2 Case Study: The Estonian Education Information System (EHIS)

The governance of skill systems is very complex. Thus, evidenced-based decision making requires reliable data. However, establishing and maintaining an integrated information system is challenging and requires commitment of different stakeholders. Estonia is one of the few countries that successfully established and maintains a digital, online and encompassing database that brings together data on important parts of the education system such as schools, pupils, teachers, exams and qualifications. This chapter analyses the Estonian Education Information System (Eesti hariduse infosüsteem) and looks at its history, how data enters the systems and how it is used for policy making. This case shows how well-developed information systems contribute to successful skill governance and develops policy recommendations that will help to develop the information system further.

Introduction

Estonia is acknowledged as having successfully developed one of the most advanced digital societies. For example, 46.7% of Estonians use Internet voting and 99% of public services are available online (E-estonia, 2019[1]). It is therefore not surprising that in the governance of Estonia's skill system, digitalisation plays an important role. All schools in Estonia use "e-school solutions" (E-estonia, 2019[2]) such as digital learning material or web-based school management software. The Ministry of Education and Research, as well as private companies, offer a great variety of online tools. For example, the "e-schoolbag" (*e-Koolikott*) is an online portal that provides digital learning materials for teachers and students across educational levels (E-estonia, 2019[2]).

Another key building block at the state level in Estonia's skills system is the Estonian Education Information System (Eesti hariduse infosüsteem, EHIS). Since 2004, this database has collected data on students, schools, study materials, examinations, curricula and teaching staff. As schools are required to enter the data directly into the system, the data are deemed reliable. EHIS is a personal-identity-based database, which means that each person is registered with an individual identification number. All events related to studies, for example grades and successfully completed certificates, are stored in EHIS. This individual-based approach allows the tracking of each student's development over time. The database is managed by the Ministry of Education and Research. The online platform Educational Eye (HaridusSilm in Estonian) makes aggregated data available to the public. Schools can access their school-specific data and, importantly, policy makers take decisions based on EHIS data, as will be explained in greater detail below.

Estonia's education system is not only one of the most digitalised, it is also one of the most successful (this is explored further in the next section), as reflected in its top performance in the Programme for International Student Assessment (PISA). In the 2018 PISA round, which compared the pupils' science, mathematics and reading skills, Estonia ranked first in science and reading, and third in mathematics among all participating countries (OECD, 2019[3]).

Evidence-based policy making in education is essential, but depends on the availability of reliable data. The case of EHIS in Estonia represents the successful establishment of an encompassing information system used by all stakeholders in the skills system to inform decision-making processes. Thus, with reference to the overall framework of this report, this case study focuses on two of the four dimensions:

- Building integrated information systems.
- Engaging stakeholders throughout the policy cycle.

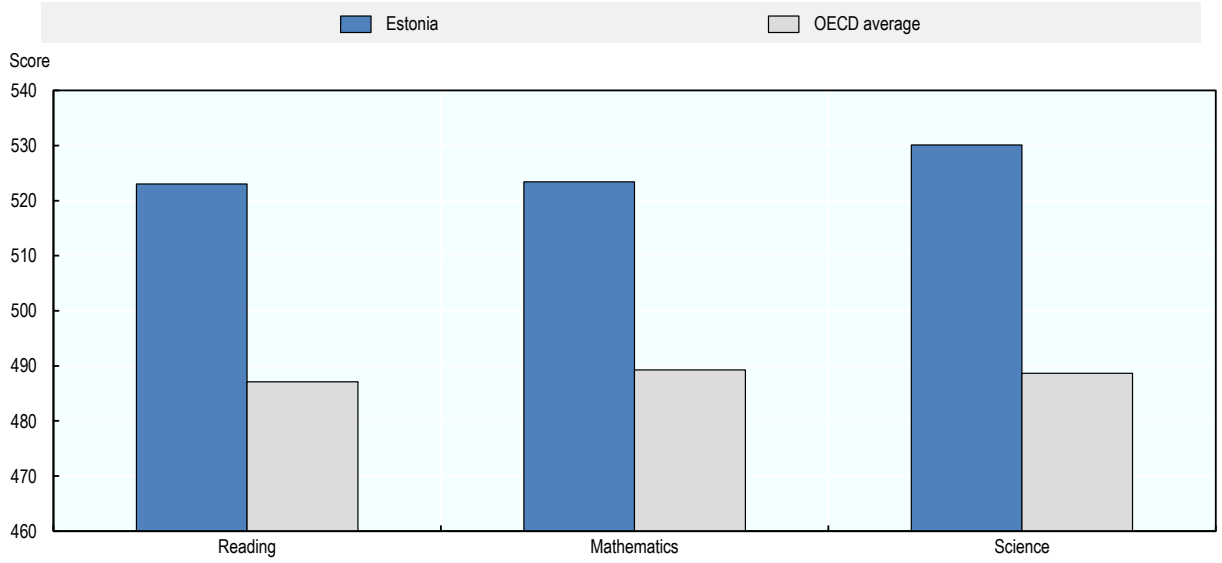
The emphasis of this case study is on the information system, but it also considers how stakeholders are involved in the governance and usage of the database. The first section introduces Estonia's education system before detailing how the EHIS database functions. The next section analyses the strengths and weaknesses of EHIS based on document research and 11 semi-structured interviews with 20 experts conducted in August and September 2019. The chapter concludes with policy recommendations.

Estonia's skills system

Top performance in PISA

Estonia's skills system is very successful in international assessments of educational performance. Estonia has participated in PISA since 2006 and from the start has performed well above average. In 2018, Estonian students achieved the highest scores in science and reading from all participating countries, and only students from Korea and Japan managed to score higher in mathematics (OECD, 2019[3]). Figure 2.1 shows Estonia's strong performance compared to the OECD average.

Figure 2.1. Estonia's PISA scores, 2018



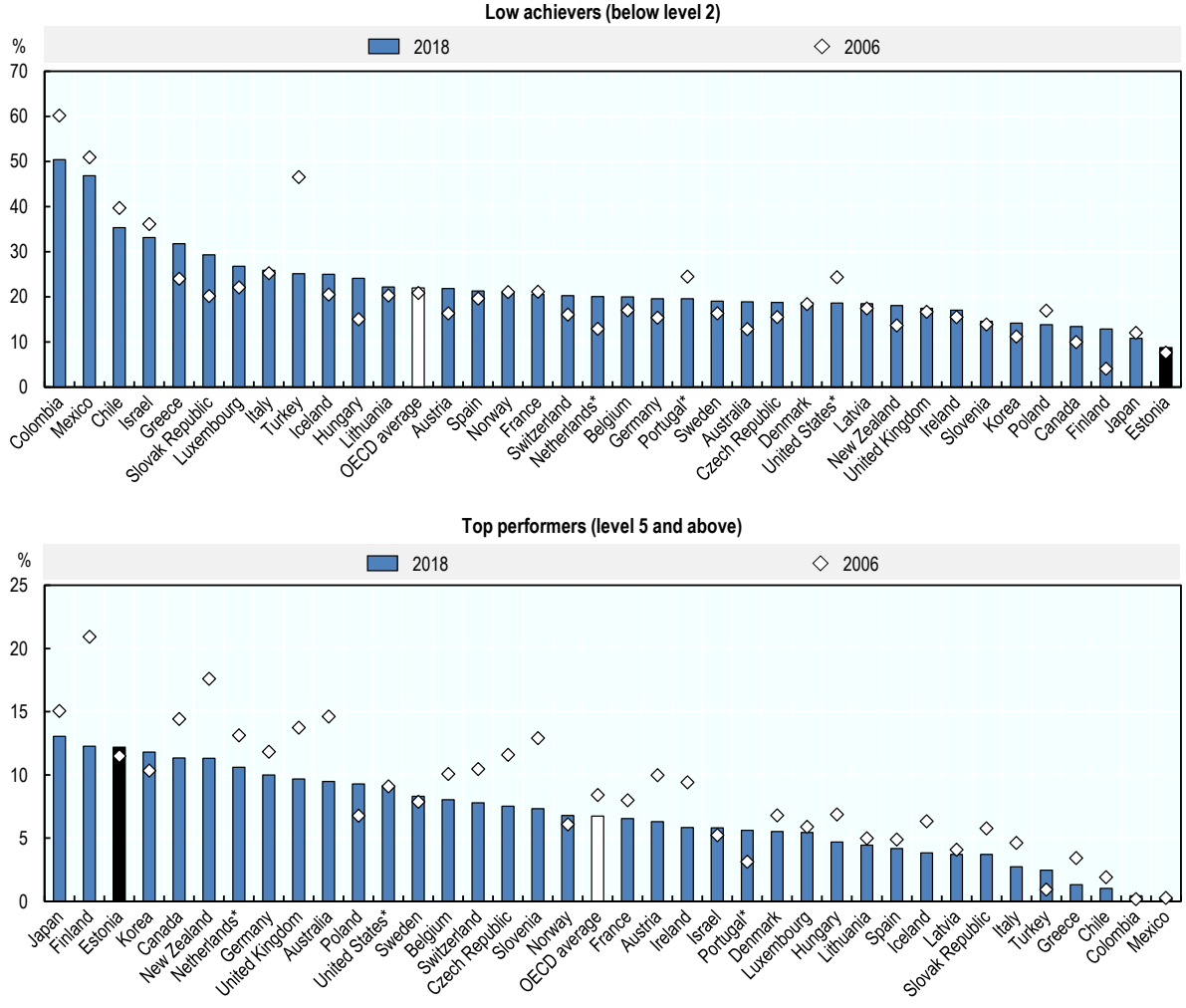
Source: OECD (2019[3]), *PISA 2018 Results (Volume I): What Students Know and Can Do*, https://dx.doi.org/10.1787/5f07c754-en.

StatLink https://doi.org/10.1787/888934112633

Besides high average scores, Estonia has the third highest share of top performers among PISA participating countries, which also increased between 2006 and 2018 (Figure 2.2). At the same time, Estonia has the smallest share of low-achieving students out of all participating countries (Figure 2.2), which implies that Estonia's strong performance in average scores is complemented with a relatively low degree of educational inequality.

The interviewees underlined that Estonia has a very egalitarian education system. The quality of schools does not differ to a great extent, which increases students' chances to receive equally good education regardless of where they live. The PISA results support this impression, showing that the socio-economic status of a student in Estonia has relatively little influence on their opportunity to attain high levels of skills. In Estonia, roughly 5% of variance in reading performance of students is explained by their economic, social and cultural status (ESCS), compared to the OECD average of 12% (OECD, 2019[4]). At the same time, 16% of disadvantaged Estonian students are academically resilient (scoring in the top quarter in reading amongst all Estonian students), which is above the OECD average of 11% (OECD, 2019[4]).

Figure 2.2. Percentage of top performers and low-achievers in science, PISA 2006 and 2018



Note: Netherlands, Portugal and the United States: PISA 2018 data did not meet the PISA technical standards but were accepted as largely comparable.

Source: OECD (2019[3]), *PISA 2018 Results (Volume I): What Students Know and Can Do*, https://dx.doi.org/10.1787/5f07c754-en.

StatLink https://doi.org/10.1787/888934112652

E-Estonia and its history

Today, Estonia is one of the most developed e-societies. In order to achieve this, it went through an intense process of change since gaining independence in 1991 after five decades of Soviet rule. The newly independent country faced severe challenges in the 1990s such as steeply rising unemployment, which exceeded 15% in 2000 (OECD, 2020[5]). Digitalisation was virtually non-existent, as the interviewees explained, and the country had very few resources to build on. However, historic ties and a shared identity with the Scandinavian countries, especially Finland, are very strong, and Estonia received significant support from Finland after independence in the form of expertise and economic investments, which helped it nurture and develop its digitalisation strategy.

One of the most influential turning points in the post-Soviet period was the project Tiger Leap (Tiigrihüpe). Tiger leap – a reference to the economic boom of the economies of Hong Kong (China), Korea,

the People's Republic of China (hereafter 'China'), Singapore and Chinese Taipei – aimed to establish an up-to-date IT infrastructure in the country, with a special focus on schools, to boost economic growth and improve the education system.

The Tiger Leap programme was launched in 1996 by the Estonian government and was institutionalised with the establishment of the Tiger Leap Foundation in 1997 (HITSA, 2019[6]), which was in place until 2000.

The Tiger Leap programme was financed by the Ministry of Education (renamed the Ministry of Education and Research in 2003) (Ministry of Education and Research, 2019[7]). Its goal was to increase the quality of education in Estonia with the help of information and communication technology (ICT) (Laanpere, 2002[8]). The Tiger Leap programme aimed to:

- Provide each school in Estonia with computers and Internet access.
- Train teachers how to use computers in school and in teaching.
- Develop educational software to enable digital learning.
- Foster students' IT skills.
- Support municipalities in developing an ICT structure.

The programme was largely financed by the state and received about USD 10 million between 1997 and 2000. This money was complemented by about USD 2 million from the European Union (EU) (Laanpere, 2002[8]). More than two-thirds of funding went to ICT infrastructure (Laanpere, 2002[8]). By the end of 2000, all schools had Internet access and were equipped with computers, with about one computer per 25 students, and 65% of teachers had received training in how to use computers (Laanpere, 2002[8]). The Tiger Leap programme was followed by the Tiger Leap Plus programme launched in 2001.

Before the Tiger Leap programme, schools did not use computers, or only to a very limited extent. Interview partners explained that in hindsight, it was an advantage that Estonia started from scratch regarding IT in the 1990s as it allowed the country to enter the process of digitalisation on an already advanced level from a global perspective. The interviewees explained that the country was not trapped in older "legacy" systems of the 1980s. This was an advantage as changing old complex systems can be more difficult than establishing a completely new system. Political support for Tiger Leap was very strong as the President Lennart Meri was greatly in favour of investing in digitalisation. The interviewees noted that he had "a vision" for Estonia to be an advanced, digitalised society.

By 2001, all schools were equipped with computers and connected to the Internet. The Tiger Leap Foundation financially supported local governments by matching their financial contributions (HITSA, 2019[6]). However, interviewees underlined that equipment itself does not bring change: users also need to be trained in how to handle computers and the Internet, as well as be motivated to make use of the new facilities. For this purpose, the Tiger Leap Foundation organised basic computer training courses for teachers that covered 40 hours of training (HITSA, 2019[6]). In 1997, almost 4 000 teachers completed this training, following by many more in the years to come. In the early 2000s, electronic educational materials were developed and shared through the educational portal SchoolLife, established in 2001.

Education was not the only area to undergo an intense significant and quick process of adaptation to digitalisation, other areas of public policy such as taxation, voting and healthcare also experienced rapid change (E-estonia, 2019[1]). In 2002, the digital ID, an ID card that contains a chip that stores important personal information, was introduced in Estonia (E-estonia, 2019[1]). The card functions as the key to e-services. Almost every citizen has their own identification card. Most laptops have a card slot for the ID card that allows the user, together with a password, to identify themselves and access e-services. Furthermore, the Mobile ID – a special mobile SIM card – and the Smart ID – a smartphone application – allow for identification without a card reader (E-estonia, 2019[9]). In the public sector, login is not possible with "just" a user name and password, but also requires either the ID card, the Mobile ID or the Smart ID.

Since the mid-2000s, the Learning Tiger programme has promoted e-learning, for example through the establishment of a web-based learning management system. Subject specific programmes were developed that targeted specific fields in education, and teacher focused training projects such as DigiTiger educated teachers on how to use information technology in learning. TechnoTiger targeted support at teachers of information technology, arts and occupational guidance with the aim of increasing the number of students who continue education in technology. Today, one in ten students in higher education choose to study IT every year (E-estonia, 2019[2]).

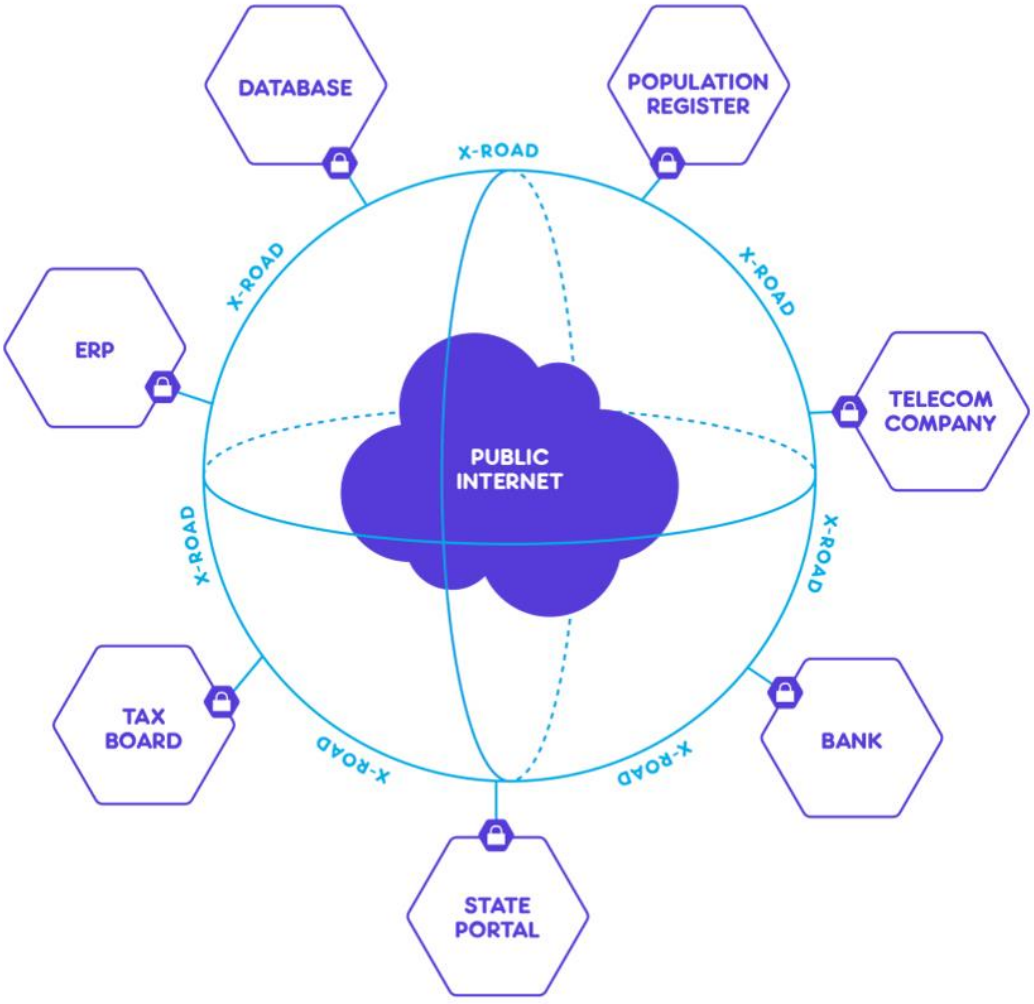
The establishment of EHIS took place in the context of this rapid digitalisation of society, in particular the educational system. Interviewees explained that collecting data from schools was not new, although it was previously less granular and detailed, as even in Soviet times schools had to keep a record of relevant educational data, such as the number of students. In the pre-digital times, however, these numbers were written down on paper in tables and books that were passed on to the municipalities, then to the Ministry of Education and Research. Data were also collected by regional authorities and public sector organisations such as the Department for Statistics. This process involved a lot of manual copying, thus it was very time consuming and prone to errors. Data were only collected once a year, which meant that information was not necessarily up to date.

The Tiger Leap programme aimed to provide all schools with computers and Internet access. This task required the Tiger Leap team to have a reliable overview of all schools, including the number of students, teachers, classrooms and existing technical equipment. However, information on schools' technical equipment had thus far not been systematically collected. In addition to the Tiger Leap programme, the Ministry of Education sought professional advice from experienced IT advisors, who suggested strengthening evidence-based decision making; however, this required reliable data on education and the skills system. Interview partners confirmed that the provision of computers and Internet access to schools opened a unique window of opportunity to lay the foundations for an encompassing digital information system. Interviewees reported that the initiative came from the small team who discussed their idea with the Ministry of Education. The minister was supportive and decided to replace paper-based data collection with a digital educational information system. The introduction of EHIS was therefore a top-down decision.

In the present day, the collection of sensitive personal data by the state is hotly debated in many countries. However, in the early 2000s, Estonia was in the middle of an intense digitisation process that brought a great deal of advantages, jobs, new educational opportunities and a bright future perspective for the country. At this time, data security was not of such importance as the Internet was not so well developed, and data leaks and hacks were not seen as potential threats. Against this backdrop, Estonia's e-society was developed and EHIS was one of its many building blocks. A special feature of Estonia's approach to digitalisation is the decentralised nature of the system. Data are stored in many different databases instead of being pooled in one. In order to understand how the e-services in Estonia work and how they are connected to each other, it is essential to look at X-tee, often referred to as X-Road, which is a "technological and organisational environment enabling a secure Internet-based data exchange between information systems" (Authority, 2019[10]). All databases, for example the population register or the tax board, function independently from each other but are (or can be) connected via X-Road (Figure 2.3).

Interviewees explained that an advantage of X-Road is that access to individual databases can be controlled and regulated, with only authorised users able to enter the databases and receive pre-defined content. Some 151 public sector institutions are connected to X-road, and it is used indirectly by 487 enterprises and institutions and about 52 000 organisations (X-tee, 2019[11]).

Figure 2.3. Internet-based data exchange: The X-Road system



Source: Estonian Information System Authority (2019[10]), *Data Exchange Layer X-tee,* https://www.ria.ee/en/state-information-system/x-tee.html.

Today, a variety of digital online tools are used in Estonia to support education delivery and progression. These tools and platforms can be connected to EHIS via X-Road in order to complement the data in EHIS. Some tools are developed by private providers and some are provided by the Ministry of Education and Research. The following are some of the most important databases and platforms:

- **eKool (eSchool)**: eKool was established in 2002 by the Look@World Foundation and has been run by a private for-profit company since 2005. eKool is an online school management and communication system for pupils, teachers, parents and government bodies (ESchool, 2019[12]). It can be used as a communication platform, to administer learning materials, or teachers can use it to document homework, grades or class absences (ESchool, 2019[12]). Basic features are free of charge for students and parents, but schools and government bodies pay a fee to use the system.
- **Studium**: Similar to eKool, studium is a management and communication tool for teachers, parents and pupils. It is designed for schools, kindergartens and “hobby schools”. It is free of charge and free of advertisement for students and parents, but schools pay to use the tool. It can be connected to EHIS and is used by more than 200 institutions. It is run by a for-profit company.

- **e-koolikot (e-schoolbag)**: The e-schoolbag is an online portal run by the Ministry of Education and Research that collects learning materials (E-estonia, 2019[2]). The portal covers materials such as texts, games and examinations for basic, general and vocational education, with users able to search material by keywords, based on curricula. Teachers can create individual collections of learning material and share them with others. Users can also comment on the materials (E-estonia, 2019[2]). The database allows for the creation of statistics on the use of different materials.
- **Study Information System (*Õppeinfosüsteem*, ÕIS)**: The ÕIS is a joint project of different stakeholders (OIS, 2019[13]). Students have to sign up with this system once they are enrolled in their education institution. It contains information about study programmes and timetables, and allows for exam registrations. It is used by vocational schools and applied higher education institutions. The first universities plan to join soon.
- **Estonian Research Portal (*Eesti Teadusinfosüsteem,* ETIS)**: The Ministry of Education and Research operates this portal, with the Estonian Research Council as the authorised processor (Etis, 2019[14]). It contains information on all researchers in Estonia, including research projects, qualifications and publications. All higher education institutions are registered and the portal can be searched by keywords.
- **Admission Information System (*SisseAstumise InfoSüsteem*, SAIS)**: This system is administered by the Information Technology Foundation for Education (HITSA). Applications to educational institutions can be made through SAIS. The portal allows for the upload of required information and can collect data from other databases, if authorised by the user.
- **Examination Information System, (*Eksamite infosüsteem*, EIS)**: The electronic environment EIS is a tool to carry out and evaluate examinations and tests (Innove, 2019[15]). It is designed to be used by students, teachers, parents and examination centre specialists. It is run by Foundation Innove, which was created in 2003 by the Ministry of Education and Research (Innove, 2019[15]).
- **Register of Occupational Qualifications (*Kutseregister*)**: This online register is run by the Estonian Qualifications Authority (Kutsekoda) and owned by the Ministry of Education and Research. Established in 2001 it brings together information on occupational qualification standards, professional councils and awarding bodies (Kutseregister, 2019[16]). The register provides information on professional certificates via X-Road to EHIS.

Governance structure of the skills system

Two governmental levels are important for the governance of education in Estonia: the central (state) level and the municipal level (Santiago et al., 2016[17]). At the state level, the Ministry of Education and Research plays a key role. The state organises vocational training, regulates national curricula and largely finances educational institutions. Furthermore, the central state is responsible for monitoring the system overall and for developing a strategic framework for Estonia's education system (Santiago et al., 2016[17]). For example, the state defines the required professional and pedagogical skill levels of educational staff and sets the minimum wage for teachers (Santiago et al., 2016[17]). The Ministry of Education and Research is divided into 20 departments (as of October 2019). Regarding EHIS, which is the focus of this case study, the Analysis Department and the E-Service Department are the most relevant.

Municipalities are in charge of monitoring and implementing national guidelines at the local level. Each municipality is governed by its own council, which is elected every four years in local elections. There are 79 municipalities in Estonia responsible for pre-primary and general education. This involves, for example, the financing of schools and paying teacher salaries. Financing is thus very decentralised and, in some cases, school directors define the salary level (Santiago et al., 2016[17]). Municipalities also monitor the provision of education by maintaining a network of schools that meet local demands for

schooling. There are 15 counties in between municipalities and the national level, but they do not play an important role in the governance of education.

Alongside these two governmental levels, the Estonian Qualifications Authority (Kutsekoda), the Information Technology Foundation for Education (HITSA), Foundation Innove and the Archimedes Foundation perform important tasks in the Estonian skills system.

The Estonian Qualification Authority sits at the intersection between the education system and the labour market. It was founded in 2001 by the Estonian Chamber of Commerce and Industry, the Estonian Confederation of Employers and Industry, the Estonian Employees' Unions' Confederation, the Confederation of Estonian Trade Unions, the Ministry of Social Affairs, and the Ministry of Economic Affairs (Kutsekoda, 2019[18]). It is subordinated to the Ministry of Education and Research, and a member of the ministry is part of the supervisory board. Organisational tasks include analysis of labour and skills demands, and analysis and forecast of skills supply

The Estonian Qualification Authority also implements the OSKA project, launched in 2014 by the Ministry of Education and Research, which aims to match skills provision to labour market needs (OSKA, 2019[19]). OSKA combines qualitative and quantitative research methods to analyse the labour market and the skills system. Its aim is to answer questions about the nature and relative quantity of different skills needed in the future labour market (OSKA, 2019[19]), but also to develop ideas on how to provide necessary skills and how the current skills system needs to be adjusted to meet future skills demands. OSKA applies a sector-centred approach in its work, with sector-level surveys helping to understand and predict future skills needs. Interviewees explained that data are complemented by information from EHIS.

The second important actor in the Estonian skills system is the Information Technology Foundation for Education (HITSA). HITSA was founded in 2000 by the Republic of Estonia, the University of Tartu, Tallinn University of Technology, Eesti Telekom and the Estonian Association of Information Technology and Telecommunications (HITSA, 2019[6]). The establishment of this foundation was initially motivated by the idea of stakeholders opening an IT College. However, the Tiger Leap Foundation then developed even more ambitious goals to modernise and boost IT in Estonia. HITSA aims to equip all students at all educational levels with digital skills. It also supports the use of digital learning tools to enhance the quality of teaching and learning (HITSA, 2019[20]). Interview partners described the foundation as the long, implementing "arm" of the Ministry of Education and Research, as it is financed by the ministry and develops and implements new technological solutions in education for the ministry, while taking into account the needs of the other (founding) stakeholders, such as universities and companies. HITSA supports innovation in digital learning and enables the exchange of information and best-practice examples among stakeholders such as schools, municipalities and companies. Furthermore, it is the official helpdesk for different education online tools developed by the Ministry of Education and Research, including EHIS. Thus, when schools have a question concerning EHIS, they contact HITSA. EHIS data, but also data from other educational online tools that collect data, are very important for HITSA's work, as confirmed by interviewees. For example, teams of developers and researchers on education in HITSA work on new web applications to support personalised learning. For this purpose, personal information on students from EHIS is very important.

Two further foundations under the Ministry of Education and Research are Innove Foundation and the Archimedes Foundation. In 2003, the Ministry of Education and Research created the Foundation Innove, which is responsible for external evaluation, curricular development in general education, and vocational education and training. In 1997, the Estonian government established the Archimedes Foundation, an independent body responsible for the implementation of national and international, especially European, programmes such as Erasmus+ (Archimedes Foundation, 2018[21]).

The Estonian Education Information System (EHIS)

The first EHIS pilot ran in 2004, and by 1 January 2005 it was fully established and available and compulsory for all schools to use. It is a state-run, web-based database that contains live data on education. It covers all educational levels, including kindergarten, primary schools, secondary schools, vocational training, universities, adult education and so called hobby schools that provide classes in, for example, music and art for young people. EHIS covers about 600 data fields. The information is individual-based, which means that each student and teacher is registered with an individual identification number. EHIS collects information on students' grade as well as their performance, state exam results or need for special support. All teachers are registered in EHIS with an identification number, and the system collects information about their qualifications, teaching hours and which grades they teach.

EHIS is connected to X-Road, with two important functions. First, it allows EHIS to complement its data with information collected in other databases. For example, EHIS collects data on the students' place of residence not from the students themselves but from the population register. Second, the connection to X-road allows other databases to complement their data with EHIS data. For example, the Health Insurance Fund uses EHIS data to determine who is eligible for student health insurance.

Some of the many online tools and platforms used by schools, pupils, teachers and parents have been introduced in the previous section. These tools and platforms can also be connected to X-road, which means that their data can be accessed by EHIS, and vice versa. As will be described in more detail below, schools can connect their online school management system to EHIS. This means that schools input information on their students and teachers to their school management system, which automatically reports this information to EHIS. X-road is the connection between all the different databases, but this connection is not automatically established. Access to EHIS data is supervised by the Ministry of Education and Research and requires a legal agreement between the two institutions responsible for the respective databases. The following section further describes how data enter the information system and how the data are used.

How data enter EHIS

EHIS combines data that comes directly from all schools in Estonia, which includes all institutions that provide education following a curriculum. In total, about 2 000 institutions enter data into EHIS. By law, all schools are required to enter the data and keep it up to date. This is an important difference to the Massachusetts' Early Warning Indicator System (EWIS) explored in Chapter 7, the US case study, in which school participate voluntarily. In Estonia, schools are required to update information immediately, for example when a student leaves the school. Schools only receive their funding if the data are complete. School head teachers are required to nominate at least two employees who are responsible for EHIS data. Interviewees explained that this responsibility usually falls to the school secretary.

When data are entered by individual schools, EHIS performs logical consistency checks, as explained by interviewees. For example, a student can only be registered with one school. When a school wants to enter a new student into their system but the "old" school did not de-register the student, the new school will receive an error report and will not be able to register the student. This mechanism helps to ensure that every person in compulsory education is always only linked to one school.

Another example of an internal control mechanism is the checking of demands for special needs. The database stores information on individual students' need for special support and is able to compare the needs of a student with information on them from previous years. If the need suddenly drops from high to zero the electronic system will send an automatic message to the school to check if this information is correct, as it is considered unlikely that a high demand for support will disappear. This feature will be implemented from 2020 onwards. These logical consistency checks, which allow for checking across

different schools as well as across time on an individual student level, make the data very reliable and accurate.

There are three ways a school can enter data into EHIS. First, schools in Estonia use several online and digital tools and applications in their daily work, and all schools use digital management software. The two most popular programmes are eKool and studium, which can be connected to EHIS and data can automatically be transferred from the school management system to EHIS without any additional action required. Thus, apart from requiring schools to enter data into EHIS in the first place, the infrastructure is designed to make the process as easy and convenient as possible. Second, schools can generate Excel sheets based on the data in their school management system and upload XML files to EHIS. Third, the data can be manually entered into the EHIS user interface. According to interview partners, the three options are equally popular among schools, with about one-third of schools choosing automatic data transfer, about one-third uploading Excel sheets, and about one-third entering data manually through the EHIS user interface.

The Ministry of Education and Research, however, prefers schools to connect their management systems to EHIS so that all information is automatically transferred. Within the ministry, the Department for E-Services is developing the next version of EHIS in which data exchange works automatically and data transfer does not require nor allow interference by schools. There will be very limited user interface in EHIS 2.0. Some schools argue that non-automatic entry allows the data to be reviewed and verified. However, the Ministry of Education and Research has concerns that such a process might also enable schools to manipulate the data to their advantage. However, this could only happen on a very small scale as the logical consistency checks guarantee the high quality and accuracy of the data. Nevertheless, schools in theory do have an incentive to reduce the number of “missed classes”, for example, in order to improve their image. They may also, in theory, report a higher number of students with special needs in order to receive more funding.

If school staff encounter problems with EHIS, there is a help desk run by HITSA. If HITSA is unable to deal with the question, it is forwarded to the E-Service Department of the Ministry of Education and Research. Interviewees argued that the questions received through the help desk help them to reflect upon which aspects, especially regarding user friendliness, should be improved.

User groups and their access to the data

The most important users of EHIS can be categorised into six main groups, as shown in Figure 2.4. Each group has a different way of using EHIS data.

Each school has its own individual online access to EHIS through the user interface, which it can use to enter data. The interface also provides an overview over the information on individual students and teachers. However, schools cannot see information on individual students from other schools. Through Educational Eye, the online platform that makes EHIS data available to the public, schools can compare their performance to all other schools in Estonia, for example the average grade in state exams. However, in interviews it became clear that schools use their own school management systems to monitor their performance and to keep track of their students, instead of using EHIS. One of the key purposes of EHIS is to develop (together with data from other sources) statistics and indicators that allow schools to compare themselves with other schools. This comparison is supposed to incentivise schools to improve their performance. However, interviews revealed that schools hardly ever use Educational Eye data as they are busy with their daily work and undertaking comparison or analysis with other schools would take additional time. Furthermore, interviewees explained that the differences between schools are usually small because Estonia has a relatively egalitarian school system, and the schools that face problems already know that these problems exist without checking the results of other schools. Nevertheless, statistics based on EHIS data in theory offer the opportunity to perform comparative analyses at the school

level. This is a very similar challenge to the problems described in Chapter 7, the US case study, on EWIS: the data are available but the schools do not make use of them.

The Educational Eye is a public online platform that contains data on all educational aspects covered by EHIS. For example, the public has access to information on the number of students by educational level, as well as the number of teachers, researchers and scientists. This information can be sorted by local government and county. Furthermore, Educational Eye contains detailed and publicly available information on each school in Estonia. Each school is represented by a "school card" (*Koolikaart*) that contains information on, for example, the type of school, the number of students, the language of instruction and the level of pupil satisfaction (Figure 2.5). The school card shows the average grade reached by pupils in the state exam in comparison to the average grade reached by all pupils who participated in the state exam. Interviewees explained that parents in particular are interested in the school's performance in state exams. This is one of the main challenges of EHIS, as will be discussed in the analysis section of this case study.

Figure 2.4. EHIS user groups and their access to the data

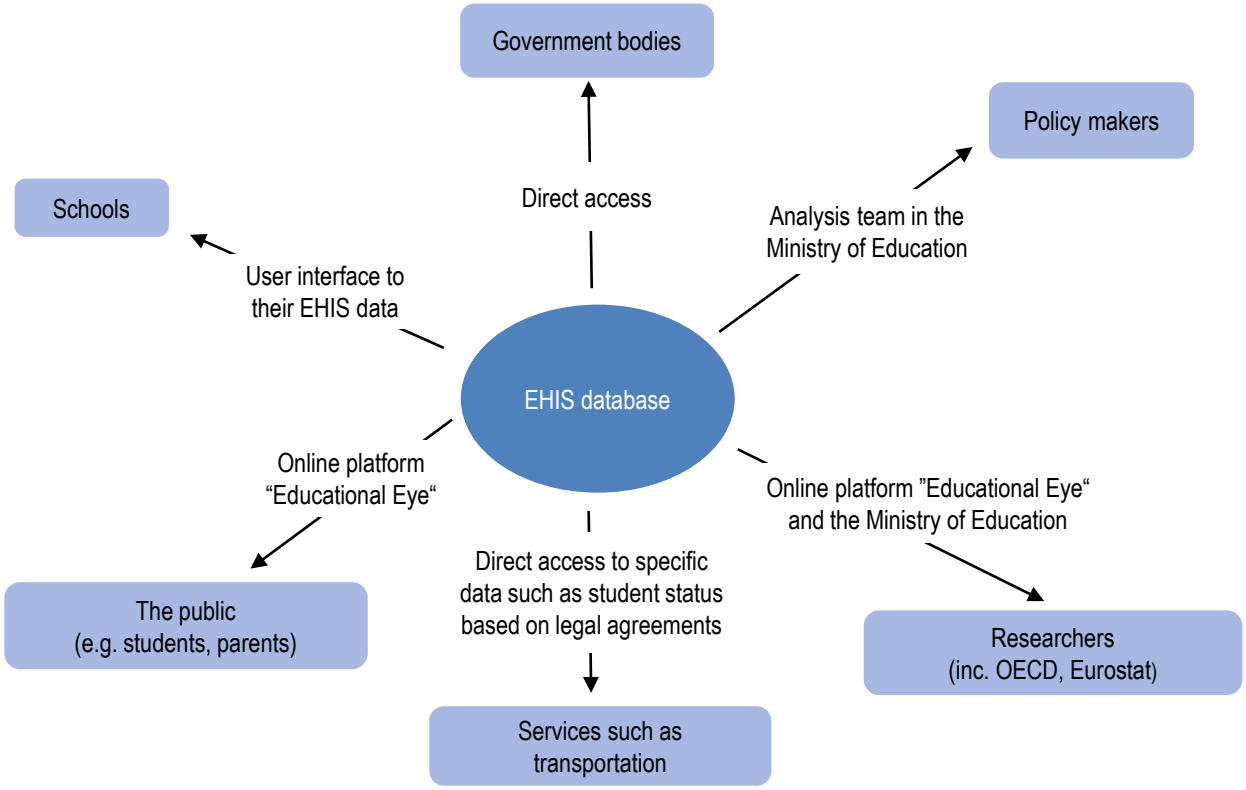
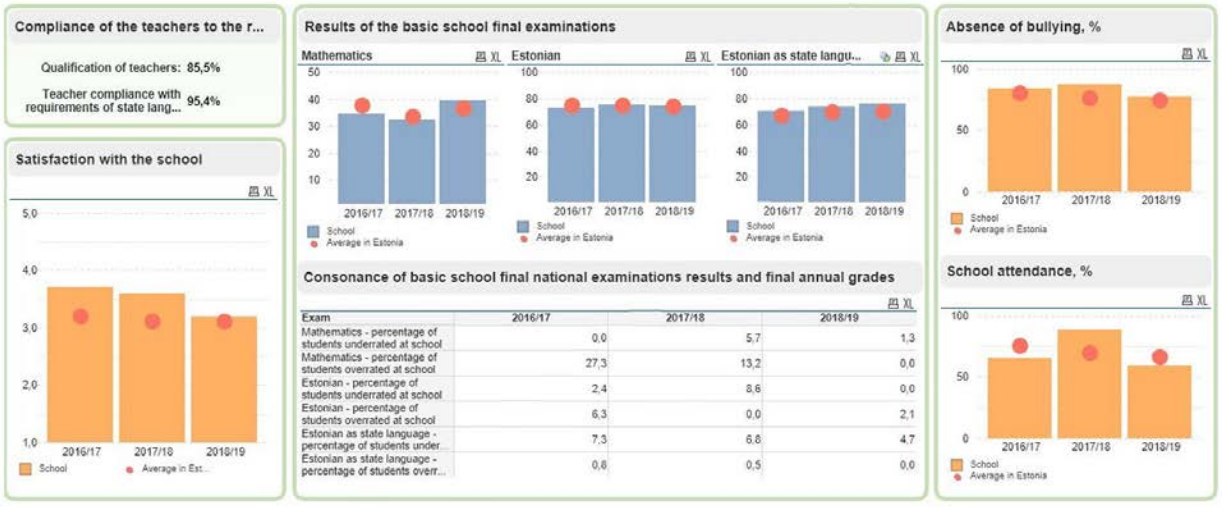


Figure 2.5. Example of a school card and results (fictional) of the state exam in comparison to the average grades

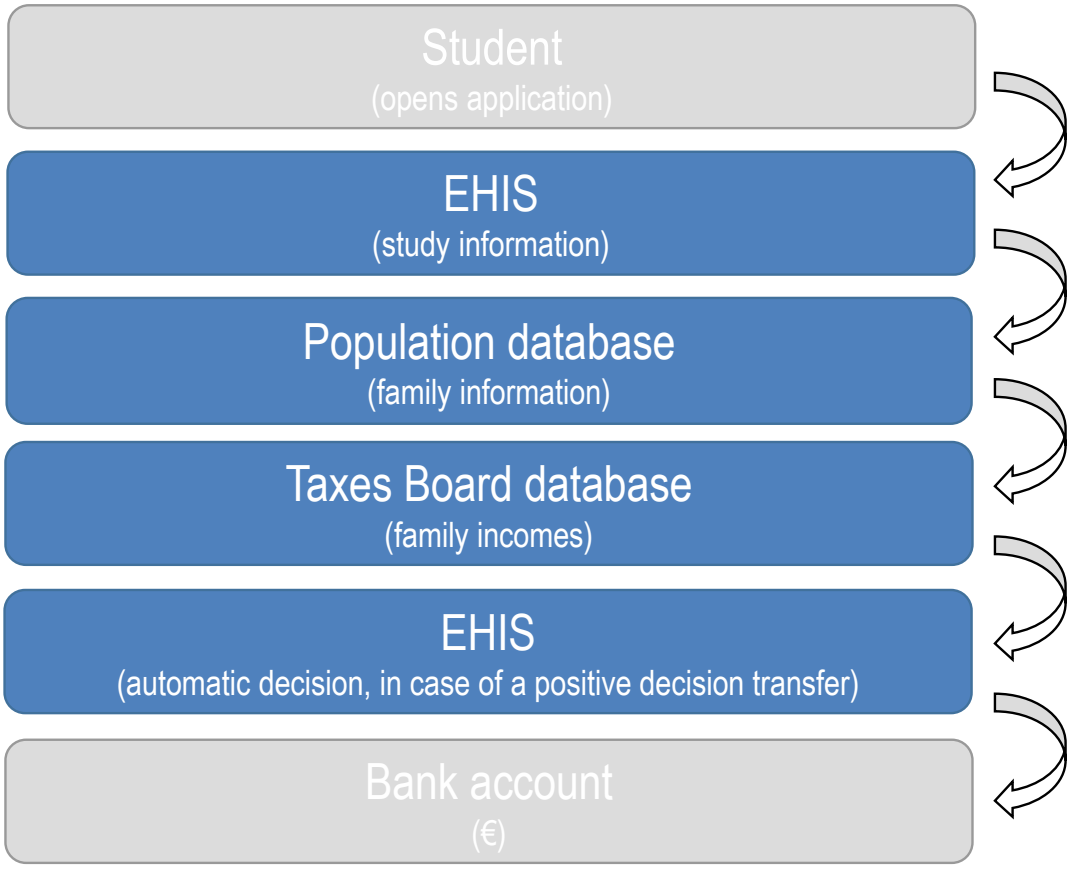


Source: Ministry of Education and Research (2020[22]), *Basic School School Card.*

Specific service providers also make use of EHIS, with access regulated by a legal agreement. In order to enter into a contract with the Ministry of Education and Research, the service provider has to submit an application that specifies the legal basis and how the data will be used by the provider. About 50 organisations have access to EHIS data. For example, as students in Estonia get a discount on public transport, the ticket inspector needs to check the student status of the passenger. For this purpose, transportation providers have an agreement with the Ministry of Education and Research that ticket inspectors have access to live data on student status, which is stored in EHIS. When travelling, the students' ID card is used to check the up-to-date student status in EHIS via X-Road. This process accounts for the highest number of queries to EHIS.

Many other service providers also have access to EHIS data, with access again strictly regulated by legal agreements between the Ministry of Education and Research and the service provider. Only the data specified in the contract can be shared and each query is tracked and documented. The contract also defines how often data can be accessed. Other examples of frequent queries to EHIS data include banks checking the status of students when receiving an application for a student loan or needs-based study allowances financed by the state. To apply for a study allowance, the student has to open an application and allow the system to receive personal information from other databases (Figure 2.6). When EHIS receives the required information, it makes an automated decision based on pre-defined requirements. In case of a positive response, EHIS sends a payout order to the State Support Service Centre (RTK) and the money is automatically transferred to the student's bank account. Interviewees explained that not all students eligible to receive support actually apply for a study allowance, even though the application process is very easy. In theory, the process could be completely automated, meaning that EHIS could technically identify all students eligible to receive a study allowance. However, this would require a change of the legal bases in order to allow the state to perform a matching of data, and would probably also increase the costs for the state.

Figure 2.6. Needs-based study allowance application process



Source: Ministry of Education and Research, (2018[23]), Estonian Education Information System.

In addition to private service providers, EHIS is connected to more than 20 other state-run information systems, including the population register and the taxation register. EHIS needs data from the population register to complete information on student's residence, and the population register needs information on citizens' educational attainment to complement information on the general population. In this way, there is close collaboration and data exchange between the different state-run information systems. However, the legal basis is necessary to allow access to the data of other state-run information systems. Interviewees explained that the responsible employees in the ministries often know each other, and that co-ordination is often informal before drafting a contract that must be signed by the head of the respective ministry. Interviewees noted that in order to reach a legal agreement, the purpose of the data use and the legal basis must be made clear.

Another category of users of EHIS are researchers from Estonian universities and international universities, from international organisations such as the OECD, and from various EU bodies and agencies. Researchers can use the public online platform Educational Eye to access data, but the Ministry of Education and Research can also grant access to more detailed data for research purposes. Similar to service providers, researchers must submit an application that specifies the purpose and extent of the data requested. Additionally, the research plan has to be approved by the ethics committee. If access is granted by the Ministry of Education and Research, a contract is signed and the data can be accessed. The ministry can also specify how the data can be accessed. In cases of very sensitive data, for example information on students with special needs, data might only be accessed in the ministry building, or be anonymised by the ministry before being sent to the researchers.

A central role of EHIS is to facilitate evidence-based policy making. Interviewees explained that EHIS data are the basis for all educational policy decisions, with financing, quality control and monitoring processes all relying on EHIS data. For example, the state uses EHIS data to calculate allocations to the municipalities and state education institutions. Municipalities use EHIS data to calculate the budget needed for their schools and to monitor and plan the development of their school network. OSKA uses data on the number of students and teachers to identify teacher shortages.

One of the few user groups with direct access to EHIS data are government bodies such as the Ministry of Education and Research and the Statistical Office (Statistics Estonia). The main users of EHIS work in the Analysis Department and the E-Service Department of the Ministry of Education and Research. They answer data queries, monitor data quality and conduct the EHIS development process. Before reaching policy makers, data from EHIS go through the Analysis Department, which writes reports and analyses the data regarding questions that are of interest to policy makers. Furthermore, the Analysis Department prepares an annual report on the education system, along with other reports available online, which rely to a large extent on data from EHIS. The Analysis Department also makes sure that the database is in accord with the legal basis. According to interviewees, most changes in data collection are caused by changes in the legal basis on educational policy. For example, if the legal basis for special needs education changes, then the data in EHIS must be adjusted to capture those students who are entitled, according to the new law, to receive additional support at school.

The E-Service Department guarantees the technical functioning of EHIS. It can also make data queries, especially when these queries exceed the standard analyses. However, the development of the EHIS code is outsourced to private IT development firms. The E-Service Department functions as the connection and communication channel between developers and users, and works closely together with the Analysis Department. Changes in data collection that require changes in the code are collected in the E-Service Department and then communicated to the external developers. As described above, users can contact the EHIS helpdesk, which is run by HITSA. Complicated problems that cannot be solved by HITSA are delegated to the E-Service Department. The development of EHIS 2.0 also takes place in the E-Service Department.

Estonian trust and the culture of data usage

In many countries, data privacy concerns are high and there is limited trust in governmental services. However, in Estonia, there are higher levels of trust in the e-society than in other countries, which can be explained by five main aspects: historic context, convenience, reliability, security and transparency.

First, to understand why citizens in Estonia give data to the state so easily, interviewees underlined that the e-society must be seen in a historical context. When the Tiger Leap initiative was launched, with a focus on digitalisation and bringing computers to schools and ministries, data protection and data piracy were not an issue because the Internet and the online connections possible today were not yet on the horizon. Therefore, it was not problematic in the 1990s to establish databases with private data. Once the databases were established and people became used to giving their data – which is often not actively given but collected from the state, with citizens not necessarily aware of which kind of data are collected – the e-society continued down this path. Against this backdrop, interviewees were unsure if the establishment from scratch of such an encompassing e-society would be possible in present-day Estonia due to a higher awareness of data privacy and data leaks than in the 1990s.

Second, e-services are very convenient for people as they replace a lot of paperwork. For example, the application process for a university study programme can be completed easily online. The applicant allows the application platform to connect to EHIS and receive information on their certificates and grades. While in other countries this requires a lot of paperwork, in Estonia, the process is completed in a very short time and can be done from home. The online tax declaration or application for study loans were named as examples of digitalisation and e-services making the lives of Estonians easier. In the context

of convenience, the “once only principle” plays an important role. The state can (by law) only ask once for citizens’ data. For example, the study application portal should not ask the applicant for information on their name, address or prior schooling because all of this information is already registered in other systems, such as the population database or EHIS. Thus, the applicant only has to identify themselves using an identification card, and the application platform collects the information needed from other databases. The “once only principle” reduces the effort required by users, which goes hand in hand with the fact that citizens are used to giving data to the state and receiving services in return.

The third important building block for citizens’ trust in e-services is the reliability and functionality of the services. Interview partners confirmed that services work well and that there are very few errors. For example, there is a website that documents the number of days of “smooth X-Road experience” (X-tee, 2019[11]). As of 1 September 2019, this number stood at 685 days.

Fourth, the state guarantees a high level of security, key to which are the decentralised structure of the databases and X-Road. Decentralisation refers to the fact that citizen data are stored in several different databases. For example, information on taxation is stored in a different database to data on health issues. Access is granted only on the basis of a legal agreement between the owner of the database, for example the Ministry of Education and Research in the case of EHIS, and the user of the data. So far, there have been no major data leaks or hacks. However, security remains an important issue, with security measures needing to be constantly updated as the tools to hack a database continue to develop.

Finally, the high level of transparency increases the trust in the e-services. Citizens can see online in their personal account who accessed which part of their data and when. They have the right to ask state authorities on what basis access was granted to their data. Furthermore, every query to any database is documented by the respective database and marked with a time stamp. This allows the database owners to trace every user of the data.

Analysis

EHIS is a complex database, but also an integral part of e-society in Estonia. However, interviews revealed that as well as the considerable opportunities offered by EHIS, there are also challenges. The strengths and challenges of the system are detailed below.

Strengths

First, one of the biggest strengths of EHIS is the accuracy of the data. EHIS is based on live data from the original source, education providers, and changes such as a new teacher starting work in a school are registered in EHIS the same day they start. Thus, EHIS data are always up to date. Additionally, the logical consistency mechanisms ensure that data are very accurate. For example, students cannot be counted twice because EHIS identifies each individual student with the help of the student’s identification number and sends an error message if a school tries to register a student still registered with another school. EHIS is connected to other state-run databases, such as the population database, which allows it to present a wide range of data to its users without needing to ask schools to enter data already available in another database.

Second, the data and structure of EHIS allow for very detailed and diverse analyses, which supports the development of a variety of innovative features in education that is hardly possible in other countries to the same extent, such as the tracking over time of individual students. Furthermore, the structure of the database allows for educational data to be connected to, for example, the tax register, which contains information on income. This allows for an analysis of the effects of educational career on income. These data are naturally very sensitive, but interviewees argued that these kinds of analyses are closely supervised by experts in the Ministry of Education and Research and the Statistical Office (Statistics

Estonia) to safeguard the security of personal data. The personalised data in EHIS also allow the individual learning process to be analysed. For example, HITSA is working on applications that allow for a comparison between the individual usage of learning materials and individual learning outcomes. In Estonia, teachers and students can chose from a variety of online sources and e-learning applications; however, the volume might be overwhelming, and teachers might not always have enough time to find the best materials for their lessons. Information on materials for effective learning and teaching strategies can be used to inform the development of teaching material collections with the help of cross-usage of data collected in EHIS and other sources. This would allow teachers to find study materials faster and receive automated recommendations on other materials related to the same topic or student skill level. EHIS is the foundation for data personalisation and contextualisation that allows for these types of analyses and deep learning.

Third, EHIS enables evidence-based decision making – not only for policy makers but also for citizens. The public can access anonymised and aggregated EHIS data through the online platform Educational Eye. Based on this information they can take informed decisions concerning their own or their children's educational career. For example, information is available on employment rates and average income level for graduates of certain study programmes or vocational training courses. Information on which schools or universities provide which type of training are also collected and made available online. Educational Eye allows the public to get involved in the monitoring of the education system in general. EHIS is also an important tool for policy makers and enables them to take evidence-based decisions. Policy makers receive analyses and reports from experts in the Analysis Department of the Ministry of Education and Research. Interviews revealed that the Analysis Department is well connected to other internal departments and to other ministries. The administrative body in Estonia is small compared to very large countries, and information channels are often informal and short. This enhances the accessibility to information for policy makers.

Fourth, competences in the governance of EHIS are clearly defined, which allows for efficient decision making. EHIS is state-run and state-financed. The Ministry of Education and Research owns the database and is the only legal partner that users can enter into a contract with to access data. This makes it easier for stakeholders to file an application to receive access to the data. The main tasks concerning EHIS, such as technical and conceptual development, are performed in the Analysis Department and the E-Service Department. Both departments work closely together and are well connected to policy makers. Thus, competences are combined, which allows for an efficient usage and development of EHIS. Even though stakeholders such as private companies or schools are not directly involved in the governance of EHIS, feedback channels allow them to state their opinion and concerns concerning the system. For example, interview partners noted that the EHIS helpdesks – there is one run by HITSA and one by the E-Service Department for more complicated issues – are an important tool to collect feedback on EHIS, which is taken into account in its further development. Furthermore, schools can participate in pilot projects to test new features of EHIS. Interviews with schools confirmed that they feel well informed and competent to use EHIS and give feedback to the Ministry of Education and Research. Nevertheless, stakeholder involvement in the governance of EHIS is very limited. But the case of EHIS shows that, even though stakeholder engagement is desirable and could be improved, it is not always necessary to build and govern an integrated information system.

Challenges

The first of the main challenges of EHIS is the unused potential for evidence-based decision making by schools. Schools enter data because they are obliged to, but they show little interest in EHIS. This is a very similar challenge to that identified in the case of EWIS explored in Chapter 7, the US case study. One of the main objectives of EHIS is to facilitate the comparison of school performance and, as a result, incentivise school improvement. However, EHIS does not fully meet this aim. While institutions in higher education and vocational education do seem to compare performance, schools providing general

education rely on their own experience and internal school management systems instead of analyses based on EHIS data. Thus, a great potential to use general education system data for evidence-based decision making at the school level is not fulfilled.

Second, stakeholder involvement could be extended and institutionalised, especially regarding the development of data-based e-services, deep learning tools and other applications. The increased involvement of schools, teachers, universities, pupils and other stakeholders in the development process would improve the quality and user friendliness of new features. Users know best about their needs. Instead of developing a "ready to use" product with little stakeholder involvement, integrating them into the development phase would allow for the tailoring of new features to their needs and demands. Feedback tools or personalised skill assessment tools would best be designed together with other stakeholders, who should be able to regularly voice their feedback.

Third, the detailed information in EHIS allows for extensive and sophisticated analyses. EHIS data are mainly used for standard reports and specific requests from policy makers, and the full analytic potential from the ability to connect EHIS data to other databases is not yet being used. The Ministry of Education and Research has started to tackle this issue and is working on more sophisticated analyses, including the tracking of teachers' careers and analysing pathways of drop-out candidates. Implementing bodies such as HITSA and the Innove Foundation have also started to consider new ways of analysing the rich EHIS data, but the process is slow. For example, data on student learning behaviour, which includes the selection of specific subjects, can be linked to career development. These are sensitive data which must be treated very carefully.

Fourth, how EHIS data is displayed to the public might lead to a limited and one-sided interpretation of the data. Educational Eye provides information on each school in Estonia in the form of a school card that summarises key indicators such as number of students or the average grade in the state exams. However, these key indicators do not represent the full range of qualities that education and schools have to offer. Interviewees explained that parents in particular pay too much attention to the grades in the state exams. The extent to which a school promotes personal development or fosters a child's interest in learning is not displayed on the school card.

Fifth, the process of how data enter EHIS is partly sensitive to errors. As described above, schools can choose between three options on how to enter data to EHIS: uploading Excel sheets, manual entering through the user interface, or automated data exchange between the schools' management software and EHIS. The first two options, however, allow schools to "check" and "correct" the data before submitting to EHIS. This means that there is the possibility to influence the data, intentionally or unintentionally, as errors might occur in the process of entering the data into the system. Furthermore, although it is a legal requirement, there are schools that do not always update the data immediately. This means that the live data in EHIS are not as live as they could and should be. However, such "manipulation" of the data is limited by the logical consistency check functions of EHIS, such as the automatic warning message if a school tries to register a student who is registered with another school, or who is not registered in the population register.

Summary

This case study on EHIS covers two policy dimensions – building integrated information systems and engaging stakeholders throughout the policy cycle. The emphasis of the analysis is on the first of these two dimensions as EHIS is a successful example of an integrated information system. As the analysis has shown, EHIS collects reliable live and personalised data that allow for detailed and even longitudinal analyses of the education system. EHIS enables policy makers to take informed and evidence-based decisions, and the analysis revealed that EHIS data are a very important source of information for policy makers. However, the analytic potential that EHIS offers is not yet fully used. One of the aims of EHIS was to incentivise schools to compare their performance with other schools, and

thus stimulate efforts for further development and improvement; however, this aim is not met by EHIS due to a lack of interest by schools in EHIS data.

Although this case study also touches on the policy dimension of engaging stakeholders throughout the policy cycle, in contrast to the other cases in this report EHIS is an example of very limited stakeholder engagement. Stakeholders such as schools or private companies can access EHIS data, and the governance of EHIS offers feedback channels such as help desks, workshops and pilot projects. However, stakeholders are not systematically involved directly in decision making, for example in how to use EHIS data and the further development of EHIS. Although the centralisation of governance competences in the Ministry of Education and Research simplifies development processes, such as the application for access to data because there is only one party responsible, opening up governance to other stakeholders might increase the use of EHIS.

Policy recommendations

Use questions as drivers of data collection

One of the most important lessons learned from this case study is that successful information systems require more than just data collection: data should also answer important questions. Thus, questions to the education systems should be the driver of data collection, not the data collection itself. The case of EWIS explored in Chapter 7, the US case study, is a good example of how a concrete question, for example which student is likely to drop out of school and thus might need support, can drive data collection. EHIS was implemented and is governed by a top-down approach by the Ministry of Education and Research, as discussed in the main section on EHIS. In the foundation phase of EHIS, concrete questions such as how many schools have access to the Internet motivated data collection. Today, EHIS answers a lot of questions discussed in reports by the Ministry of Education and Research. It seems clear to the ministry what questions EHIS answers; however, schools and other stakeholders do not seem to know about the questions driving data collection. This should be made more transparent as it would increase the visibility of EHIS.

Support innovative data analyses

EHIS generates and collects a great deal data that allow for very detailed and innovative analyses. However, as discussed in the analysis section, the analytic potential is not fully used. HITSA explores new ways of connecting databases to generate new insights in learning processes and career development. This, however, should only be the beginning of innovative research. Estonia has the potential to generate very useful new insights into learning behaviour, learning materials and the effects of educational attainment on careers. These efforts could be intensified by investing in research teams that develop new questions for educational systems.

Put the data into perspective

The value of data comes with how they are interpreted and used, not merely with the collection. However, data interpretation can be difficult, and there is often more than one way. One example of problematic data interpretation concerns the school cards described previously, which summarise key indicators for a school such as the average grade of the pupils in state exams. It is essential to put these data into perspective, and users might need help with the interpretation of data and to understand that good education is more than just the final grade in the state exam. This can be achieved by, for example, educating users about the context of certain indicators, such as additional explanations in written form to help users to put numbers into perspective. Furthermore, the analysts who compile the data for the public should be aware of this challenge and consider how to provide further information, as well as which indicators are published.

The Ministry of Education and Research is aware of this problem and has started to complement information on the school with aspects such as pupil satisfaction. Ministry reports should explain the complexity of educational systems and not focus too much on certain numbers.

Streamline and automate the data collection process

As discussed in the analysis section, errors are most likely to occur in EHIS when schools enter their data. From the perspective of the schools, entering the data is an extra burden as most schools do not use the automated connection between their management system and EHIS. For some schools, this option is not available, and some schools prefer to have a final look at the data before submitting to EHIS. Thus, there are different ways to enter the data, and many manual steps that might lead to mistakes in the data. The Ministry of Education and Research has identified this problem and is working on EHIS 2.0. The new version of EHIS is supposed to collect the data automatically from the school's management systems and to remove human interaction in the data collection. A streamlined and automated data collection process would reduce the chances of errors entering the data, but it would also require getting the schools on board and establishing a process that they understand and support. For this purpose, schools need to be open to use new e-school management systems and be convinced that it is not necessary to check the data in person before submitting to EHIS. Moreover, streamlined and automated data collection would require streamlining the e-solutions, which is the task of the Ministry of Education and Research and private providers.

Promote the use of EHIS data among schools

Schools are the source of the data and the providers of education, and therefore are key players. Getting them on board in the data collection process is essential, and getting them to use EHIS data is important as it was one of the main goals of EHIS. The Ministry of Education and Research is working on how schools can be motivated to use EHIS data. One important aspect is to avoid increasing the burden of schools by using existing mechanisms and channels of communication. Schools rely on their own internal online management systems for evidence-based decision making. EHIS offers two advantages compared to the school management systems: it can connect to other databases and it contains data on other schools. Thus, EHIS allows schools to put themselves in a much broader context. Schools need to be educated about these advantages and need easy access to EHIS data that is of use to them.

Increase user friendliness

One way to make EHIS data more attractive is to increase the user friendliness of the access points. For example, the online platform Educational Eye contains a great deal of data but is not always easy to use. Citizens most likely do not use these tools on a daily basis, so the portal must be as intuitive as possible. User friendliness is important to make data accessible, and thereby lay the foundation for data collection in general. Increasing user friendliness requires research on the needs and behaviour of the users. In the case of EHIS this could be a challenge as a great variety of users access EHIS data. Thus, the portal has to be able to speak to many different perspectives. User friendliness is also one of the aspects of governance to be improved in the case of EWIS which is described in Chapter 7, the US case study.

References

Archimedes Foundation (2018), *Archimedes Foundation - Homepage*, http://archimedes.ee/en/archimedes-foundation (accessed on 3 January 2020). [21]

Authority, E. (2019), *Data Exchange Layer X-tee*, https://www.ria.ee/en/state-information-system/x-tee.html. [10]

E-estonia (2019), *Education*, https://e-estonia.com/solutions/education/. [2]

E-estonia (2019), *E-identity*, https://e-estonia.com/solutions/e-identity/smart-id. [9]

E-estonia (2019), *We have built a digital society and so can you*, https://e-estonia.com/. [1]

ESchool (2019), *About eKool*, https://ekool.eu/index_en.html. [12]

Etis (2019), *Terms and conditions of use*, https://www.etis.ee/Portal/Article/Index/f214f72b-3333-4426-8f31-2db3f1cb0b52?lang=ENG. [14]

HITSA (2019), *About us*, https://www.hitsa.ee/about-us. [20]

HITSA (2019), *Historical overview 1997-2017*, https://www.hitsa.ee/about-us/historical-overview. [6]

Innove (2019), *About Innove*, https://www.innove.ee/en/about-innove/. [15]

Kutsekoda (2019), *About Estonian Qualifications Authority*, https://www.kutsekoda.ee/en/about-kutsekoda/. [18]

Kutseregister (2019), *Avaleht (Home Page)*, https://www.kutseregister.ee/. [16]

Laanpere, M. (2002), “Tiger Leap Plus – an ICT Strategy for Estonian Schools, 2001 – 2005”, *Baltic IT&T Review*, Vol. 01/24. [8]

Ministry of Education and Research (2020), *Basic School School Card*. [22]

Ministry of Education and Research (2018), *Estonian Education Information System*. [23]

Ministry of Education and Research (2019), *Contacts*, https://www.hm.ee/en/contact. [7]

OECD (2020), *Unemployment rate* (indicator), https://dx.doi.org/10.1787/997c8750-en (accessed on 28 January 2020). [5]

OECD (2019), *PISA 2018 Results (Volume I): What Students Know and Can Do*, PISA, OECD Publishing, Paris, https://dx.doi.org/10.1787/5f07c754-en. [3]

OECD (2019), *PISA 2018 Results (Volume II): Where All Students Can Succeed*, PISA, OECD Publishing, Paris, https://dx.doi.org/10.1787/b5fd1b8f-en. [4]

OIS (2019), *Õppeinfosüsteem (Study Information System)*, https://www.ois.ee/. [13]

OSKA (2019), *What is OSKA*, https://oska.kutsekoda.ee/en/. [19]

Santiago, P. et al. (2016), *OECD Reviews of School Resources: Estonia 2016*, OECD Reviews of School Resources, OECD Publishing, Paris, https://dx.doi.org/10.1787/9789264251731-en. [17]

X-tee (2019), *X-tee factsheet*, https://www.x-tee.ee/factsheets/EE/#eng. [11]