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Digitalization as an Engine for Change? Building a Vision Pathway towards a Sustainable Health Care System by Using the MLP and Health Economic Decision Modelling

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Abstract: Grand social challenges, such as type 2 diabetes (T2D), are increasing, which creates sustainability problems for health care service systems. To reduce socio-economic burdens, changes are required in the socio-technical system. However, there is an uncertainty of the most cost-effective policy action that can create sustainability while providing health benefits. To find potential solutions to these challenges, the multi-level perspective (MLP) and health economic decision modelling was used to study socio-technical change and project potential health economic consequences of different scenarios. The study focuses on creating a vision pathway for reducing T2D in Finland. In total, 23 interviews were carried out and the results were analyzed utilizing the MLP model. As a result, five themes towards prevention of T2D were identified. Digitalization was found to be a cross-cutting theme for preventing T2D and was thus taken as the object of study and the main focus of this paper. As a result, this paper reports on the opportunities and barriers for using digital tools in a transition towards T2D prevention. A health economic decision modelling revealed that the highest expected savings could be obtained by prioritizing prevention programs based on T2D risk. Finally, the model was converted into a web-based online tool by combining vision pathway, transition-focused storylines and forward-looking health economic scenario analysis to give the policy makers an overall picture of the needed societal changes and support the impact assessment of alternative policies in a case of T2D prevention in Finland.

Keywords: multi-level perspective; transition studies; health economic decision modelling; vision pathway; transition pathway; health promotion; type 2 diabetes

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1. Introduction

In Europe, chronic diseases cause an estimated 86% of deaths and 77% of illnesses [1]. Type 2 diabetes (T2D) is a chronic disease with wide social and economic impact. Around 143 billion euros are spent on diabetes treatment and its complications each year in Europe, and this figure only includes direct costs of the disease (i.e., productivity losses due to morbidity and mortality caused by T2D are not included in this figure [2]). In Finland, more than 300,000 people were diagnosed with diabetes in 2016, and currently the estimated annual direct costs of T2D are around 1.5 billion euros [3]. Assuming that the same trend in the annual number of new people with diabetes diagnosis continues, there will be more than half a million Finnish people with diabetes by the year 2030. The incidence of T2D is strongly associated with the ageing of populations, lifestyle factors, and socioeconomic status. Preventative actions such as healthy lifestyles have proven to be effective in reducing T2D [4,5]. However, embedding these actions in health care organizations has been difficult, even though prevention has been shown to be the more desirable option from a health care payer and a societal perspective (i.e., less costly and more effective) [6–8].

The growing number of T2D creates pressure for the sustainability of the health care system and a need for a change. Sustainability can be defined as " . . . development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [9]. Jameton and McGuire [10] define sustainability in health care through three key balancing factors: the needs of patients, economic concerns and environmental costs. Fineberg [11], in his definition, emphasizes affordability for patients, employers and government, and acceptability and adaptability of the health system. Sustainability in the health care sector can be tied to the UN sustainable development goal of "ensuring healthy lives and promoting wellbeing for all at all ages" [12], which cannot be achieved without finding new ways to reduce the socio-economic burden of chronic diseases to health care services. Setting a goal on good health and wellbeing for all requires a systemic understanding of health care systems and supporting policy makers to develop such perspective to help with complex decision making.

Digitalization refers to the use of digital technologies in the context of production and delivery of a product or a service that allows organizing, producing or delivery of health care services in a new way [13] and has created promising opportunities for change in the system. Virtanen and Stenvall [14] argue that digitalization of our society has had a significant impact on health care and the health care system. It affects ways of working, processes, resource allocations, policies, and the way health is understood, experienced and measured. They [14] also point out that different sensing devices, mobile apps and web services enable citizens to play a more active role in maintaining their health. For lifestyle-related diseases, collecting information about individuals' daily activities could motivate them to change their behavior. For example, Tatara et al. [15] notes that mobile communication device interventions to support diabetes management have been effective. New apps and services based on personal data have the potential to prevent and help manage diseases [15]. Digitalization was chosen as the main focus of this study due to the fact that the qualitative analysis found it to be a cross-cutting element for the various ways of reducing T2D.

As stated above, there are possibilities to promote change, but there are also structural barriers. There is a need for a transition towards a society that promotes preventative action in health care and not only treats diseases when they occur. Supporting a transition towards more sustainable health systems necessitates new methods for understanding potential actions and their impacts. For this purpose, this article draws on transition research methods to conceive of the changes required for digital technologies to be developed and adopted for purposes of sustainable T2D prevention in health care systems. Facilitating the change, this article also aims to develop and apply a health economic modelling tool to support decision making in this transition.

Transition studies and the multi-level perspective (MLP) form the theoretical bases of the study. The MLP introduced a transition pathway typology in 2007 [16], and it has been used to characterize the overall course of development of innovation and frame the analysis of occurred transitions. In recent years, there have been demands that transition studies should initiate and catalyze transitions and not focus only on describing them [17]. Köhler et al. [17] have noted that transition scholars should focus on system innovation in-the-making and develop forward-looking analysis and policy-relevant scenarios and toolboxes. However, the complexity of the transition challenges anticipating ex ante impacts of the changes and the research in transition studies has thus avoided formal modelling and quantification [18]. Policy makers tend to favor quantitative elements [19] and bridging quantitative and qualitative elements to forecast future impacts has become an important research stream in transition studies even though there are identified challenges of using the methods [17,18].

This article is produced in a Finnish Strategic Research Council project StopDiabetes—Knowledge based solutions 2016–2019. The aim of the project has been to empower individuals with increased risk for type 2 diabetes in adopting and maintaining healthy lifestyle, and to achieve this by combining individual level intervention with changes

in living environment to support healthy behaviors, and by identifying societal barriers and facilitators for the implementation. Additionally, the project answers, how a healthy lifestyle can be supported by individual level solutions utilizing digitalization and by altering living environments to make healthy choices preferred and easier. The active cooperation with the public sector and the key actors of civic society will ensure direct integration of developed solutions into Finnish society.

The study aims at creating a vision pathway towards prevention of T2D in Finland and to develop transition-focused storylines and forward-looking scenarios to demonstrate the needed changes and the expected national savings potential of T2D prevention in Finland. It thus answers to the identified research needs in transition studies (e.g., initiating and catalyzing transition and developing forward-looking analysis and policy-relevant scenarios).

Based on the previous studies [13–15], this study assumes that digitization and the use of digital tools can have positive effects on the system change. However, it should be noted that the change towards prevention of T2D is systemic, meaning that there should be changes in different levels of the society, e.g., in organizations, practices, services and in technologies. Due to the systemic nature of change, this study presents a vision pathway for prevention of T2D where the needed changes in different levels are identified. However, while conducting the study, it became evident that due to the methodological differences between transition studies and health economic decision modelling, it was necessary to focus on a more detailed theme than the entire transition. The interviews guided the research to focus on the theme of digitalization, as it was present in every identified theme and was situated as a cross-cutting theme. Moreover, digitalization can also be seen to intertwine to the changes required in socio-technical change. Digitalization or the use of digital tools is not understood in this study as a way of solving the problems by itself, but as a part of the possible solution.

The basis of the vision pathway is Geel's [20] MLP model, which pictures the current system that consists of landscape, regime and niches where the aim is to understand the dynamics of systemic change in socio-technical systems. The study presents Finland's current system (with the focus on prevention of T2D) in the MLP model and develops a vision pathway where the identified needed change-themes are placed in the MLP model's different levels. The study calls the created pathway a vision pathway instead of a transition pathway that is most commonly used in transition literature, because it is focused on forward-looking analyses instead of analyzing past transitions. Through transition pathway literature, it analyzes the current state of the transition in the Finnish health care system towards a more preventative system. For the development of the vision pathway, interviews of a variety of actors that operate inside or close to the health care system were carried out. The results from the interviews are placed in the MLP to form transition-focused storyline that identifies the barriers and facilitators of change.

In addition to the vision pathway and transition-focused storyline, a health economic decision model was created to answer to the needs identified in the transition literature (e.g., catalyzing transitions). The previous studies [17,18] have suggested to use quantitative modelling in incremental innovations with sufficient historical data on impacts of changes in a sufficiently stable system. The challenge of modelling a complex transition was also noted in this study through the lack of data required in the development of a very complex health economic decision model. For these reasons, and the findings from the interviews highlighting the importance of estimating impacts of prevention, one theme was selected from the vision pathway to develop a health economic decision model. The theme was a cross-cutting theme of digitalization. The study presents three health economic scenarios of expected economic outcomes of a digitally supported prevention program in different risk-based target subpopulations.

In order to promote developments and findings among different stakeholders in the society, a web-based online tool with interactive quantitative modelling and qualitative vision pathway was developed. Reports produced by the online tool include the user-defined projections of expected economic impacts of preventive measures in a selected

target population, as well as the vision pathway and transition-focused storylines towards the change to reach those expected economic impacts and promote transition towards prevention. Integrated quantitative modelling and qualitative narratives aim to support policy makers to understand the expected impacts of preventing T2D in their target populations, as well as the idea of needed changes in the system.

The paper is structured as follows: In the second section, the theoretical background of our study is presented. The third section describes the context of the empirical study and the methods for data collection and analysis. In the fourth section, the results are presented, followed by conclusions in the last section.

2. Multi-Level Perspective and Health Economic Decision Modelling as a Theoretical Framing of Digital Socio-Technical Change

2.1. Digital Technologies Create Promises in Changing the Health Care System towards Prevention

Digitalization has had an impact on health care since the mid-20th century, and digital disruption has become a phenomenon of the 21st century [21]. The European Union report of EXPH [13] defines digitalization in health care as "the use of digital technologies in the context of the production and delivery of a product or service". Such digital technologies allow health care services to be organized, produced and delivered in new ways. Authors of the report note that digitalization affects many aspects of health care systems in terms of structure, culture, professions, treatments and outcomes. They also acknowledge that this is in some occasions referred to as "digital transformation", which indicates that health care services and systems are in a transition in which more health services and processes will be digitalized. Innovations change health care processes and impacts health care systems in a way that can be described as fundamental.

In their study of digital transformation in healthcare, Kraus et al. [21] note that research in this area has focused on operational efficiency by healthcare providers, patient-centered approaches, organizational factors and managerial implications, workforce practices and socio-economic aspects. Although many changes have taken place in the health care sector, digitalization can be expected to have even more profound changes in health promotion, prevention, primary care, specialized care, long term care, social care, and self-care in the future [13]. The EXPH report [13] highlights the importance of evaluating the impacts of digitalization to health care systems, and whether digital health services contribute to health system goals in an optimal way. Nonetheless, the report note that specific forecasting is difficult, certainly when it comes to the expected costs and benefits of new technologies.

Digitalization can also change the way preventative actions and health promotion is implemented. Lupton [22] highlights the change that has happened through mobile digital devices and applications that offers new ways of monitoring, measuring and visualizing health. In her study, she notes that there are different terms used for using digitalization in health care. She notes that digitized health promotion is a subset of digital health technologies and it includes digital devices, tools and platforms. Previous research has shown that citizens have better motivation to take care of their health if they have better control over their personal data [23]. Mäkinen [24] has argued that better control can also be seen as a way to empower citizens. These research results have created promises for a more efficient and sustainable health care system. However, the discussion of digital health promotion technologies is dominated by technical solutions and rarely focuses on the issues of social, cultural, political or ethical dimensions [22].

Producing new digital services has faced challenges, and the new system has not yet emerged [25]. For example, elderly citizens often have low computer skills, which makes it difficult to function well in an era where technology is increasingly being used in health care [26]. Citizens also have fears of privacy, especially when the information gathered is sensitive [27]. In digital applications, users voluntarily expose their personal data, which is then simplified to easily understandable modes such as graphs and charts. This intimate and long-term data is interesting to companies, health agencies and governments [28]. Lupton [29] notes that users judge the information stored in their apps to be private, and

had during the publication of the research in 2014 only recently started to realize that the developers use this information for their own purposes.

Another problem is that even though modern technology offers new solutions for managing daily activities, only a few health-promoting applications have reached widespread use [30]. In addition, changing behavior is very complex even when the applications are taken into a use. However, Kaipainen [30] adds that applications can contribute to improved well-being and support behavioral changes as long as they are simple, attractive and easy to integrate into everyday life. Harjumaa et al. [31] studied the use of an internet-based lifestyle intervention for people at risk for type 2 diabetes, which was designed to support formation of healthy habits and to explore its user engagement during the first 6 months of a randomized controlled trial (RCT). Their study showed that this type of intervention can be delivered to large groups of middle-aged and older adults, many with limited experience in digital app use, without additional user training. Their study also showed relatively good engagement of users, but did not report if the weekly engagement was enough to change the lifestyles of the participants.

2.2. Finnish Health Care System and Multi-Level Perspective (MLP) Explaining the Socio-Technical Change

The creation of the vision pathway and health economic decision model is created in the context of the Finnish welfare state and public health policies. In Finland, the public sector actors play an essential role in defining the dynamics of health care and welfare services [32]. The health care system in Finland is largely based on public sector services that are financed through tax revenues. Municipalities are responsible for maintaining the health care services, and the services supporting healthy lifestyle. Any individual living or working in Finland pays a tax-based social insurance that ensures the right to use public health services and occupational health care [33]. Even though there is a secured access to health care service, lifestyle-related non-communicable diseases are increasing in Finland. This is unfortunate since scientific evidence shows that lifestyle interventions are effective in the prevention non-communicable diseases, such as T2D [5,34,35]. This can to a large extent be explained by difficulties in creating efficient incentives to integrate evidence-based intervention models into the health care system.

To understand the realities of transforming a system, a multi-level perspective (MLP) is used as a theoretical starting point. MLP has been developed and presented in socio-technical change-related literature [20,36–39] to explain the dynamics of transformation and transition in different systems. The perspective emphasizes the interactions between actors, resources, technologies, practices, and rules as origins of change and stability and provide an understanding of the dynamics of systemic change and system innovation.

MLP stresses that systems change through the interplay between landscape, regime and niche-level processes [37,39]. Socio-technical landscape refers to relatively stable, slowly changing factors such as cultural and normative values, long-term economic developments and societal trends. Changes in the landscape create pressure for change in the system. The socio-technical regime refers to established practices in the existing socio-technical system. It includes institutions, infrastructure, regulation as well as organizational and social networks that structure and organize a particular societal function such as health care. Regimes tend to generate incremental innovations, while radically new innovations are generated in niches. Radical new innovations need protection because their cost efficiencies, technical performance and usability often need improving. Niches provide locations for experiments and learning processes, and space to build social networks, which support innovation [32,37,39]. Geels [37] explains that radical innovations break from the niche-level when the external circumstances are right. If the practices and structures in the regime level are not compatible with the landscape, it destabilizes the regime and creates a window of opportunity for niche innovations.

The MLP facilitates systemic identification and analysis of the facilitators and barriers of change. It makes the facilitators and barriers transparent and explains the interdependencies and interactions. By revealing these mechanisms, it helps to understand the needed

change and steers the change management. Through socio-technical change theories, it is possible to understand the pressure of developing new innovative solutions to existing problems (e.g., prevention of diseases).

Transition studies has focused mostly on sustainability issues and environmental problems such as climate change, and most of the publications that focused on the future directions are directed towards these issues. Even though environmental problems are in the heart of transition studies, Köhler et al. [17] notes that there has also been an expansion to other societal domains. According to Köhler et al. [17], this development and the interest from policy makers to use transition studies to promote change in the society has challenged the transition scholars to focus on system innovation in-the-making and develop forward-looking analysis and policy-relevant scenarios and toolboxes. What is new in transition studies is the request that research should not only be for describing transitions, but for initiating and catalyzing them.

2.3. Transition Pathways

In MLP literature, transition pathway typology has been discussed since 2007. The typology characterizes the overall course of development of innovation and gives a frame for the analysis of occurred transitions. Based on Geels and Kemp [16], Geels and Schot [39] have analyzed change in socio-technical systems and proposed pathways of reproduction, transformation, de-alignment and re-alignment, technical substitution and reconfiguration. They also note that transition pathways are not deterministic; for example, a transition may start with one path but shift to others.

Geels [40] has also reformulated the transition pathway typology through the lens of a local logic that views decisions, actions or events as part of particular developments and that pays particular attention to the actors involved. In the reproduction pathway, the system is stable and only incremental innovation occurs by incumbent actors. Landscape pressure exists in the transformation pathway, but the niche innovations are not developed enough to transform the system. Incumbent actors reorient towards innovations, which may be incremental or radical, leading to transition. In the de-alignment and re-alignment pathway, the existing regime is faced by external shock causing major problems. Incumbent actors lose faith to the system, causing struggles between actors to fill in the existing "vacuum". Multiple and embryonic niche innovation will compete, and eventually one niche innovation becomes dominant and forms the core for re-alignment of a new regime. The technological substitution pathway starts with a specific shock or disruptive change from the landscape in a moment when niche innovations are at a sufficient level. The pressure leads to major regime tension and creates a window for opportunity for radical niche innovations. These innovations may even come from outside of the sector.

Others have also contributed to the discussion of transition pathways [41–43]. Foxon [42] has created transition pathways to meet the challenge of connecting actors to socio-technical change. These transition pathways focus on the action of the actors and the governance arrangements that frame these choices. The pathways start from the present and aim to describe how possible futures could evolve from the current situation. The pathways aim to show, from the different lenses of government, market and civil society actors, how different framing of the issue could lead to different outcomes.

Hammond et al. [41] have also created transition pathways for a more electric future. They see transition pathways as a form of socio-technical scenarios, which explore the future development of a system. Their analysis shows that these scenarios could have a significant role in helping to build consensus between actors for their shared vision and action needed for the change. However, Foxon [42] argues that developing transition pathways goes beyond the existing work of developing socio-technical scenarios by paying attention to economic aspects, the role of actors and interaction of social structures and technological elements. He also notes that more research is needed to estimate the expected cost of different pathway options.

In their paper, Papachristos et al. [43] focused on the interaction taking place among sociotechnical systems during transitions. They noted that the study of multi-system interaction faces challenges of (1) defying the boundaries of the system under study and (2) identifying mechanism, processes and actors influencing the evolution of a socio-technical change. Actors outside the system are involved in transitions, but Papachristos et al. [43] notes that they have not attracted much interest. Niches and regimes of external systems that influence transition are not highlighted either.

Rosenbloom et al. [44] and Rosenbloom [45] have also introduced the concept of storylines where the use of language in innovation debates is the focus. Storylines are actively constructed when actors respond to competing storylines. Rogge et al. [46] have developed qualitative and quantitative socio-technical scenarios for future socio-technical pathways and storylines. The storylines give insight into how transitions can be implemented and how policymakers can use transformative policy mixes to govern transition processes. Pel et al. [47] have studied the governance of transition and especially how transition as evolutionary processes with different future pathways can be studied. Their article focuses on directionality-conscious transition governance that should target wide socio-technical and institutional innovations and not just isolated technologies.

2.4. Quantitative Modelling Tools in Transition Studies

Geels et al. [18] note in their research that impacts of innovations have not received great attention in socio-technical research. The problem is that authors in socio-technical research have questioned the possibilities of anticipating ex ante impacts and measuring them ex-post due to the complexity of change [17,18]. Geels et al. [18] see that measuring the potential future impacts present a risk of not capturing all the relevant mechanisms. The impacts of change in a complex system are mediated through multiple interdependencies, time-delayed feedback loops, path dependencies and threshold effects. Additionally, Köhler et al. [17] have highlighted that the problem has been how to set indicators that can take into account the complexity of transition. Geels et al. [18] see that because the anticipating impacts in advance is seen in socio-technical literature as problematic, the researchers have focused more on transition processes than the impacts of transitions and avoided formal modelling and quantification. However, Geels et al. [18] note that there are a few examples where quantitative modelling and qualitative storylines have been used together [19,48,49]. Köhler et al. [17] have also noted in their article a few examples where qualitative and quantitative approaches have been bridged together [50,51].

Even though Geels et al. [18] and Köhler et al. [17] note that anticipating radical systemic innovation is difficult or even impossible, they see the use of quantitative modelling tools and using new techniques and bridging quantitative and qualitative to forecast future impacts is an important research stream in transition studies. Köhler et al. [17] see that there are promises of using modelling tools that can provide an explicit, clear, and coherent system representation. Even though there are identified challenges of using quantitative modelling, they see that transition research that aims to engage with an evidence-based policy environment requires the development of indicators and measurement techniques. Additionally, Fortes et al. [19] note that policy makers tend to favor quantitative elements and thus using modelling and transition studies together can create opportunities to promote transition.

Geels et al. [18] have noted that quantification of impacts can be feasible in incremental innovations with restricted spatial boundaries. They see that in these examples, there can be sufficient historical data on impacts of changes and the system is sufficiently stable for future impact modelling. Estimating potential impacts for radical innovations over a longer period of time presents greater difficulties. They also note that the problem when using modelling tools is that there may not be enough basis for assigning values or ranges to relevant parameters. However, they see that when the limitations (e.g., over-simplification) of using these tools is acknowledged, they can provide useful information of the changes. Understanding impacts of specific innovations or clarifying the long-run relationships

between aggregated measures of productivity, consumption and growth are examples of the impacts that can be modelled [18].

2.5. Health Economic Decision Modelling

Health economics is a branch of economics concerned with issues related to efficiency, effectiveness, values, and behavior in the production and consumption of health and health care services. In the context of health economics, the sustainability of health care systems could be considered as efforts to balance rising cost pressures against limited resources. To answer this type of sustainability challenge, health economic evaluation is used as a tool to inform policy decisions on how to maximize health returns from limited resources under uncertainty [52–56].

The health economic evaluation based on mathematical modelling (i.e., the health economic decision modelling) is nowadays a commonly used approach to support health care decision-making. The health economic decision modelling provides an explicit and logical framework to combine quantitative data from multiple sources and to project the potential health and economic consequences of different comparative policy scenarios. These ex-ante appraisals help to identify policies and technologies that are potentially an efficient use of limited health care resources maximizing the expected health returns from limited available resources. Currently, the ex-ante health economic evaluations are regularly used by, e.g., many European health technology assessment (HTA) agencies aiming to provide national guidance and advice to improve health and social care (see, e.g., https://eunethta.eu/ (accessed on 21 October 2021).

3. Materials and Methods

This paper uses qualitative methods for constructing a vision pathway, and quantitative methods for developing health economic decision modelling for purposes of supporting decision making. The paper attempted to combine the resulting vision pathway with health economic modelling in an online tool that visualizes and calculates possible economic impacts of various future scenarios. Next, qualitative data collection and analyses is presented, followed by a description of the development cycle of the health economic decision model and its online tool.

3.1. Data Collection for Vision Pathway Formulation

A vision pathway is constructed in this study by forming systemic understandings of the potential of digitalization in reducing T2D and the facilitators and barriers towards an envisioned change. To study the system-level changes towards prevention of T2D, it was important to identify and interview a variety of actors that operate inside or close to the health care system. Stakeholders outside the healthcare sector were perceived as important, as prevention of T2D is based on a range of social and environmental factors and interventions that are not directly connected to health care and the transition towards a sustainable health care system needs multi-voices and new stakeholders as change promoters.

First, a stakeholder analysis was conducted to identify the actors most relevant for the purpose of the study. The stakeholder analysis utilized a 'diamond model' that categorizes stakeholders into four groups according to their different relations to relation to health services: providers, users, societal actors, and purchasers/refiners [32].

Altogether 23 semi-structured interviews were carried out between May and September 2017 with stakeholders that have an important role in using, developing, or supporting new or existing operating models for the prevention of T2D (Table 1). These included 10 'users' (diabetes-related organizations and associations, unions representing industry and workers, consumers, physicians, and pharmacists); six 'providers' (public and private health service and health research providers, 'best place to work'-companies); four 'societal actors' (public entities such as a ministry, welfare and health funding, social insurance

institution, immigration service); and three 'purchasers/refiners' (an innovation fund, a public health organization, an organization promoting physical activity).

Table 1. The interviewees' occupations and expertise areas.

Occupations Include	N 23	Expertise Areas Include	N 23
Medical adviser	4	Diabetes	4
Senior Researcher	2	Social-, health- or labor policy	4
Business manager	1	Occupational healthcare	3
Chairman of the board	1	Public health	2
Chief Director	1	Human Resources	1
Chief occupational health physician	1	Cardiology	1
Chief physician	1	Funding Preparations	1
Chief public health nurse	1	Healthy physical activity	1
Executive manager	1	Solution architect	1
Expert Pharmacist	1	Immigrant health	1
Grants officer	1	Nutrition research and obesity prevention	1
HR manager	1	Political science	1
Medical director	1	Public administration	1
Program Director	1	Youth- and physical education policy	1
Project manager	1		
Research Director (tai: CEO)	1		
Secretary General	1		
Senior physician	1		
Social policy specialist	1		

The interviews were guided by insights from the MLP [20,37] that emphasize the importance of understanding systemic aspects and multiple perspectives of change. The interviewees were asked to define the current state of and needed changes in health promotion strategies, to pinpoint actors relevant for the identified change, and to map barriers and facilitators for the change. These questions were then discussed in relation to digitalization and related new technologies; the regional government; health and social services reform; possibilities and importance of cost-effectiveness information; and co-operation between public, private and third sector actors.

The interviews were recorded and transcribed. The transcribed interviews were analyzed and encoded by means of qualitative content analysis in Atlas.ti by classifying and restructuring the data into themes that describe suggestions for changes needed for individual, organizational, municipal, and societal transitions towards comprehensive T2D prevention. In the first stage of analysis, five key transition themes were identified. These relate to municipal decision-making, individual motivation and support, customer-centric and personalized health-care, profitability of health promotion, and implementation of models created in health promotion research projects (described in more detail in a Finnish report from 2018 [57]). Digitalization was at this stage identified as a cross cutting theme, becoming a central element to all of the major themes, and thus taken as the object of study in this paper. In the second phase of the analysis, interview data relating to digitalization, i.e., adoption and use of digital tools in health care organizations and among citizens, was analyzed closely in order to identify potential facilitators, barriers and future visions of digital tools in T2D prevention. For this round of the analysis, Atlas.ti was not used, but several iterative rounds of content analysis were made to derive meanings and remarkable

findings from the data. While going through the selected data, most typical themes were uncovered and classified.

3.2. Data Collection and Analysis of the Health Economic Decision Model and an Online Tool

In the present study, the health economic decision modelling was applied to demonstrate quantitatively the expected economic outcomes of a hypothetical national digitally supported prevention program leading the lower incidence of T2D during the next 10-year time horizon in different target populations. More specifically, the aim was to demonstrate the potential value of recruiting individuals at highest risk of T2D for a digitally supported prevention program. Conservatively, it was assumed that these preventive actions lead to modest (i.e., on average 2.5%) weight (kg) loss during the first year of the program, even if previous studies have showed greater weight losses (3.5–7.0%) during the short-term periods [58–61]. The association between the expected weight loss and the long-term incidence of T2D was estimated based on a post hoc analysis of the Finnish DPS follow-up data [35].

The development of the health economic decision model included the following phases:

- Developing the conceptual model. Modelling process was started by defining the parts of reality in a case of T2D prevention in the Finnish adult population aged 45–75 years, where the incidence of T2D is the most typical. The focus was on the modelling of the incidence of T2D based on its known risk factors; and how the modification of this underlying risk could affect the annual incidence of T2D at the target population level.
- Constructing the model. A simple, commonly applied cohort-based, Markov-type, discrete state transition model with three health states (i.e., no T2D, T2D, and death) were developed to model population transitions between the defined health states in the model.
- Informing the model parameters. Models require evidence to inform their parameters. In this case, the age- and sex-specific proportions of Finnish adult population at moderately or high risk of T2D was derived from the national FINRISK follow-up data [62] by applying the FINDRISC score [35], which predicts 10-year risk to develop T2D based on socio-demographic, behavioral and anthropometric factors. Additional direct (i.e., due to health care use) and productivity (i.e., due to work absenteeism and permanent work disability) costs associated with T2D were obtained from a previous study applying the national social and health care registries [3]. Changes in risk of all-cause mortality due to T2D was obtained from a previously published study [63].
- Exercising the developed model. Formulating scenarios, which were developed for the purposes of the present study focusing on digital tools.
- Online tool. The developed model was published as a web-based online tool with automatic reporting to allow different stakeholders from various organizations to build their own projections and manipulate model assumptions related to, e.g., a level of baseline risk in a target population or an applied perspective of analysis (i.e., a health care payer vs. societal perspective), as well as change parameter values (e.g., a size of target population, a cost of prevention program, etc.) as needed. The pdf report that the users receive from using the tool included the calculations of potential savings and the vision pathway with identified themes from the interviews. The transition-focused storylines of each of the themes gives users information of the barriers and facilitators of the needed changes in the health care system.

4. Results

4.1. Contextualizing the Digital Transition for T2D Prevention

In Figure 1, the MLP model of this study is presented, which focuses on the change towards a health promoting society with a specific focus on prevention of T2D in Finland. The figure is based on the current structure of Finnish health care and it is formed based on the information from the interviews. By using the MLP, we aim to visualize the multiple technologies, regulations and practices needed for the change. It is not a comprehensive

picture of all the issues related to the prevention of T2D, but it aims to picture the on-going changes. It also offers a contextual basis for the creation of the vision pathway.

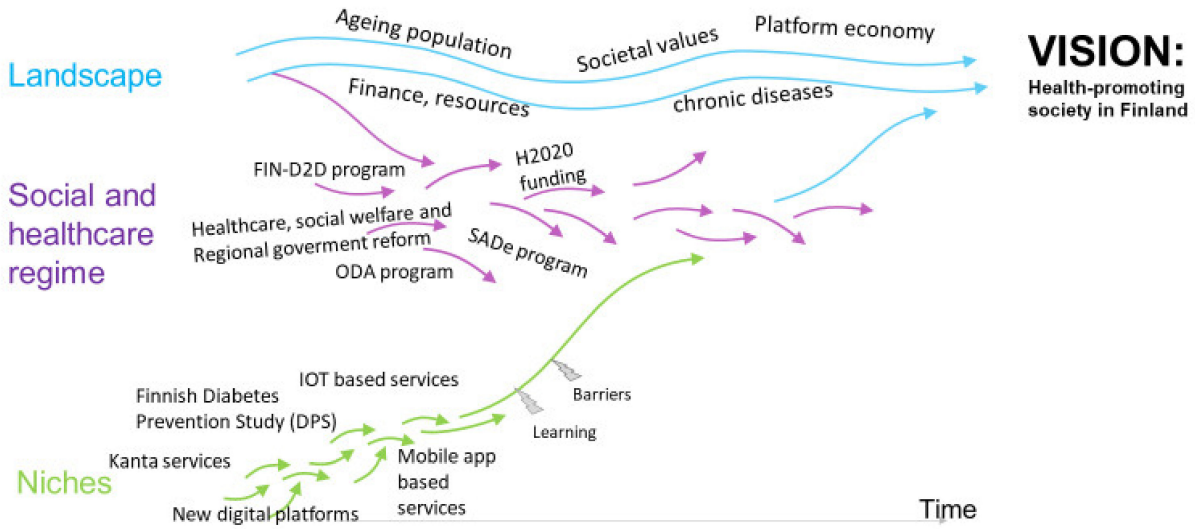

Figure 1. Multi-level perspective of the change towards prevention of type 2 diabetes in Finland by 2030 (modified from Geels [20]).

At the landscape level, an aging population and decreasing resources create challenges for the sustainability of the current system. The platform economy challenges the current system and its societal values, pressuring a shift towards personalized and citizen-centric services where values are created together with citizens. The current social and health care regime is trying to respond to changes in the landscape by modifying the legislation (e.g., healthcare, social welfare and regional government reform) and fostering innovations through policy actions (e.g., H2020 funding). For example, the ODA program (self-care and digital value services) is a Finnish government project focusing on developing a new digitalized service for citizens which brings together information from different sources. The SADe program (Action Programme on eServices and eDemocracy) provides interoperable public sector services via digital channels [64]. With a focus on T2D, the FIN-D2D program tested the Programme for the Prevention of T2D in Finland in practice and developed new action models to be taken into use nationwide [65]. In the niches, innovations are created that have a possibility to change the system. New digital platforms, mobile app-based services and IOT-based services are in the core of innovations. As an example, Kanta services offer a nationwide platform where citizens can see their personal health records. Research results (e.g., DPS study) are proving that T2D can be reduced by lifestyle interventions [66] and digitalization can offer tools to better manage health and wellbeing.

The socio-technical changes required for successful adoption of digitalization are contextualized within the theoretical lenses of multi-level perspective and the existing structure and operations of the Finnish health care system, including the actual barriers and facilitator of the five themes that guide the change towards transition of prevention of T2D. This vision pathway was named "change towards prevention of type 2 diabetes in Finland by 2030" (Figure 2). Embedding and scaling up health promotion interventions is situated between the niches and the regime. The challenge is that the innovations stay local and do not change the health care system in a comprehensive way. Creating health promotion innovations also demands new finance structures. Citizens centric and personalized health care requires development of innovations and changes in the regime. Setting health promotion as apriority is something that policy makers and politicians can make, and it is thus situated in the current regime. Supporting healthy lifestyle is a system level aim that crosses different sectors and is not situated only in the health sector. The

vision pathway was named as change towards prevention of type 2 diabetes in Finland by 2030 (Figure 2).

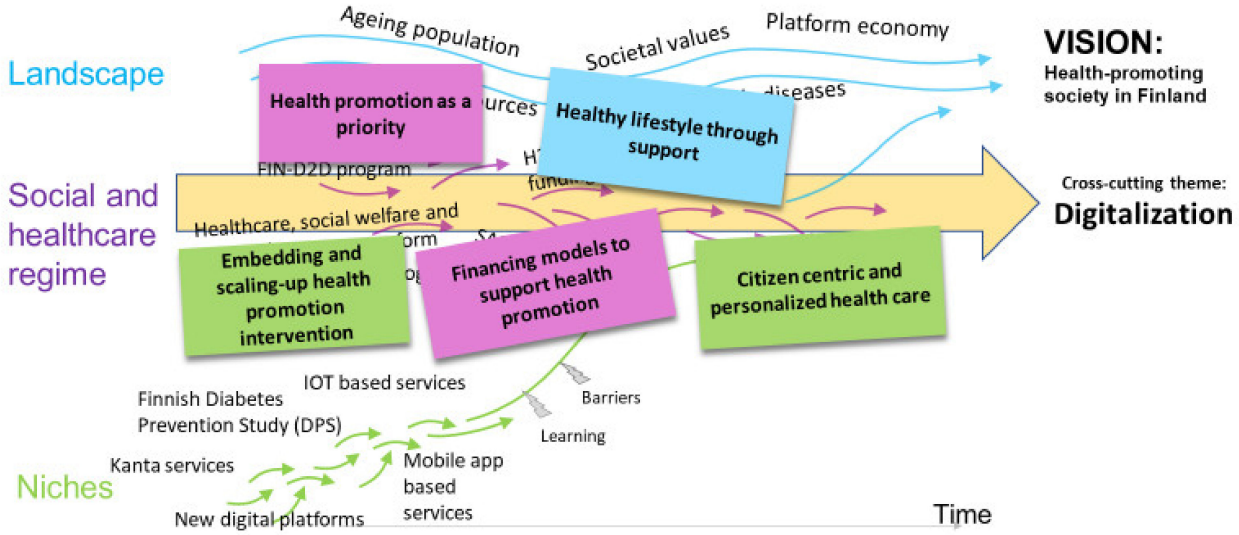

Figure 2. Vision pathway towards prevention of type two diabetes in Finland by 2030.

The vision pathway included transition-focused storylines of the barriers and facilitators of change, which were formed from the analyses of the interviews. In the next section, we present the storyline of digitalization. The analyses of the interviews point out the issues that facilitate or act as barriers of change.

4.2. The Opportunities and Barriers of Digital Tools for a Transition towards T2D Prevention—Analysis of the Interviews

4.2.1. Health Care Organizations Are Yet to Utilize the Full Potential of Digitalization

Health care organizations are yet to utilize the full potential of digitalization. One of the reasons seem to be the lack of structural and organizational changes needed in order to sufficiently benefit from digital technology. A senior physician described the current situation as follows: "*Well, we are not digital yet. At the moment, digitalization means that things are transferred from paper to pdf. Or old working practices are transferred to be done with a computer. We need to become aware that the change needs to happen in organizations and systems' structures*". In reality, health care professionals do not often perceive everyday practices and services from the novel perspectives offered by digitalization. When old practices are simply transferred to the digital world into current organization of services, it does not create new structures where innovations' potential would be sufficiently harnessed. Efficient use of digital tools would require management to ensure organizational capabilities in meaningfully adopting new practices, technologies, services, and changes in ways of working. A business manager considered the problem of uptake as follows: "*many things are related to the misunderstanding that things are fixed after buying a digital solution. It does not work like that. In many instances, it would require changes in operational practices. These new practices have proven to be very difficult to introduce in organizations. It could be a matter of organisational capabilities*" (Business manager).

4.2.2. Digital Tools Can Empower Citizens in Individual Health Promotion

Interviewees pointed out that change towards wider adoption of digital health promoting practices has not happened yet in a large scale, but a transition is possible. The interview viewpoints were in a sense anticipatory; a perspective exemplified by a medical adviser (A): "*The change is happening, but I do not think a transformation has happened yet. I think that in ten years the number of citizens that can take care of themselves through applications or digital systems will increase. It will increase significantly*". While the nature of change remains

tentative, interviewees held that digital tools contain potential to empower citizens to foster health promotion. A quote from a project manager working with diabetes related projects crystallizes the idea of patient empowerment through a digital leap in health care: "*the current practice is that a patient comes to the doctor's appointment, gets instructions and guidance and acts according to them. Digitalization enables patients to also have an opinion about their care*". This is also due to the fact that citizens have become increasingly interested in their own health. They use different methods to collect their health information or gain access to information produced by healthcare professionals. Based on new information created through digital applications, citizens can also have a more accurate understanding of their current health and become active partners in their care. Thus, using this information can give citizens new knowledge of preventative methods and an ability to detect preventable health issues.

4.2.3. Individually Collected Health Data Integration with Health Care Practices Would Benefit Patients

Citizen demands are one of the key drivers in spurring change towards citizen centered health care model. The interviewed actors noted that citizens sometimes share self-collected health information with health care professionals, and that the professionals value this information. A senior physician pointed out that "*patients bring their own excel documents and other data to doctor's appointments. It would be a dream if we could get this information to our systems automatically*". However, there is no easy way to complement patients' data with the health care system data. The physician continues: "*the problem nowadays is that patients have so many different forms of collecting data*". Thus, data compatibility and interoperability issues remain an obstacle for smooth integration between health care and personal data. Encouraging a faster pace of change would, according to a business manager, require that citizens start demanding data integration to initiate otherwise slow change among health care providers: "*this problem could start to unravel if the citizens become active and demand more from private and public health care provider (. . .) If you analyze how the health care professionals have facilitated the change, you have to say it has been very slow*".

4.2.4. Hard to Motivate Investment in Health Promotion as No Immediate Effects Can Be Observed

Our interviewees pointed out the problem of sufficiently proving the impacts of disease prevention innovations. The impacts of prevention projects are difficult to verify because the impacts are observable only some years or even decades after initiation of the intervention. A research director held that: "*If you think about prevention or health promotion, the effects and impacts of certain action will be visible in years or even decades. And the cost-effectiveness can be even negative for the first years*". This problem becomes visible in designing and planning new projects, where the funder needs some estimation of how the innovation will provide savings or produce quality in citizens' life. Without this information, policy makers have a hard time in justifying spending on new technologies. A medical adviser (B) described the issue as follows: "*Studies to show the cost-effectiveness are necessary because that is the thinking that politicians understand. We need to show that spending money will produce impacts, whether they are cost savings or health benefits or both*".

4.2.5. Citizen-Centered Design Is a Potential Solution for Digital Capability Problems

A commonly voiced notion and worry was that mainly younger generations have the ability to use digital tools, and senior citizens do not have knowledge or the necessary equipment to use many of the applications available. A social policy specialist illuminated the problem as follows: "*There is research from Finland that half of senior citizens over 65 do not use digital tools. That is about 500,000 people, which is a lot*". The specialist maintained that the problem will persist regardless of technical development: "*I do not also think that this is a problem which will go away when citizens get more used to digital tools. Digital tools are being upgraded all the time and there will always be customers who are falling behind*". The different capabilities for using digital tools could mount up to a structural problem of

some populations not being able to use these tools. According to a medical adviser (A) this is a present risk: "*a major risk is the growing inequalities between different population groups, especially how connected they are to digital tools. During the next 10 years, this issue requires attention. We have to make sure that everyone will stay on board*". Thus, it becomes essential to design alternative ways of maintaining good quality services: "*we also have to think what to offer to citizens who are not using digital services (. . .) with senior citizens there are vision, dexterity, and memory problems and so on. We have to have other options for these citizens*". (Social policy specialist). However, these views were contested by a more optimistic business manager: "*Before the assumption was that all citizens are not able to use digital services, but now the trend and time is on our side*". The manager held that digital capabilities themselves are not the problem. Instead, the question is one of design: "*Senior citizens know how to use internet bank services or Facebook, so the assumption is that they become more able to use also digital health services. There is no problem if the services are designed to be user friendly*" (Business manager). Thus, the important thing is to design these tools according to citizens' needs and capabilities.

4.2.6. Gamification and Displaying Impacts Can Support Longer-Term Health Application Use

Some interviewees noted that the fast pace of digital development and the large quantity of available digital applications provide possibilities within the healthcare sector. A project manager told that: "*if you go to the App Store and type health or diabetes, you will get thousands of applications*". However, there are problems with unconnected data and incompatible formats between programs and applications. A medical adviser (C) pointed out the problems through an example of nutrition apps, where: "*you have to fill in the information on the application. It should be more automatic. The more manual work there is, the more easily people will get bored*".

Another problem is that citizens use applications for a relatively short time. Commenting on the problem of attracting citizens' attention for a longer time in digital tool use, a chief occupational health physician pointed out that: "*gamification is one solution. And it is just not for young people, but also for senior citizens*". Gamification describes using elements of game playing to increase motivation and engagement with digital applications. Another way of maintaining motivation for healthy lifestyle routines is to visualize the benefits of lifestyle changes. A research director commented that: "*Citizens want to see the results of their actions relatively swiftly. Lifestyle changes reduce the risk of getting type 2 diabetes but if the citizen can see the effect years from now, it is not likely to motivate them. Applications can help to visualize results and affects their everyday life*". The idea is that people in general do not promote a healthy lifestyle in order not to get T2D in 10 years, but have more immediate reasons for motivating action. Combining applicable technical interoperability standards, gamification, and visualization of immediate health benefits, could support longer-term health application use and thus a healthy lifestyle.

4.2.7. Identified Facilitators and Barriers towards the Change in MLP Model

The interviews pointed out facilitators and barriers towards the use of digital tools to prevent T2D in Finland. These observations are situated in the MLP model to show the needed actions in different levels (Figure 3). The identified facilitators are colored in green and the barriers in red.

Digital tools that has been tested in the current system has shown that they have the possibility to empower citizens and give them tools to promote their health (e.g., 53 and 54). However, the regime is not utilizing the full potential of the digitalization and the systems is trying to cope with the old rules and ways of working and interacting. There are many possibilities in the niches that are identified by the interviewees. As the citizens are collecting more and more data about their health, the interaction to health system would have a great advantage to the citizens and their possibilities to prevent diseases. Citizen-centricity and new ways of delivering services can be seen as a potential solution for digital capability problems. The new tools are not just for younger citizens, but they can also motivate senior

citizens as also pointed out in the study by Harjumaa et al. [31]. Gamification also has possibilities to promote a longer usage of digital tools and different applications can help to visualize changes. However, as the socio-technical change literature suggests, developing these new innovations in the niches requires protection from the market selection (e.g., creating opportunities to test new innovations and providing funding). If the innovation that focuses on preventing diseases cannot prove its impacts, it is difficult to convince the policy makers and other funders to give resources to innovation development.

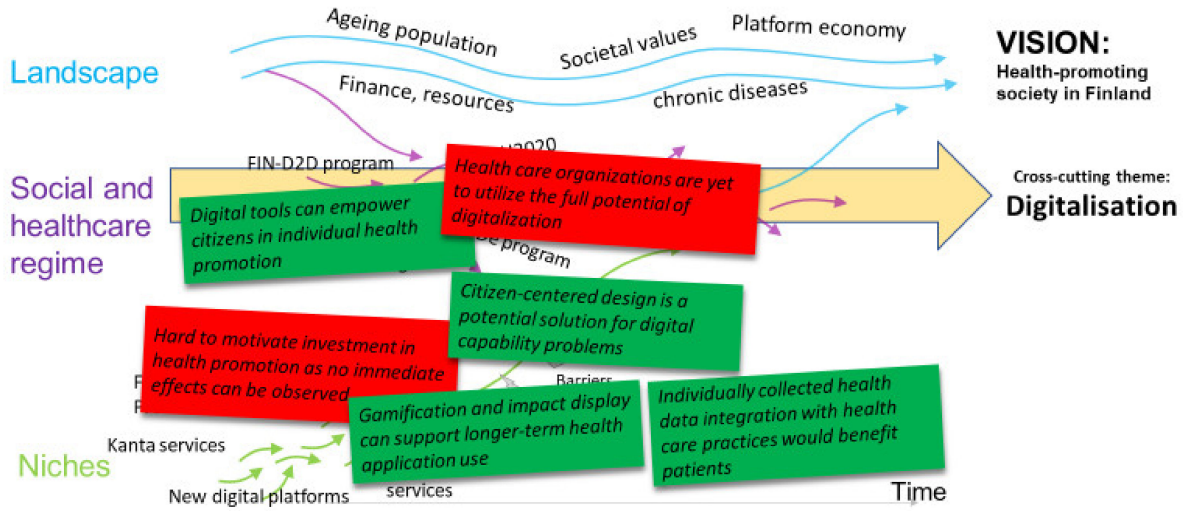

Figure 3. Facilitators (green boxes) and barriers (red boxes) for using digital tools in the prevention of T2D in Finland situated in MLP model.

4.3. The Use of a Digitally Supported Prevention Program in Different Target Populations—Health Economic Outcomes

The future is unknown for all us, but using foresight methods, such us scenarios, we can create understanding of the potential futures, and also the potential impacts. This study refers to the impacts of using digital tools to prevent T2D, which were estimated through scenarios. Three different scenarios were made to demonstrate the potential value of recruiting individuals at highest risk of T2D for a digitally supported prevention program (Table 2). The scenarios were (1) targeting a digitally supported prevention program to all Finnish adults at 45–75 years of age (2) targeting a digitally supported prevention program to all 45–75-year-old adults at moderately elevated risk of T2D (FINDRISC Score > 12) and (3) targeting a digitally supported prevention program to all 45–75-year-old adults at high elevated risk of T2D (FINDRISC Score > 15).

Table 2. Studied scenarios aiming to demonstrate the expected economic outcomes of a digitally supported prevention program in different risk-based target subpopulations.

Scenarios	Description of Scenario
Scenario 1	A digitally supported prevention program targeted to all Finnish adults at 45–75 years of age
Scenario 2	A digitally supported prevention program targeted to all 45–75-year-old adults at the moderately elevated risk of T2D (FINDRISC Score > 12)
Scenario 3	A digitally supported prevention program targeted to all 45–75-year-old adults at the high elevated risk of T2D (FINDRISC Score > 15)

Figure 4 presents the results of the modelled example scenarios. As shown in Figure 3, targeting a digitally supported prevention program to adults at highest risk could be expected to provide the relatively highest total savings at the population level during

the next 10 years. At the individual level, the expected savings per person were −261€, −900€, and −1535€ among all adults at 45–75 years of age, adults at 45–75 years of age with moderate T2D risk, and adults at 45–75 years of age with high T2D risk, respectively. The results of these scenario projections indicate that it is worthwhile to offer the digitally supported T2D prevention program to all Finnish adults at 45–75 years of age. However, if the health care system can afford to provide the prevention program only a fraction of adults at 45–75 years of age, the highest expected savings could be obtained by prioritizing prevention program based on T2D risk.

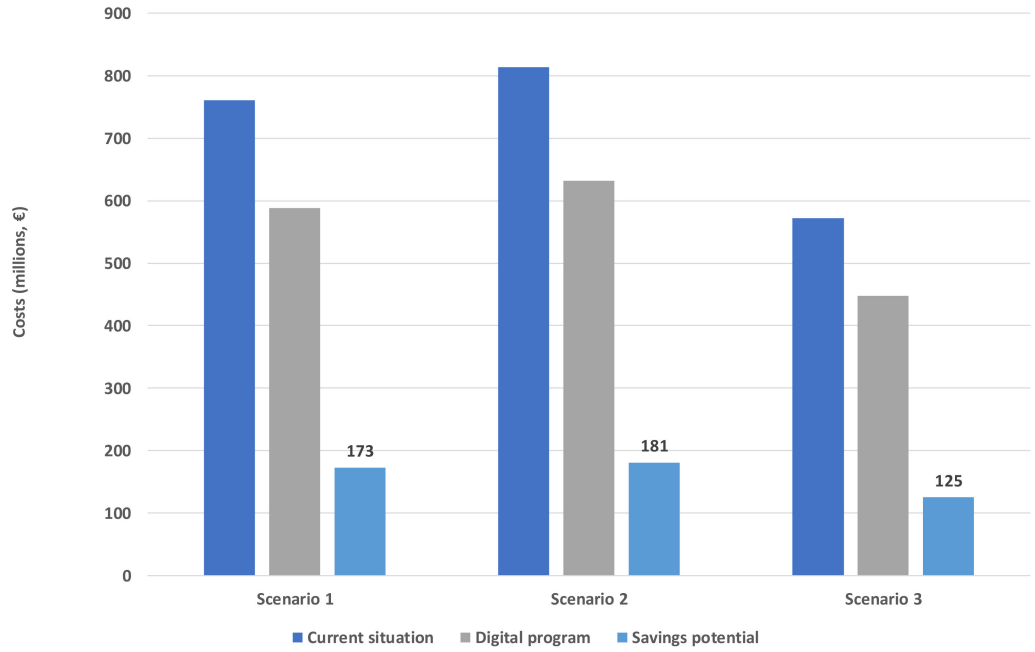

Figure 4. Results of the example scenario analyses demonstrating the expected 10-year savings potential (millions) of national digitally supported prevention program in the selected target populations.

4.4. Online Tool Combining Transition-Focused Storylines and Forward-Looking Scenario Analyses

As mentioned above, the web-based online tool (https://esior.io/stopdialaskuri1/ (accessed on 21 October 2021)) was developed to enable user-defined scenario analyses for savings potential in different target populations while considering different values, e.g., for a cost of prevention program, size of target population, etc. (Figure 5). In addition, the online tool combined these user-defined scenarios with the transition-focused storylines to provide the vision pathway for change in the prevention of T2D in Finland. The online tool was targeted to policy makers in the municipalities to help in estimating the potential savings of using preventative tools to reduce T2D. Therefore, it was considered important to integrate the vision pathway to the online tool as it gives policy makers an overall picture of the needed changes in the system.

The transition-focused storylines presented barriers and facilitators towards the use of prevention of T2D in Finland. The barriers and facilitators were categorized under the identified themes of setting health promotion as a priority, embedding and scaling up health promotion interventions, new financing models to support health promotion, healthy lifestyle through support and citizen centric and personalized care. The transition-focused storylines with barriers and facilitators are not presented in detail in this paper as the focus is on the digitalization and the possibilities it has to transform the current health care system.

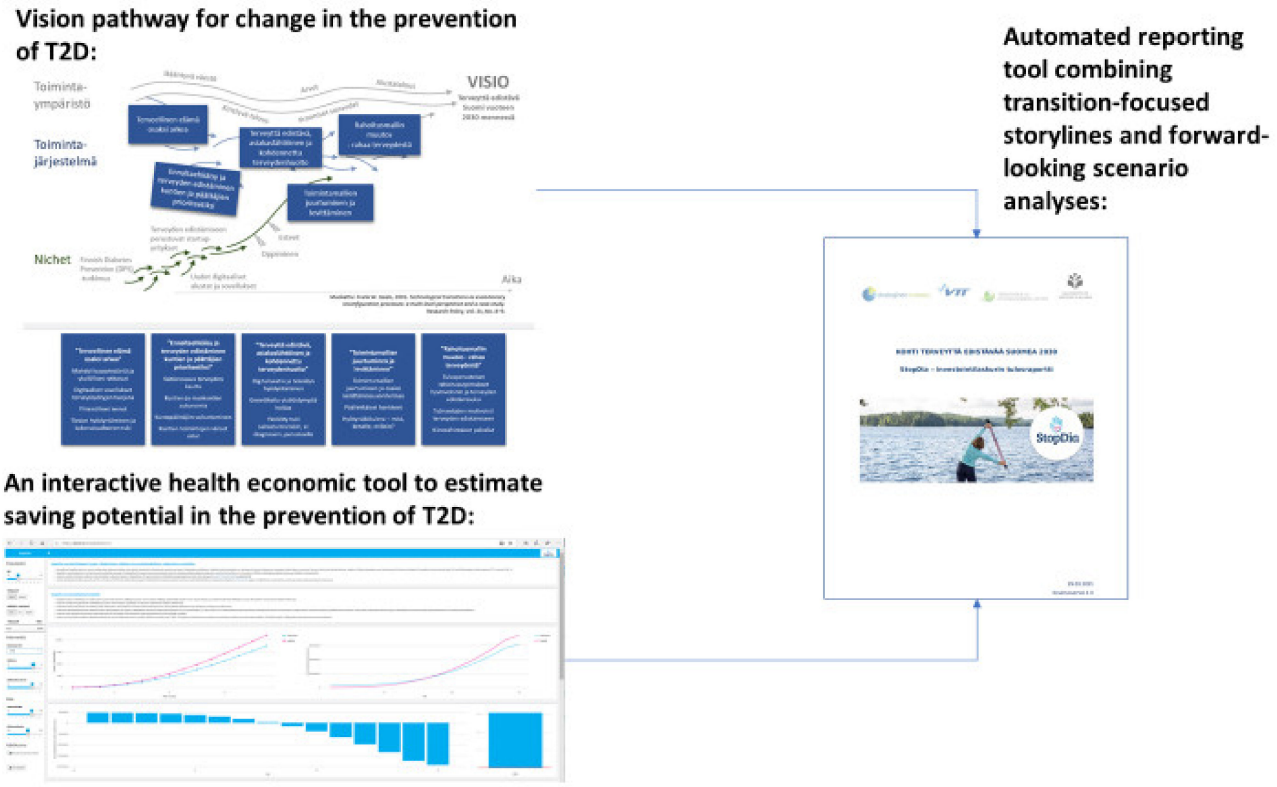

Figure 5. Print-screens of the developed online tool (https://esior.io/stopdialaskuri1/ (accessed on 21 October 2021)) combining the transition-focused storylines and forward-looking scenario analyses. Automated reporting enables users to generate downloadable reports (including user-defined scenarios supported by transition-focused storylines) for further use. The online tool is currently available only in Finnish.

Thus far, the feedback received from local decision makers on the online tool has been supportive. However, the feedback called for even more simplified user interface, which is something that could be developed in the future. From the point of view of policy impacts, the online tool has raised interest not only among the local decision makers, but also in the Finnish Prime Minister's Office. The joint analysis, assessment, and research activities (VN TEAS), which works under the leadership of the Prime Minister's Office, initiates funding that supports decision making procedures, working practices and management by knowledge. One of their recent funding calls was based on the online tool presented in this paper, which they have identified as unique policy-relevant tool and thus, the objective of the call was to find out if there are similar tools published in other countries and if these recognized tools could be applied in the Finnish context to support local planning and decision making. This could be considered as a clear indication that there is a need to develop and use these kinds of interactive tools to help steer policy making towards more sustainable health systems. Based on our knowledge, there are only few other health economic tools in the field of T2D prevention, such as NHS Diabetes Prevention Programme Return on Investment Tool (https://dpp-roi-tool.shef.ac.uk/ (accessed on 21 October 2021)) and Centers for Disease Control and Prevention's Diabetes Prevention Impact Toolkit (https://nccd.cdc.gov/Toolkit/DiabetesImpact (accessed on 21 October 2021)).

5. Discussion

There is a need to change the health care system in Finland towards preventing diseases in order to ensure the sustainability of the system and improve healthcare. Chronic diseases, such as type 2 diabetes (T2D), create challenges to sustainability that can be better tackled by more preventative actions [4,5]. Currently, however, T2D interventions mostly focus on a single innovation or a tool and test the impact on, e.g., weight loss [58–61].

In addition, using preventive methods have proven to be difficult and there are barriers towards the change even though digitalization has created new promises. This study has grasped these problems and created a vision pathway towards prevention of T2D in Finland and developed transition-focused storylines and forward-looking scenarios to demonstrate the needed changes and the expected national savings potential of T2D prevention in Finland. The study has also created an online tool to promote changes and give policy makers a tool to estimate expected economic impacts of preventing T2D, as well as ideas of the needed systemic changes.

This study proposes that transition towards sustainable health system require a large-scale socio-technical change. This change can be studied from the perspective of transition studies and more precisely from the approach of multi-level perspective (MLP) [16,20]. In this study, the MLP model's landscape level concerns the aging population, decreasing resources and shifting societal values towards personalized and citizen-centric services, which has created pressure for system change. The social and health care regime is trying to respond to these changing values via different legislation renewals and policy actions. There are also a number of niche innovations that drive the use of more preventative methods. It appears that digitalization has the possibility to renew the fundamental architecture of the Finnish social and health care system.

Transition pathways [16,39] have been used in transition literature to explain the overall course of development of innovation and giving frame for the analysis of occurred transitions. The research is mostly focused on analyzing past transition, but there are also studies that has focused on future transition pathways [46]. This research contributes to this discussion by developing a vision pathway towards the transition in Finnish health care system towards prevention of T2D. The study focused on identifying large themes towards a health promoting society in Finland. These themes were identified from the 23 interviews of actors and were situated in the MLP model to give insight into the changes required in different levels. These themes were named as setting health promotion as a priority (regime level), embedding and scaling up health promotion interventions (regime and niche level), new financing models to support health promotion (niches), healthy lifestyle through support (regime) and citizen centric and personalized care (regime). Although, the interviews were carried out 2017, the system level change as well as enablers and barriers of the change are not growing old quickly.

A cross-cutting theme of digitalization was also identified from the interviews. Digitalization was selected as a focus theme in this study because it was identified as a cross-cutting theme and of the need to handle complexity and lack of data required for the development of a very complex health economic decision model to support impact assessment of alternative policies. Transition-focused storylines opened up the facilitators and barriers towards the change, which were based on results from the interviews. The results confirm the previous findings [14,15,23,24] that digitalization can promote transition in health care.

Results show that digitalization is framed positively as providing a range of solutions for improving health promotion, even though digital technologies are yet to transform health care. Stakeholders see opportunities for more agile, citizen-centered, customized, and empowered care. Digital technologies can make health promotion better through empowering tailored and customized individual health promotion; by integrating health care system data with individually collected data; and by using gamification and visualizing impact of health promotion practices. Moving towards an increased focus on prevention is a means to achieve a more sustainable health care system. However, the results show that attempts to increase focus on preventative health care is still hindered by the current information input and financial incentivization structure within health care: the effects of many health promotion activities are hard to measure and thus investing in means to promote them hard to legitimize. It is essential to provide opportunities for niches to develop new innovation, but showing the impacts of innovations focusing on prevention needs new tools and value assessment approaches [67]. It is also important to acknowl-

edge citizens' different capabilities to utilize digitalization. Nonetheless, new tools are not just for younger citizens, but they can also motivate senior citizens as pointed out by Harjumaa et al. [31].

The research results indicate that currently the change in Finland towards prevention of T2D is in the transformation pathway (e.g., Geels [40]). The results also confirm previous findings (e.g., [25]) that developing new digital services has faced a number of challenges and the new system has not yet emerged. According to the results of the study, it can be assumed that a system level transition is an ongoing process and the change has not yet happened. Nonetheless, the window of opportunity is about to open through the introduction of digitalization. Geels and Schot [39] note that the transition pathway can shift to another pathway. Our analyses indicate that the current transformation pathway is shifting towards a reconfiguration pathway where multiple niche innovations solve the problems in the regime. This leap from a transformation pathway is in many ways challenging and represents fundamental change in the system, which may lead to a transition to a completely new system.

In addition to the vision pathway and transition focused storylines, a health economic decision model gave information on what are the possible impacts of using digital tools to prevent T2D. The scenarios indicate that it is worthwhile to offer digitally supported T2D prevention programs to all Finnish adults at 45–75 years of age. However, the highest expected savings could be obtained by prioritizing prevention programs based on T2D risk. This confirms the findings from the previous literature (e.g., [68]). The online tool was developed to offer municipal policy makers tools to estimate expected economic impacts of preventing T2D, as well as ideas of the needed systemic changes. By using the online tool, user receives a report that presents the vision pathway and transition-focused storylines together with health economic decision modelling results.

The presented study has grasped some of the problems identified in the transition literature. First, it has followed the same ideas that Foxon [42] have used in his study by describing possible futures. However, Foxon [42] highlights in his article the need to estimate the expected cost of different pathway options. There are also identified needs to evaluate the impacts of using digital tools [23]. The study has answered this need by creating scenarios. In addition, Papachristos et al. [43] have noted in their article that it would be beneficial to study the change from the point of view of actors outside the system. For this, the study has also interviewed outside actors of health care to cover these different views since the since prevention of T2D is based on a range of social and environmental factors and interventions that are not directly connected to health care.

Second, as Geels et al. [18] have noted, it is not easy to bridge transition studies together with quantitative modelling due to the systemic nature of innovations. However, they have noted that there are circumstances where the use of quantitative tools is possible. There should be sufficient historical data on impacts of changes and the system is sufficiently stable for future impact modelling. The examples of using qualitative and quantitative methods are mostly focused on the energy and environmental sustainability issues, and the sustainability of health care systems have not been studied from this perspective. In the presented study, the use of quantitative modelling and vision pathways has followed the notions from previous studies. Instead of modelling the entire transition towards prevention of T2D, the study focused on a single theme of digitalization. There are accurate medical data of the impacts of using preventative methods to citizens health, which are used in the study to estimate the future impacts. In addition, the health care sector can be seen to be sufficiently stable to estimate the impacts.

The third issue pointed out by the transition studies is the identified need for focus on system innovation in-the-making and development of forward-looking analysis, policy-relevant scenarios, and toolboxes due to the demands to initiate and catalyze transitions and not just describing them [48]. In addition, Foxon [42] has called for more research to estimate the expected cost of different pathway options. What is new in this study from the point of view of transition studies is the developed online tool with interactive quantitative

modelling and qualitative vision pathway together with transition-focused storylines. In this respect, the study has followed the ideas presented by Rogge et al. [46]. The online tool is an addition to the study of Rogge et al. [46] as it gives the users information about the possible impacts and in addition to the storylines of needed changes.

What was also learned from this study is that while interdisciplinary research is considered something to aim at, it takes time to get the common, novel and unique understanding of the goals, results and conclusions that have been realized. The value addition of the disciplines, approach and method triangulation brought the researchers to the essence of research in the method of trial and error. In this study, it has been essential to understand system-level changes, but a triangulation of methods and approaches was challenging due to the differences between the methodological starting points of transition studies and quantitative modelling. Health–economic modelling needed quite explicit definitions of evaluation objectives to make scenarios, while the identified systemic changes were mostly descriptive without actual data of the impacts.

What can be learned from this study is that even though quantitative tools alone have a hard time capturing the systemic nature of innovation and change, they can be used in a focused setting to evaluate the impacts of different future possibilities. This study agrees with Geels [18] that there should be sufficient historical data on the impacts of change and have clear spatial boundaries. Without this information modelling, the change is somewhat impossible. However, obtaining this kind of information about systemic change is problematic, and when focusing on smaller changes or themes, there is a danger of missing the essence of systemic change. Nonetheless, this study proves that while acknowledging these restrictions, using transition studies together with quantitative modelling has possibilities to promote transition in-the-making called for from the previous studies by Fortes et al. [19] and Köhler et al. [17].

6. Conclusions

This paper has aimed to demonstrate that even though modelling the impacts of the transition is difficult due to the complexity of change, it is possible to project possible impacts of different changes and thus help decision makers direct their choices. This study brings new insight to the field of health care, where the problems of sustainable systems are situated in an environment where innovations often are intangible and the impacts are problematic to verify. Thus, the research provides new ideas to the transition literature on how to tackle societal needs to promote transitions in different systems. Transition studies have looked for ways to promote changes in the society and develop policy-relevant scenarios and toolboxes [17]. This study has presented one way to foster the change through using vision pathways and health-economic modelling. These results can guide the research towards developing solutions to existing problems. However, future research could focus on developing methods and tools where the pathways and modelling results are better integrated to each other.

It should be noted that this research does not capture all the elements and mechanisms of change in a complex health care system. It has focused on preventing T2D and a single theme of digitalization and presented the findings from that perspective. Transition towards prevention of T2D requires socio-technical change where changes need to happen in different levels of the society. The presented vision pathway has tried to picture these multiple changes required for transition.

However, the results are not specific to T2D prevention alone, but can be interpreted to concern health promotion activities in general, and an increasing transformation in the health care system towards emphasizing preventative measures alongside acute care. In addition, the web-based online tool does not focus just on digitalization and aims to capture the impacts of the use of preventative action as a whole. It also broadens the perspective by providing knowledge of needed systemic changes in the socio-technical system.

Author Contributions: J.L. was the main author of the article. She was responsible for the theoretical analysis of transition studies. She also carried out the empirical analysis with the help of A.S., who also helped with the description of the research methods. J.M. was responsible for the health economic decision modelling and the results of the scenarios. The online tool was done in collaboration with J.L. and J.M. Results were carried out in the collaboration of J.L., J.K. and J.M., J.K. and J.M. participated formulating the discussion and conclusion, but J.L. had the main responsibility for these sections. J.P. edited the article and acted as a supervisor for the article. All authors have read and agreed to the published version of the manuscript.

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