

Future Research in Health Information Technology: A Review

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Abstract

Introduction: Currently, information technology is considered an important tool to improve healthcare services. To adopt the right technologies, policy makers should have adequate information about present and future advances. This study aimed to review and compare studies with a focus on the future of health information technology.

Methods: This review study was completed in 2015. The databases used were Scopus, Web of Science, ProQuest, Ovid Medline, and PubMed. Keyword searches were used to identify papers and materials published between 2000 and 2015. Initially, 407 papers were obtained, and they were reduced to 11 papers at the final stage. The selected papers were described and compared in terms of the country of origin, objective, methodology, and time horizon.

Results: The papers were divided into two groups: those forecasting the future of health information technology (seven papers) and those providing health information technology foresight (four papers). The results showed that papers related to forecasting the future of health information technology were mostly a literature review, and the time horizon was up to 10 years in most of these studies. In the health information technology foresight group, most of the studies used a combination of techniques, such as scenario building and Delphi methods, and had long-term objectives.

Conclusion: To make the most of an investment and to improve planning and successful implementation of health information technology, a strategic plan for the future needs to be set. To achieve this aim, methods such as forecasting the future of health information technology and offering health information technology foresight can be applied. The forecasting method is used when the objectives are not very large, and the foresight approach is recommended when large-scale objectives are set to be achieved. In the field of health information technology, the results of foresight studies can help to establish realistic long-term expectations of the future of health information technology.

Keywords: health information technology, future research, foresight, forecast

Introduction

Information and communication technology (ICT) is a broad term that covers any product that stores, retrieves, manipulates, transmits, or receives information electronically and in a digital form. The application of ICT in healthcare, which is known as health information technology (HIT), includes a variety of technologies that are used to collect, transmit, display, or store patients' data electronically.¹ HIT is also a concept that describes the application of computerized systems to access healthcare information by patients, healthcare providers, insurance companies, and other government agencies. The

use of HIT helps to reduce medical errors, costs, and paperwork; increases the efficiency and quality of healthcare; and empowers patients and clinicians.²

HIT includes a wide range of products, technologies, and services, such as remote and mobile health technology, cloud-based services, medical devices, telemonitoring tools, assistant and sensor technologies, electronic health records (EHRs), and other applications of information technology in healthcare. These technologies can help users to collect, share, and use health information for different purposes.³⁻⁴

Cresswell and Sheikh argued that the use of HIT tools has been widespread across healthcare settings.⁵ Because of the proven benefits of such tools, the use of these technologies seems to be inevitable.⁶⁻⁷ However, the balance between benefits and risks of using information technology in healthcare organizations in the coming years is not clear. Therefore, to improve planning and successful implementation of these technologies, the use of technology forecasting methods has been recommended.⁸ Using these methods, healthcare organizations and policy makers can consider the issues that may occur in the future.⁹ Because of the rapid development of information technology, the expected benefits and future challenges of HIT will affect decisions made by policy makers.¹⁰

According to the literature, two approaches to predicting the future are available: forecasting and foresight.¹¹ Forecasting is the estimation of the short-, medium-, and long-term future in a particular research field. It normally ends with the identification of possible futures; however, forecasting does not necessarily mean a belief in the prediction or the predictability of the future in general.¹² Because the traditional methods of forecasting are not reliable approaches for future planning,¹³⁻¹⁴ systematic approaches, such as a future study, can be used to assess the future to identify future trends and directions correctly.

A future study may be called foresight, strategic foresight, prospective study, prognostic study, or futurology.¹⁵ Foresight is widely used to create long-term and medium-term visions for technological development.¹⁶ Martin defined foresight as “the process involved in systematically attempting to look into the longer-term future of science, technology, the economy, environment and society with the aim of identifying the emerging generic technologies and the underpinning areas of strategic research likely to yield the greatest economic and social benefits” and stated that “foresight is NOT the same as forecasting—it is a process not a technique.”¹⁷

Foresight studies are conducted to gain knowledge so that today’s decisions can be based more solidly on the available expertise. It is more than prognosis or prediction, and it holds the promise of managing uncertainty through intensive interaction between stakeholders.¹⁸ Technology foresight identifies the vital technologies of a country or industry that need to be developed to shape the desired future.¹⁹ It also is considered one of the most important elements of the technology development process. This process provides outputs to establish technology strategies and infrastructure. In addition, technology foresight supports public and private companies in terms of innovation, technology transfer and management, and competitiveness.²⁰ Today, technology foresight is widely accepted worldwide.²¹ The most important foresight methods include the Delphi technique (a method of obtaining a consensus of opinions of a group of experts by means of a series of questionnaires and feedback given to the participants), expert panels, literature reviews, scenario building, and identification of key/critical technologies.²²

The application of future studies in HIT was proposed by Englehardt and Nelson in *Health Care Informatics: An Interdisciplinary Approach* in 2002.²³ In 2013, another book, titled *Health Informatics: An Interprofessional Approach*,²⁴ emphasized the use of future studies to analyze the future of health information systems. These books emphasized the necessity of using foresight to provide a basis for designing and constructing future health information systems.

According to the literature review, many studies have investigated the future of HIT using different methods.²⁵⁻⁵² However, few studies have used foresight methods.⁵³⁻⁵⁶ This study aimed to review the literature on forecasting HIT across the world to help obtain a deeper understanding of HIT forecasting methods.

Methods

In this study, a comprehensive literature review was conducted. The study was completed in 2015.

Search Strategy

A number of databases, such as Scopus, Web of Science, ProQuest, Ovid Medline, and PubMed, were searched to obtain related articles. The keywords *foresight*, *future study*, *futurology*, *prospective*, *prognosis*, and *future* were combined with *health information technology (HIT)*, *health informatics*, *medical informatics*, *e-health*, *healthcare IT*, *health IT*, and *electronic health record (EHR)*. Boolean operators (and/or) were used to focus on the most related papers, and the time frame was between 2000 and 2015.

Selection Criteria

All non-English documents and editorial letters were excluded from the study. In addition, if the full text of an article was not available and the researchers were not able to obtain it by contacting the corresponding author, the article was excluded. Because of the limited number of research papers related to the future study of HIT, other documents, such as reports or review studies with a focus on forecasting or foresight of HIT, were included in this study.

Data Classification, Extraction, and Analysis

Initially, 407 papers were identified, and 45 of them were excluded because of duplication. Another 28 papers were removed because of the unavailability of abstracts or full text. The 334 remaining papers were screened with respect to their titles and the relevancy of their abstract to the subject of this study. At this stage, 47 papers were identified as relevant, and their full texts were studied. Having read the full texts, the researchers found that although the term *future* was used in the topic or the abstract of some papers, many of the papers mostly reviewed the existing literature and suggested the use of new or specific technology in the future or the development of the specific systems, such as EHRs. However, the researchers aimed to review and compare studies in which HIT was seen as a diverse set of technologies and different research methods were used to examine the future of it, preferably within a given time horizon. Therefore, considering the above mentioned criteria, only 11 papers were found appropriate to be reviewed in depth and were included in the study. (See Figure 1.) These papers were examined in terms of the country of origin, study objective, methods, and time horizon.

Results

As noted, the number of studies related to the future study of HIT was limited, and both forecast and foresight studies were included. Therefore, the results of this study are divided into two parts. The first part is related to research with a focus on forecasting the future of HIT ($n = 7$).⁵⁷⁻⁶³ The second part is related to research with a concentration on the foresight of HIT ($n = 4$).⁶⁴⁻⁶⁷

Forecasting the Future of HIT

According to the literature review, seven studies were related to forecasting the future of HIT. The country of origin, objective, methods, and time horizon of these studies are compared in the following sections.

Country of Origin

Studies related to forecasting the future of HIT were conducted in the United States,⁶⁸⁻⁷⁰ Austria,⁷¹ Britain,⁷² Japan,⁷³ and Bangladesh.⁷⁴ Table 1 shows more information about these studies.

Study Objectives

The papers that forecasted the future of HIT had different objectives. The objective of some papers was investigating the effects of HIT in the future.⁷⁵⁻⁷⁷ Other objectives included providing a road map⁷⁸⁻⁸⁰ and forecasting the acceptance of HIT in the future.⁸¹

Haux et al. studied the future of HIT in 10 years (2003 to 2013). They aimed to examine the impact of HIT development on healthcare and forecasted the possible impact in 2013.⁸² Sittig described some key concepts of clinical information management technologies and how these technologies may affect cancer care in the future.⁸³ Lucas investigated the potential values of various information and communication technology innovations and some of the obstacles that need to be dealt with in developing countries.⁸⁴ Kuzuno et al. stated their objective as providing a vision of HIT in 2025 to support the ideal vision of healthcare in 2025.⁸⁵

Bates and Bitton studied the future of HIT with an emphasis on patient-centered medical homes. Their study aimed to provide a road map for different areas of HIT.⁸⁶ Blavin and Buntin used experts' opinions to forecast the adoption and meaningful use of EHRs between 2012 and 2019.⁸⁷ Sheraz et al. concentrated on alternative futures of the use of e-health in decision making in Bangladesh.⁸⁸

Research Methods

Most of the studies related to forecasting the future of HIT were based on literature review.^{89–94} However, one study used the six pillars method,⁹⁵ and one used the Delphi method.⁹⁶

Haux et al suggested 30 forecasts about the future of HIT based on the results derived from a literature review. They then set a number of objectives to achieve that future.⁹⁷ Having completed a literature review, Sittig forecasted that in 2015, the next generation of Internet and wireless handheld devices, clinical decision support systems, large and integrated clinical and genetic databases with intelligent data mining techniques, and other related technologies would have a major impact on cancer care.⁹⁸ Lucas reviewed the literature to determine the potential benefits and challenges of information and communication technology innovations in healthcare settings.⁹⁹ In another study, Kuzuno et al. forecasted the future of HIT in 2025,¹⁰⁰ and Bates and Bitton suggested a road map of HIT based on the existing literature.¹⁰¹

Blavin and Buntin used different methods to complete their research. They conducted a literature review, collected experts' opinions, and used a modified Delphi technique, the EFTE (estimate, feedback, talk, and estimate) framework, to forecast the application of e-health in the coming years.¹⁰² The six pillars approach, a step-by-step approach for thinking about the future to understand the change process, was used by Sheraz et al.¹⁰³ The six pillars approach focuses on the desired changes. The focus on the future means that more than one possible future can be considered.

Time Horizon

In the studies related to forecasting the future of HIT, a time horizon is considered. Most of the reviewed studies had a 10-year vision.^{104–106} The time horizon was not specified in two studies^{107, 108} and few of them had a time horizon longer than 10 years.^{109, 110}

As noted, Haux et al. considered a 10-year vision (2003–2013) in their research.¹¹¹ Sittig looked at 10 years after the writing of the study, namely 2015.¹¹² Lucas considered the medium-term impact of HIT and did not mention a particular year in the future.¹¹³ Kuzuno et al. used a time horizon longer than 15 years and forecasted the future in 2025.¹¹⁴ Bates and Bitton did not consider any specific year in the future and provided a road map for the coming years.¹¹⁵ In the study by Blavin and Buntin, the time horizon was between 2012 and 2019.¹¹⁶ Similar to Kuzuno et al., Sheraz et al. examined a time horizon longer than 15 years, namely 2025.¹¹⁷

HIT Foresight

The literature review showed that a limited number of studies were related to HIT foresight.^{118–121} Although the term *foresight* was not used in some studies, the use of foresight methodologies, such as the Delphi method and scenario building, was considered in the process of selecting these documents. These methods have been used to determine the long-term future of HIT.^{122, 123} According to the literature review, four studies were related to HIT foresight. The country of origin, objective, methods, and time horizon of these studies are presented in the following sections.

Country of Origin

One study related to HIT foresight was conducted in Nordic countries (Denmark, Finland, Iceland, Norway, and Sweden),¹²⁴ and one was conducted in Germany.¹²⁵ Two other studies were conducted in Austria.^{126, 127} The details of these studies are summarized in Table 2.

Study Objectives

The research objectives of the selected studies were different. Some studies aimed to build scenarios for the future of HIT¹²⁸ and determine barriers to the use of the technology.^{129–131} One study examined the feasibility of using the technology.¹³²

The Nordic ICT foresight project was conducted to determine the application of ICT in northern Europe in 2005–2006. This project aimed to identify, select, and build scenarios to determine potential ICT applications with regard to the changes in technology, applications, and markets. The application of ICT in the health sector was part of this project.¹³³ Another project, which was called FAZIT (an acronym for its name in German), aimed to determine the future of information technology and barriers to the use of the technology in the health sector. This foresight study was conducted in 2006–2008 and answered the following questions: How will information technology change healthcare in the coming years? Which of these technologies cause changes? When and how can ICT be used to improve healthcare? What is possible but undesirable in relation to the use of ICT?¹³⁴

The studies conducted in Austria had different objectives.^{135, 136} In one study, Haluza and Jungwirth aimed to identify different Austrian stakeholders' perceptions of the future of clinical information technologies.¹³⁷ In another study, Haluza and Jungwirth investigated the future of information technology in relation to health promotion. In that study, the researchers collected data about the views and experiences of different stakeholders in Austria.¹³⁸

Research Methods

Studies that focused on HIT foresight used mixed methods.^{139–142} For example, the Nordic ICT foresight project included five main steps. In the first step (literature review), the boundaries of the technologies were determined. In the second step (analysis of strengths, weaknesses, opportunities, and threats [SWOT]), the national ICT business processes were identified in the selected countries (Finland, Sweden, Norway, Iceland, and Denmark). The third step included scenario building and workshops. The fourth step involved road mapping workshops in which sociotechnical visions were developed for the knowledge, science, business, market, and governmental sectors. The last step was a workshop in which strategies, action plans, and strategy-related subcategories were identified. Finally, the activities were evaluated to promote the expected results.¹⁴³

Similarly, in the FAZIT project, a mixed-methods approach was used. Because economic and social trends were investigated in this study, a combination of foresight methods was used. Possible technical and social developments were investigated using a Delphi technique. Initially, the possible information technologies in the next 20 years were identified and were classified in the form of theses. Then, 230 experts in the first phase and 86 experts in the second phase assessed the theses in terms of importance, feasibility, and desirability. Finally, the results derived from the previous phases were used to build a scenario for the future.¹⁴⁴

In one study conducted by Haluza and Jungwirth, the future of HIT was investigated in terms of patient-physician relationships. This study included four phases. Initially, scenarios related to the future of HIT were identified. Then, each scenario was evaluated in terms of its future benefits, potential challenges, innovation level, desirability, and year of realization between 2010 and 2030. In the third phase, the Delphi technique was used to collect the experts' views. Finally, the data were analyzed, and the results were reported to the experts.¹⁴⁵ The other study conducted by Haluza and Jungwirth used a similar approach. However, this study differed from the previous one in terms of the subject and the number of scenarios.¹⁴⁶

Time Horizon

The time horizon in most studies was more than 20 years.^{147–149} One study had a 10-year vision, but in practice the time horizon was longer than 10 years.¹⁵⁰ Specifically, in the Nordic ICT foresight project, the time horizon was between 2007 and 2017. However, the future roadmap was divided into three categories: short-term (1–5 years), medium-term (5–10 years), and long-term (10 years and more).¹⁵¹ In the FAZIT project, the following time periods were considered: 2006–2010, 2011–2015, 2016–2020, 2021–2025, 2026–2030, and later.¹⁵² In both studies conducted by Haluza and Jungwirth, the time horizon was between 2010 and 2030.^{153, 154}

Discussion

The current study showed that research related to forecasting the future of HIT was limited. Although many studies focused on forecasting or estimating the future of HIT,^{155–161} few studies used systematic approaches to HIT foresight.^{162–165}

Comparison of these two groups of studies revealed that the main difference between them was related to their objectives. In the forecasting studies, the objectives included generating theses for the future,¹⁶⁶ providing key concepts,¹⁶⁷ determining the advantages and drawbacks of using the technology,¹⁶⁸ providing prospects for the future,¹⁶⁹ developing a road map for the future of information technology,¹⁷⁰ forecasting the use of EHRs,¹⁷¹ and outlining an alternative future.¹⁷² Also, in the forecasting studies, the objectives were related to a small number of technologies. In the HIT foresight studies, however, the objectives were complicated. For example, in one study the objectives were the identification, selection, and presentation of scenarios to determine the vision of ICT applications considering changes in technology, applications, and markets.¹⁷³ In another study, numerous possibilities for the future of HIT were closely examined.¹⁷⁴ Investigating the perception of different stakeholders regarding the future of HIT was the objective of other studies.^{175, 176}

Another difference between the foresight studies and other future research was related to the research methodologies. Literature reviews were often used in forecasting the future of HIT,^{177–181} while more complicated methods, such as modified Delphi¹⁸² and six pillars¹⁸³ techniques, were used in the foresight studies. A combination of a survey, SWOT analysis, a scenario and vision workshop, a road mapping workshop, and an action workshop¹⁸⁴ or a combination of a literature review, an expert panel, the Delphi technique, and scenario building were used in HIT foresight studies.¹⁸⁵ Some studies used a combination of scenario building and the Delphi technique.^{186, 187} Moreover, it was found that foresight studies emphasized the opinions of the experts and stakeholders, whereas in the future forecast studies, researchers forecasted the future on the basis of the literature review.

Another difference between the forecast studies and the foresight studies was related to their time horizon. In the future forecast studies, usually a time horizon of 10 years^{188–190} was considered, and in a few studies, the time horizon was longer than 10 years.^{191, 192} In some papers, no time horizon was specified, and the future was considered in general.^{193, 194} In contrast, the foresight studies had a long-term time horizon, usually longer than 10 years, and had a more realistic view of the future.^{195–198} It is notable that, according to the literature, researchers may consider 5 to 50 years as the future,^{199, 200} which may cause an overlap between the concepts of foresight and forecasting.²⁰¹

Finally, a comparison between studies related to forecasting the future of HIT and those providing HIT foresight showed that these two types of study had fundamental differences. The foresight studies focused on networking and making decisions regarding the future. This is one of the reasons that foresight studies have been conducted in many countries and have been substituted for forecasting the future since the 1990s. The results of foresight studies provide information about the future, which is essential for strategic planning and decision making.²⁰² Because efforts to develop and implement health information systems have faced severe economic challenges and growing demands for better services,^{203, 204} policy makers prefer to use the results of foresight studies in this area to be able to make better decisions and design an appropriate road map with more confidence.

Conclusion

HIT is considered one of the most promising areas of technological development in healthcare. As a result, substantial investments have been made in this area in countries around the world. To make the most of an investment and to improve planning for and successful implementation of these technologies, a strategic plan for the future needs to be established. To achieve this, methods of studying the future of HIT, namely, forecasting the future of HIT and HIT foresight, can be applied. The forecasting method is used when the objectives are not very large, and the foresight approach is recommended when large-scale objectives are set to be achieved. The use of mixed methods in the foresight studies can help to gain a more precise and realistic picture of what has to be done to reach the desired future, whereas forecasting seems to be more theoretical than practical.

HIT foresight can be used to identify, select, and present scenarios for a longer-term future in this field. It seems that the results of such studies can provide a basis for decision making and policy making in the field of HIT, particularly at a national level. Moreover, the involvement of experts and policy makers can help to provide more realistic expectations of the future of HIT in a long-term perspective.

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Notes

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Figure 1

The Process of Selecting Papers for Research

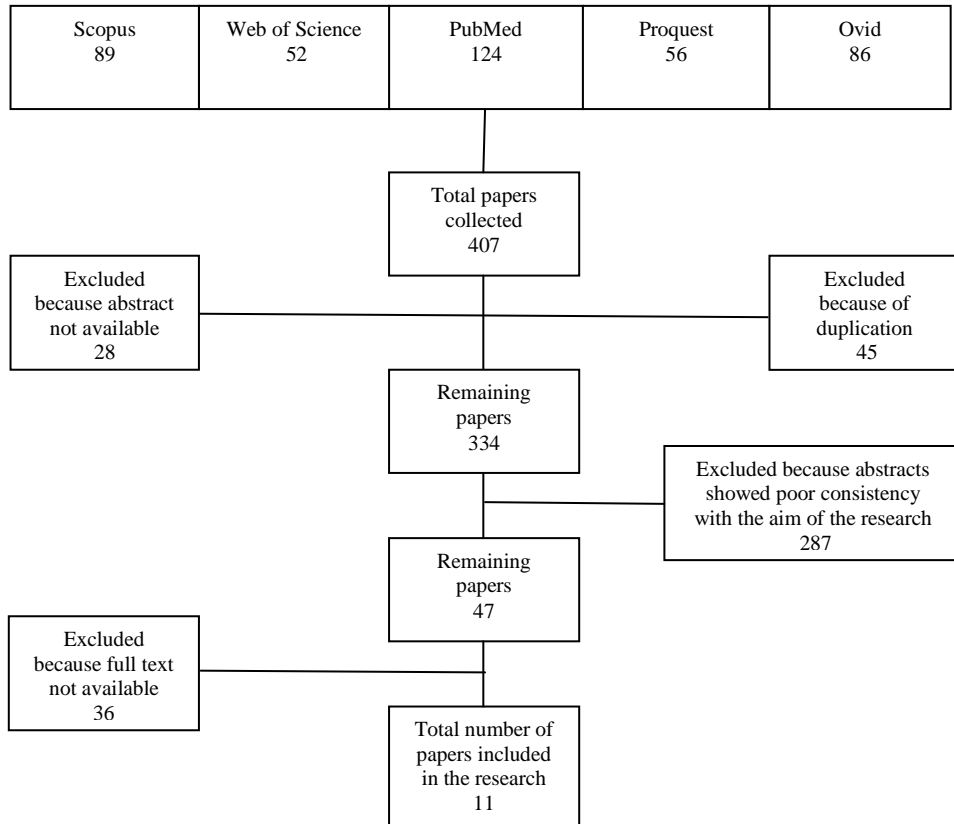


Table 1

Studies Related to Forecasting the Future of Health Information Technology

| Title | Year | Author(s) | Country | Objectives | Methodology | Time Horizon |
|---|-------------|-------------------|----------------|---|---------------------------------|----------------------|
| “Health Care in the Information Society: A Prognosis for the Year 2013” | 2002 | Haux et al. | Austria | To set up 30 theses for healthcare provision in the year 2013 to cover areas of healthcare, such as its people, its information systems, and information and communication technology (ICT) tools | Literature review | 2003–2013 |
| “Potential Impact of Advanced Clinical Information Technology on Cancer Care in 2015” | 2006 | Sittig | United States | To describe a few key concepts in clinical information management and communication and how those technologies might affect the cancer care continuum in the future | Literature review | 2006–2015 |
| “Information and Communications Technology for Future Health Systems in Developing Countries” | 2008 | Lucas | United Kingdom | To assess the potential benefits of a diverse range of ICT innovations and some of the constraints they will need to overcome | Literature review | Future (unspecified) |
| “Perspectives of Future Healthcare IT” | 2008 | Kuzuno et al. | Japan | To develop healthcare information technology (IT) solutions that will support a vision of a society that achieves optimum use of healthcare services | Literature review | Up to 2025 |
| “The Future of Health Information Technology in the Patient-centered Medical Home” | 2010 | Bates and Bitton | United States | To propose a road map of the related features of patient-centered medical homes | Literature review | Future (unspecified) |
| “Forecasting the Use of Electronic Health Records: An Expert Opinion Approach” | 2013 | Blavin and Buntin | United States | To forecast the percent of office-based physicians who will become adopters and “meaningful users” of health information technology | Delphi study (experts’ opinion) | 2012–2019 |
| “E-health Futures in Bangladesh” | 2013 | Sheraz et al. | Bangladesh | To delineate alternative e-health futures for public health policymaking in Bangladesh | Six pillars | Up to 2025 |

Table 2

Studies Related to Foresight of Health Information Technology

| Title | Year | Author(s) | Country | Objectives | Methodology | Time Horizon |
|--|-------------|----------------------|------------------|--|---|---------------------|
| <i>Nordic ICT Foresight: Futures of the ICT Environment and Applications on the Nordic Level</i> | 2007 | Ahlqvist et al. | Nordic countries | To contribute to the strategic intelligence of the Nordic region so that the full potential of information and communication technology (ICT) can be exploited to increase welfare in the Nordic countries | Survey SWOT (strengths, weaknesses, opportunities, and threats) analysis Scenario and vision workshop Road mapping workshop Action workshop | 2007–2017 |
| “Future Information Technology for the Health Sector—A Delphi Study of the Research Project FAZIT” | 2009 | Cuhls et al. | Germany | To identify developments in information technology that could become relevant during the next 20 years | Expert panel Delphi method Scenario building | 2006–2030 and later |
| “ICT and the Future of Health Care: Aspects of Doctor-Patient Communication” | 2014 | Haluza and Jungwirth | Austria | To identify specifications and perceptions of different interest groups regarding future demands of ICT-supported doctor-patient communication in Austria | Scenario building Delphi method | 2010–2030 |
| “ICT and the Future of Health Care: Aspects of Health Promotion” | 2015 | Haluza and Jungwirth | Austria | To assess the prevailing opinions and expectations among Austrian stakeholders regarding ICT-assisted health promotion | Scenario building Delphi method | 2010–2030 |