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Information ecology in digitalising welfare services: a multi-level analysis

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Abstract

Purpose: This paper's aim is to examine and re-interpret information ecology in the context of the changing environment of services, which has been strongly affected by digitalisation and increasing citizen engagement. Here, information ecology refers to the interaction and co-evolution of technologies, human beings and the social environment.

Design/methodology: The data consist of 25 thematic interviews conducted in a public Finnish organisation responsible for organising welfare services, and in its collaborating organisations. The interviews were analysed qualitatively. The analytical framework is based on Nardi and O'Day's five components of information ecology: system, diversity, co-evolution, keystone species and locality.

Findings: The analysis shows that these basic components still exist in the digitalisation era, but that they should be interpreted and highlighted differently, for example, stressing the openness of the information system instead of closed systems, as well as emphasising the increasing meaning of diversity among digitalisation, and the dynamic co-evolution between the elements of the system. New capabilities, such as the ability to combine various kinds of information and knowledge, are needed in this adaptation.

Research implications: The study illustrates a wider, updated information-ecology concept with the help of empirical research. Technology affects care organisations' information ecologies in numerous – often invisible – ways, which this study brings into light.

Originality/ value: So far, information-ecology research has overlooked social and health care, but this study provides findings concerning this societally important sector.

Keywords: End users, Health information system, E-health, E-service, Information Management, Organisation, Multilevel research

1 Introduction

Digitalisation challenges current business models, practices and service organisations in all fields and spheres of life. The utilisation of digitalisation is about grabbing new opportunities, and researchers have claimed that all that can be digitalised will be digitalised (Brynjolfsson and McAfee, 2014). Although digitalisation has much to offer in the effectiveness of service operations, the control and agency over the quality of services are no longer embedded in the dyadic relationship between citizens and frontline service personnel. This is the case in point in contemporary welfare services. Complex relations among citizens (with various digital competencies), the front line personnel and digital infrastructure transform the care system into a diffuse system (Breit and Salomon, 2015).

The operational environment of welfare services is experiencing changes in many societies. According to Oborn and Barrett (2016), two contemporary trends are seen as having the capacity to significantly reshape healthcare delivery in the coming decade. The first trend is digital health and big-data science, and the second is increasing patient and citizen engagement (Oborn and Barrett, 2016; see also Pekkarinen and Melkas, 2019). These trends are strongly related to increasing citizen responsibility, co-production of information, usage and mastery of one's own health data and digitalisation of (self-)services. These trends also seem to play a major role in Finland, where the structure of public welfare services – meaning social and healthcare services – are under reconsideration.

Digitalisation plays a major role in renewing welfare services, and high hopes have been placed on digitalisation and technological innovations such as electronic health (e-health), various types of health and safety monitoring, home automation, and robotics (Pekkarinen and Melkas, 2017). The government has adopted strategies for enhancing the digitalisation of public services (Ministry of Finance, 2019). Services can be produced in a new manner, and service processes can be optimised with the help of digital tools, with the aim of supporting both users and professionals. However, concerns have arisen regarding citizens' equal opportunities and their access to digital services, as well as care professionals' changing work tasks, new demands and requirements, such as online chat and service-advisor roles (Hyppönen and Ilmarinen 2016; Vehko *et al.*, 2019).

E-health and health-information technology have traditionally supported patients by enabling better access to records, integrated diagnostics and information searches, but nowadays, patients can engage with their health and other care services in new ways, such as via social media. In doing so, patients and service users are also creating new forms of data, evidence, knowledge and support that can offer value to different stakeholders (Oborn and Barrett, 2016), but there has been a research gap on how to handle this issue at the strategic level. Thus, digitalisation includes both hardware (i.e., different kinds of technological devices), software (i.e., information systems) and combinations of the two, in addition to human factors and practices. However, according to Oyeyemi and Scott (2018), there are serious challenges regarding interoperability in health and social care, in the ability to exchange and use information in different systems. Organisational barriers as well as unawareness related to different regulations and standards turn to be the biggest challenges in this regard (Oyeyemi & Scott, 2018).

Information management has traditionally been approached through investment in new technologies, which is not sufficient in organisations, as it just gives ‘an illusion of control’ and is detrimental to an organisation’s productivity and effectiveness (Melkas, 2010). A human-centred approach to designing and managing information environments encompasses (i) information strategy; (ii) information politics, behaviour and culture; (iii) information staff and management processes; and (iv) information architecture. It has been noted that an economic view that does not include social dimension is too narrow, especially from a long-term perspective (Davenport and Prusak, 1997; Hyytinen *et al.*, 2019). One response to this shortcoming is the *information ecology* perspective.

This article explores service digitalisation and its impacts on a care organisation’s information ecology. The aim of this study is to analyse the ongoing changes in the care sector in light of the information-ecology perspective, with the aim of reinterpreting and enriching this framework. The main research question is:

In what ways are the elements of information ecology changing, along with the changing information environment of a care organisation, which is strongly affected by digitalisation?

This question is examined by looking into the expectations, experiences and roles of care managers, professionals and citizens as service users of digitalised services in an environment (i.e., a care organisation) that is characterised by ongoing multi-level changes. Examining the information ecology of an organisation provides valuable knowledge in the current era, when information ecologies in care organisations are likely to be affected in numerous ways by technology (Hope, 2019; Hyysalo, 2007; Miettinen *et al.*, 2003). This qualitative case study is focused on an intensive digitalisation phase of the welfare services in a Finnish care organisation.

In this study, it is asked how the conceptualisations of information ecology found in the literature fit into our multi-level context of change in welfare services, and whether the study offers some novel perspectives to existing conceptualisations. The concept of ‘multi-level’ refers here to different organisational and network levels, covering user levels and non-governmental organisations (NGOs) in addition to ‘line organisation’ levels. We will discuss the applicability of the concept in the present digitalisation era, using it as an analytic tool to assess the ongoing changes in the care sector. We will study the most prominent features and challenges in these changes from the point of view of different stakeholders in a care organisation.

This study highlights the social dimension and contributes to a human-centred approach (e.g., an employee-driven approach; Saari *et al.*, 2019b) in a digitalising care-service context. To fix hot-spot issues in social development, such as aging populations, scholars should conduct research at various levels, including at the organisational level, by applying information-ecology theories and using case studies and empirical research methods, such as exploring ways to apply information and communication technology (ICT) (Wang *et al.*, 2017).

The structure of the paper is as follows. In the next section, the concept of information ecology is presented, which forms the theoretical background of the study and the basis of the analysis. In the following methodology section, the case context and the subsequent collection of empirical data, as well as data analysis, are described. After the methodology section, the results of the qualitative analysis are presented, followed by the re-interpretation of the framework of information ecology in the digitalisation era. Finally, the conclusions and discussion are presented with theoretical insights and practical implications.

2 The concept of information ecology

This study's central concept is information ecology, a term first used in the context of the evolving information society in the 1980s and 1990s. It reflects a connection between ecological ideas and the dynamics and properties of the increasingly dense, complex and important digital-information environment. Hasenyager (1996), for example, noted that paying attention to an organisation's information ecology, and the skilled personnel as part of it, will make the use of information technologies more efficient and thus lower the costs. (Hasenyager, 1996).

The concept has been used in a growing number of disciplines, often as a metaphor that views the informational space as an ecosystem (Davenport and Prusak, 1997). There seems to be a research gap in utilising the concept in the context of welfare services (Wang *et al.*, 2017); nevertheless, a few studies can be found (e.g., Melkas, 2010; Nazi, 2013; Teodoro, 2016). Related concepts include Star and Ruhleder's (1996) classic contribution on ecology of infrastructure associated with large information spaces, identifying the tension between the local and flexible use of an information system on the one hand, and the need for standards and continuity on the other. A more recent contribution (Tilson *et al.*, 2010) suggests that digital infrastructures are a 'new species of IT artifact' that expand the information systems research views on information infrastructures. Although we see infrastructure as a key concept in the digitalisation of work, we chose to apply the information ecology framework to represent the constantly evolving, multi-level change context of digitalising welfare services.

In an organisational context, information ecology is not only about architectural designs and IT solutions, but also information strategy, politics, behaviour, support staff and work processes (Davenport and Prusak, 1997). Information ecology has also been described as a science (Eryomin, 1998) that studies the laws governing the influence of information on the formation and functioning of bio-systems, including those of individuals, human communities and humanity in general, and on the psychological, physical and social well-being of humans. Furthermore, it is a science that strives to develop methodologies to improve the information environment. Wang *et al.* (2017) considered information ecology as 'a field that studies how human beings, information and communication technologies and the social environment can develop together in a harmonious fashion'. The concept of information ecology offers a potentially useful perspective on daily services in increasingly technological environments. According to Miyazaki *et al.* (2012), information ecologies can provide new frameworks for interpreting the complex relationships among organisations, information technologies and information objects in the context of information (Wang *et al.*, 2017).

According to Eddy *et al.* (2014), the two general contexts in which the term information ecology is applied can be categorised as (i) information environments within human organisations and (ii) information environments that involve interaction between human systems and natural systems. The first area focuses specifically on information technology and management, with particular emphasis on political and cultural aspects of information use within human organisations. In this context, ecology is used as a metaphor for the contention that processes affecting information flow and use in human organisations exhibit characteristics similar to processes observed in natural systems. The second area in which definitions have been proposed are those that include the study of information processes in both the human domain and the natural world, with particular emphasis on the role of information in interactions between the two. Eddy *et al.* (2014) argue that what is missing in the extant literature is a model that can provide a more explicit link between how information functions in natural systems and human systems in an adaptive, evolutionary context. While Eddy *et al.* propose a conceptual model to fill this gap – an interesting multi-level framework to information ecology – their general model seems to focus mostly on the science-policy interaction level. Therefore, this study of a care organisation is mainly built on Nardi and O'Day's (1999) conceptualisation, in which they defined information ecology as 'a system of people, practices, values and technologies in a particular local environment', which is more applicable to the organisational context. The spotlight here is not on technology, but on the human activities that technology serves.

According to Nardi and O'Day (1999), information ecology is a complex ecosystem of parts and relationships, and the focus of attention is on relationships involving tools, people and their practices. The five different elements or properties that they highlight as relevant to information ecology – system, diversity, co-evolution, keystone species, and locality – are outlined in Table 1.

TABLE 1 AROUND HERE

Table 1. The elements of information ecology as a framework for analysing the empirical data (Nardi and O'Day, 1999).

In a care context (e.g., a hospital unit), information ecology is a system that consists of human experts and different kinds of healthcare technologies that all have a role to play in delivering services and ensuring smooth care. Though this setting obviously relies on advanced technologies, it is clear that human expertise, judgement, empathy, cooperation and values are central in making the system work (Nardi and O'Day, 1999).

To describe information ecology in welfare services, new concepts that stress the creation and sharing of information and knowledge, particularly as a social process, can also be utilised. For instance, knowledge mobilisation (Swan *et al.*, 2016) offers a perspective on how to tackle the persistent 'knowing-doing gap' in health care. This gap contends that when new knowledge is created, only some of it is shared, and even less is used (Gkeredakis *et al.*, 2011). A more dynamic perspective is needed because 'evidence-based management', as a rather linear, science-based model, underestimates the social nature of knowledge and the challenges of mobilising knowledge across boundaries created by different kinds of practice (e.g., different occupational groups; Swan *et al.*, 2016). In this perspective, knowledge is not something people 'have', but rather what they 'do' and who they 'are' (Cook and Brown, 1999; Swan *et al.*, 2016). Thus, knowledge is socially created, shared and transformed in different communities in practice. In this social process, there are not only knowledge producers and utilisers, but also multiple agents operating in different domains of action, for example, management decisions, clinical projects and regulatory systems (Swan *et al.*, 2016). As a reverse side, there are also concerns about privacy and security as barriers to the adoption and use of knowledge, thus affecting information ecology. Personal health records are an example of these concerns (see, e.g., Nazi, 2013).

The different conceptualisations presented in the extant literature contain a basic shared idea of the co-evolution of technologies and social aspects, but some of these studies take a scientific approach, while others are more focused on the system dynamics in practice at the organisational or wider levels. The present study could be characterised as taking the middle ground, as it both updates the information-ecology concept and focuses on organisational system dynamics in local practice.

3 Case context and methodology

The case study sheds light on the operational side of service digitalisation. The case organisation has been a national forerunner and one of the benchmarking models in organising welfare services in a novel way. The strategic aims of this particular case organisation correspond quite well with contemporary digitalisation trends (Oborn and Barret 2016), as well as Finnish national digitalisation objectives, which makes it particularly interesting for a case study.

The case organisation provides primary and secondary healthcare services, family and social services, rehabilitation services and services for senior citizens. It is responsible for integrated social and health care in a rather broad geographic region in Finland, consisting of both urban and rural municipalities with a total population of 130,000. The organisation had a budget of 450 M€ and over 4,000 employees during the empirical data collection period. It utilises expertise and resources from private- and third-sector actors (associations) in its development processes and partially in its service delivery.

The organisation's recent digital strategy maintains that digitalisation aims to support the development and integration of the entire service system of the district. Today, instead of separate information systems in each of the nine municipalities of the area, common systems are increasingly in use in the integrated social and healthcare district, including an electronic patient health record (PHR) system, an electronic social service client (CRM) system, a centralised placement (assess-quality-place, AQP) system, a financial system and a personnel system. This reflects the digital and big-data science trend referred to by Oborn and Barret (2016). Multi-level changes in the operational environment also include a homecare-based care model, e-services, development of process support and logistics, transparency of management operations, services 'on wheels', and replacing traditional PHR and CRM systems with modern systems incorporating co-usability and user-accessible features. Among these, the homecare-

based model, e-services and the anticipated partial-user access in the PHR and CRM systems represent the trend of patient and citizen engagement discussed by Oborn and Barrett (2016).

The data collection involved 25 thematic interviews (24 persons, one person was interviewed twice) in the public care organisation and in an organisation with which it collaborates. Of these 24 interviewees, five were service users or family members. To secure an in-depth analysis of information ecology on the organisational level, the 19 professionals interviewed were purposively selected from different tasks and organisational levels that were identified as central for the ongoing change of increasingly digitalised services. The number of participants per group was selected in order to create a balance between the groups. A written consent for participation and for audio recording was obtained from the interviewees. The interviews were combined with a literature review. The interviewees' profiles are described in Table 2.

TABLE 2 AROUND HERE

Table 2. Interviewee profiles (19 professionals from management and employee positions, and five service users or their family members).

The interviews were transcribed and analysed in consideration of the five aforementioned elements of information ecology (Nardi and O'Day, 1999), with attention paid to the characteristics (e.g., how the aforementioned trends of digital health and patient engagement become visible in the data) of the local healthcare system. Thus, it was a qualitative content analysis with a theory-driven approach, but inductive and deductive phases alternated. After reducing the data into essential expressions concerning the relationships of technology and people, the information flows, and information sharing, and inductive formation of subcategories, these subcategories were classified along the elements of information ecology. An example of how the analysis was done is described in Table 3.

TABLE 3 AROUND HERE

Table 3. Example of the analysis.

The first phase of the analysis was to develop a thick, contextual description of each participant group's point of view. A thick description explains behaviour in its social and cultural context (Hennink *et al.*, 2011), which means respecting participants' perspectives and their personal accounts of their actions and experiences related to change. The interview topics covered stakeholders' roles and working tasks, and the changes experienced within them. Broader-level developments (e.g., related to changes in work and competencies needed) were also mapped. The interviews clearly provided a forward-looking nature, as they also focused on future developments. In the second phase, interviewees' perceptions of their past, present and future experiences/expectations, roles, practical tasks/duties, benefits and ideas related to their work/services were traced (multiple-points-of-view analysis). The interviews also included a few narratives about everyday life in the workplace. The themes were the same for all professional interviewees, which means that similar types of questions were asked of all participants, but the formulation and perspectives of questions varied depending on their work (or other) roles (Hasu, 2005; Rhodes and Pullen, 2009). The professional interviewees were asked to ponder the issues from their own professional perspectives in relation to other groups. As for the service users, the interviews covered their overall living situations, experiences with services, and their willingness and ability to use digital services.

The focus of this study is on information ecology in the local changing environment of welfare services, with a focus on one organisation because of its forerunning position, representing multi-faceted changes in the whole field. The aim is to grasp information ecology as a systemic issue in which several actors and levels of the organisation are involved. Because the ongoing changes concern the entire organisation, the aim is to grasp the different aspects of digital change related to information on various levels of the organisation. The expectations, experiences and roles related to information from different perspectives are studied, including management, ICT development, healthcare

professionals (employees), users and users' relatives. Appendix 1 shows the framework used to identify central themes in the data, drawing from extant literature and considering interviewees' varying organisational positions.

4 Findings

In this study, it was asked how information ecology is changing, along with changes in welfare services, focusing on the two trends of digitalisation presented by Oborn and Barrett (2016). Information ecology in a social and healthcare organisation is, in many ways, affected and transformed by the development and use of digital technologies and citizen engagement. According to the interviewees, especially those in management and development positions, digitalisation is not a separate issue in the organisation in question, but linked to changes in services and in wider thinking models, such as making the service user act in a more proactive role rather than a reactive one. Electronic communication is considered to be an integrated part of multi-level change.

In this section, this change of increasing digitalisation is examined through the five components of information ecology: system, diversity, co-evolution, keystone species and locality (Nardi and O'Day, 1999). Each component is studied from different perspectives (stakeholder groups: management, development, employee, user, users' relatives) within the case organisation in order to analyse the meaning and interpretation of each component from the point of view of each group. Also, the challenges related to the component in question were studied. The findings are summarised in Table 4, followed by more detailed descriptions. In addition, some insights and interpretations related to these findings based on the literature are offered.

TABLE 4 AROUND HERE

Table 4. Summary of findings: the elements of information ecology from the point of view of stakeholder groups.

4.1 System

According to the findings, there are some differences between the groups (i.e., objectives at the management level and the level of practices).

The *managers* highlight that welfare services are changing in many ways from a systemic perspective: health is perceived as a more holistic issue, and new players and actors with new technologies are entering the service system, with increasing interdependencies between them. An interviewed manager described: '[I would highlight] the broad view of rehabilitation – not only physical, but including also mental and social viewpoints, and where digitalisation is combined with multi-professional need assessment and rehabilitation. But also, with the help of digitalisation, the citizens are empowered to participate in every way, and also the families and other stakeholders, like peer actors and third-sector actors'. Overall systemic thinking is stressed, as well as increasing digitalisation as a general practice and 'a new normal'. How to get personnel involved in this digital transformation is seen as a challenge.

The *developers* are striving to develop services and technology simultaneously and continuously. The challenge felt by ICT departments is that they view themselves as a 'primus motor' in innovating new practices because the units are not eager to innovate themselves. Too many kinds of information systems and incompatibility between them are viewed as a major challenge, as one ICT developer described: 'The biggest issue concerns the integration of the patient information system, which will not be a reality in the near future'. Also, the performance of information systems is a problem in a broad geographical area with several municipalities. Therefore, many different information systems are needed.

Care professionals feel that collaboration between technology developers and healthcare professionals is not adequate. One interviewed physician noted: 'The ICT people came to teach us about the functionalities of encrypted email, but our first question was, "What do we use it for and why would we need it?"' Another factor is inadequate training for skills that are expected to be mastered in the changing environment. Professionals are expected to have

the knowledge and the time to accomplish many new tasks, even installing new systems. One developer observed: 'The technology enterprises assume that the nurses should install the systems. However, nurse education is lacking such training'. Therefore, more volunteers and third-sector actors would be welcome in the system.

Interviewed employees also said a holistic view of a service user's situation is often lacking, for example, when the patient leaves hospital care, she or he may not always remember, even if it has been explained, whom to contact for care needs from home. However, joint information systems between primary and specialised health care have been helpful. Still, some information systems do not 'collaborate', and patient information is not recorded properly. Thus, the service user must provide the same information several times. The new system seems somewhat complicated to service users.

When information systems do not communicate with one another, it causes double work for professionals as well. One system is needed for communicating with service users, and another is needed for documentation, as one nurse described: 'Probably the biggest problem is that the communication system does not communicate with the patient information system and, therefore, we need to do a kind of double documenting when we first reply to the customer in one system and then document it in the other'.

Third-sector actors (associations) have entered the healthcare system as new actors and provide voluntary peer instructions for technological use. Their role has been considered important, both on the strategic level and in practice. As described by one employee: 'They should be better utilised. For instance, if a person has a cardiovascular disease, she or he could get peer support in this way'. However, their role in the system is somewhat unclear. They are perceived as important, for instance, in the promotion of health, but because of somewhat unstructured collaborations, the needs and offerings do not meet, and the full potential of these organisations as a resource has not been fulfilled. For the elderly *service users*, the new system with digitalisation is unclear; at least some of them miss the old (simpler) system.

The analysis of the points of view of various stakeholder groups together shows that there are incompatibilities concerning how the different actors see their role and place in the system, as well as what the role of technology in the system is and how technology interacts with various practices. In the literature, these incompatibilities can be interpreted as a 'structural lag' (Riley and Riley, 1994) in the complex system, in which different parts of the system do not perceive needs and offerings (e.g., individual and societal needs) and the development of technologies and services. Many interviewees noted that it is quite typical for technologies to be developed separately without much thought given to the technologies' functions and aims. Related to the trend of digital health, it is typical to allocate resources for the design of e-services and digital channels, but apparently, only information technology experts are developing information systems. Related to the trend of citizen engagement, in turn, service users and care workers using these systems in practice rarely participate in this work, hindering their development and implementation. One of the aims of involving third-sector actors has been, for instance, to provide peer support in the promotion of health, but their unclear and somewhat unestablished role in the system hampers their usefulness. Previous research on the adoption of e-services has indicated that citizens' digital skills and readiness for digital communication play a crucial role in how the work of service providers may be organised. It seems that citizens who do not have the ability to use e-services force service providers to organise assistance for them to become future users of digital interfaces, while also providing face-to-face services. This is often experienced as work overload by frontline personnel and remains a rather invisible problem for managers (Åkesson and Edvardsson, 2008; Berger *et al.*, 2016; Breit and Salomon, 2015).

4.2 Diversity

In information ecology, different kinds of people and tools work together in a complementary way (Nardi and O'Day, 1999). Diversity of actors seems to be central to the changing environment of welfare services. In this changing environment, new actors have entered the system.

The *managers* highlight the willingness to think differently and develop new ideas outside the organisation and the care field, as it was expressed by one person in management: 'It would not be so bad, if we would think about issues in more of an engineering way, because you easily become blind to what you do. Always, when someone looks at things from an outsider's angle [...] it's never bad when someone questions why this is done in this way'.

The *developers* mentioned that citizens' new, more central role demands collaboration between professionals, and that the question of considering the service user as a citizen who may need something besides medical care is central. One developer describes the present activities: 'We have strong collaboration with associations, various group activities and lectures in well-being centres. We have been praised for raising also other issues besides getting the diagnosis. This means that the concept of health or well-being is perceived as more holistic'.

Care professionals say they have new workmates from many different professional groups, for example, preventive healthcare work is done in a joint group with representatives from every municipality of the region working in collaboration with police, fire and rescue, churches, educational organisations and several NGOs. Great experiences working closely in pairs, one from the side of health care and another from social work, have been reported. In addition, collaborations with technology providers concerning different technologies are needed, but in this case, the organisation's information technology department often plays the role of 'interpreter'. Different actors with different kinds of knowledge and skills complement one another, but at the same time, they require new skills, such as openness, a willingness to learn and the ability to combine knowledge.

Third-sector actors (associations) have a lot of unused potential in preventive activities, providing 'other kinds of support' (as described by a person working in an association), but this potential is not yet fully realised. They are interested in collaboration, but they need more support to become better integrated into the system and see their role in it.

Increasing diversity also has its challenges. Working with different people from different practices and backgrounds, with different kinds of knowledge is also a question of trust. Some trust problems have been noted between professionals, with healthcare professionals tending to prefer mastering their work and time themselves, seemingly not trusting other professionals' expertise. For example, when assessing whether a service user needs to book an appointment for a professional from another field, one coordinator noted: 'The prevailing thinking model is: "This is my appointment book, and no one is going to touch it"'.

This new, active role for the *service user* is also part of the diverse and multi-faceted knowledge now available. It means that medical professionals do not necessarily give unconditional and imperative orders about what the patient should do, especially regarding long-term diseases and the promotion of health. Instead, as a physician noted, the patient is asked to commit to certain issues first (e.g., to increase exercising if she or he does not feel ready to stop smoking yet). In this kind of user-centred and contextual thinking, the user is a subject and a co-producer of health information that is often a combination of clinical knowledge and the user's experience-based knowledge. An older service user herself noted the change in the way of speaking: 'We are now clients, before we were patients'. These changes in terms of new roles and new communication channels sometimes cause insecurity among older people.

To summarise, diversity is seen as richness by all the stakeholder groups, but many feel that it is challenging to determine how to benefit from it more. The new role of the citizen is perceived as particularly challenging. When examining extant literature, this is completely different from the old-style model, in which services were presented to users in a uni-directional fashion, rather than working with them in a partnership (Jung, 2010). For instance, rethinking chronic diseases, such as diabetes, as a lifestyle rather than a mere disease may question prevailing assumptions and connotations within the current medical model (Storni, 2013). It is essential that the current base of power be re-delegated so that it incorporates citizens because without a fresh mindset and supporting technology, patient empowerment and cooperative partnerships will remain a mere theory (Lahtiranta *et al.*, 2015). Traditionally, the healthcare system has been characterised by professionalism and unquestioned administrative authority, with little room for diversity and individual user involvement, which is noted by Evers (2006).

In addition to demands to take the service user seriously as part of information ecology and as a producer of knowledge, the interviewees note that users increasingly differ from one another, and that the number of service users with multiple problems has increased. Furthermore, as McColl-Kennedy *et al.* (2017) note, health care is no longer viewed merely as a transaction between the patient and the professional, but instead relies on collaboration between multiple actors in an ecosystem, and that the roles, activities and responsibilities of service users and professionals keep changing. Modern health care also highlights the importance of the patient's broader network, such as family, friends and other patients (McColl-Kennedy *et al.*, 2017). This is strongly related to the trend of citizen engagement and the co-production of information and knowledge (Oborn and Barret 2016). In utilising

information provided by the citizen and her or his relatives and combining it with other information sources, skilful management of the diversity aspect of information becomes crucial.

4.3 Co-evolution

Co-evolution is very much related to interconnected changes in the system by diverse actors. From a co-evolution point of view, one clear developmental path identified during the interviews was the perception of digitalisation as functional and operational rethinking, which entails developing technologies simultaneously with operations and services. People in management and developmental positions in the case organisation recognised that the digitalisation of services is more than just applying technical solutions and information technology to move from face-to-face services to mobile or web-based services. Instead, it is functional and operational rethinking, with the intensive use of process-related information.

Both the *managers* and *developers* highlight that technologies should be developed and implemented simultaneously and in interaction with the services, functions and operations in the organisation, as well as in relation to the entire field of social and health care. Digitalisation also demands changes in one's working habits. A manager noted that: 'Digitalisation is not everyone's own digitalisation, but it combines parts of the whole. For some, it is difficult to grasp that the work becomes more transparent and is visible to others'.

The developers pointed out that ICT should proactively support these operational changes and the active role of the citizen. One developer said: 'The world is digitalising, and processes, habits, structures and funding structures are changing. ICT should proactively support these activities and changes'. Locking into certain technologies or old practices hinders development and co-evolution. The developers also said there are problems finding the time to learn new systems and obtain know-how, and that using temporary systems and piloting new ones are tiring for personnel and may hinder readjustment. The importance of orientation and continuous learning were highlighted.

In the development processes, the central question related to information ecology is how to tackle 'incompleteness'. The systems and technologies require practice-based information to be developed further and fitted into their context of use, but users (i.e., care professionals) are often tired of producing this information, as incomplete systems disturb their tasks and routines in a busy working environment. Such frustration and pressure may well be behind viewing digitalisation as something extra (i.e., not part of the care they provide). To combine technological and service development, various kinds of knowledge are needed in the early stages of reform. According to one developer: 'The development of technologies is typically still in progress when they are taken into use, and responding to the practical needs often demands long-term dialogue [with the developers] and iterative rounds'. The combination of knowledge consists of, for example, technical knowledge, service-related knowledge and process-related knowledge, as well as practical, everyday knowledge about the service users and working contexts.

The people working in development positions said it is quite common that digitalisation in the healthcare sector is perceived as not being part of healthcare professions, and that technological skills do not need to be learned because of the perceived characteristics of these professions. Technology and digitalisation are considered as a separate issue from primary-care or clinical work, even though technology could be perceived as an information channel or tool that is a normal part of this work. One developer stated: 'People working in health care do not perceive the information systems as part of their work. To be frank, they think that putting a bandage on is part of the work, but that documenting is not'. Another developer noted: 'The attitude may not be the only reason; perhaps haste is another reason, as there are no such moments when one could think about how to change the work. When new things are suggested, those are immediately perceived as extra work. [...] We have good experiences of "electronic rooming-in", that is, we release the person from her or his ordinary tasks to learn and to provide orientation to others'.

Usability and flexibility of information systems according to service needs is an example of co-evolution between technology and operations. According to a developer, however, lingering lock-ins into old systems remain, which hinder mutual adaptation: 'We pay attention to usability from the point of view of the professional and the citizen. In the first version, the technical issues, like the codes, were too prefixed. The need changed, but the technology could not be changed [...] it was like it was carved in stone. Technology has to be much more flexible so that we are able

to live with it. Electronic forms are one example: at present, we need to build the entire service chain, not only the form, like it previously was. The technology should adjust to these changing needs’.

The process of functional and operational rethinking taking root is necessarily time consuming. An information technology professional noted that: ‘It takes time to understand the benefits of digitalisation for one’s own work. It requires rigorous management of the service areas. You have to measure and ask how the rooting has gone. If the manager doesn’t ask, people will say that it is not important’. Sometimes too much is expected from information technology professionals, who are tired of being in charge of finding and correcting errors in highly unfinished systems: ‘We are a kind of rocket that does trial runs and others come hang on to our coattails. [...] It is actually really hard’. Roles and responsibilities need to be considered in a systemic way.

Care professionals note that involving more technology in care work has elicited changes in work tasks. Accordingly, there is an increasing need to master technologies besides ‘traditional’ care work. However, extra work generated by incompatibility among various information systems and issues in their usability, as well as several information channels themselves sometimes frustrate these professionals, even though they see the possibilities as well. One service advisor noted: ‘It [information] comes from so many channels: phone, notes, communication systems, patient information systems. It feels like, “Oh no, how can I handle it all”. But of course, it is a learning process for myself as well and it will become smoother [...] And sometimes I wonder who has designed these information systems, they are not always so well-functioning [...] But it is the future and I see it as a possibility: when a client ponders some issue at 23:30, she or he doesn’t have to wait until 8 in the morning, and then wait on the phone line. So in principle, it gives more freedom, and there is better access to information’.

The role of *third-sector actors (associations)*, especially in the promotion of health and in giving peer advice in technology use, is felt to be important. However, the interfaces between sectors have many unsettled practices and shortcomings in the flow of information, as one third-sector actor describes: ‘In the healthcare centre, everyone does not even know who we are, they have been watching like, “What are you doing here?” The grass-roots personnel have not been informed, and we do not have a proper space there’.

The *service users* are an essential part of the co-evolution, as they are put into the centre of the new thinking. However, the elderly users seem to be a bit confused about this change and the technological tools. An older homecare client said: ‘I think that it is much nicer to have a living person here, even only once a day [...] so that the homecare provider would visit here, and not only the machine’. The willingness of older people to test new technologies depends, for instance, on their usability and/or relatives’ attitudes and resources for assistance.

From the co-evolution perspective, in the era of digitalising services, there is not only a need for collaboration among different actors, but also for different kinds of knowledge and skills for all stakeholders. In extant information-ecology literature, co-evolution of a system means mutual adjustment of the different parts of the system in times of change, but this adjustment is rather slow locally due to different clashes, lock-ins and path dependencies. According to Nardi and O’Day (1999), local changes to a system can disappear without a trace if they are incompatible with the rest of the system. For instance, if new goals are set, but new evaluation tools responding to the goals are missing, old practices tend not to change (Nardi and O’Day, 1999). There is also a risk regarding the development of data-driven digitalised health services and the co-production of information and knowledge together with professionals and citizens – the two trends presented by Oborn and Barrett (2016) – if the holistic picture is not seen or is not treated as a holistic issue with interdependencies. In digitalised work, information technology generates data about an organisation’s underlying productivity and administrative processes. It provides a deeper level of transparency for activities that had been either partially or completely opaque. Events, objects and processes become visible, knowable and shareable in a new way (Melkas, 2010; Zuboff, 1988).

Increasing interdependencies in the care sector and the resulting need to collaborate with different parts of the system often seem to create clashes with old practices and working tasks. The organisational culture in the public sector is often characterised by hierarchy and bureaucracy (Borins, 2001, Vigoda-Gadot *et al.*, 2008). Cultural change is slow due to path dependency; decisions made in the past, as well as related lock-ins, may have an effect on the unconscious level, even if the need for change is recognised (Vigoda-Gadot *et al.*, 2008). For instance, according to interviewees in this case study, excessive willingness to master one’s own work and distrust, deriving from the old practices, hinders information sharing and the development of smooth service chains for users.

4.4 Keystone species

Information ecology includes certain keystone species as critical actors whose presence is essential to the survival of the ecology itself (Nardi and O'Day, 1999). Related to this, the *managers* noted an increasing importance assigned to people who work across boundaries. To be more specific, the *developers* stressed the importance of people who understand both technology and practice. For instance, information technology personnel who have knowledge of both technical processes and an organisation's needs, in terms of operational and service changes, are playing an increasingly important role in digitalising information ecology. This is described by one developer as: 'The world is going more digitalised, and meanwhile, the processes, habits, structures and funding are changing. IT should support this change proactively. IT should act in a different role than before in these continuous changes in services. The information-management department is strongly involved in all the development projects, which include customer processes, internal professional processes, management processes, as well as information management and subcontracting processes'. For example, head nurses, who were acting as part of middle management and serving as gatekeepers, were stressed. Due to the relative hierarchy in the healthcare field, if a person in a middle-management position has problems using technology, it is often a barrier to technology implementation in the whole department.

The interviewees representing several groups mentioned service advisors as key care professionals. Their role is especially important for serving those whose problems are mainly other than health-related. At the nodal point of information ecology related to service chains are case management and service advising, which have received special emphasis in the case organisation.

Care professionals note that for the sake of smooth information flows to benefit service users, it is important that the service advisor plays an integral role in the work community. While describing her own work, a service advisor stated: 'I diminish the extra work from others; I call around to home care units and explain and try to find out who has taken care of the client's issues and who the responsible person is. It kind of helps to straighten the curves so that things go smoother and the clients are served well'.

Service advisors themselves think that in addition to formal information and the ability to collaborate, tacit knowledge and sensitivity in assessing users' needs also seem to be extremely important features in service advising and case management: 'You cannot be scared to collaborate with different actors, and you need the ability to listen [...] also to hear the things that are not said. You have to be very flexible, and to be able to find out and solve things and to encounter different kinds of people. It is good if you have good networks so that you know that all the time, there is someone who you can call and ask'.

One physician noted: 'The aim is to provide targeted care and service-need assessment as smoothly as possible, to identify if the citizen's problem is a matter for the physician, social services or the police'. Need assessment is a critical issue in terms of care accessibility and targeting resources in a reasonable way. Well-being centres (no longer solely healthcare centres) will be places where professionals from different fields and sectors collaborate; thus, the citizen will be directed to the proper place. This presupposes a broad understanding of each profession's expertise, willingness to share information and willingness to trust others' expertise. Since the context is health care, willingness to share information is not the only issue; the kinds of information that are allowed to be shared also need to be assessed.

In the first contact, e-health and self-care are rising trends in case management as well. With non-acute health problems, the citizen could answer some test questions online first, and on the basis of the test results, the system would provide health counselling or further instructions, or book an appointment with a medical professional if necessary. At present, however, professionals may be playing a greater role in hindering digitalisation than the citizens. As one interviewed developer noted: 'Some of the citizens are willing to adapt to the e-services, but the professionals say that it is not possible because they have not adapted to those themselves'.

User-centred thinking in the care sector implies, for example, smooth service chains in which professionals cooperate for the benefit of the service user and in which patient information is transferred between professionals. In practice, it means, *inter alia*, like one developer described: 'If the citizen has any kind of worry or concern, she would always be aware of whom to contact and where her concern would be taken seriously and brought forward. It should not be the citizen's responsibility to consider if this is a matter for health care or social care'. In addition to

case management and user-centred service chains, user-centred thinking is about involving the service user more deeply in care, moving from an object position to a subject position.

Third-sector actors, such as peer instructors for technology use or associations providing health advising, with their role between the citizen and the professionals, are considered to be just as important. A service advisor said: 'If we take, for instance, heart issues and healthy diets [...] I have many things to check and do with the client in the 40-minute appointment, and very little time is left for healthy diet instructing'. Associations having expertise in these issues are considered to be essential resources as knowledge-providers.

Service users value the work of the care workers whom they know 'face-to-face' and with whom they have built a relationship. The service advisors are considered to be important in this sense, also because they have a capability to ponder the citizen's situation in more holistic ways.

All the stakeholder groups perceive that the key actors are the professionals who work across boundaries (either horizontal or vertical) and make links with others in the system. This change, regarding key actors in the system, is also noted in the extant literature. The social and organisational changes implicated in patient use of personal health records require a significant cultural change for medicine (Nazi, 2013), and a change in care professionals' roles. In the old system, it was mainly medical practitioners who formed the basis of the healthcare system and acted in this key role, but it seems that with the increases in diversity of actors, technologies and system complexity, the roles of various skilled 'boundary spanners' (Long *et al.*, 2013) – who can serve as translators, facilitators and teachers – become crucial in terms of efficient information flows and connectivity (Nardi and O'Day, 1999). According to Long *et al.* (2013), 'Boundary spanners facilitate transactions and the flow of information between people or groups who either have no physical or cognitive access to one another, or alternatively, who have no basis on which to trust each other'. On one hand, information technology has facilitated boundary spanning by offering access to knowledge that is relevant to the problem, despite where the information exists, thereby providing access to new sources of information (Dewett and Jones, 2001). On the other hand, information technology demands boundary-spanning capabilities itself when this multi-sourced information must be combined and interpreted. The trend of increasing citizen responsibility combined with the trend of big-data science (Oborn and Barret, 2016) highlights the importance of these boundary spanners. They are the ones who interpret the information coming from different sources when assessing citizens' holistic situations and needs.

The smooth operation of user-centred service chains and user-centred thinking in general, which are central to the system, require actors who can connect and coordinate with other kinds of actors. Assessing needs is related to managing the right information: the right piece of information in the right format in the right place at the right time is required (Lillrank, 1998; Melkas, 2004).

4.5 Locality

Nardi and O'Day (1999) defined locality and specific local knowledge as a central element in information ecology. However, there were somewhat differing views depending on the stakeholder group.

The *managers* stress the standardisation of practices; they see huge possibilities in 'big data' for better 'mastering' the population in the area. A manager analysed the change in the role of data in the following way: 'When the computers came, we first collected data, then transferred data and now we analyse big data. We can see a person's well-being in a completely new light'. Managers see huge possibilities in this kind of 'big data', such as in the prevention of health problems. Also the *developers* highlight the standardisation and understanding of the holistic situation: 'So that information on the wider perspectives would come across, that is, understanding about the bigger whole'. To form this wider picture, they negotiate with local professionals who have differing needs depending on the practical context.

The challenge seen by *care professionals* is the perception of one's working tasks in relation to wider entities, as well as the growing amount of information and its interpretation. On the other hand, information flows related to changes in digitalisation are problematic, as a care professional described: '...the amount of information is so enormous that we cannot read everything. One would need to be reading a news release all the time'.

From the point of view of the *service user*, digitalisation of services also offers the citizen a chance to take more responsibility for her or his health, and the citizen will more often act as a co-producer of the health information, together with healthcare professionals. However, in practice, the ways to handle communication with an individual user in a multi-professional network can be challenging. Citizens' situations and capabilities vary considerably, but the organisational rules tend to be standardised and normative. For example, it was noticed that from an elderly citizen's point of view, advice was inadequate – either it was not received as promised, or responsibility was continuously transferred to another professional. An elderly service user stated: 'Damn! I realised that I belong to nobody anymore!' The healthcare professionals do not necessarily trust the information provided by the citizen (e.g., blood-pressure measurements taken at home); thus, the same measurements are retaken. In contacting the healthcare organisation, an elderly service user values simpler, local, decentralised methods; '[I contact the healthcare centre] by phone. But it is quite complicated nowadays [...] Press this and press that. [...] There used to be a number where a person answered, and if not, they called back in a while. Now it has been all removed; there is only one big place'. Everyday-life coping and quick access to concrete help are central values of the service users.

In this sense, concerning the question of standardisation or allowing local variety, there are somewhat differing views between managers and developers versus care professionals and service users. The *third-sector actors (associations)* fall somewhere in-between: they represent the variety of needs on the grass-roots user level, but also see the 'bigger picture' for the public good. In a big organisation, managers and developers strive to ensure quality of care and the transfer of information with the help of standardisation of working practices, length of appointments, etc. The other side of the standardisation coin is that some local, context-related and important knowledge and flexibility might be lost – elements that care personnel can be somewhat worried about. Interviewees' views seemed to differ somewhat concerning standardised practices and local knowledge allowing for more flexibility. Actually, the concept of locality is likely about to change in a digitalised, networked society, as locality means not only geographical proximity, but also access to context-related information that can be acquired in various ways.

On the basis of the differing views concerning the importance of the aspect of locality, we can conclude that local knowledge seems to be combined with more broad-based knowledge. The dynamics of this combination characterises the new information ecology of a care organisation. For example, it was stressed in the interviews that a merely local understanding related to organising services is not enough when services are produced in a broader geographical sphere and in collaboration with various actors. On the other hand, when a citizen is given more responsibility, this may mean increasing recognition of her or his particular knowledge. We can, thus, say that the locality aspect concretises the combination of the two trends of data-driven digitalisation and citizen engagement, and makes them visible.

The value of context-related and everyday-life information is rising in information ecology in welfare services (e.g., the combination of different data sources, such as shopping behaviour combined with health data). It is noted in the literature that the challenge of healthcare informatics is to make sense of the 'big data' generated from several sources and disparate systems, as the amount of such data is enormous (Liyanage *et al.*, 2012). On the other hand, when dealing with ongoing and chronic illnesses, patients are often experts in their own disease or conditions and can exert greater influence on their care (McColl-Kennedy *et al.*, 2017), which means local knowledge is stressed. Intermediate processors, operating between generators of data and users of data (McColl-Kennedy *et al.*, 2017), and related training that combines both field-specific and technical issues are both needed here. Here, the knowledge mobilisation perspective (Swan *et al.*, 2016) of how the knowledge is socially created and how it emerges in different contexts and in different combinations seems to be useful. The amount of data, coming from different sources is huge, but its usefulness is strongly dependent on local interpretations. The locality aspect is a special challenge in terms of safe, ethical production and handling of data; for instance, questions of how to evaluate the quality of data and how to differentiate between standardised or automated data, on the one hand, and 'authentic data' in local situational contexts, on the other.

5 Information ecology revisited

The aim of this paper was to discuss and reflect upon the applicability of the concept of information ecology in the current era of intensive digitalisation, in which knowledge and information are created and utilised in new ways and with new actors. The analysis shows that the elements of information ecology are perceived somewhat differently among the stakeholder categories (managers, developers, employees, third-sector actors and service users) regarding

the two trends of digitalisation: the growing importance of the use of big data and digital health, and increasing patient and citizen engagement.

The basic components of information ecology created by Nardi and O'Day (1999) still seem useful. Although they are important in the digitalisation era, they should be reinterpreted and highlighted somewhat differently, for example, stressing the openness of the system instead of closed systems, as well as emphasising increasing meaning of diversity and dynamic co-evolution between the system's elements (see Table 5).

TABLE 5 AROUND HERE

Table 5. The components of information ecology reinterpreted in relation to the era of digitalisation.

The results confirm the major changes that digitalisation has been eliciting, which require a rethinking of the system. These changes are affecting information ecology in many ways, which were presented with the help of the five elements related to information ecology. In addition, the care sector is changing in many ways from a systemic perspective. Health is perceived as a more holistic issue, and new, diverse players and actors involving new technologies are entering into the service system. Technologies and social practices co-evolve and adapt to each other when change occurs, but there appear to be clashes between actors in this adaptation. These clashes must be addressed via new capabilities, with the emergence of new key roles and 'keystone species'. This system is evolving from medical professionalism to networking and 'boundary spanning', in which case managers, service advisors and information-management professionals, who can master both service and technology development, play crucial roles. The ability to change, adapt and become an agent responsible for the modification of one's own work will be required (Hopia and Hakala, 2016; Saari *et al.*, 2019a). The need for a combination of local and broad-based knowledge is also stressed.

The challenge is to have standardised practices and benefit from the broad knowledge base in a big organisation, while not losing the benefits of local, often-personalised knowledge. Thus, a balance must be sought between broad and standardised information on the one hand, and local and particular information on the other. Digitalisation is also linked to the continuous life cycle of information, as data volume increases, the transformation of information accelerates, and faster and better visualisation of information is enabled. Information access may improve, but more obstacles may be created if these issues are ignored.

6 Conclusions and discussion

6.1 Theoretical insights

Information ecology in welfare services highlights the dynamic interplay among technologies, people, practices and values occurring in the context of an ecosystem in which organisational and social factors influence technology use (Nazi, 2013). In this ecosystem, systemic problems are related, for instance, to practices that are lagging behind, and system incompatibility. Concerning technical and social interoperability, for making technology effective in supporting and improving care services, careful attention must be paid to aligning the use of the technology with care processes and clinical workflows (Nazi, 2013). However, changes are difficult because one thing affects another, and systems are not sufficiently flexible. As the systems 'do not discuss' issues with one another, data must be recorded several times. Another issue is that the information written in electronic health records is sometimes felt to be bureaucratic and "stiff", and may have lost important "invisible" – meaning corporeally mediated – tacit knowledge (Hämäläinen and Hirvonen, 2020). Furthermore, stakeholders, such as third-sector associations and voluntary workers outside the care organisation, are viewed as important, but are not included in information ecology. Those organisations could provide access to various health-supporting groups, among other benefits, but demand and supply do not meet each other due to missing links in information. In other words, the lack of interconnected systems, meaning both technical and social systems, may have negative effects on information ecology's effectiveness.

There is a system transition occurring in the care sector, and technological and social elements are strongly co-evolving in the transition process (Pekkarinen and Melkas, 2019, Pekkarinen, Melkas, and Hyypiä, 2019). This study contributes to a better recognition of the increasingly multi-level organisational changes that digitalisation brings forward in care services, which has both theoretical and practical relevance. The framework of information ecology still seems useful and important in this context. In this study, the basic components of information ecology have been reinterpreted, which makes the framework more applicable in analyses concerning the era of digitalisation and its effects on organisations, sectors and societies.

While demonstrating this rich variety within information ecology through a nuanced interview analysis, the findings cannot be generalised as such. The chosen method provides limited knowledge, for example, about the reality behind the interview accounts, such as the interviewees' actual capabilities, work situations with information systems and non-linguistic practices. Equally rich perspectives on information in other care settings facing intensive digitalisation are expected to be unveiled in other studies, but information perspectives and categories are likely context-specific.

6.2 Practical implications and future avenues

At a practical level, taking into account the elements of information ecology and the new interpretations of them in the digitalisation era can help the care sector and organisations steer their change processes in a more focused way. The analysis, in which the different levels and perspectives in a care organisation were studied, has unveiled certain previously invisible elements. These elements concern the relationships between the levels of an organisation and their interconnectedness. When shedding light onto the different levels and participant perspectives in the development of digitalisation, this study reveals the messiness and slowness of development when reaching for digital services. Utilising the information ecology perspective with its five components in a societally important context, namely the care sector, has helped to refine the framework further, for instance, by highlighting the knowledge mobilisation aspect in the locality component. All in all, the growing importance and timeliness of the locality component can be seen, which highlights the combination of large digitalised systems and broad data masses with (very often forgotten) local grass-roots knowledge.

Further research should better identify and compare different contextual settings with varied characteristics of local information ecologies, and show what kinds of key capabilities are needed to run, develop and sustain them. Longitudinal exploration on how participant perspectives on digitalisation and on relevant information in service digitalisation co-evolve and change over time would also be needed, and on how information ecology manifests itself and changes in relationships between different professionals, as well as between professionals and citizens. Studies of these layers of reality could be combined to provide a better understanding of interactions between different types of information contexts over time. Particularly, further research is needed on the locality aspect of information ecology: the detailed examination of combination mechanisms of local and broad-based knowledge and information. Here, when combining various sources of information, particular attention needs to be paid to privacy, data security and legal liability issues. Maintaining privacy and security of individual information while improving the efficiency and effectiveness of information sharing practices among health care providers is a constant balancing issue (Tan, 1999).

Recommendations for practitioners should be produced from the point of view of different professional groups to adopt the human-centred approach to designing and managing information environments. The changes are even bigger if there are many digital devices and solutions used in the services. They may constitute a technological and informational 'jungle', in which the co-impacts of various devices and systems also affect the organisation and work in question. Agentic professional competence is needed from careworkers to become change agents of the new technology-mediated and -oriented work (Saari *et al.*, 2019a).

On the other hand, if only a clinical perspective is utilised in the design of technological tools and services, the end result may be to equip patients with technologies that only suit professionals' needs and perspectives (Storni, 2014). At best, digitalisation enables more inclusive solutions for both employees and citizens within welfare services. It is not only about implementing technical solutions, but entailing a holistic rethinking of organisational functions and operations. As information becomes more visible, new kinds of collaboration and trust between different professional groups, and between service users and professionals, become increasingly important. Thus,

digitalisation is essentially intertwined with service development and integration in which, to succeed, many different types of information and knowledge (e.g., technological, clinical, practical and contextual) must be combined. Skills to analyse these types of information and knowledge are also needed.

The topic of information ecology is wide and holistic, as are the topics of change management and competence management that are vital in care services undergoing the digital transformation. Furthering judicious application of technological innovations requires careful attention, including a comprehensive examination of their suitability for users and employees alike. It is likely that when employees receive proper orientation (Melkas *et al.*, 2020) and become familiar with technological innovations by having enough time and space to learn, they will be able to adjust the technologies to suit their own needs (Watanabe *et al.*, 2015), and thereby positively affect information ecology. In such a situation, employees would be welcomed, alongside managers, to co-create human-centred, ‘bottom-up’ information ecology in their increasingly technological work environments.

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Appendix 1. The framework used to identify central themes in the data.

	Management	Development/ Information and communications technology (ICT)	Professional/Employee + third-sector organisations	Service users + family members
Locus of digital change related to information (system, locality)	Is the focus on overall/holistic information strategies, systems and/or availability in local uses? Internal information strategies or joint strategies with external parties?	Is the focus on information-operations management and/or usability of information systems and interfaces in local uses?	Is the focus on organising and performing care work with a variety of ICT tools and information sources and/or care value (effects) in use?	Is the focus on digitally managing one's own health and/or everyday-life coping and safety at home?
Characteristics of digital change (co-evolution, variety, keystone species)	Allowing more information/service variety or restricting it? Openness of information? Allowing a slow pace or quick pace in changes? Top-down/one-sided or bottom-up/collaborative changes?	Applying few or many experiments with digital services? Inclusivity of systems development? Dealing with problems and breakdowns? Role of collaboration across functions?	Including/engaging users in managing health/health-related information? Dealing with challenges related to variety of users and their situations? Collaboration across occupations?	Relations of support and availability of assistance in everyday-life situations?