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A comprehensive analysis of the inputting and storage of data received by Estonian optometrists and potential areas of application in the future

Master's thesis

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Tallinn 2021

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Analüüs Eesti optometristide poolt saadud andmete sisestamise ja salvestamise ning potentsiaalsete kasutusvaldkondade kohta tulevikus

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Author’s declaration of originality

I hereby certify that I am the sole author of this thesis. All the used materials, references to the literature and the work of others have been referred to. This thesis has not been presented for examination anywhere else.

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10.05.2021

Abstract

Background: An optometrist is a healthcare professional who is one of the first to inspect person's vision. Vision control is a multi–step procedure in which information from different aspects of vision is collected. Vision related data is used not only for optical aids but also in other areas of healthcare as well as outside healthcare facilities. Dealing with eye conditions is time–consuming and costly for both the individual and the state. The role of the optometrist is important in discovering eye conditions before permanent damage. Applying data collected by an optometrist in other areas is a potential opportunity to improve data flow as well as decision–making. *Aim*: The aim of this thesis is to show that during eye checkup optometrists already collect data needed by other institutions and their use could contribute towards more effective solutions. Therefore, this thesis maps the current situation among Estonian optometrists to understand the compatibility of the existing databases with other institutions. In addition, to show the satisfaction and analyzability of data flow in optics stores. Finally, to highlight potential areas for development of the data collected in other institutions and to show potential opportunities for cooperation. *Method:* Four different methods were used: Literary review, standards analysis, survey of optometrists, interviews with optics store owners and stakeholders. *Results:* The results showed that data collected by optometrists is sufficient for the Estonian Health Information System. Technologically, the obstacles are minimal, and all stakeholders are interested in working with optometrists. However, the lack of regulation in the optics businesses over the amount of data and different databases make the flow of data difficult at this stage and would need to be developed further. *Conclusion:* The data set recorded by optometrists has the potential to be introduced and added into the Estonian Health Information System. Some of the fields exist in the database and some should be added. This data would contribute to the monitoring of eye conditions and towards accuracy of the documentation of the authorities involved.

This thesis is written in English and is 82 pages long, including 8 chapters, 15 figures and 1 table.

Annotatsioon

Analüüs Eesti optometristide poolt saadud andmete sisestamise ja salvestamise ning potentsiaalsete kasutusvaldkondade kohta tulevikus

Taustainfo: Optometrist on üks esimestest tervishoiutöötajatest, kes kontrollib nägemist. Nägemiskontroll on mitme astmeline protseduur, kus kogutakse teavet nägemise erinevatest aspektidest. Nägemisandmeid kasutatakse lisaks optiliste abivahendite valmistamisele ka teistes tervishoiuvaldkondades ning asutustes. Kuigi nägemiskontrolli pääsemine on Eestis lihtne, on silmahaigustega tegelemine nii inimesele kui ka riigile aeganõudev ja kulukas. Optometristil on nägemises tähtis roll, fikseerides silmahaigusi ennem, kui tekivad püsivad kahjustused. Optometristi kogutud andmete rakendamine teistes valdkondades on võimalus nii andmevoo kui ka otsuste tegemise parandamiseks. *Töö eesmärk:* Lõputöö eesmärk on näidata, et optometristid koguvad nägemistestide käigus ka teistele asutustele vajalikke andmeid ja nende seotum kasutamine looks kasulikke lahendusi. Selleks kaardistati hetkeolukord, et mõista olemasoleva andmebaasi ühilduvust teiste asutustega. Lisaks näidata optikakaupluste andmevoo rahulolu, analüüsitavust ja tuua välja erinevaid andmete kasutamise valdkondi ja koostöövõimalusi. *Meetod:* Neli erinevat meetodit olid kasutusel: kirjanduslik ülevaade, standardite analüüs, optometristide küsitlus, intervjuud optikapoe omanike ja huvigruppidega. *Tulemused:* Tulemused näitasid, et optometristide andmed on Tervise Infosüsteemi jaoks piisavad. Tehnoloogiliselt takistused on minimaalsed ja kõik huvigrupid on huvitatud optometristidega töötamisest. Kuid optikaäris andmebaaside regulatsiooni puudulikkuse tõttu on andmete liikumine keeruline ja vajab arendamist. *Kokkuvõte:* Optometristide salvestatud andmekogul on potentsiaal saada lisatud Eesti Tervise Infosüsteemi. Osa väljadest on andmebaasis olemas ja mõned tuleks lisada. Need andmed aitaksid kaasa silmahaiguste jälgimisele ja seotud asutuste dokumentide täpsusele.

Lõputöö on kirjutatud inglise keeles ning sisaldab teksti 82 leheküljel, 8 peatükki, 15 joonist, 1 tabel.

List of abbreviations and terms

EHIS	Estonian Health Information System
EHIF	Estonian Health Insurance Fund
GP	General Practitioner
SNOMED–CT	Systematized Nomenclature of Medicine Clinical Terms
TEHIK	Health and Welfare Information Systems Centre
ICD–10	International Classification of Diseases, Tenth Revision
WHO	World Health Organization
AMD	Age–related macular degeneration
NIHD	National Institute for Health Development
ECOO	European Council of Optometry and Optics
PC	Publication Center
HCP	Health Care Provider
EOS	Estonian Society of Optometrists
ETA	Estonian Transport Administration
IOP	Intraocular pressure

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1 Introduction

Seeing is one of the most important senses for a person – starting from a new–born, learning to perceive the world around them to an elderly person to maintain their independence. Despite the importance of vision in our lives, research shows that eye conditions and vision impairments are widespread and often untreated. 2.2 billion people worldwide suffer from visual impairment, and 1 billion of them could have prevented their visual impairment or at least done something about it. Most of the people mentioned above live in low – and middle – income countries, are old and live – in rural areas [1].

The demand for eye care is growing – population growth and aging, including changes in people's behavior and lifestyles, are leading to more people with eye conditions, visual impairment, or blindness in the coming decades. It is estimated that there are 11.9 million people worldwide with moderate or severe visual impairment and/or blindness could have been prevented [1]. An optometrist is a healthcare professional whose main tasks are to study and improve people's visual function [2].

Usually, it is the optometrist in Estonia who performs the basic vision tests and is the first to meet the client [3]. Thus, the optometrist plays a very important role in person’s eye health. Over the last twenty years, the role of the optometrist in Estonian healthcare has become increasingly important. As there are currently at least 20% of Estonians wearing glasses and 10% contact lenses, it is to be feared that this number will increase even more in the coming years [2]. The optometrist usually works in an optical store and does not have access to the data in the Estonian Health Information System (EHIS) [4].

As there are no standards for processing information and no access to the EHIS, there is no complete overview of how information is stored as well as entered at the optometrist's workplace. Inherent in the professional standard, the optometrist is obliged to save the client's personal data [5].

This information block makes it difficult for optometrists as well as family doctors, ophthalmologists, and other interest groups to monitor information related to person’s

vision. A client who has come to the optometrist for a vision test may not be able to get a definitive solution to their eye condition, but with early enough prevention work, the optometrist can early discover potential vison impairments [1].

The aim of this thesis is to map the current situation of optometrists in Estonia. An overview of information that is important for the work of optometrists and how the information is recorded, stored, and preserved. To present the potential applications of the data obtained by optometrists, which could be applied by other stakeholders in addition to optometrists themselves. An overview of the technological and human factor related obstacles in creating a harmonious data exchange within the optical businesses and EHIS.

The thesis concentrates on the following research questions:

1. How do optometrists store and apply data in their work?
    - How is the current landscape with optometrists mapped in terms of data storage and application?
    - What assessments do the optics business owners make of the quality of the data obtained by the optometrists working under their authority?
2. What would be the potential development areas in the work of an optometrist that could be applied to their job?
    - What are the suggestions by optometrists for further possible development areas?
    - Which stakeholders would find use of the data received from the optometrists?
3. What are the difficulties to the harmonious input and redistribution of data in technology–intensive optical businesses?
    - To what extent do today's Estonian Health Information System standards allow for the sharing of eye examination data?

The study uses four different methods to answer the research questions. Firstly, the collection of descriptive and comprehensive background information to support the objectives of the work. Secondly, surveys with business owners and optometrists. Thirdly, thematic analysis with a focus group. Fourthly, compliance analysis of standards.

2 Background information

There is a wide variety of effective methods for dealing with vision problems to reduce the risk of developing an eye condition or eye disease. Chapter 4 outlines a selection of eye conditions, some of which may cause vision problems or blindness, and others typically do not. Although some eye diseases are preventable, this is not possible most of the time. Each eye condition requires a different approach [1].

Fortunately, there are effective methods to address the needs of eye conditions and diseases through prevention, vision tests, treatment, and rehabilitation. In promoting eye health, an optometrist can help other stakeholders to raise public awareness of their health status [1].

2.1 Definition of optometrist

An optometrist is a healthcare professional whose main tasks are to study and correct people's visual function, to adjust, manufacture and do minor repairs to glasses, contact lenses and other optical aids. The optometrist's daily tasks also include advising clients who need visual aids and, if necessary, referring them to an ophthalmologist [2]. The standard vision tests include a 10–step examination: medical history, prescription, follow–up visit, eye motility, anterior eye assessment, objective and subjective refraction, binocular vision assessment, assessment of nearsightedness, consultation [3].

2.1.1 Optometrist in Estonia

Over the last twenty years, the role of optometrists in Estonian healthcare has become increasingly important. Estonia's first nine optometrists received their diploma in 2002 [6]. Every year, Estonia gets on average 14 new optometrists [3]. As of 2021 there are 313 optometrists in Estonia. 298 optometrists have graduated from Tallinn Health Care College, 4 optometrists have acquired their education in St. Petersburg and 11 optometrists have received a bachelor's degree from the University of Latvia. 13 out of

313 optometrists have also graduated from the University of Latvia with a master's degree in optometry [6].

The optometrist usually works in an optics business and/or a vision correction office [5]. However, there are also a small number of optometrists in Estonia who work in private clinics and hospitals instead of an optics store [7]. There are 1.82 optometrists per 10,000 inhabitants in Estonia. The need for an optometrist is great – at least 20% of the population in Estonia wears glasses and at least 10% contact lenses [3].

Despite a great deal of responsibility for one of the most important senses of a person, the work of this health care professional is not regulated by the state. The work of Estonian optometrists is set by a professional standard based on the requirements of the European Optometry and Optics Council established in 1998. In addition, the professional standard is aligned with the requirements of the European Diploma [5].

On average, optometrists start receiving clients aged 8 and over. Children under the age of 8 are usually treated in Estonia by a pediatric ophthalmologist. If the client needs treatment or surgical intervention to improve the condition of the eye, one will consult an ophthalmologist. Estonia is one of the European countries where optometrists do not issue referral letters to doctors [3]. The global shortage of trained professionals is a challenge that also affects the accessibility of eye care services. If the availability improves, it could reduce the incidence of eye conditions as well as blindness, or at least the cases would be addressed to some extent [1].

According to the law, optometrists may also participate in the provision of health care services. From 1 January 2021, optometrists will have access to the personal data of the patient in the Estonian Health Information System (EHIS), including special types of personal data, except for the data of the following documents transmitted to the EHIS:

- Health certificates
- Death notices
- Statement of the cause of death
- Notification of the cause of perinatal death [4]

Nevertheless, not all optometrists have access to the EHIS and the ability to compile referrals to other physicians, complete, and view client vision data from the system. Despite the access granted by law, it became clear after an interview with the Health and Welfare Information Systems Centre (TEHIK) employee Kerli Linna that only optometrists working in hospitals can access the EHIS. The information request is made through a Health Care Provider (HCP) working in the institution, because Estonian optometrists are not in the Health Board's Register of Health Care Workers. The current register consists of doctors, dentists, midwives, and nurses [8].

2.2 Estonian Health Information System

The EHIS processes data related to the field of health care for concluding and fulfilling a contract for the provision of health care services, ensuring the quality of health care services and patients' rights, protecting public health, and maintaining health records, health statistics and health management. This system has been in use since 2008 and interfaced with X–Road in 2009 [9].

The e–services created based on the EHIS enable the provision of better health care services and provide an overview of the treatment process and health data for both medical professionals and patients. The EHIS is a database belonging to the state information system, in which data related to the field of health care are processed. The Ministry of Social Affairs is responsible for its operation and development [10].

2.2.1 Eye health care services taxed by Estonian Health Insurance Fund

To get an appointment with an optometrist, the client must turn to the optician's business and book an appointment, for which the customer must generally pay according to the store’s price list. Optometrist services are not included in the health care services paid for by Estonian Health Insurance Fund (EHIF).

The list of health care services taxed by the EHIF in connection with eye health are listed in the Chapter 4 Examinations and procedures § 32 [11]. The following healthcare services are set out for ophthalmological examinations and procedures:

- Determination of astigmatic, prismatic, or telescopic spectacles (Code 7251)

- Gonioscopy, perimeter (Code 7252)
- Removal of corneal and white corneal sutures (Code 7253)
- Chalazion and other mucosal and mucosal operations (Code 7254)
- Probing and rinsing of tear ducts (Code 7255)
- Corneal cryotherapy (Code 7256)
- Corneal abrasion, removal of foreign body deep from the cornea (Code 7257)
- Opening an orbital phlegmon (Code 7258)
- Parabulbar and subconjunctival injections (Code 7259)
- Bottom photography (Code 7260)
- Fluorescent angiography (Code 7261)
- Computer perimeter (Code 7262)
- Examination of the fundus with a triple mirror lens or Volk lens (Code 7263)
- Study of eye motility and fusion ability using a synoptophore (Code 7264)
- Ophthalmic muscle function study using Hess display (Code 7265)
- Prism correction with Fresnel prism stickers (Code 7266)
- Examination of ocular refraction by means of autorefractometer (Code 7267)
- Eye ultrasound (Code 6004)
- Optical coherent tomography of the fundus (Code 7268)
- Optical coherent tomography of the front of the eye (Code 7269)
- Topographic study of optic disc and nerve fiber layer (Code 7270)
- Intravitreal drug administration (Code 7271) [11].

Based on the above list, one can point out that the services of optometrists are not among the health care services paid for by the EHIF in Estonia.

2.3 EHIS Physician Portal (*Arstiportaal*)

The EHIS Physician Portal is a web–based software that TEHIK provides to all doctors and nurses who wish to use it. Using the Physician's Portal, the healthcare provider can access documents that other doctors have previously sent to the EHIS about the patient, epicrises, referrals and referral responses, notifications, health certificates, ambulance cards, dental records. In addition, get acquainted with the patient's time–critical data, diagnoses, test answers, visits, medications. Prepare patient health records and transmit them to the EHIS [12].

2.4 Standards for treatment guidelines

A treatment guide is a document that provides recommendations for activities that improve health. It provides evidence–based guidance to healthcare professionals on how to diagnose and treat diseases and may include recommendations for disease prevention or patient education strategies. The information provided in the treatment guide helps to make choices between different interventions that affect health, the quality of treatment and the use of health care resources. Both clinical evidence and local costs and estimates must be considered in their design and approval. International data sources support the assessment of clinical evidence [13].

Many different organizations and professional associations in Estonia have been compiling them. Even though the handbook for compiling treatment guidelines developed by the EHIF for the health care sector has been in use since 2003, the current situation regarding treatment guidelines and the level of evidence–based validity in Estonia is very uneven [13].

2.5 Definition of international classification of diseases (ICD)

The classification of diseases can be defined as a system of sections into which diseases are assigned according to established criteria. The purpose of the ICD is to enable the systematic recording, analysis, interpretation and comparison of morbidity and mortality data collected at different times in different countries. The ICD is used to transmit disease diagnoses and other health problems as alphanumeric words, allowing easy storage, retrieval, and analysis of data [14].

In practice, the ICD has become an international standard diagnostic classification for all general epidemiological and various health management purposes. These include the analysis of the general health status of population groups and the monitoring of the incidence and prevalence of diseases and other health problems in relation to other characteristics and situations of those affected [14].

ICD is authorized by the World Health Organization (WHO). The primary user of ICD codes is a health care worker, and the secondary user is someone who already uses the encoded data in a health care facility or health plan to conduct research. The coded data is also used in public health [15].

It is important to note that although the ICD is primarily designed to classify existing diagnoses of illness and injury, not every reason or problem can be classified in this way when contacting the health service provider. Therefore, the ICD offers a wide range of signs, symptoms, aberrant findings, complaints, and social situations that may appear in health–related entries instead of diagnosis [14].

2.6 Systematized Nomenclature of Medicine Clinical Terms (SNOMED–CT)

SNOMED–CT is a standardized nomenclature of clinical terminology that allows for consistency in the use of diagnoses, data entry, transmission, and processing in registries. The use of the SNOMED–CT nomenclature to encode diagnoses helps to achieve unambiguous data transfer between different pathology departments and information systems of clinical specialties. By combining structured disease protocols and SNOMED–CT nomenclature, better compatibility of different information systems for case registration is achieved. This helps to assess the current epidemiological situation of cases, if necessary. SNOMED–CT allows the aggregation, indexing, storage, and retrieval of clinical data between different disciplines and healthcare institutions. Well–structured medical records reduce data disparities and provide automated support to healthcare professionals [16].

Based on SNOMED–CT, the Estonian Society of Pathologists have created a list of diagnoses in Estonia where the tumor terminology corresponds to the modern WHO classification of tumors, and the diagnoses of non–tumor diseases have been updated according to modern literature. The list is published by TEHIK. SNOMED–CT lists are integrated with the information system of the hospital's pathology department [16].

In Great Britain, the use of SNOMED–CT topography, morphology and procedure coding in histopathological studies has been identified as an indicator of the quality of pathology service. The use of SNOMED–CT coding facilitates the work of multidisciplinary councils, improves electronic data exchange with the cancer registry and enables audits. The goal is to answer all histopathological examinations with SNOMED–CT topography, morphology, and procedure coding [16].

2.7 Protection of patient data in the field of healthcare

A healthcare provider who has a legal obligation to maintain secrecy has the right to process personal data, including sensitive personal data, necessary for the provision of healthcare without the consent of the person. The healthcare provider is required to provide the EHIS with data on the services provided to the patient [17].

The optometrist mostly works in the optics business and outside of the healthcare institution. However, the processing of sensitive personal data should be monitored in the same way. To date, there is no complete picture of how many optometrists have emphasized the privacy of customer data in the course of their work.

2.8 Definition of data harmonization

Data harmonization is the improvement of data quality and utilization using machine learning capabilities. Data harmonization interprets existing data characteristics and actions taken on data and uses the information to convert or propose subsequent changes in data quality. Data harmonization thus significantly reduces the time to generate and access insights, while at the same time minimizing the overall cost of data analysis [18].

There is no specific standard for processing and collecting data that stipulates how much information optometrists must store. Following the results of the surveys, set out to define steps what kind of work needs to be done to achieve the harmonious exchange of information between the different systems.

3 Stakeholders

In addition to optometrists themselves, there are other stakeholders that use eye–related information [19]. Thus, the data already collected by the optometrist could be used. Removing this information block could potentially improve decision–making processes. In addition, it avoids additional testing, speeds up the treatment process and reduces costs and time for both the patient/client and the stakeholder.

3.1 General Practitioner (GP)

Often the first person to be referred to for health concerns is a GP. The family doctor may not always have the time and opportunity to perform all the examinations necessary for vision control and will refer their patient to an ophthalmologist or an optometrist [3].

The GP can also refer their patients to an optometrist for a range of vision concerns, including glasses and contact lenses, vision therapy, workplace occupational health and safety. Effective collaboration between GPs and optometrists can improve patient care and offer better utilization of valuable time for different healthcare professionals [20].

Collaboration between optometrists and GPs would allow optometrists to gain a better understanding of the client's physical condition and to make connections as to why vision does not improve with optical aids or what potential future eye conditions may be associated with the client's chronic illnesses.

3.2 Estonian Transport Administration

To drive a motor vehicle, the driver needs a medical certificate, part of which is a vision assessment [19]. At present the results of the vision tests currently performed by the optometrist are only stored on paper and may not necessarily reach a GP who gives the final confirmation to the medical certificate. One potential way would be for the Estonian Transport Administratsioon (ETA) to get information directly from optometrists as to whether the person is competent to drive or not. The issuer of a medical certificate is either a GP, an occupational health doctor or a traffic medicine commission [21].

3.3 Occupational health

One of the mandatory parts of occupational health evaluation is vision testing, where optometrists could be used more extensively [22]. If an eye related accident at work has occurred, often the injured person must see an ophthalmologist. However, one of the roles that an optometrist could play here is prevention work through education and checkups. In the case of office work, the assessment of eyesight due to close–up work is a common part of the daily work of optometrists [23]. Optometrists could get information and an overview of the last visit and to assess how the workplace has affected vision over time. In addition to vision, general health is assessed, which provides additional information to the optometrist for the client's medical history.

3.4 Ophthalmologists

An ophthalmologist is a doctor who diagnoses, treats, and monitors eye diseases and vision disorders. An ophthalmologist deals with inflammatory, acute, and chronic diseases, eye injuries and vision problems that require urgent or emergency treatment. The optometrist does not treat eye diseases, but the eye examination can determine whether the patient needs to see an ophthalmologist and give recommendations on how to maintain eye health while waiting for an ophthalmologist [24], [25]. The cooperation of optometrists and ophthalmologists makes it possible to reduce the burden on hospital services [26]. If the ophthalmologist's data shows that the client has already been diagnosed with an eye disease, then in the case of certain eye diseases, the measurements made in the eyewear store could be continued to monitor by the optometrist for changes in vision and in intraocular pressure. If abnormalities occur, the client can be referred to the ophthalmologist immediately [27].

3.4.1 Long waiting lists for an ophthalmologist's appointment

There is a large shortage of trained specialists and their distribution is uneven. In rural areas, the need for eye care is higher, but due to urbanization is not accessible and therefore, people may not get help fast enough. Eye care should be distributed according to the needs of the population. Ophthalmologists are primarily responsible for performing eye surgeries and treating all major eye conditions such as glaucoma, diabetic retinopathy, and age–related macular degeneration [1].

3.4.2 Availability of hospital services according to 2019 data

Due to the lack of capacity, hospitals can serve for practically as many patients as 2018. Due to the lack of doctors, patients must wait longer (more than 42 days). One of the specialties where the shortage of doctors in hospitals is greatest is ophthalmology. Among the specialties of contract partners (procurement partners) outside the hospital network, the number of admissions registered in treatment queues for ophthalmology at procurement partners has increased [28]. Due to the low capacity of the medical institutions, 4% of the procurement partners' waiting list for outpatient specialist care must wait longer (more than 42 days). Of the specialties, the shortage of doctors is the largest in the field of ophthalmology. The proportions of admissions in the outpatient specialties of hospitals with a waiting period of up to 42 days (in the waiting list) and the actual data on admissions show that in fact, in the field of ophthalmology, as of 01.01.2020, 28% of ophthalmology appointments have been registered in waiting lists with a waiting time of up to 42 days. In 2019, this percentage was 45% [28].

3.5 Public health research

Vision difficulties and blindness are not only problems that affect the individual themselves, but also their family members and society. Visual disturbances and/or loss of vision can lead to general health problems – decreased quality of life and increased deaths. Deterioration of vision also affects a person from a socioeconomic point of view, where a person may lose their job, become more economically dependent and one’s productivity decreases [1].

A study conducted in 2018 compared the eye–related information systems of Australia, America, and England. For example, in England there is a register of visual impairments, which collects cases across the country and transmits them to a general database where all cases of visual impairment and blindness are stored. A copy of the information received is automatically sent to the Public Health Board after each case. If the selected person agrees to receive assistance, support services, training, rehabilitation services then their data is also stored in the Visual Impairment and Blindness Registry. In addition, there is a National Ophthalmology Database in England, that stores disease status, eye, and vision care, coordinated by the National Health Service information system and the Royal College of Ophthalmology [29].

Being aware of the health of the eyes is the first step in identifying health events, preventing disease, and improving human health behaviors. Storing information about eye health conditions is a complex process, especially when the information comes from several different sources at the same time. Entering information in the common database in the same way, would possibly enable public health research to be conducted. In addition, this would open the potential for clinical trials, environmental monitoring, the updating of disease registries as well as the improvement of clinical information systems.

4 Eye diseases that require early intervention

Some eye conditions cause vision problems, and some do not. Nevertheless, they can lead to personal difficulties as well as financial difficulties. Eye conditions that cause vision problems and blindness are a major focus for the health care professional to intervene as early as possible. Even if the condition does not cause blindness, it should not be understated. In higher–income countries such as Australia, America, and Saudi Arabia, it turns out that the main reason a person visits an ambulance is conjunctivitis – a condition that usually resolves on its own. Data collected in low– and middle–income countries show similar trends, with ambulance often being used for non–vision–threatening ocular conditions such as conjunctivitis, eyelid abnormalities, pterygium, and dry eye [1].

The following list of diseases is based on WHO statistics, where an Estonian optometrist could improve the situation with their own intervention [1]. For diseases, the ICD–10 code is added at the end of the title.

4.1 Common eye conditions that do not typically cause vision impairment

4.1.1 Dry eye syndrome (H04.1)

Dry eyes are a common concern with people of different ages turning to an optometrist [30]. The prevalence of this disease varies from 5% to 34% of the world, depending on the country [31]. Dry eye syndrome occurs when the amount or function of a tear is inadequate and causes an unstable layer on the surface of the eye. Dryness of the eye surface interferes with the optical ability of the eye and the protective function of the eye surface [32].

Dry eye syndrome is a multifaceted disease that significantly reduces the quality of life and can cause stress [32]. There are various measures to combat dry eye, and the first steps can be taken by a person suffering from dry eye disease in cooperation with an optometrist. The availability of optometrists is better than that of ophthalmologists

(especially due to shorter queues), which allows them to act more quickly on clients' concerns. It is therefore important that optometrists understand their role and importance in managing this disease [33].

4.1.2 Disorders of sclera (H15)

An optometrist is the first healthcare professional to be approached with this health concern. Because anterior uveitis can also be a sign of much more serious diseases such as sarcoidosis, multisystem inflammatory disease, idiopathic juvenile arthritis (which affects children) and tubulointerstitial nephritis, an inflammatory kidney disorder then it is very important that the optometrist, in addition to the observation with a slit lamp, also measures the intraocular pressure (IOP) and takes a medical history with the client [34].

Other eye diseases that irritate the sclera include blepharitis, an inflammation of the eye near the eyelids, characterized by redness and irritation of the eye itself and around the eyelids. Pterygium, pinguecula and subconjunctival hemorrhage are eye conditions, where intervention by both a physician and an optometrist are not necessary [1].

Although an optometrist in Estonia is not the one who directly treats ocular inflammation, but to recognize this condition, they must have the necessary knowledge to refer the person to an ophthalmologist or GP if necessary.

4.1.3 Chalazion (H00.1)

Chalazion is caused by blockage of the eyelid gland and causes pain to the person [1]. Often it the condition resolves on its own and disappears completely, especially if helped by a warm compress and a gentle massage of the eyelid. In the worst case, chalazion lasts for several weeks and becomes so large that it is not only unpleasant, but also unaesthetic. The large chalazion exerts pressure on the cornea, temporarily making the eye surface uneven and thereby stimulating astigmatism, which causes blurred vision [35]. However, some barley blockages may not disappear on their own, but will persist and may even increase. In this case, surgical removal of blocked gland helps. Optometrists should recognize this, and in case of their limitation should seek further advice or refer their client elsewhere [35].

4.1.4 Visual disturbances (H53)

Eye fatigue is a combination of vision problems associated with the use of digital devices (desktop, laptop, tablet, and smartphone) that deplete the visual perception. Because the use of digital screens has become a big part of people's daily lives. About 90% of screen users experience eye strain at some point. Symptoms include eye fatigue, headache, dry eyes, blurred vision, and double vision. There can be various reasons for this – uncorrected refractive error, low blinking, accommodation problems, long working under intense light, short working distance and small font size. To find a solution to this concern, it is necessary to consult an optometrist and perform a vision test, which would eventually allow the person to continue their work as needed and find a solution to their concern. Since the general solution to the situation is to dispense glasses according to the need for correction, moisturizing eye drops, rest breaks and eye exercises, the optometrist can successfully solve these problems [36], [37].

4.2 Common eye conditions that can cause vision impairment including blindness

4.2.1 Senile cataract (H25)

Optometrists are the main healthcare professionals who first provide help to people with cataracts. They assess, advise, and refer clients with cataracts to an ophthalmologist [38]. Due to the aging population, cataracts are one of the most operated pathologies. Despite the length of treatment queues, Estonia has more cataracts than the EU average. Compared to other countries, cataract surgeries are performed in Estonia more than average and the share of day care is the highest among EU countries (99%) [39]. Comparing the number of cataract surgeries per 100,000 inhabitants by country according to EUROSTAT data, the Estonian indicator in 2015 is among the highest (1104.2). Only Bulgaria, Denmark, the Czech Republic, and Germany have higher figures. The corresponding figure is lower in Finland (1040.3), Sweden (1029.3) and Lithuania (780.5) [40].

4.2.2 Glaucoma (H40)

According to the WHO, glaucoma is one of the main reasons why people go blind [1]. In addition to the cataracts, glaucoma is an eye disease in which early detection can prevent

blindness. As of 2020, 76 million people between the ages of 40 and 80 have glaucoma [1]. Glaucoma causes blindness in 10% of people in Estonia [41]. However, because the training of optometrists varies from country to country, it is only possible for optometrists to recognize glaucoma by conducting a history of familial ocular diseases, eye checkup as well as measuring IOP. Although IOP measurement depends on many different factors, high IOP can be a sign of a potential ocular disease, in which case the optometrist can refer their client to an ophthalmologist if necessary [42].

4.2.3 Diabetic retinopathy (H36)

Diabetic retinopathy is an eye disease caused by diabetes that can also lead to blindness. Early detection is very important in this eye disease to reduce the potential vision loss in the future. According to 2016 data, 146 million adults worldwide have diabetic retinopathy [1]. According to the International Diabetes Federation, the prevalence of diabetes in Estonia in 2017 was 5.7% [43]. Because there are very few symptoms at the onset of the disease, detecting the disease can be a complicated process [44]. The preferred methods for diagnosing diabetic retinopathy are ophthalmologic examination or ophthalmoscopy and/or fundus imaging. If necessary, the examination is preceded by dilation of the pupil with eye drops or mydriasis. In addition to fundus examination, the patient's visual acuity is assessed, IOP is measured, and additional examinations such as optical coherence. The same methods are used to monitor both disease progression and post–treatment course [43].

Here, the optometrist can record the initial results by measuring visual acuity and IOP, and in the event of deviations in the results, one can refer their client to the eye doctor. Also, if the optometrist hears during the medical history that a person has diabetes, then they can educate and encourage lifestyle changes and in case of doubt, refer the client to an ophthalmologist [45].

4.2.4 Macular degeneration (H35.3)

Macular degeneration is mostly associated with aging but can sometimes occur at a younger age. According to 2020 data, 195.6 million people between the ages of 30 and 97 have been diagnosed with macular degeneration [1]. According to 2016 data, age–related macular degeneration (AMD) occurs in Estonia in approximately 120,000 people in the over–65 age group to some degree, and a total of 7,600 people are diagnosed with

advanced AMD. More than 3,200 people have severe visual impairment in both eyes due to this diagnosis [46]. In the same way, this disease can lead to blindness, which in turn leads to a significant reduction in the quality of life. The optometrist comes to the person's aid here by performing regular eye examinations. Low visual acuity, which does not necessarily improve with correction and, in addition, in line with the medical history, are indications that there is potentially a bigger visual impairment and there might be a need to refer the client to an ophthalmologist [47].

4.2.5 Disorders of refraction and accommodation (H52)

Due to the abnormal shape or length of the eye, light does not focus on the retina, resulting in blurred vision. The most common refractive errors are myopia and presbyopia. In the case of myopia, it is difficult to see things from afar, i.e., a person is short–sighted. According to 2020 data, there are 2.6 billion people in all age groups worldwide suffering from myopia. In 2015, there were 312 million people under the age of 19 with myopia. Presbyopia is generally due to age–related changes that begin after the age of 40, where it is difficult for a person to see objects at a near distance. According to 2015 data, 1.8 billion people in all age groups have presbyopia [1].

For the aforementioned refractive errors, there is also farsightedness, in other words hyperopia, which makes close objects look blurry. Astigmatism blurs objects or distorts them. It is important to have eye checkups regularly by an optometrist. If vision can be corrected, the optometrist prescribes glasses or contact lenses. Sometimes surgery is required to change the shape of the cornea of the eye to correct the refractive error [48].

5 Research methodology

The aim of the thesis is to first map out how optometrists currently record their data and if it is reproduceable and harmonizable to be tied with the EHIS. Also, to understand if the data saved is detailed enough for it to be possibly used by other optometrists, stakeholders through the EHIS to improve the quality of services provided. Optics business owners' assessments were analyzed to see their insight about data quality within their businesses and the possible applications of it. It is also investigated what kind of human factor as well as technological obstacles are in creating a harmonious data exchange.

Four different methods were used to achieve the goals of the work. Firstly, the collection of descriptive and comprehensive background information to support the objectives of the work. Secondly, compliance analysis of treatment guideline standards. Thirdly, online surveys with optometrists and interviews with optics business owners or representatives. Fourthly, thematic analysis with focus groups. The research approach of this qualitative case study can be described in the following Figure 1:

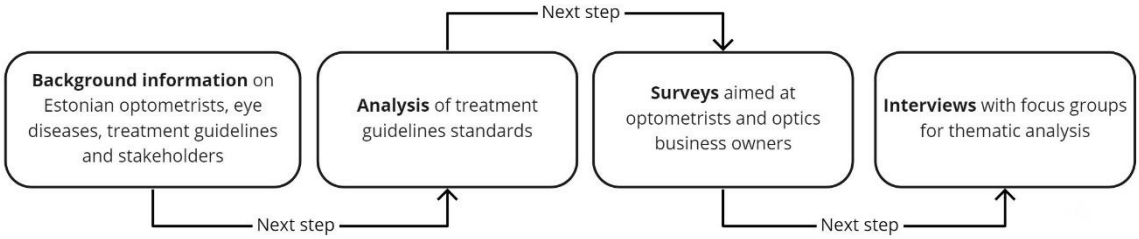

Figure 1. Research approach.

The thesis concentrates on the following research questions:

1. How do optometrists store and apply data in their work?
    - How is the current landscape with optometrists mapped in terms of data storage and application?

- What assessments do the owners of the optician's business make of the quality of the data obtained during the work of optometrists working under their authority?

2. What would be the potential development areas in the work of an optometrist that could be applied to their job?
    - What are the suggestions by optometrists for further possible development areas?
    - Which stakeholders would find use of the data received from the optometrists?
3. What are the difficulties to the harmonious input and redistribution of data in technology–intensive optical businesses?
    - To what extent do today's Estonian Health Information System standards allow for the sharing of eye examination data?

5.1 Overview of background information

The Google Scholar database was used to provide an overview. The search strategy included citations mainly from 2011 to 2020. By way of exception, one of the sources is from 1996, as this source gave the best overview of ICD–10 from the available articles. The search was conducted by using simple search terms (free text) which were developed by the author and applied to the database according to the construction of the database. The main step was to find a connection between the work of an optometrist and the most common eye condition, as well as to find mutual connections between different interest groups. A complete list of search terms can be found in the Appendix 1, page 72.

The list of eye diseases is based on the WHO world report, which lists six eye diseases that do not usually cause vision impairment and seven eye diseases that cause vision problems, including blindness. Three ocular diseases such as blepharitis, conjunctivitis and subconjunctival hemorrhage were combined into Chapter 4.1.4, page 27.

Trachoma was represented in WHO statistics, but was excluded from this list of eye diseases that cause vision impairment including blindness. It is a disease that can cause blindness due to an infection, it is a bacterial infection that is more prevalent in developing countries where there is a problem with hygiene, water availability and sanitation [1].

The stakeholders (hereinafter referred to as the focus group) were selected based on legislation who need vision–related data in their work.

5.2 Analysis of data fields

The Publication Center (PC), which is the environment for publishing medical classifications and standards and manuals managed by TEHIK, were revised. According to PC standards, all information where eye–related information can be found in the Outpatient epicrisis standard [49] (*Ambulatoorne epikriis*), the Guide to filling out a health certificate for doctors [21] (*Tervisetõendi koostamise juhend arstile*) and the EHIS analysis models [50].

For the analysis, a table was prepared containing eye conditions, procedures required by treatment guidelines for filling in the required fields in EHIS and possible procedures for the optometrist to examine the selected eye conditions.

The eye conditions identified in previous chapters by WHO statistics were compared with the fields required by the current EHIS, to find out how many information fields already overlap with the current system. For each eye condition, a code was searched in the ICD–10 database. For each EHIS required procedure, the most suitable SNOMED–CT code from the author's point of view was searched in the database.

The analysis of the data fields was performed by comparing the data fields based on the information obtained in the work of the optometrist with the data fields that already exist in the EHIS. In addition, EHIS analysis models were examined to see how many templates are associated with eye/vision findings and whether there are differences in the format of this data.

5.3 Survey to optometrists

A survey was sent to optometrists working in optical stores or hospitals using the snowball method. The first person to whom it was distributed to was Vootele Tamme, who then proceeded to share the survey with other specialists through the mailing list of the Estonian Society of Optometrists. For more answers, the author searched for optometrists through social media and approached them personally. A face–to–face

interview was conducted with two optometrists to evaluate and compare the results of the completed online survey.

This survey consisted of 13 questions to map the storage and retention of data obtained from eye examinations and information gaps in current work. The survey was conducted on a Google Forms page. The questionnaire was in Estonian and was divided into four different sections.

The first section was to find out whether the optometrist works daily and what information is recorded, where it is stored and whether the client is asked for permission to do so. The second section focused on the activities that optometrists would normally have to do in the course of their work, while assessing the activities. The third section focused on health–related data. Whether they are satisfied with the availability of information or whether it creates difficulties in their daily work. The fourth section was a potential opportunity for optometrists to assess whether they would like to do something in addition to their existing responsibilities. In addition, there was an opportunity to provide separate feedback.

The survey questions are based on the skills and responsibilities set out in the professional standard for optometrists [5] and the European Council of Optometry and Optics (ECOO) comparative data in ECOO Blue Book issued in 2020 [3].

The purpose of the questionnaire was to receive feedback on how optometrists record information when doing their work, what kind of input is important in their work. In addition, optometrists were asked what potential development opportunities they see in their own work that they could implement in the future. The list in the survey is based on trends in Europe that optometrists in other countries observe in addition to vision tests. It has been borne in mind that the capabilities of an optometrist vary from country to country.

In total, 97 surveys were filled and two of them answered questions during the interview. The analysis of the information gathered is presented in the results sections of this research.

The survey is included in the present research in the Appendix 2, page 74.

5.4 Survey to optics business owners

From all optics companies operating in Estonia, the 12 largest optics chains were selected, from which the owner of the company was contacted in person by e–mail or telephone to conduct an interview. All necessary contacts were found online or by the snowball method. To participate in the interview, the person did not necessarily have to be the owner of the company, but a person who could assess the technical condition of the company and the company's satisfaction with the data flow.

The interview consisted of 13 questions, during which the aim was to map the methods of storing information obtained during a vision test and to find out the technological readiness of the stores for integration with the EHIS. In addition, the interviews focused on the job satisfaction of the optometrist and the company's vision to cooperate with other institutions outside the optics business.

As technology is not represented in the same way in every optics business, it is therefore important to map out the current situation to offer solutions and proposals based on the results later in the discussion. Because optometrists do not have an overview of the company's technology, then, therefore, they were not asked for that part. They may also not have enough experience as well as technical knowledge to provide an overview of the information.

All interviewees were given written or oral confirmation that the results of their survey would be analyzed for this thesis only and that no internal information would be disclosed to third parties.

In total, 7 interviews were conducted, and the analysis of the information gathered is presented in the results sections of this research.

The survey is included in the present research in the Appendix 3, page 77.

5.5 Thematic analysis with focus group

The focus group consisted of stakeholders selected based on legislation who need vision–related data in their work. One representative from each stakeholder group was selected to conduct the interview. The person was selected based on who was easiest to reach.

The interview contained 5 question points. The purpose of the questions was to find out the satisfaction of the availability of information among the stakeholders. In addition, it was examined whether they would be interested in the availability of optometrist data from a common database to avoid possible additional tasks. The work and responsibilities of each interest group are different, so the questions asked during the interview were rather indicative and changed according to the interviewee.

In total, 5 interviews were conducted, and the analysis of the information gathered is presented in the results sections of this research.

The survey is included in the present research in the Appendix 4, page 79.

5.5.1 Questionnaire participants

For the survey, interviewees were found from five different fields who gave their assessment of the optometrist's data and their needs based on their work and in general. Dr. Madis Tiik represented his opinion on behalf of family doctors. The ophthalmologist's position came through Dr. Aap Toming. Marika Luik and Liis Sepp were contacted from the Estonian Transport Administration. Piret Kaljula provided input from the Labor Inspectorate and Kerli Linna provided her own input from TEHIK. All interviewees were conducted either via a video call (Skype or Microsoft Teams) or by telephone.

6 Results

The following chapter provides an overview of the results collected for this thesis. Results of a review and analysis of literary sources, survey results, and interviews. The first part focuses on the background information of the EHIS database and interview with TEHIK. The second part on the views of the optometrists, the third part on the technological conditions of the optics businesses and the last fourth part describes the side of the focus groups.

6.1 Analysis of treatment guidelines standards

Health information systems have been used to collect, standardize, encode, and manage information relevant to health indicators, determinants of health (including eye conditions and visual impairments) and health systems (government, workforce, technology, and access to services). This information is needed to make policy changes and to identify and respond to problems. Also, to direct resources efficiently and thereby create even more efficient services. Therefore, it can be said that the Health Information System is one of the points of reference for health-related decisions in policy, management, and clinical care [1].

Figure 2 below shows the collection of information that is currently entered in the EHIS in relation to the eyes and vision. Ocular information primarily concerns the patient's visual acuity in both corrected and uncorrected eyes. The visual acuity results are recorded as a real number in the database and measured both individually and together. All other eye/vision findings are included in free text.

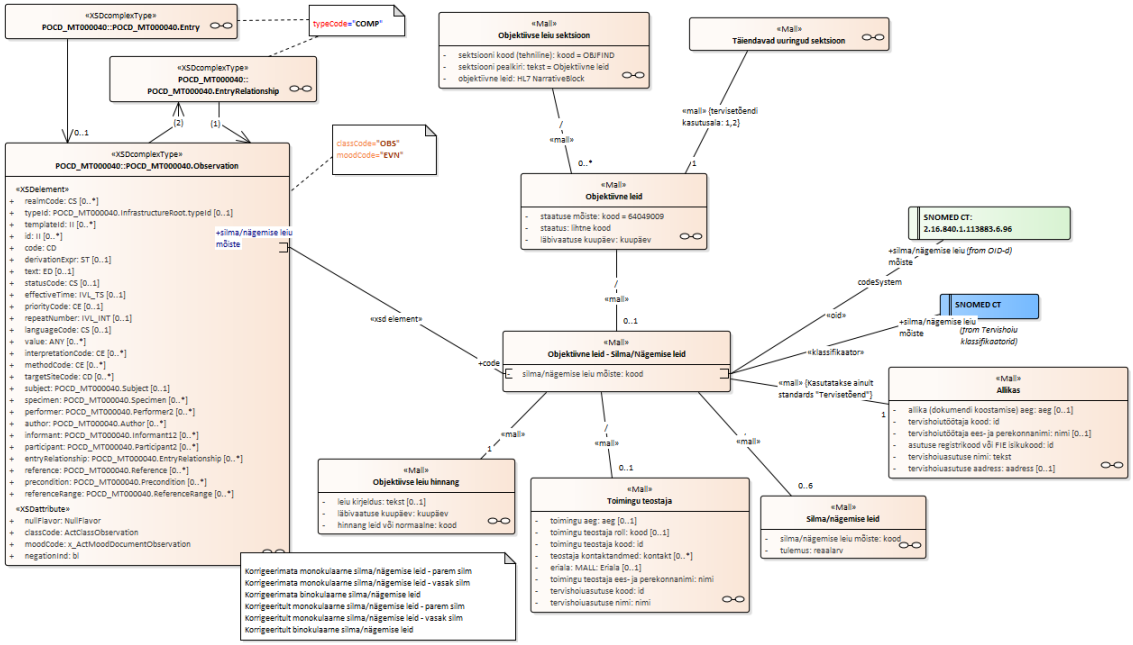

Figure 2. EHIS template for capturing eye and vision related information [50].

The following Figure 3 shows the fixed fields for eye/vision in the EHIS with SNOMED–CT procedure codes, separated.

(386709002) Uncorrected monocular eye / vision finding - right eye
(386708005) Uncorrected monocular eye / vision finding - left eye
(420050001) Uncorrected binocular eye / vision findings
(397535006) Corrected monocular eye / vision finding - right eye
(397534005) Corrected monocular eye / vision finding - left eye
(397536007) Corrected binocular eye / vision finding

Figure 3. Fixed data fields related to eye/vision findings in the EHIS [50].

Based on the previous Figure 3, it can be pointed out that the amount of information that the EHIS itself requires is rather small. The interview with Kerli Linna from TEHIK revealed that all the information related to the eye and vision is structured according to the form of the health certificate. Nevertheless, not all fields required for the health certificate are fixed in separate boxes.

The measurements required for the health certificate also include in addition to the visual acuities the visual field and contrast sensitivity. However, this value is not fixed as a requirement and is currently written in free text. The following Table 1 shows a table in the subsection of the medical certificate concerning vision. This guide has been prepared by TEHIK for doctors to complete a health certificate [21].

Table 1. Data collected for the health certificate and entered in free text into EHIS [21].

Medical certificate findings and examinations	**Motor vehicle driver (Group I)**	**Motor vehicle driver (Group II)**
Free text description of other visual findings: (including visual field and contrast sensitivity)		
Horizontal visual field	≥120º	≥160º
The visual field extended to the temporal right	≥50º	≥70º
The visual field extends to the temporal left	≥50º	≥70º
Visual field down	≥20º	≥30º
Visual field extended	≥20º There must be no defect within a radius of 30 º of the central part of the visual field	≥30º

As the eye examination already includes fixing the visual acuity and the optometrist can also evaluate the assessment of the visual field for the health certificate, the transmission of this information from the optical stores to the EHIS would enable a more thorough overview than at present. Here is a possibility to monitor the eye conditions/diseases to some extent and react if necessary.

Figure 4 shows how eye/vision related data migrates in different units in the EHIS. Even though not all data collected in vision tests or by ophthalmologists are recorded here, then, nevertheless, the data continues to flow through the database in the same format. It shows how outpatient epicrisis standard includes vision–related information, which was shown in Figure 3. Another major standard related to vision data is that of a medical certificate, which includes decision–making templates as well as restrictions on, for example, driving a motor vehicle (glasses and contact lenses). Figure 4 is in a larger format in the Appendix 7, page 82.

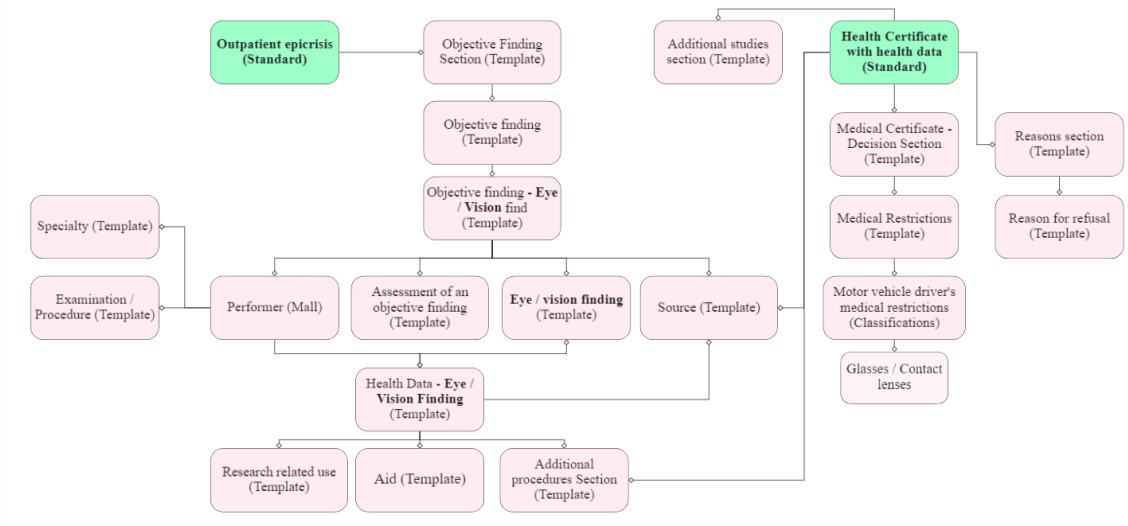

Figure 4. Eye/Vision related data flow in EHIS [50].

As optometrists do not currently have access to the EHIS, potential access would allow them to query the following data in Figure 5.

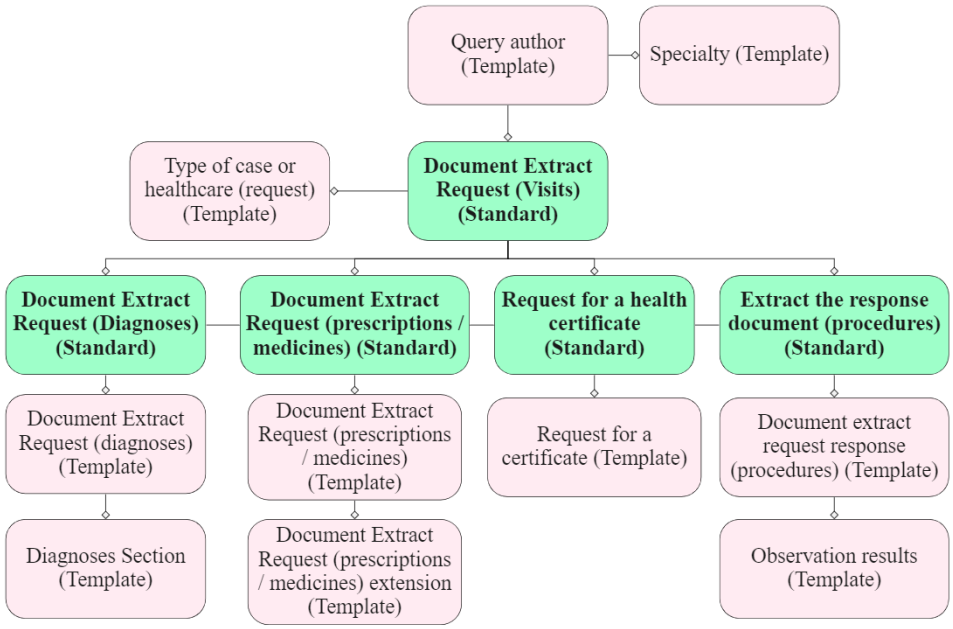

Figure 5. Data request in the EHIS by optometrists [50].

Figure 5 also shows the standards and document templates for data queries, which optometrists actually wanted when answering the surveys, which can also be seen in Figure 9 and Figure 10. Figure 6 below shows what procedures the optometrist can perform in case of a suspicion of an eye disease. The list of procedures is based on what literature sources allow the optometrist to do in the store with the available tools. It should

be borne in mind that the optometrist does not treat the eye and many eye diseases/conditions may have similar symptoms at first. Nevertheless, they should not be ignored.

The procedures highlighted in green in Figure 6 represent the fields available in the EHIS or the fields required of a healthcare professional to enter them [51], [52]. For example, perimeter is a required field for a health certificate, but is not actually fixed in a database with a specific cell. The green boxes under eye conditions (with ICD–10 codes) represent the optometrist's ability to perform their own procedures for each disease to take further action if necessary. This may be a screening with a client who has been diagnosed with an eye disease/condition and is undergoing routine eye checkups at an optics store. In the case of an eye condition unknown to the client or which has not been dealt with before, the optometrist can refer their client to an ophthalmologist or GP.

	Eye condition (ICD-10)								
Procedure (SNOMED–CT)	H04.1	H15	H00.1	H53	H25	H40	H36	H35.3	H52
Anamnesis (940000)									
Verification of allergy status (370860007)									
Intraocular pressure test (252832004)									
Visual acuity testing (16830007)									
Binocular vision test (252848003)									
Objective refraction (397276001)									
Perimetry (103752008)									
Ocular slit lamp examination (55468007)									
Cover test (400917006)									

Figure 6. Table of eye conditions (ICD–10) through procedures (SNOMED–CT) that can be recorded by an optometrist during their work.

It can be seen from this table that IOP is one of the measurements that is not actually recorded in the EHIS. High or low IOP can be a sign of an eye disease that a person may not perceive until permanent vision damage has occurred. Glaucoma H40 (Chapter 4.2.2), diabetic retinopathy H36 (Chapter 4.2.3) and macular degeneration H35.3 (Chapter 4.2.4)

are the three main eye diseases that can cause blindness [1]. For better screening it would be possible to add an IOP cell to the EHIS, which in the future could be combined with the program in the optical store. To do this, it is necessary that every optics store has a tonometer, the optometrist measures the IOP regardless of age, and the service is provided to the customer at an affordable price.

6.2 Results of the survey of optometrists

First, the survey was forwarded via e–mail to the Estonian Society of Optometrists (ESO), and then an invitation to participate in the survey was sent to graduates in person via social media. To obtain a population of 313 people with 95% confidence with a 5% margin of error, the number of respondents should be 173 people. However, the target number of people could not be reached. 95 people responded to the online survey and two optometrists were interviewed, representing 31% of the 313 optometrists. Which means that the current result is represented by a 95% confidence level with an 8.29% margin of error.

6.2.1 Part I – Collecting information

91 (93.75%) of the respondents currently work as optometrists and 6 respondents (6.25%) used to work but not anymore. Optometrists are exposed to sensitive health data in their work, but this is not properly regulated in the optics business. One of the questions regarding the data protection law was whether optometrists ask for permission before documenting and processing customer data, where it turned out that in fact 50 (51.55%) of respondents never do so [53]. In certain optical stores orders may be placed online, where it is not possible to start processing data without client’s consent. Or in other cases, client’s consent is fixed by signature on the purchase receipt. Nevertheless, this is not necessarily the case when a person first goes for a vision test, where in fact the most sensitive data transfer takes place in the whole process.

During the interview with optometrists, it became clear that sometimes, with the client's permission, the client's health data had been requested to be viewed from the EHIS to specify the data entered by the ophthalmologist. 92 optometrists (94.85%) of the respondents do not have access to the EHIS. The latter may be related to the fact that currently it is only available to optometrists working in hospitals.

To better understand what kind of information optometrists, save with each client, optometrists were asked to record all the information they record about the client during the vision test. It also provides a better understanding of the potential compatibility of the data with the EHIS in the future.

Figure 7 below lists the data that is generally recorded during a vision test.

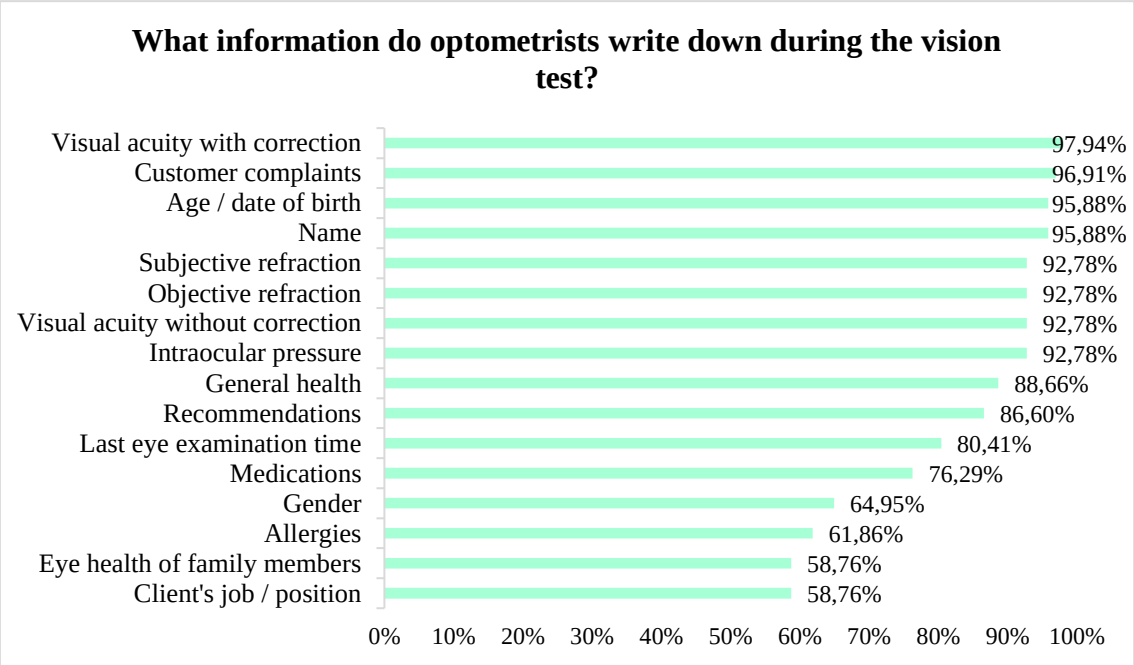

Figure 7. Data recorded in eye examination by optometrists.

Comparing this with the data fields required by the EHIS, most respondents record visual acuity without correction 90 (92.78%) as well as with correction 95 (97.94%). There is also a high proportion of measurements of IOP for the screening of eye diseases 90 (92.78%) [49].

When optometrists were asked to indicate all the possible options how their workplace obtains results during eye examinations, the responses were divided into several categories, as shown in Figure 8.

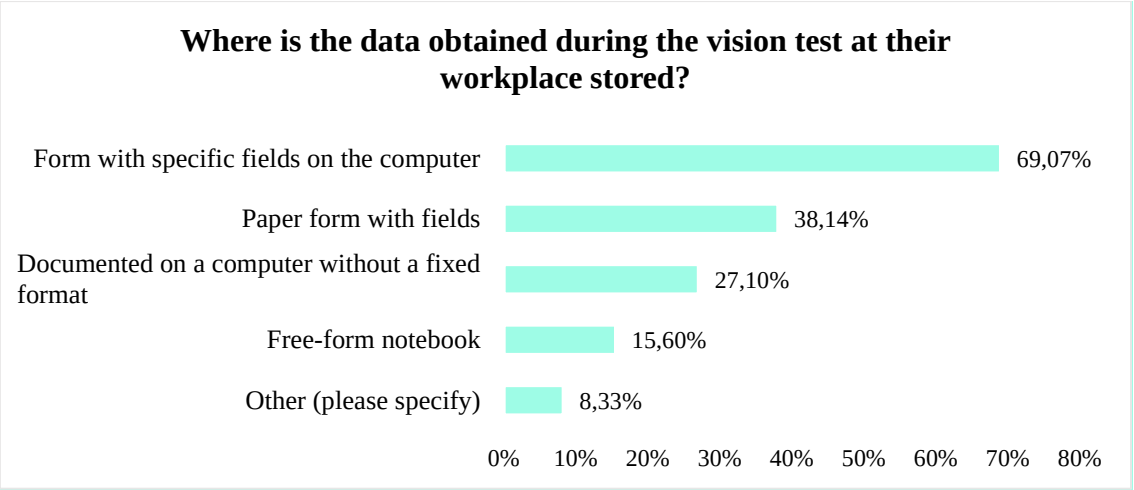

Figure 8. Place of data storage at workplace.

Eight (8.33%) of respondents chose another option for storing information. For example, three (3.1%) optometrists working in a hospital use the hospital's information system LIISA.

As the data entry formalities are not always completely fixed in optic stores, the results show that many different methods of recording data are used within the companies This was also confirmed during interviews, where optometrists admitted that based on their experience, there has not always been only one specific method of storing data in the company.

The interview also revealed that, in fact, there may be a different perception among respondents about saving data on a computer. One of the interviewees said that she records the data on a computer, which meant scanning the handwritten medical history page into it and later linking the data to a spectacle ordering program. Since the same optometrist also works in another store, there the company is editing information with a completely paperless economy, and everything is done in a cloud–based program with fixed fields. Another interviewee also thought that her formatting method is entering data into a computer program with fixed fields. It was a table created in a Word document, where a new one is created for the client each time.

Thus, the answers given in the survey may not actually be accurate here. This was also one of the reasons why additional interviews were also conducted with optics business owners so that they could give a better overview their systems used by their company.

6.2.2 Part II – Daily work tasks

In the second part of the survey, optometrists were asked to indicate the activities they do during the vision test and to evaluate the activities on a 3–point scale: 1 – never, 2 – sometimes, 3 – always.

One of the points was measuring IOP, which 3 (3.1%) of respondents never do, 68 (70.1%) do it sometimes and 26 (26.80%) always measure IOP. Here certainly the fact that this service is not necessarily included in the price of eye examination in the optics business plays a role as it must be paid for separately. The price of this service varies between 3€ – 9€. Also, IOP measurements tend to be done with an elderly person or a client who already knows that they have problems with IOP.

22 (22.68%) of the respondents never record eye diseases, sometimes record 47 (48.45%) of optometrists. However, 28 (28.87%) of respondents always record eye diseases. Interviewees said that only dry eye and cataracts are the ones that get most attention, but other diseases are not probably recorded. There were various reasons for this. Because the pupil cannot be enlarged in the optics store, many eye diseases go unnoticed. Also, many eye diseases require a good skillset of various biomicroscope techniques, which are not done due to lack of time and lack of skills.

69 optometrists (71.13%) sometimes issue a health certificate, 18 (18.56%) always issue and 10 (10.31%) never do so. At the same time, 44 (45.36%) never do perimeter and 50 (51.55%) of respondents sometimes do perimeter or visual field survey. Only 3 (3.09%) of the respondents fix the customer's visual field each time. It can be concluded that even though the health certificate is issued by most respondents, in fact the necessary check for the health certificate is not carried out in full.

6.2.3 Part III – Availability of information

In the third part of the survey, optometrists were asked to assess the availability of data. 78 optometrists (80.41%) of the respondents said that they had experienced insufficient availability of customer data in their work. Optometrists were then asked to give examples of the lack of data that made their work difficult.

Figure 9 shows what information is most needed by the optometrists. For the table, the 4 most incomplete data sets presented out of all responses were selected.

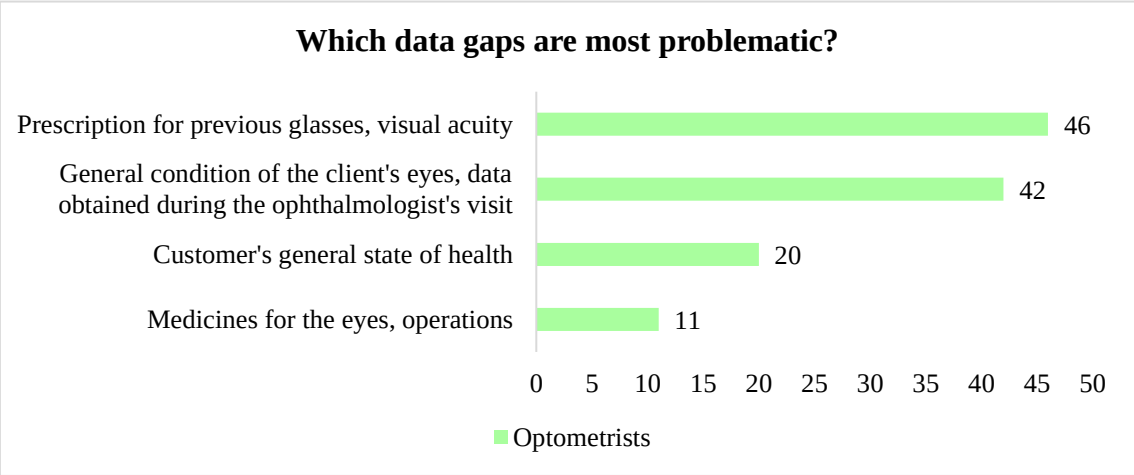

Figure 9. The four most incomplete customer data that optometrists do not always have access to.

The biggest problem is the lack of information related to previous glasses. At this point, it is worth investigating further whether this is a problem for customers from other optics businesses who have lost their prescription and/or glasses, or whether it is a problem starting from the optometrist's own workplace where optometrists do not write down all the necessary information.

The second most pointed out issue was that optometrists wanted to see the data recorded during the ophthalmologist's visit. Starting with when the last ophthalmologist's visit was, has the client already been diagnosed with eye diseases/traumas, consulted an eye doctor and prescribed treatment, has the eye(s) been operated on. Sometimes the client does not remember the data correctly or remembers it incorrectly. The same applies to the general health condition where certain diseases may affect vision or the disease against which treatment is taken also affects vision as a side effect.

Of the potential opportunities, optometrists were able to express their opinion on whether they would like to perform more procedures than they can now. 57 (58.76%) of optometrists do not want to perform additional procedures and 40 (41.24%) would like to. These 40 optometrists were enabled to give examples as to what procedures they would want to do. The most popular answers were fundus examination, which was named by 19 respondents, and cycloplegia which named 8 times. Some optometrists also indicated that they would like to have time at work to deal more thoroughly with their clients. Incorporating these procedures into the work would help to map eye diseases and

conditions even more thoroughly, but unfortunately most optometrists are not interested in additional tasks.

6.2.4 Part IV – Potential additional responsibilities

As a final question, optometrists were offered a list of procedures they could add to their everyday work as shown in Figure 10.

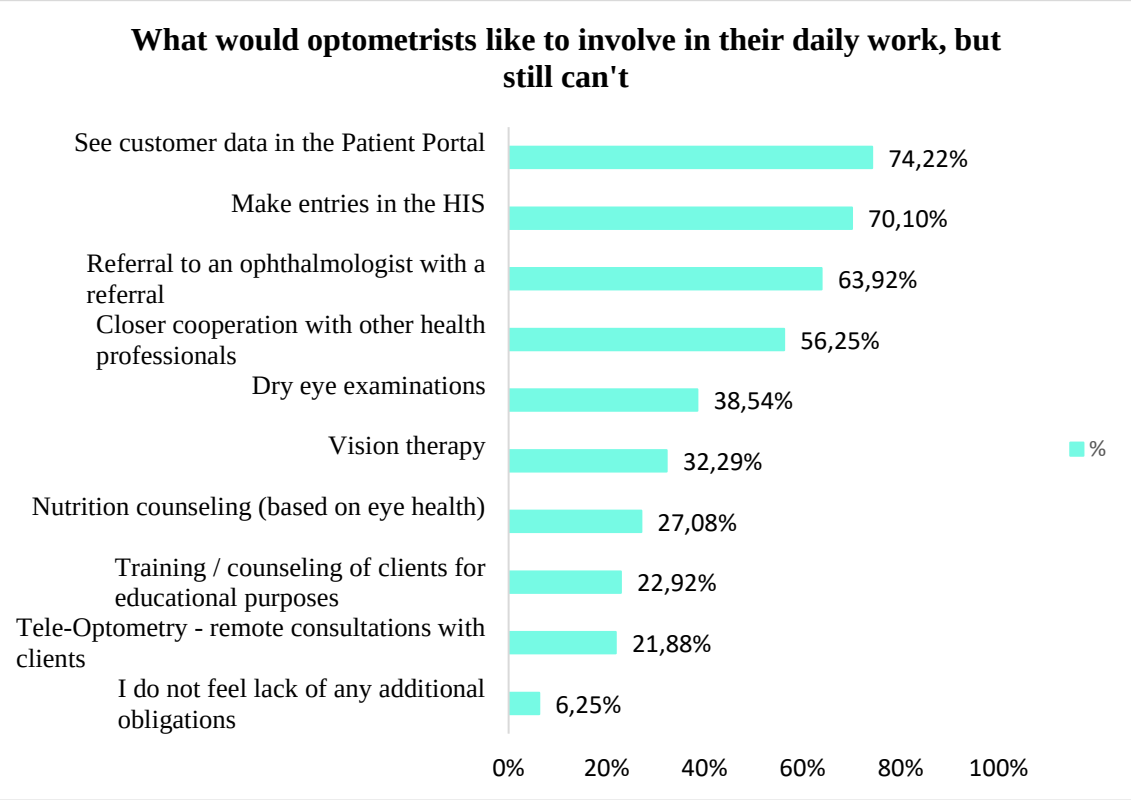

Figure 10 List of additional procedures in addition to the optometrist 's existing duties.

Most optometrists want to see (74.22%) and enter (70.10%) information about their clients into EHIS. In addition, work more closely with other health professionals. An interview with a family doctor and an ophthalmologist resident shows their position on cooperation.

6.3 Results of a survey of optics business owners

A total of seven representatives of the optics company were interviewed. The condition for participating in the interview was not to be the owner of the company, but to have a sufficient overview of the company's technological status and data exchange to assess it. Of the three companies, the optometrist answered the interview questions, of the two

companies the owner of the company answered the interview himself, of one of the companies the answers were given in writing by the secretary, and of one company the answers were given by telephone by a consultant. They received questions by e–mail before the start of the interview.

The responses of all companies to the storage of eye related data were different. Regardless of whether the company's optometrists fill in a paper–based medical history or with fixed fields on a computer, all seven representatives of the optics store confirmed that in the end the data must reach computer–based database. It should be added here that the amount of information that reaches the computer is not specifically fixed more than the amount of information related to the prescription of the glasses. At this point, all companies were referring to the prescription for the right and left eyeglasses and pupil distance. Only one company said it was also important to get the IOP, visual acuities, and optometrist's name in the store database. Some representatives of the optics store said that even if the prescription and the pupil distance are not written in the database, it will probably not be noticed before the client orders glasses again in 1–2 years and the optometrist need this data.

In four out of seven stores, a computer program is used mainly to map the information obtained in the vision test. Three companies have software specially designed for the optics store. The rest of the companies use existing accounting software, a program designed for warehouses, or apartment association software. For example, when a company confirmed that they had a separate cell in the database for each piece of information, it turned out that it was a free text field to which the optometrist would enter all other notes. For example, for IOP, no one other than one store has a fixed field that is also in the correct unit. This creates a situation where, despite the use of the program, it is not necessarily compatible with the EHIS, and the information entered is often innumerable to the machine in the form of free–field text.

The interviews revealed that the contribution of optometrists to data entry is often their own responsibility and how much they want to write down. As this has caused problems and/or made it difficult for the optometrist to do the work themselves, as well as for the flow of information in the company in general, employers were also asked about the control of the optometrist's work. Four out of seven companies check the working optometrists' methods or knowledge on an ongoing basis. One of the methods is a

performance review every five years. Two companies indicated that they have knowledge tests for optometrists as well as interviews. Companies that said they do not do knowledge tests for their employees. They added that they do not think it is necessary for the owner to have an evil hand to punish their employees. It was feared that this would create conflict rather than benefit, and it was felt that one's employees should be trusted rather than constantly monitored.

On the technological side, they were asked to point out the equipment and solutions that exist in their optics businesses, as shown in Figure 11 below. The technological equipment has been selected on the basis what is the minimum necessary to access the EHIS and to transmit the necessary measurement results.

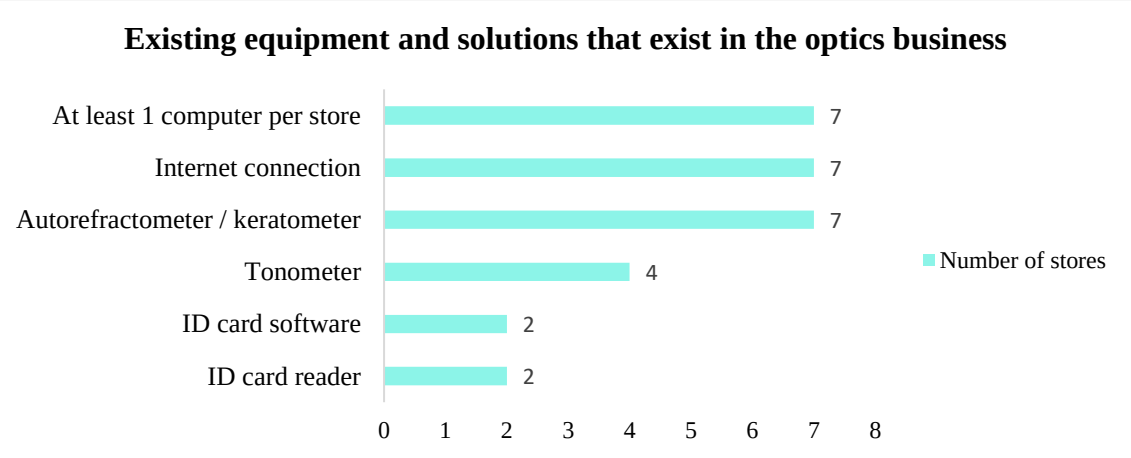

Figure 11. Representation of equipment and solutions in stores.

One company among the respondents stated that they were getting tonometer soon in their stores. Other stores that are missing a tonometer according to the same list means that at least one or more stores do not have the appliance.

Most of the respondents currently lack ID card software and a reader but obtaining it would not cause any problems for the respondents in the future. Certainly, it is important to note here that although all respondents have at least one computer per store, this meant that at least half had it in the sales hall not in the optometrist office. Therefore, to see sensitive health data in the future, in addition to the missing tonometer, it is necessary to think about the way in which the optometrist can process the data privately. At present, four companies confirmed that their optometrists can enter and view data in a separate computer in their office.

At this point, the question arose as whether permission was requested from the customer for data processing. Only three companies confirmed that they have a requirement to ask the customer for permission. In two companies, permission is requested for a special form, and in one company, information related to data processing is given orally to the client. To the question of why this is not implemented by other stores, although the law requires it, no conclusive answer was given.

When the company was asked to assess its data quality, six companies were satisfied with their data exchange and one was not. Dissatisfaction was due to the slow flow of information. The fact that the assessment was made by the optometrist and not by the business owner may play a role here. Also, during the interviews, it became clear that while the owner of the company assessed the quality of the data and the flow of information as very good, the optometrist of the same company did not actually agree with this statement during the interview. One even said that the exchange of information is not satisfactory but rather bad, because there is no contact person who can be contacted if necessary, and the response to situations as well as the flow of information is so slow that it hinders work. Six companies admitted that they had never analyzed the data or considered it necessary to do so.

When potential cooperation with other institutions was explored, six out of seven companies were interested or had already started cooperating with an institution. All interviewees agreed that storing information is very important and ensuring access to the EHIS for optometrists would make the work even smoother and more thorough. Thus, should a company need to make appropriate adjustments to achieve compatibility, all but two of the responding companies would be willing to invest at this stage. From the reason was both a lack of interest and a concern that the creation of this information flow by optometrists would cause more confusion and potentially have a negative effect on the business.

6.4 Results of the focus group interview

The focus group was interviewed for the following positions: Estonian Transport Administration (ETA), resident / ophthalmologist, family doctor and labor inspectorate. 1–2 persons were selected from each position, with whom five topic points were

discussed. The questions varied according to the person interviewed. The interview conducted with the person does not represent the opinion of the entire interest group, but the personal position of the interviewee based on their own experience and views.

6.4.1 Interview with Estonian Transport Administration (ETA)

The optometrist and the ETA are connected by a health certificate required for a motor vehicle [19]. There is currently no exchange of information between the two parties. Road safety issues are not only related to people with vision problems, but also to general health.

There are people in traffic who have conditions due to both general health and eye health that prohibit driving, whether temporarily or permanently. The problem area is drivers whose health checks are superficial. There are people behind the wheel with diagnoses which should not allow them to drive. If a traffic accident has occurred and it has been analyzed, then complete statistics cannot be presented, but it is understandable that a person may have had a traffic accident due to a health disorder. However, it also includes activities with extraneous activities (such as being on a smart device) or being tired. No one can admit that they were focused on extraneous things while being behind the wheel. Statistics on what are the subdivisions of health disorders are not directly available. This will depend on an in–depth analysis carried out by the committee of inquiry. There is a lot of emphasis in the analyzes of traffic accidents on the environment – car maintenance, tires, road surfaces and traffic signs. Less attention is paid to the driver's health condition and the health of their eyes.

There are clearly problems with health certificates. This problem is much broader than vision related information. Today, doctors in a specialty other than a GP or occupational health doctor (in this case, an ophthalmologist or optometrist) cannot revoke a medical certificate or even inform a person's GP in a reasonable manner. The Ministry of Social Affairs promised to develop an e–system for the information solution in the Traffic Committee of the Government of the Republic already at the end of 2018 / during 2019, but this has not been done so far.

As society ages, the health of drivers is also deteriorating. As the health certificate is renewed every 10 years, The Traffic Examination Committee has a great responsibility in passing through every new potential driver. An example was given during the interview

of a person postponing his examination for several months because he was detained in a psychiatric hospital, but at the same time he had a valid medical certificate that no one had stopped. It also became clear that even if a healthcare professional wanted to suspend a medical certificate, they do not know how to do it. There have been situations where GPs have asked how to suspend a health certificate. There is no detailed system on how this information would reach the GP by the ETA and vice versa.

Last year there was a record number of traffic accidents among cyclists. In 2020, according to statistics, 376 traffic accidents occurred among cyclists, 378 people were injured, and 4 people died. Statistics on road accidents with human casualties in 2020 recorded 1436 traffic accidents, injuring 1,658 people, and killing 60 people [54]. The question arises as to whether the general condition of the person, including vision, could have played a role in the background of the accident, which could have been potentially prevented if the information flow were quicker.

Both interviewees admitted that there are problems with the exchange of information between different institutions. Information with medical certificates should move faster, including data from eye examinations. The optometrist's data could be passed on to the EHIS for the GP to have a better overview during the health examination. One of the interviewees admitted that the recent visual examination performed on her by the GP was very superficial. The movement of information obtained in eye examination in a common system would make work at the ETA easier and traffic safer.

6.4.2 Interview with an ophthalmologist

Every hospital in Estonia has its own information system that fragment information between systems. However, according to the interviewee properly completed epicrises can be found in the EHIS and their use is generally very convenient. Unfortunately, the data of optometrists cannot be found there, but the information given to the patient on paper is useful and necessary. There have been situations where the information obtained in the optometrist's vision test would have been necessary but has not been available in the database or on paper. The interviewee stated that even if the information is available from the hospital database or health information system, even in this case, receiving patient information on paper is pleasant and shows respect for other doctors.

There are views among ophthalmologists where optometrists should only prescribe glasses and contact lenses. To do more, optometrists should initially have more in–depth training with a stronger focus on eye diseases. This would give the optometrist additional responsibility. The interviewee confirmed from personal experience that the examination of the fundus requires a long and thorough training, which cannot be taught by just a few trials.

In general, ophthalmologists are grateful that an optometrist refers their client to an ophthalmologist. Nevertheless, optometrist data in the EHIS should be kept to a minimum. It is suggested that in the future, optometrists could note in the database the expression "*Vision decreased for non–refractive reasons*." The interviewee also found that the information entered by doctors may not be externally comprehensible to other parties, which is why access to the data may not provide sufficient clarity to third parties.

The interviewee was asked what his position would be for the optometrist to record and map the IOP of their clients. He found that measuring IOP was a good way to screen people for referral to an ophthalmologist. It potentially helps to save people's vision. There are situations where a person uses eye drops due to a condition of the other eye, which increases the IOP as a side effect. At the same time, the prescription is constantly updated without anyone measuring the IOP in the meantime. Especially in situation when it comes to a young person. In general, IOP is associated with aging problems [1]. He added that despite this, only high IOP is not an indicator that a person may have eye problems. In certain eye conditions, the IOP may be normal, so the optometrist should not make hasty statements telling the person that everything is fine with their eyes.

6.4.3 Interview with a family doctor

The family doctor does not have access to the optometrist's data either digitally or on paper. Related to the eye, there are three areas where vision data is needed:

- Medical certificates.
- Preschool vision testing for infants.
- Regular user of eye drops.

The family doctor does not measure IOP. In most cases, eye problems have been treated by the patient's ophthalmologist, the treatment has been received and will be updated by the GP in the future. At the same time, there is little or no communication with the ophthalmologist. A situation arises where the GP to some extent blindly rewrites the prescription for the patient. There is an information block – whether the treatment prescribed for the eyes is lifelong or needs to be checked from time to time. If so, what needs to be checked (IOP, for example).

Now the prescription is updated through the patient's statement (they have received the same treatment for years). The patient will not see an ophthalmologist to update the prescription. There could be more information about the treatment issued by ophthalmologists here and ophthalmic–enabled measurement of IOP to create an information triangle between the optometrist, the ophthalmologist, and the GP. Ophthalmologist visits do not usually show up in epicrises, especially if the procedures are performed in a private clinic.

The interviewee suggested that IOP, info regarding fundus and visual acuity could be standard information that other HCP would see and be standardized. Agreed data could be found in the EHIS. The GP thought that in the future the role of optometrists could be even bigger than the author did so far. In the future, the basic equipment of optometrists could also include more tools to help detect eye diseases even faster. For example, in the case of diabetes to identify different stages. Non–invasive measurement of blood glucose to find minimal protein residues. This would make it possible to screen the population for a certain disease in the optics store. The network of eyewear stores is wide, and it would be an additional support for the medical system. A person should receive help no matter which store one goes to and possible additional measurements in addition to what is available could be taken. This would benefit both the patient and the general medical system.

The topic of health certificates was also discussed during the interview. It is convenient to make a medical certificate, but it is difficult and unclear how to suspend it. Technically, this is easy to do, but the problem stands in legal issues. The Traffic Act sets out diagnoses and conditions that limit the rights of use of a motor vehicle [55]. If, for example, a person has a heart attack, this information should automatically suspend the health certificate through the EHIS. It should not always be a GP. To suspend medical certificates now

would mean that the GP goes to each patient to see if there is a reason to close the patient's medical certificate.

In addition to legal problems, there are also problems among doctors. Doctors do not want to take responsibility for refusing to issue their patient's health certificate. As one solution, the interviewee has made medical certificates for a shorter period. For example, for three or six months. An extended medical certificate shall not be issued until the person has found a solution to the condition. The interviewee believes that the treating physician should make the final decision on the period of the medical certificate. The treating doctor is not always a family doctor. Especially when it comes to eye diseases, eye surgeries.

The availability of data from other institutions was also discussed. It was pointed out that occupational health related information is incomplete. The patient undergoes an occupational health examination but does not receive any documentation. The client's verbal statement is not a point of reference. Interviewee opinion is that there is never too much information. Just that the information must be correct, standardized and can be processed.

6.4.4 Interview with Labor Inspectorate

At the Labor Inspectorate, exposure to eye examination data is very low. The main eye–related information is related to the compensation of glasses for the employee by the employer. No vision information is generated in connection with accidents at work, as this would mean that the person who caused the accident admits that they have insufficient vision to perform work tasks.

Difficulties in daily work have arisen in situations where GPs or other HCPs should issue a certificate to the labor inspectorate but have not done so. This becomes apparent ex post when supervision or counseling is provided. During the interview it was investigated whether the availability of optometrist data would potentially make the work process easier. While the indication of the need for glasses could be beneficial it would also be enough for the Labor Inspectorate.

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7 Discussion

The inclusion of optometrist data would provide many opportunities for the healthcare sector and the medical field in general. Applying the data collected by the optometrist would open many different possibilities to make treatment better, more effective, and faster for the patient.

When a new database is introduced or an existing one is updated, maximum application should be strived for to provide best care for the patients. Optometrists are statistically one of the first healthcare professionals who performs eye examinations, which is why their role in human eye health is very important [3]. At this point, it is important that no piece of information is lost during the patient's interaction with different institutions.

This thesis analyzed the different techniques of how optometrist data is being and could be recorded and stored. One of the research questions was to find out how optometrists enter data in their daily work. In addition to the optometrist's point of view, the position of the optics business representatives was also analyzed in terms of data quality. As there are no specific standards for data storage in optical stores, the goal was to find out how sensitive data of the company's customers are handled. For a better overview, the following Chapter 7.1 provides a schematic overview of how data is currently handled in optics stores.

7.1 AS–IS

To find potential development areas for optometrist data and to better understand who else could also benefit from the data provided. For that the current situation was mapped among Estonian optometrists.

Different nuances play a role in the availability of optometrist data. Figure 12 shows an overview of how optometrists are currently exchanging and recording data. All points are based on the Professional Standard for Optometrists and the results of the ECOO are

included in the local optics store database and eye examination procedure boxes in Figure 12 [3], [5]. Although the information that the optometrist collects from the local database as well as in the course of their work is considerable, it does not necessarily reach the local database after eye checkups at all. Even though both the professional standard and all interviewed optics businesses have a requirement for that [5].

Figure 12 compares the results of the databases and procedures with the results of the survey for optometrists. Boxes marked in yellow indicate information that may be difficult to obtain from local databases or a procedure that may not necessarily be performed by the optometrist. Boxes highlighted in pink indicate data fields that may not be available from the local database because the input of these fields is low / non–existent according to the survey answers. Also, procedures that are pink indicate low / non–existent information. Figure 12 is also included in a larger format in the Appendix 5, page 80.

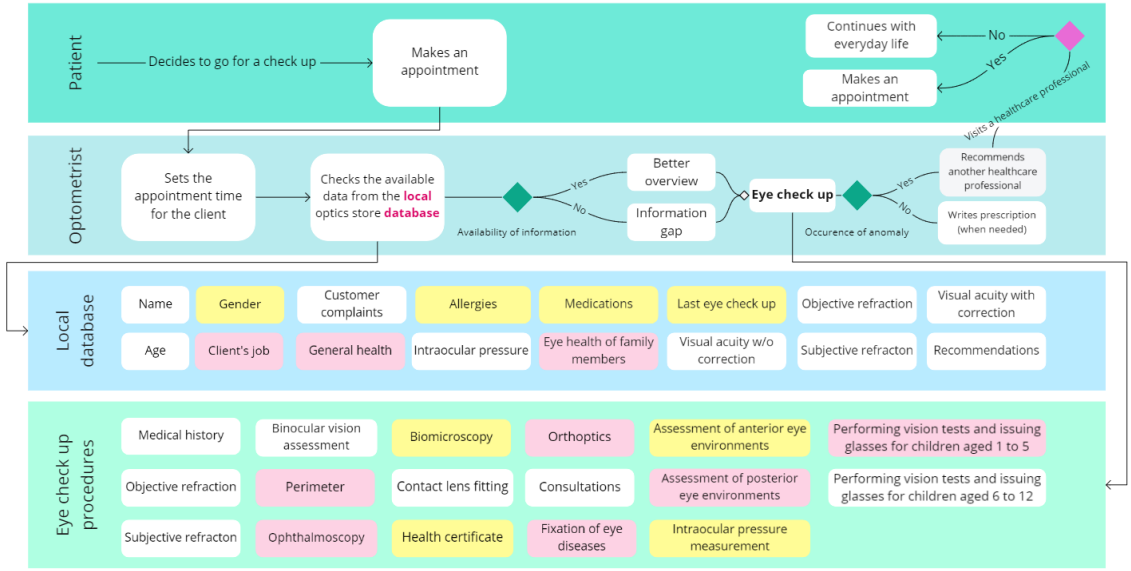

Figure 12. AS–IS scheme. Current information exchange and input by optometrists.

Usually, the customer calls or books an appointment online for a vision check. Access to the optometrist is fast and there is generally no waiting time in spectacle shops. Upon appointment, a query is made from the local optics store database for client's data to see if there is any previous data. The data is created there by optometrists from the same company in a format built according to the store's software system. It is not possible for the optometrist to see the data entered outside the company. If the client's information is only on paper, there will be difficulties in accessing the information already within the

company. As this is a local database, any information received during eye examinations will not be passed on to potential stakeholders such as a GP, ophthalmologist, ETA, or the Labor Inspectorate.

From the answers of the optometrists, it emerged that not all data is recorded to the databases and not all procedures are performed on clients. The lack of performing some procedures and the recording of them make it more difficult to find a way to forward the relevant data to different stakeholders.

Several aspects play a role here:

- Lack of data regulation – optics stores do not have a fully fixed database, also what they expect their employees to enter the local database. According to the professional standard, there is a requirement to record the results, but this has not been communicated in detail [5]. In the same way, the information obtained during the eye checkup is stored, either on paper or entered as a free text to the local program. At the same time, interviews with representatives of the optics business and optometrists revealed that even if this data is not filled in, there would currently be no repercussions or issues caused. The lack of regulation creates a feeling of comfort, which in fact leads to the loss of information obtained during the eye checkup [1].

- Database clumsiness – According to the interviews, most of the cells in the optical shops are in free text or with incorrect inputs. The results of the interviews with optometrists and optics company representatives revealed that four out of three companies did not were using a program which was originally created for optics store. Querying and entering data is cumbersome and therefore the fields are left blank. People have different computer skills, so databases should be as user friendly as possible.

- Forgotten information – the initial data collection takes place on paper in several optical stores, which is why the transfer of data is forgotten or it is no longer considered important to do double work here. This was also confirmed by 51 (52.58%) optometrists who responded to the survey that information is stored on paper at their workplace.

- Lack of appliances – Feedback from the optics stores revealed that not all optics businesses are able to offer optometrists a separate computer for eye examinations to enter and view client's health related information. Also, not all stores (three out of seven) have a tonometer so all optometrists cannot measure IOP.

- Lack of training at school – during the interviews optometrists and ophthalmologist stated that the training of eye diseases should be much more thorough and with a longer practice to gain better confidence in the future. Due to a lack of confidence, the optometrist does not always dare to take responsibility for a more thorough examination of eye diseases at all or to take the next steps if a problem occurs. Although the optometrist does not treat the eye in Estonia, they should be competent enough to recognize the disease and examine it with their existing equipment [5], [3].

- Optics businesses do not see a problem – Although six out of seven companies admitted that they had never analyzed the data entered by the optometrist, they were nevertheless satisfied with the company's data exchange. This is probably as the exchange of data refers to the information needed to order spectacles or contact lenses and there are no significant obstacles in this area. Dissatisfaction was expressed by only one representative of a company and, in addition, by one of the optometrists during the interview with them. As the employer of the interviewed optometrist was later interviewed, it turned out that from the owner's point of view, the data exchange is fine and effective. The fact that both do not need the same data for their daily work certainly plays a role here, but here perhaps the owners of the company should pay more attention to the daily need of optometrists working for them.

The shortcomings pointed out by the optometrists themselves were the lack of data of the latest eye examinations and the difficulties in accessing information on eye diseases and general health. One solution would be to give optometrists access to the EHIS and make the filling in of data fields there mandatory to reduce information block. This allows the

client's data to be placed in a common database, to which all optometrists across Estonia would have access, regardless of which optical store the customer decides to go to.

Even in countries with developed information systems, Health Information Systems do not contain enough data on eye conditions and visual disturbances, which can lead to a lack of decision-making to make sufficiently evidence-based policy decisions. Hence the big gap that is known to policyholders, health professionals and what would actually be needed to improve public health. Moreover, eye health is strongly challenged by spectacle shops in the private sector, where parallel databases do not work together with public sector databases [1].

Since optometrists can store data in many ways in the same optics business and there is no specific overview or control over it, storing optometrist data is not fully understood at present. At this point, it would be worth taking a certain number of optometrists from within the same optics store and from other optics businesses as a focus group to better map the current situation in Estonia. Nevertheless, it cannot be denied that there is no unification in the data exchange and that this needs to be addressed before the data collected by optometrists can be transferred to larger databases.

7.2 TO–BE

Regardless of the patient's location, their health information should be available as needed to provide the person with the best solutions. It is the responsibility of the healthcare professional to ensure that the information is not lost.

The second research question for the thesis was based on the analyzed literature sources, interviews as well as surveys, which found potential areas for development that optometrists could use in their work. The surveys examined the views of optometrists themselves. Also, according to the legislation, GP, ophthalmologist, ETA, Labor Inspectorate and TEHIK were interviewed to see their work experience and views on the need for optometrist data in their work and the overall usefulness in healthcare [19]. To enable the wide dissemination of data, it is necessary to start with the data harmonization within optical shops [18].

57 (58.76%) of optometrists do not want to perform additional procedures and 40 (41.24%) would like to. More than half (58.76%) of the optometrists who responded to

the survey do not want additional tasks in their daily work. However, most surveyed optometrists (74.22%) would like to see the data and 70.10% would like to enter the information to the EHIS. Although the difference between the two percentages is not large (4.12%), interviews with both ophthalmologist and optometrists revealed that the entry of data to the EHIS is an additional task to undertake which involves and increases responsibility.

The optometrists in the interview admitted that they are insecure recognizing eye conditions/diseases. There may be similar feelings among the 4.12% of respondents. As in the interview, the ophthalmologist suggested a more in–depth training at university or additional training for optometrists who had already graduated from higher education. Through practice, they would increase their confidence and courage in taking responsibility. There can always be optometrists who never want to take on this responsibility. As a solution, different levels of specialization can be formed based on the skills and knowledge of an optometrist, which would be expressed in terms of tasks, responsibilities, and remuneration.

For better information flow the first step should be to store internally regulated data so that it can be transferred to a single database. As the GP said during the interview – standardized information collection helps to ensure that regardless of the store the person goes to, they will receive an equivalent service.

Figure 13 and Figure 14 provide an overview of the potential for better data flow between different stakeholders.

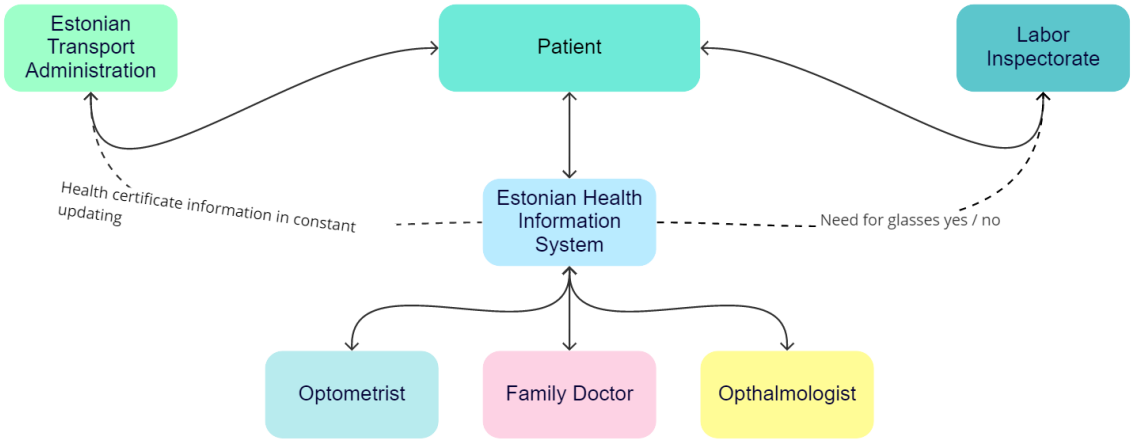

Figure 13. Potential information exchange between different stakeholders.

After interviews with GP, ophthalmologist, the Labor Inspectorate, and the ETA, it was confirmed that there is interest for optometrist's data and any cooperation with each other would improve the flow of information and enable better decision–making. Regardless of the institution, all interviewees felt that co–operation should take place and that the data entered by the optometrist would be useful to them. Similarly, a survey of optometrists showed that information related to both general health and eye health is beneficial for them in their daily work and would make the decision–making process easier. The central point of all data could be the EHIS shown in Figure 13.

The information gathered during the visits to all health care professionals would be transferred to the EHIS. For example, in the event of a serious medical condition that requires time for a person to recover the healthcare provider can make an entry in the EHIS and the health certificate would be suspended automatically, either temporarily or permanently, on the instructions of the treating doctor (who is not always necessarily a GP).

As both the ETA and the GP stated during the interview that there is a lot of misunderstandings about the suspension of the health certificate and obstacles in the legislation. Extending the health certificate and suspending it for shorter periods is one of the potential ways to avoid long periods of uncertainty. Overall GPs would like to have a better overview of the eyes for the health certificate and the treatment/surgery epicrises by the ophthalmologists. The Labor Inspectorate would like to receive information on the need for glasses to better advise employers and employees daily.

Figure 14 is a diagram of a potential flow of information between an optometrist, a GP, and an ophthalmologist. All of them would be connected by information requests to the EHIS, to which all parties would have access. Before the start of the eye examination, optometrist could make a request to the client's data from the EHIS and later it would be possible to enter the data that was created during the checkup. The data would be standardized and compatible with the already existing data in the EHIS. In addition, the perimeter and IOP would be also added as fixed fields. An interview with an ophthalmologist as well as a GP confirmed the desire as well as the need for IOP and to also provide an opportunity to screen people's eye health before potential problems arise [1]. Figure 14 is available in a larger format in the Appendix 6, page 81.

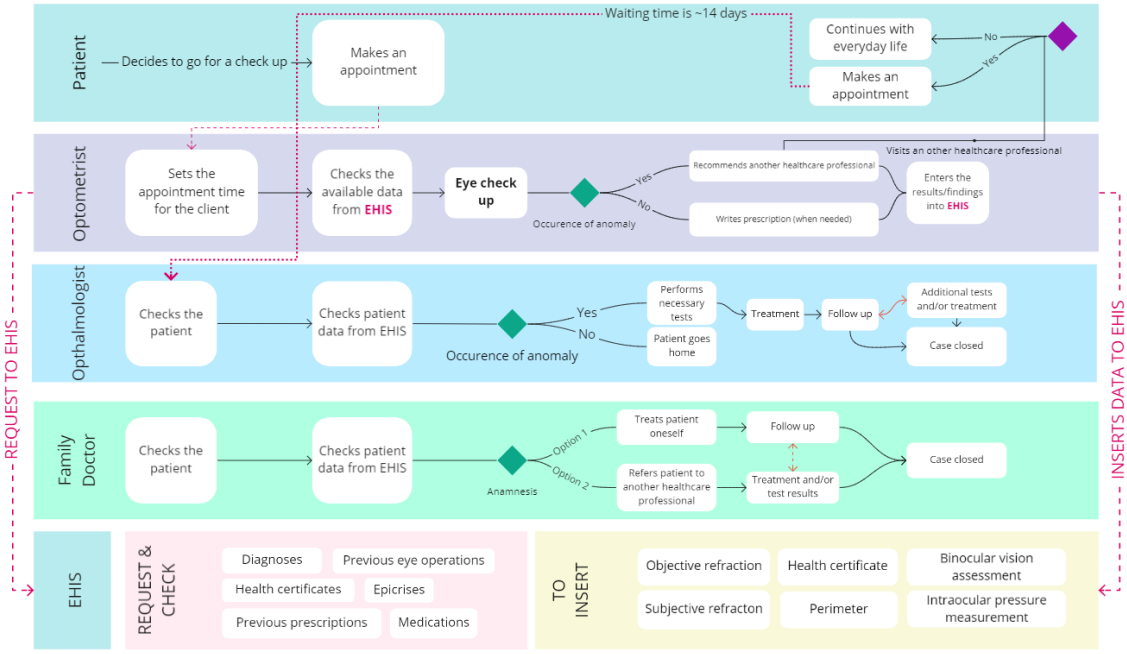

Figure 14. TO–BE scheme. Information exchange between optometrist, GP, and ophthalmologist through the EHIS.

Second thesis research question was to find out the potential developmental points of optometrists in their daily work. Here are some suggestions to realize them:

- Regulating the exchange of information in optics stores to prevent internal loss of information.
- When storing customer health data, permission is requested in a documented form or at least discussed orally.

- Adding optometrists to the Health Care Providers and place them in the Health Care Professionals Register of the Health Board [8].

- Giving optometrists working outside the hospital and clinic access to the EHIS [4].

These points are confirmed by the optometrists' own proposals for development, as well as by interviews with potential stakeholders, where all parties are interested in closer cooperation and data sharing. As all parties have an interest and a willingness to cooperate, data should not be retained in local databases.

7.2.1 Technical barriers

The analysis, from the data entered by the optometrist as well as from the data in the EHIS, showed that there is a need for more fixed data fields on top of the current eye/vision related ones – visual acuity, both corrected and uncorrected, and binocular vision [50]. The EHIS has simplified the lives of healthcare professionals and patients for years. They both have the possibility to query different data. Figure 15 below provides a more detailed overview [10], [12].

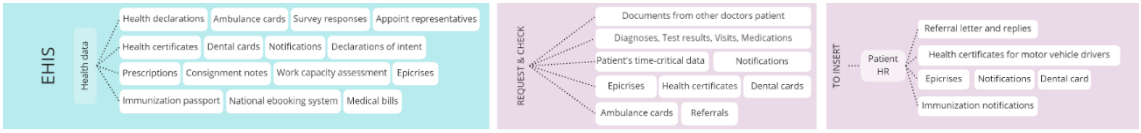

Figure 15. EHIS query options. Blue (left): patient. Purple (right): Healthcare professional.

At present, optometrists are not on the Health Care Professionals Register of the Health Board and do not have access to the EHIS. The exceptions are optometrists who work in a hospital and have access to a patient's electronic data through an ophthalmologist [4]. Optometrists collect a wide variety of data in the course of their work, with the potential to find application in different fields. Increased data transmission would improve data quality and potentially decision–making.

Although not all optics business stores have a tonometer and a second computer for optometrists yet, the current results show that, based on the equipment, compatibility with the EHIS is feasible. Rather, the problem is with the databases used in the various stores. They are not standardized, and companies have introduced a program which was originally designed for a different purpose but was easy to implement. Therefore, most of

the optometrist's text that is saved on a computer is free text and unformatted. Implementing these changes will require standardization of databases and financial outlay for the optics business.

Conducting periodic audits in the optics business would help maintain a consistent level in all optics businesses. The goal is not to be put pressure on optometrists, but to find the maximum application to the data they collect anyway in their work that will allow patients the best treatment in the future.

7.3 Limitations

Even though the thesis goal was achieved, there are some limitations to this study. First, the choice of literary sources. The responsibilities and rights of an optometrist vary from country to country, which made it difficult to find information sources like the procedures done by an Estonian optometrist. Most of the research described the work of an optometrist in the form that is performed in Estonia by an ophthalmologist.

Second, the surveys were not based on previous ones, as there are no similar studies that would have used such surveys. To get the most accurate answers possible for the survey, the author based the questions on her own experience and literature review. In addition, the response rate did not meet the target set in both the optometrist survey and the interviews with the optics business.

The focus was primarily on mapping the current situation among optometrists. Repeating this study could give somewhat different results. There was no strict criterion for how a party is selected. The anonymity and demographic deficit of optometrists increase the unreliability of the results. Anonymity did not allow for the analysis of data exchange or storage, both internally and in comparison, with other optics businesses. As it has already become clear from the interviews that everyone has a different understanding of recording data gathered form eye examinations, this is likely to reduce the reliability of the data in the survey conducted for optometrists. There are also no optics businesses in the survey, which own only 1 store in Estonia, which is why it is not possible to assess technical condition or data satisfaction of small businesses.

7.4 Suggestions, further studies, and developments

Thesis methodology can be used for future research, as the need for optometrists in society is growing. An aging society and the increased use of technology call for better vision care than ever before. It is recommended to conduct a more thorough and comprehensive study on this topic. Potentially involve funding from the EHIF or the Ministry of Social Affairs to monitor the study.

The study should focus on technological terminology to ensure the accuracy of the data. Since everyone has different exposure to technology and knowledge, for a better overview of how optometrists store data, it would be advisable to conduct more interviews for the study to have better understanding how the information is being entered. Different aspects could be measured for the best result: internal information entry in different optics businesses, time spent storing information, cost of updating databases, and inclusion of more businesses in the survey. In addition, the views of ophthalmologists could be further explored, and their data flow mapped, as they use different information systems.

8 Summary

Optometrists are healthcare professionals who collect much more data than might seem at first glance. The analyzes and interviews conducted in this work showed that the optometrist's data could be used both in their own work and in other areas, so that it would be possible to find a solution for the patient more quickly and provide a higher quality health care service. Especially where a person's eyesight is potentially in danger and in fact something could have been done there. For example, measuring intraocular pressure, which plays an essential role in preventing human vision loss. Based on the findings of the research, the following conclusions can be drawn:

- Optometrists meet the requirements of the fields related to eyes and vision in the EHIS. In addition to the information available in the EHIS, optometrists could also record intraocular pressure to screen for eye diseases/conditions among their clients that could potentially lead to blindness.

- In the optics business, a common database still must go through several stages, but almost all companies have the technological readiness with some shortcomings.

- The organization of databases in the optics business takes the most work, and this field would need a uniform standard, which does not currently exist. The professional standard for optometrists is not detailed enough for harmonious data exchange.

- The fulfillment of the previous points could be implemented in the future by the agreement of additional SNOMED–CT/ICD–10 codes and the introduction of additional equipment.

The inclusion of optometrist data in healthcare systems should be as important as the entry of any other doctor. With further research in the future, it will be possible to find the best solutions for patients that are easily accessible, securely managed, easy to use for all parties and inexpensive.

Acknowledgement

Throughout the writing process, I have received a lot of support and encouragement.

First of all, I would like to sincerely thank my supervisor, Janek Metsallik, your input to continue on this topic and your patience with me has been invaluable and a great help in creating this thesis. Your excellent knowledge and inspiring feedback guided my way of thinking and kept inspiring me to keep going onwards.

I would like to thank all the people who contributed to the survey and those who discussed it with me in interviews and correspondence.

I would also like to thank my schoolmates, with whose common help we encouraged time and time again to keep going and not give up.

Finally, I would like to thank my family and friends, who have always supported me when I needed it. I could not have done it without your support.

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Appendix 1 – List of search words

- Age–related macular degeneration (+ optometrist)
- Blue Book 2020
- Cataract (+ optometrist) (+Estonia)
- Chalazion (+ optometrist) (+Estonia)
- Data harmonization
- Data protection
- Disorders of sclera (+ optometrist) (+Estonia)
- Dry eye syndrome (+ optometrist) (+Estonia)
- Estonian Health Information System
- Estonian Health Insurance Fund
- Estonian Society of Optometrists (*Eesti Optometristide Selts*)
- Estonian Transport Administration (*Transpordiamet*)
- European Council of Optometry and Optics
- Eye conditions (+ optometrist)
- Eye diseases (+ optometrist)
- Glaucoma (+ optometrist) (+Estonia)
- General Practitioner (+ optometrist)
- Health and Welfare Information Systems Centre (TEHIK)
- Health Board's Register of Health Care Workers
- Hospital services

- ICD–10
- Ministry of Social Affairs
- National Institute for Health Development
- Occupational health (+ optometrist)
- Ophthalmologist (+ optometrist)
- Optometrist
- Physician Portal (*Arstiportaal*)
- Professional standard (*Kutsestandard*)
- Public health research (+ optometrist)
- Riigi Teataja
- SNOMED–CT
- Visual disturbances (+ optometrist) (+Estonia)
- Waiting list for (eye) doctor in Estonia
- World Health Organization (WHO)

Appendix 2 – Survey for optometrists

1. Do you work as an optometrist on a daily basis?

    - Yes
    - No, never practiced
    - I used to work, but not anymore

2. Do you ask the customer for permission to store data before starting the vision test?

    - Yes, always
    - Sometimes
    - No, never

3. Do you have access to the Health Information System (HIS) at work to view customer personal data, including various kinds of customer's personal information?

    - Yes
    - No

4. What information do you write down during the vision test? (Please tick)

    - Name
    - Age / date of birth
    - Gender
    - Client's job / position
    - Customer complaints (Why did he/she contact you?)
    - General health
    - Allergies
    - Intraocular pressure
    - Medications

- Eye health of family members
- Last eye examination time
- Visual acuity without correction
- Objective refraction
- Subjective refraction
- Visual acuity with correction
- Recommendations

5. Where is the data obtained during the vision test at your workplace stored? (Please select all appropriate options based on your workplace.)

    - Paper form with fields
    - Free–form notebook
    - Form with specific fields on the computer
    - Documented on a computer without a fixed format
    - Other (please specify)

6. If you selected "other" in the previous question, please specify:

7. Please indicate the activities you will perform during the eye examination evaluating as follows:

    1 – No, never
    2 – Sometimes
    3 – Yes, every time

    - Medical history
    - Objective refraction
    - Subjective refraction
    - Binocular vision assessment
    - Intraocular pressure measurement
    - Biomicroscopy
    - Assessment of anterior eye environments
    - Assessment of posterior ocular environments
    - Contact lens fitting
    - Fixation of eye diseases
    - Writing a prescription for glasses
    - Health certificate

- Customer consulting
- Orthoptics
- Ophthalmoscopy
- Perimeter
- Performing vision tests and issuing glasses for children aged 1 to 5
- Performing vision tests and issuing glasses for children aged 6 to 12

8. Have you experienced a lack of access to customer data in your work?

    - Yes
    - No

9. What kind of data deficiency produces most problems in your work?

10. Do you feel that you would like to do additional procedures in your work, but cannot?

    - Yes
    - No

11. If you answered "Yes" to the previous question, can you name the procedures you would like to perform?

12. Select from the list the procedures you would like to include in your daily work, but have not yet done / cannot do so:

    - See customer data in the Patient Portal
    - Make entries in the HIS
    - Referral to an ophthalmologist with a referral
    - Closer cooperation with other health professionals
    - Tele–Optometry – remote consultations with clients
    - Dry eye examinations
    - Nutrition counseling (based on eye health)
    - Vision therapy
    - Training / counseling of clients for educational purposes
    - I do not feel lack of any additional obligations

13. Comments

Appendix 3 – Survey for optics business owners

1. How is the data obtained from the vision test stored?
    - Is the computer program used to gather information from eye examinations in your company? What is the name of the program?

2. Are the working methods / knowledge of optometrists checked on an ongoing basis during the work (e.g., test / interview)?

3. What equipment do you have in stores:
    - Autorefractometer / keratometer
    - Tonometer
    - ID card reader
    - ID card software
    - Internet connection
    - At least 1 computer per store

4. Is there a tonometer in each optician's shop?

5. Is there a separate cell in the computer database for storing intraocular pressure?

6. Does the optometrist have a separate computer in their office to enter and view client’s data?

7. Is there a requirement in your company to digitally store the results of the vision test for later use?
    - Is the data accessible throughout the company or only on the local computer where the information was stored?

8. Do you have any requirements for filling out the program that the optometrist must enter when filling in the customer data (cannot be left blank, etc.)?

9. Do your company's employees ask the client for permission to save their health information or vision test results?

10. How do you record the customer's permission to process and store data?

11. How do you assess the data quality of your company?

    - Have you ever analyzed it?

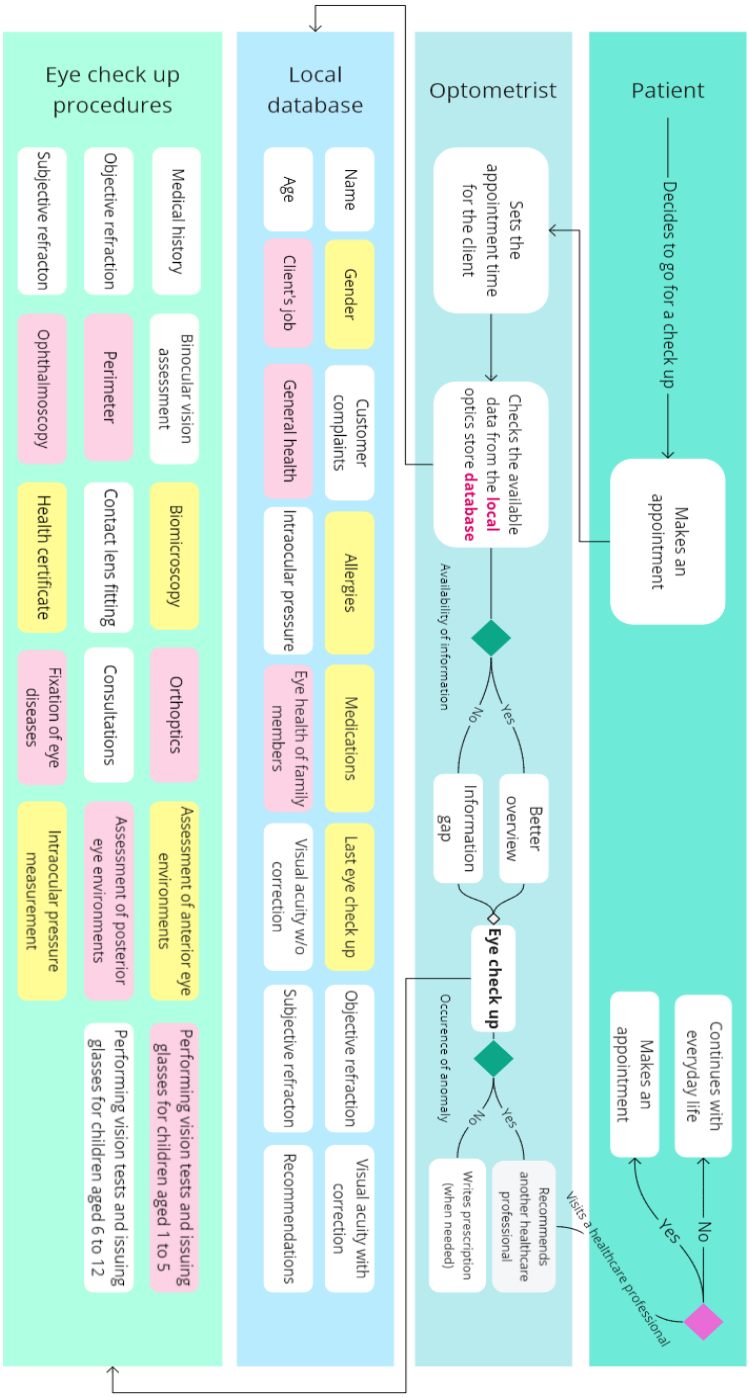
12. Do you have or have you considered cooperating with other stakeholders?

13. Are you satisfied with the information flow in the company?

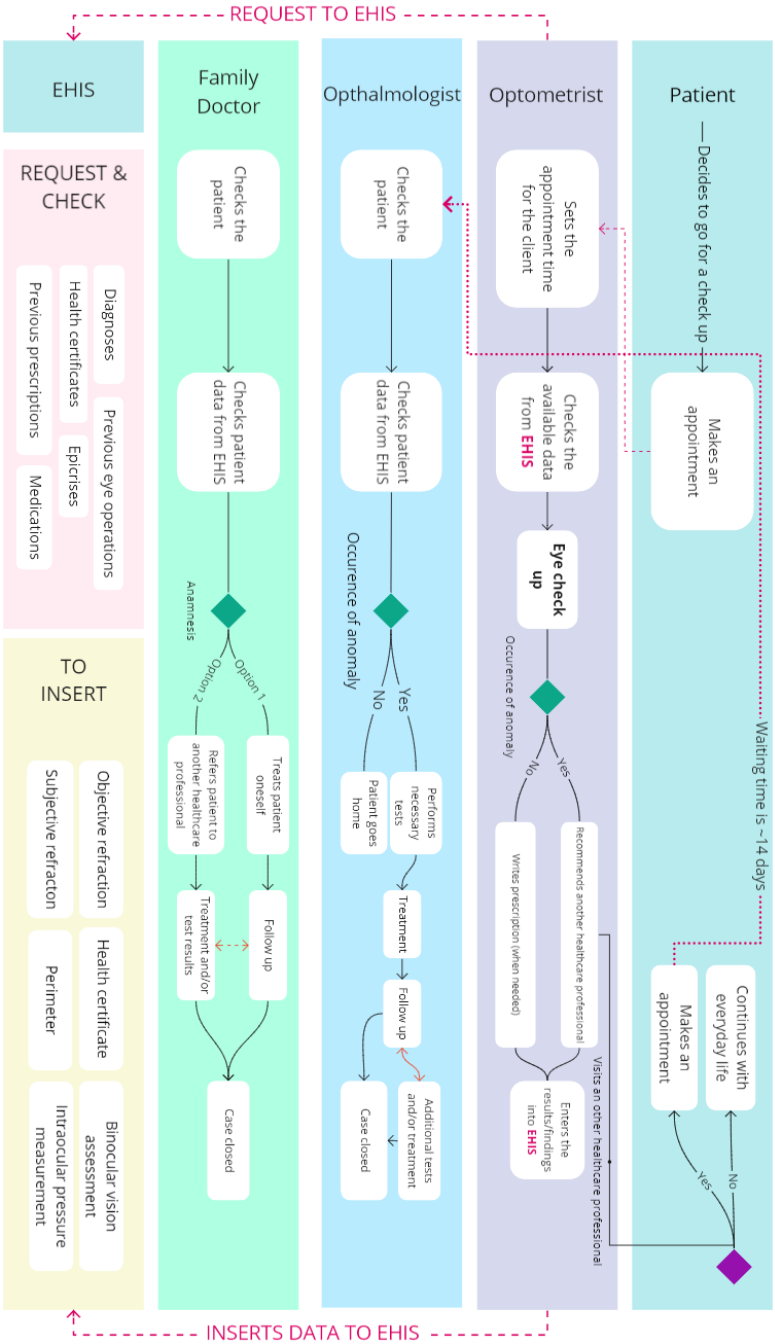
Appendix 4 – Focus group interview

1. Are you satisfied with the current exchange of information in your workplace?
2. Have you ever encountered situations where, due to a lack of information, it is difficult to work or requires more time than usual?
3. Have you had situations where access to client / patient data from previous optometrist visits is incomplete / nonexistent but necessary?
4. Would the information entered in the optometrist's vision tests into the common information system make your job easier?
5. Own suggestions / recommendations / ideas

Appendix 5 – AS IS



Appendix 6 – TO BE



Appendix 7 – Eye / vision findings in the EHIS