills", regards more infrastructural actions relating to the construction and consolidation of IT infrastructures, techniques, and methodologies.

The two blocks therefore contain activity clusters that call to actions belonging to different organisational structures and whose implementation requires collaboration and interaction between several structures. Using the matrix makes it possible to highlight the need for different structures to collaborate and therefore represents a tool for raising awareness on the necessity for intra-structure interaction.

The area relating to soft skills, includes the actions related to all kinds of organisational support. Specifically:

- Human Resources area. It concerns investments in new skills, with specific reference to the strengthening of the data science area.
- Legal area:
  - Identification of new forms of agreements, partnerships, and contracts for access to sources.
  - Development of privacy by design and privacy by default tools.
  - Development of ethical codes for data usage and of artificial intelligence tools for data processing.
- Planning and performance areas: definition of organisational support actions aimed at the TSS system; inclusion of TSS within strategic planning and definition of the public value of TSS.
- Communication area: identification of innovative tools for the communication of the new products and design of a new communication paradigm to enhance and disseminate the new outputs.
- Third Mission area: identification of new stakeholders and new information necessities.
- The infrastructural actions that fall into Methods and Techniques Area – Hard skills can be linked to the following areas:
  - methodological: identification of new methods, techniques, tools, and standards (aimed, for example, at reducing the risk of biases in big data-derived statistics, specifically selection biases and non-representativeness of sources).
  - IT: identification of modern IT infrastructures and consolidation of existing ones.
  - Data collection: industrialisation and use of new sources (web scraping, satellite images...).

All these actions – and the operational activities connected to them – have been included in the monitoring framework in order to measure the overall maturity level of the Institute's TSS system.

To do this, the TSS Center made use of an adapted version of the Organisational Maturity Matrix, an assessment tool created within the UNECE in 2020 by the 'Team on Training, Competencies and Capacity Development of the UN Global Working Group on Big Data' [19].

This Maturity Matrix represents a self-assessment tool to help statistical institutes understand to what extent they have developed the infrastructures and actions necessary to integrate new sources into statistical production processes, so as to understand their own level of "organisational maturity". From the results of this matrix it is possible to development a plan for future actions: the Maturity Matrix can be used to define the target level the institute can aim for. This is because the Matrix also provides specific indications on which actions are necessary to achieve each level and therefore also provides a sort of ideal evolutionary trajectory to move from 'starting' to 'Expert' level.

When integrated with the Istat framework for TSS, this tool allows for the recognition of strengths and weaknesses and thus also helps to identify which actions are needed to achieve the objectives recognized in the Roadmap: the framework also becomes a real organisational performance management tool. The measurement of the degree of maturity of each area has been integrated with an additional indicator, which defines the degree of coherence of each of the actions included in the monitoring by the individual departments. It takes into account the objectives included in the Roadmap and measures the performance or the contribution of the individual actions against the achievement of the objectives declared in the Roadmap.

The framework and related indicators have been designed with the intention of overcoming a vertical approach associated to the measurement of single activities. The matrix represents a performance management tool and not a list of separate, unrelated actions. In-

deed, starting from the very definition of the actions, a systemic vision was adopted, allowing for the evaluation of the contribution of each action and the necessary interactions with other activities. This allows for shedding light on the previously mentioned level of organisational sustainability.

7. Outcomes and comparison with other European experiences

The European orientation just described has prompted several countries to internally organize themselves to support, from an organizational perspective, the drive towards innovation required by the new models of statistical production. As many NSIs have started using new data sources, the need for a strategical approach has become increasingly clear [20]. In addition to the Istat experience, which is the focus of our work, at the global and ESS levels, we consider the CBS Statistics Netherlands's experience with the Centre for Big data Statistics (CBDS)[4] and that of the Office for National Statistics (ONS) with Data Science Campus[5] to be two particularly significant examples.

In 2016, Statistics Netherlands established the Center for Big Data Statistics, concentrating various human resources with the aim of becoming the data hub of the Dutch government. Dealing with data and establishing collaborations with external bodies is its core business. The CBDS is led by a Program Director, a Methodologist/Data Analyst, and an Innovation Manager. One notable outcome was that, by mid-2015, CBS became the world's first statistical bureau to launch official traffic statistics produced with big data.

The ONS established the Data Science Campus in 2017, comprising a substantial core of qualified researchers within a robust research network from the institutional, governmental, and academic world. The Campus's slogan, *'Data Science for Public Good'*, indicates its strong recognition at governmental and political levels. Indeed, the Campus is an intergovernmental body focused on exploring the use of new data sources for the public good. It undertakes projects for the government and international organizations, supporting decision-making processes and providing relevant, up-to-date information. The Data Science Campus operates with an Advisory Board to advice the ONS Director General for Data Capability and the Campus Managing Director on research priorities, partnerships, ethical issues, and legal considerations.

In essence, both instances have cultivated partnerships with their respective governments, directing substantial external resources into considerable economic investments and acquiring new capabilities. In contrast, Istat, unlike the two instances mentioned, faced constraints in making substantial economic investments and acquiring fresh expertise. Instead, it prioritized fostering external collaborations, leveraging the research infrastructures established since 2017. The focus shifted towards a more efficient allocation of existing internal resources within the Institute, directed at projects deemed priorities by the Institute's board and detailed in the corresponding Table 4.

In many respects, the experience of Istat aligns closely with that of CBS. Drawing inspiration from the Dutch model, Istat established the Innovation Laboratory (LabInn)[6] in 2017. This dedicated space serves as a hub for the development of innovative projects aimed at enhancing statistical production and fostering research and innovation. Istat researchers propose projects, and once approved by governance bodies, these initiatives are implemented within a specified timeframe and in a designated space equipped with dedicated IT infrastructures.

LabInn has emerged as a collaborative platform, bringing together diverse skills for experimental and innovative projects. It serves as a testing ground for interdisciplinary collaboration and the practical application of the concept of organizational sustainability.

Despite minimal additional costs primarily associated with setting up LabInn's IT infrastructure, the Institute successfully generated and launched new statistics, as detailed in paragraph 6 and table 3. These statistics seamlessly integrated into the existing production, introducing new approaches, methods, and tools, thereby contributing to the cultivation of a fresh organizational and methodological culture.

From a legal standpoint, the experience in the Trusted Smart Statistics field has empowered Istat to actively engage in the revision of internal regulations, facilitating data access in compliance with current legislation. This effort also translated into Istat's contribution to the proposal for revising Regulation 223/2009, playing

[4] CBS, Statistics Netherlands Centre for Big data Statistics https://www.cbs.nl/en-gb/about-us/innovation/nieuwsberichten/big-data/cbs-launching-center-for-big-data-statistics.

[5] ONS, Office for National StatisticsData Science Campus https://datasciencecampus.ons.gov.uk/.

[6] Istat, Istituto Nazionale di Statistica https://www.istat.it/it/ricerca-in-istat/organizzazione/laboratorio-innovazione.

Table 4
TSS projects at Istat

TSS projects at Istat
Accidents' rate indicators according to road arc and extension from Open Street maps data
Consumer price index with the use of Scanner Data
Electronic transactions for statistics and macroeconomic forecasts
Estimate of the kilometres covered by vehicles on national roads from the Big Data source 'Autoscout' by means of web-scraping
Hate speech on immigration on Twitter data
Land cover classification with the use of satellite images (Sentinel-2)
Methodological elements for the analysis of people's mobility by means of Big Data
Price indexes enriched with company sites' information
Shipping and harbour use statistics by means of Automatic Identification Systems (AIS)
Social Mood on Economy Index
Statistics on the identification and characterisation of the Smart Specialisation Strategy (S3) dimension of companies
Statistics on vacancies and skills sought by companies
The war in Ukraine through Twitter data
Use of electronic billing data
Use of smart meters for updating the Basic Registry of Individuals and the Permanent Census of Population and Housing, and for energy consumption monitoring.
Web-scraping on 'agriturismi'

a crucial role in establishing collaborations with private data providers, such as telephone operators, for the implementation of projects utilizing mobile data.

The positive outcomes of this new statistical production influenced the Institute's board to further invest in the realm of Trusted Smart Statistics. This expansion included incorporating innovative activities into strategic planning, initiating training courses on specific aspects of data science for existing staff, and, notably, recruiting numerous new talents equipped with data science skills. In addition, with a proactive approach, the TSS Center promoted training initiatives to developing the skills necessary to adapt to new statistical production models, promoting the professional growth of the institute's researchers. These achievements demonstrate that the chosen path yielded positive results, even in the face of resource constraints. The decisions taken, the initial outcomes achieved, and collaborations with other NSIs underscore the efficacy of investing in research and innovation. This strategic approach not only enhances statistical information but also improves organizational practices and reinforces the Institute's standing within the European and international statistical community.

8. Conclusions

The fast, constant, and irreversible changes characterizing digital transformation require statistical institutes to update their business models through collective and interdisciplinary decision-making processes. These processes enable them to redesign relationships with users and stakeholders, aiming to maintain and increase levels of trust that citizens place in official statistics. The new business models integrate technical and organizational solutions into a coherent and interdisciplinary vision, necessitating collaboration and input from experts across different fields of knowledge. Istat has been on this path of organizational evolution for some time now through strategic choices that began with the approval of the Modernization Program, the centralization of methodological skills in a dedicated organizational structure, the implementation of research infrastructures (Research Laboratories thematic, Innovation Laboratory, Advisory Committees for statistical methodologies, establishment of two big data Committees (2013–2016) and more recently the creation of a governance body involving all organizational dimensions. The TSS Center ensures the non-fragmented development of new productive and research systems in coherence with the approach suggested by organizational sustainability. This approach necessitates the essential reengineering of organizational and cross-functional processes, along with an adjustment of all organizational components, ensuring that it does not compromise the quality, relevance, and robustness of the outputs produced and the normal functioning of the Institute.

The TSS Center embodies the complexity of multidimensionality, mitigates risks associated with organizational and activity fragmentation, fosters collaborations among the Institute's structures, and has consistently achieved significant objectives over time. These include: (i) overcoming organizational fragmentation on TSS projects and enhancing operational efficiency; (ii) conducting an analysis of the current state, identifying all TSS-related initiatives and activities within the Institute; (iii) identifying new initiatives for launch and integrating them into the Institute's strategic plan-

ning; (iv) monitoring launched projects to identify areas for improvement; (v) driving innovation and promoting interdisciplinary collaboration through matrix cooperation among various structures; (vi) improving skills in the field of data science; (vii) achieving a balance between scheduled releases for production needs and the introduction of new innovative statistical products, while maintaining the reliability of previously disseminated information unchanged.

All these results have contributed to the consolidation of ongoing experiments, the enhancement of statistical information, and the initiation of new projects that, in turn, have fostered collaborations with new data providers. These new products and the necessary partnerships to realize them represent an asset to be valued, aiming to strengthen the positioning of the Institute and maintain citizens' trust in official statistics.

Istat and national statistical institutes must continue actively exploring opportunities presented by Big Data to enhance their traditional positioning and maximize achieved results. Many other potential data sources for statistical production will emerge: the Internet of Things, composed of a wide range of devices of varying sizes, will continue to provide a vast amount of data useful for obtaining information on personal health behavior, energy consumption, people's movements, and many other aspects.

The most advanced statistical institutes are in an excellent position to leverage their expertise, citizens' trust in official statistics, and continue providing increasingly up-to-date and timely statistical information.

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