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Description of Crowdsourcing and AI-Based Tool for Knowledge Management and Systems Change in Public Services

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This study presents a crowdsourcing IT platform and working model intended to support knowledge management processes and systems change to help public service organizations fulfill their purpose and perform their tasks in a rapidly changing environment. The tool brings together tacit and explicit knowledge regarding organizational processes in one database and provides an AI-assisted platform for knowledge processing. Additionally, it allows for disseminating refined data to grassroots-level actors, enables the implementation of initiatives, and monitors their effectiveness. By utilizing crowdsourcing, the tool leverages the collective

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intelligence of actors across organizational boundaries, thereby promoting collective, knowledge-based learning and organizational self-renewal.

Keywords: Knowledge management tool; systems change; crowdsourcing; artificial intelligence; collective impact; public service organization.

1. Introduction

Public service organizations — including educational, social and healthcare service organizations — aimed at children, young people, and families have been the focus of numerous development projects in recent years [Ministry of Social Affairs and Health (2012, 2019); Sama-Miller and Baumgartner (2017)]. However, the capability of organizations to fulfill their purpose and perform their tasks has remained weak. This is indicated by, for example, the increase in the number of children taken into custody and the usage levels of institutionalized psychiatric services for adolescents [Lipson *et al.* (2018); McManus *et al.* (2019); Kääriälä and Hiilamo (2017)]. Challenges in the development work of public service systems include the presence of disparate policies, a lack of collaboration between services [e.g. Lelliott *et al.* (2017); Takalo *et al.* (2022)], and externally guided or top-down initiated development projects [Kaarakainen *et al.* (2022); Saari *et al.* (2015)]. These approaches have failed to integrate development work into the daily routines of employees, with projects often being perceived as separate and having short-term impacts [Kaarakainen *et al.* (2022)]. There is a need for structures that enable development work to emerge from organizations' internal needs, thus facilitating the use of employees' expertise and the sustainability of development efforts [e.g. Hakkarainen *et al.* (2018)].

The purpose of this study is to provide a description of and theoretical foundation for a new information technology (IT) tool called *Itla View*. This tool was developed to facilitate practices for the internal renewal of public service organizations aimed at children, young people, and families, including non-profit organizations (NGOs). The fundamental concept of the tool is to help multidisciplinary service organizations make use of the knowledge that already exists within them for development purposes rather than initiate reforms through external or top-down approaches. In practice, the tool strives to make the knowledge within organizations and at their interfaces more accessible, improve the processes for sharing and managing that knowledge, and thus create opportunities to use that knowledge in decision making.

1.1. *Knowledge management as a facilitator of systems change*

There is broad consensus regarding the importance of knowledge for the survival of organizations in today's dynamic era. It is the foundation of organizations' operational capability, as it informs decision making, fosters innovation, and enables effective adaptation in a dynamic environment [Grant (1996); Kogut and Zander (1992); Nahapiet and Ghoshal (1998)]. In organizations, knowledge is often defined into two types — explicit and tacit [Polanyi (1961, 1962); Howells (2002); Mohajan (2016)]. Explicit knowledge (EK) typically takes the form of documents, databases,

and registers and is easily encoded, transferred, and shared within the organization. It provides, for example, long-term information about the utilization rate of services in a certain area or the functioning of different services. Tacit knowledge (TK) is subjective knowledge contained in the minds of professionals working within an organization or close to it. It consists of knowledge related to the *expertise* of professionals and knowledge related to the *cognition* of professionals, such as their ideas, perceptions, values, and beliefs [Damm and Schindler (2002); Mohajan (2016); Nonaka and Konno (1998)]. In contrast to EK, TK is context-specific, a result of individual experience, and is therefore more difficult to formalize.

The ability to use TK has proven to be a crucial element in the survival of organizations that try to tackle today's complex issues. It provides access to short-term information necessary for organizations to remain capable of reacting quickly under changing conditions [Zuchowski *et al.* (2016)]. Moreover, it forms a basis for renewing organizations. According to the systems theory discourse, change must begin from within the system [Ludvig (1972); Prigogine and Stengers (1984)]. In other words, to bring about meaningful change in an organization or multiple organizations, the impetus for change should come from within rather than being externally imposed. This means that change should be regulated and managed using knowledge formed in ongoing processes within an organization and between different organizations [Prigogine and Stengers, 1984; Ståhle, 1998). In this, knowledge possessed by the members of the organization plays a critical role. Being an integral part of the system and interacting within the system, members of an organization have the capability to gain an understanding of the internal dynamics of the system and regulate its actions [Prigogine and Stengers (1984)]. Accordingly, actors within the system can be seen as contributing agents, who through daily experiences acquire, accumulate, and generate new knowledge that is necessary to renew their organization and create systems change [Berger and Luckmann (1966); Damm and Schindler (2002); Howells (2002)].

The realization of systems change is strongly intertwined with knowledge management (KM), which aims to understand and use knowledge as a strategic resource in organizations [Karamat *et al.* (2019); Massaro *et al.* (2015)]. In this study, KM is understood as a set of processes such as *knowledge elicitation*, *knowledge sharing*, and *knowledge utilization* [Dayan *et al.* (2017); Rao and Nayak (2017); Shujahat *et al.* (2019)]. Knowledge elicitation is the process of extracting or externalizing information, ideas, and suggestions that individuals related to organizations hold privately. Its purpose is to convert valuable TK, such as information, ideas, and knowledge assets and insights, held by individuals into explicit form of knowledge. Knowledge sharing, in turn, is a process that facilitates collaborative interaction to distribute the knowledge within an organization. It ensures that the knowledge elicited is accessible to those who can benefit from it, leading to improved decision making and organizational learning. Knowledge utilization refers to the application of or responses to collective knowledge assets. It involves taking the knowledge and insights and using them to inform actions, strategies, and responses. Even if knowledge sharing is regarded as the most critical phase requiring support [Mirzaee and Ghaffari (2018); Witherspoon *et al.* (2013)],

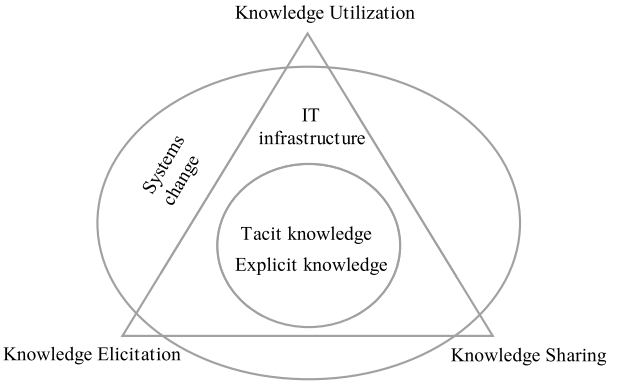

Fig. 1. IT infrastructure facilitating knowledge management processes and systems change.

the successful realization of all these processes is a prerequisite for efficient KM [Shujahat *et al.* (2019)].

IT infrastructure, including data management, data processing, and communication platforms, plays a central role in enabling efficient ways of conducting activities related to knowledge elicitation, sharing, and utilization [Damm and Schindler (2002); Mirzaee and Ghaffari (2018); Zuchowski *et al.* (2016)]. Furthermore, as knowledge managed emerges from within an organization, conditions for systems change can be created (see Fig. 1). There are many technologies available to facilitate the various processes of KM, such as elicitation [Agarwal and Poo (2008); Dimitrova and Scarso (2017); Khan and Khader (2014); Pham and Hara (2009)], sharing [Dimitrova and Scarso (2017); King and Marks (2008); Li and Lu (2007); Majewska and Szulczyńska (2014)], and utilization [Kingston (2012); Rohrbeck *et al.* (2015)]. However, a comprehensive framework specifically tailored to support knowledge management activities within public service organizations is lacking. Crowdsourcing is recognized as a way to facilitate all these activities, as it offers a platform for task sharing and execution with the help of a large group of users [Dimitrova and Scarso (2017); Rao and Nayak (2017); Zuchowski *et al.* (2016)]. In the next section, the potential of crowdsourcing in facilitating KM processes and furthering the systems change of organizations is discussed.

1.2. *Crowdsourcing tool for the knowledge management of public service*

Crowdsourcing refers to processes of bringing into use the collective intelligence and creativity of a large group of people through an open call on the internet [Hossain and Kauranen (2015); Howe (2006)]. In practice, requesters (organizers/crowdsourcers, typically management decision makers), use various tools to create and send an open call to responders (crowdworkers) [Iskender and Polzehl (2021); Zuchowski *et al.* (2016)]. Depending on the purpose of the requested knowledge, the open call may be limited to people within organizations [*internal crowdsourcing*; Rao and Nayak (2017); Zuchowski *et al.* (2016)], or it can be directed to an undefined network of

people [*external crowdsourcing*; Simula and Vuori (2012)]. Crowdworkers give their input for a specific task and share it with the requester via a crowdsourcing platform. Information obtained via the open call is collated by the organization and is used to develop solutions, processes, and decisions [Ulbrich *et al.* (2021)].

Crowdsourcing activities are very much related to KM processes. Crowdsourcing can open a fast and direct channel of communication between knowledge holders and the management team of an organization and create an effective way of externalizing and sharing the TK of a large group of individuals for the use of the organization's management [Ulbrich *et al.* (2021)]. Its short-cycle nature has been deemed effective for decision-making [Garrigos-Simon *et al.* (2015); Zuchowski *et al.* (2016)]. By facilitating the fast flow of information, crowdsourcing supports the ability of organizations to foresee the potential need for change and can support the rapid generation of solutions to problems. Furthermore, by allowing for the input of a wide range of individuals, it increases the diversity of perspectives on an issue. Diversity of inputs can enhance the quality of work, as the crowd can collaborate and build on each other's ideas, thus promoting collaborative learning [Bjelland and Wood (2008); Rao and Nayak (2017)]. Moreover, by involving employees in problem solving and decision making, crowdsourcing can create conditions for the organization to consistently renew and develop itself. It has been found that crowdsourcing increases employees' engagement in their work, as they feel more invested in the outcome and feel their contributions are valued [Malhotra *et al.* (2017); Pohlisch (2021); Scupola and Nicolajsen (2014)]. Development work can become part of their daily work, instead of being perceived as a distinct program [Iskender and Polzehl (2021); Ulbrich *et al.* (2021)].

The development of IT has led to the creation of specialized crowdsourcing IT platforms that can be tailored to the needs of a particular organization or enterprise [e.g. Abu El-Ella *et al.* (2013); Hamilton *et al.* (2011); Kong *et al.* (2019); Rohrbeck *et al.* (2015); Westerski *et al.* (2011)]. Such platforms enable repeatable and well-defined crowdsourcing processes and can be adjusted to suit organizations' or enterprises' specific needs [Iskender and Polzehl (2021); Zuchowski *et al.* (2016)]. The platforms serve as the primary means of interaction and point of contact between the requesters and the crowdworkers. Requesters control every aspect of the process, commencing with registering crowdworkers on the platform. The process then extends to stating the crowdsourcing task, as defined by the requester, assigning the task to the selected crowdworker profile, gathering responses from the crowdworkers, processing the data, and returning the refined result to the crowdworkers [Kong *et al.* (2019); Zuchowski *et al.* (2016)].

However, it has been recognized that platforms may not be transferable as is from one organization to another. Instead, their design should be based on a clear understanding of the amount and type of data they will process, while also considering the specific needs of the organization's management structure [Rohrbeck *et al.* (2015)]. In this study, we introduce *Itla View*, a new crowdsourcing IT platform tailored to address the needs of public service organizations. As a source of information, *Itla View* uses TK possessed by employees working at the grassroots level of public service organizations and by various fieldworkers outside the public sector

who encounter service users (children, young people, and families) in their everyday work. Additionally, existing EK [Mohajan (2016); Nonaka and Konno (1998)], such as registry data and local news, are used and combined with TK in a single database to offer a holistic understanding of phenomena occurring in local children's growth environment. Furthermore, as the tool is designed to access TK captured in qualitative form, artificial intelligence (AI) search methods have been applied to facilitate its efficient utilization [Deerwester *et al.* (1990)]. Moreover, AI search methods are used to leverage the accumulated TK to identify EK (e.g. indicators) that is pertinent to the particular region. In the next section, the reasons behind the choice of AI semantic search methods are presented.

1.3. *Description and motivation of the AI semantic engine for data processing*

The semantic engine that drives the AI-assisted searches and recommendations is based on a natural language processing (NLP) technique called latent semantic analysis (LSA) that employs a noise-reduction linear algebra operation known as singular value decomposition (SVD). LSA is a collection of theoretical and computational approaches that emerged in the late 1980s to early 1990s [Deerwester *et al.* (1990)] as an information retrieval and NLP technique designed to improve library indexing and search engine query performance [Dumais and Way (2007); Manning *et al.* (2008)]. The initial information retrieval context was subsequently followed by psychological work in discourse processing. LSA is a theory of meaning as well as a method for extracting that meaning by statistically analyzing word use patterns and brings together researchers from computer science, psychology, linguistics, cognitive science, information systems, and education. The main premise of LSA as a theory of meaning, pioneered by psychology professor Thomas Landauer, is that meaning is constructed through experience with language [Landauer (2007)], which relates closely with the cognitive psychology viewpoint of LSA being intimately linked to the acquisition, induction, and representation of knowledge [Evangelopoulos (2013)]. In this respect, LSA is particularly interesting as a method to handle all the processes of TK management, specifically because it poses as a quantitative NLP algorithm and at the same time exhibits qualitative, intuitive tendencies akin to those of human reasoning [Kuo (2019)]. Besides the typical organizational and technological contexts of LSA application in modern times, there is also a more social perspective. For instance, a notable study used LSA to process cultural records of the Greco-Roman and Judeo-Christian literary traditions to inform the nature of introspection in the collective social consciousness through the ages [Diuk *et al.* (2012)]. Another case, closer to youth wellbeing, involved using LSA to process language patterns of high-risk youths to automatically predict the later onset of psychosis, apparently with 100% accuracy [Bedi *et al.* (2015)]. The diverse semantic capabilities of LSA have made it a popular NLP technique in handling a variety of fuzzy problems that have traditionally been computationally difficult. Nevertheless, to the authors' knowledge, no studies have been done using LSA to process unstructured texts of observations made by fieldworkers related to youth wellbeing, thereby enabling the

sense-making and induction of potential phenomena while relating to the content of media and other statistical sources.

In addition to its semantic capabilities and proven uses for modeling aspects of human knowledge, another important aspect of LSA is the ability to process datasets of unstructured textual observations that vary in size, with a corpus that can grow over time. Although there is still little agreement on the expected size of the LSA corpus or what comprises a large or small corpus [Crossley *et al.* (2017)], LSA has been successfully used on unstructured datasets of various sizes, spanning orders of magnitude from just a handful of documents to tens of millions of documents [Bradford (2008); Evangelopoulos (2013); Kuo (2019); Olney (2011); Sarkar *et al.* (2010)]. In addition, LSA has been specifically shown to perform well on small datasets [Hong *et al.* (2021)], even those of less than 100 documents [Cvitanic *et al.* (2016)]. Given that our use case requires that a small number of initial observations be processed effectively and that the effective capability to scale up as the corpus grows over time needs to be maintained, LSA is particularly appropriate. In this study, LSA is used to process the collected TK of organizations to identify a meaningful phenomenon and to guide the analysis of register data, that is, to determine the appropriate questions and indicators for organizing services in specific areas.

1.4. *Study aims*

The aim of this study was to present a detailed description of the development process and the characteristics of the IT-based tool *Itla View*, which was developed to promote systems change in public service organizations by supporting KM processes and related activities. The following research questions were presented:

(1) How is the tool developed?
(2) What are the key characteristics of the tool?
(3) How the tool can be used to enhance KM processes in public service organizations?

2. Methods

2.1. *Study context*

Public education and social and healthcare services aimed at children, young people, and families form a large multidisciplinary service system with the common goal of supporting the wellbeing of children, young people, and families. In the current service structure, services for the different needs of children and families are divided into separate service sectors. In practice, each service provider independently strives to promote the wellbeing of citizens or to tackle the related challenges. Furthermore, NGOs act as separate organizations that work to provide complementary services and leisure time activities to support the wellbeing of children, young people, and families in everyday life. In Finland, these services fall under the national family center scheme. Family centers in each region are responsible for coordinating and

implementing services and activities for children, young people, and families living there. Each family center has a multidisciplinary regional management team (MMT) that includes all relevant leaders from all public service sectors and NGOs. The tool developed in this study was designed to assist the MMTs of local family centers to enhance their collaborative learning and communication with grassroots-level actors.

The development work of the tool was conducted as a part of the work of the Childhood Builders Regional Learning network (CBRL) [Ristikari *et al.* (2021)] that seeks to help public service organizations create structures for organizational self-renewal. The network applies the collective impact (CI) framework [Kania and Kramer (2011)]. The CI framework is intended to reinforce actions needed to achieve common goals in a complex organization and to promote the renewing of the organization [Hanleybrown *et al.* (2012); Kania and Kramer (2011); Niemelä *et al.* (2019); Ristikari *et al.* (2021); Takalo *et al.* (2022)]. It is based on five conditions that should be considered to achieve successful change: continuous communication, a common agenda, mutually reinforcing activities, a shared measurement system, and a backbone support organization (BSO) [Hanleybrown *et al.* (2012); Kania and Kramer (2011)]. Supporting the fulfilment of these conditions served as the basis of the development of the *Itla View* tool.

2.2. *Participants*

The study involved various participants, including professionals from family centers, city of Tampere, and CBRL ($n = 41$), researchers from different fields ($n = 9$), and external experts ($n = 9$). Some participants were engaged throughout the entire development process, while others were involved only at the beginning or the end. MN, professor of practice at the University of Oulu and TR, research professor at Itla Children's foundation were involved in the development work from the beginning as its initiators and overseers. The actual design of the tool began with Itla Children's foundation, and input was received from a consulting firm called PTC Services Oy (Ltd.). This firm organized dialogue workshops involving researchers and professionals from public education, social services, healthcare, and NGOs. Detailed design and technical implementation were collaborative efforts, with MH from Itla Children's foundation serving as the project manager, PT from Hahmota Oy (Ltd.) being responsible for the design and technical implementation of the web platform, TA from VXT-Research Oy (Ltd.) handling semantic search and backend processing, and a research group from the University of Oulu being responsible for technical implementation of the mobile application.

2.3. *Design research as a research strategy*

In this study, a design research strategy is applied [Cobb *et al.* (2003)]. It is a research strategy that combines theoretical research with practical and context-specific knowledge with the aim of enhancing the understanding and investigation of real-life problems within their ecosystems. In the design research, researchers and practitioners work together to identify problems and to develop innovative solutions to them. Progress occurs iteratively through repeated design cycles, resulting in the

creation of new practical models and research knowledge. This iterative development process begins with the recognition of the need for change, followed by the development of a functional output or model, ultimately leading to the generation of knowledge that enhances learning [Cobb *et al.* (2003)].

To conduct design research, a co-creation method was used. This refers to the participation or contribution of citizens and/or clients in the work of planning and producing public services [Alford and Freijser (2018)]. In this study, it meant engaging various stakeholders, including civil, social, and healthcare stakeholders (specifically the employees of family centers) from the Tampere city area, in collaborative teamwork and open communication to develop new practices to enhance public services. This collaboration also involved external experts and researchers from diverse fields [Lazo-Porras *et al.* (2020)]. The co-creation process included the needs identification phase and the development phase to construct the actual tool and the working model. In the needs identification phase, challenges related to the organization's renewal were pinpointed, whereas in the development phase the tool to address these challenges was developed. Co-creation activities were structured in the form of dialogue workshops and user tests. These encouraged the sharing of ideas, knowledge, and insights to collectively generate solutions. A total of 26 co-creation sessions and workshops were held between May 2021 and December 2022 that lasted from 1 to 4 hours each. The number of participants in the workshops and sessions varied between 3 and 21, depending on the goal and the theme. The description of the development process for the tool is based on the notes and materials gathered from the meetings and design templates used during the co-creation process.

3. Results

3.1. *The development process of Itla View*

The years between 2014 and 2020 can be considered the needs identification phase of the co-creation process when MN provided consulting services to municipalities and public service providers focused on knowledge-based service development and management. During this consultation period, two key challenges related to organizational management and development were identified. First, it was perceived that development and renewal projects implemented in the organization often struggled to align the ongoing operations and priorities of the service system with their own objectives, timelines, and funding sources. Externally initiated development projects were often seen as disconnected from the day-to-day work and consequently remained less effective. Second, it was perceived that the information needed to plan services reached decision makers only after a considerable delay, or it was challenging to effectively identify and compile. The existing feedback system lacked adequate tools and instruments to continuously collect and process feedback about implemented measures and to identify relevant information from a huge amount of data. For example, upon analyzing the register data, it was observed that in some schools in the Tampere city area, numerous wellbeing indicators (such as student

health and wellbeing surveys, service utilization rates, and staff turnover rates) indicated significant wellbeing issues, while in other schools such problems did not occur. Based on the information obtained through the registry data, additional resources and targeted development measures were implemented. However, a challenge that persisted was that such information, acquired through the analysis of registry data, reached service providers only after a delay, thereby limiting their ability to organize preventive services or intervene in wellbeing issues in a timely manner. Similarly, information about effective wellbeing-promoting practices was also not received.

To address the identified challenges related to the management of the organization, a development process involving civil, social, and healthcare stakeholders (employees of family centers) from the Tampere region and researchers from different disciplines was instituted. At first, it became apparent that TK possessed by grassroots-level fieldworkers, both inside and outside the organization, who routinely interact with service users (in this case children, young people, and families) held significant importance. TK was recognized as a valuable resource, offering real-time and highly localized information essential for anticipating service requirements, formulating preventive strategies, and implementing targeted interventions within specific communities. Moreover, it was acknowledged that by anchoring the organization's development initiatives on the competence and expertise inherent in its fieldworkers, a conducive environment for organizational self-renewal could be cultivated. Crowdsourcing was considered a way to involve a diverse group of grassroots-level actors from a large organization in the organization's development efforts. In this way, a channel of communication between the grassroots-level actors and management decision makers of the organization and between actors from different organizations could be created. In essence, crowdsourcing was seen as enabling organizational renewal from within, as it would elevate employees' TK to the forefront of development efforts. It then became evident that TK had the potential to enhance the analysis of EK. Combining the analysis of TK and EK could serve as a starting point for the more effective development and organization of services. Moreover, the use of AI emerged as a viable approach to enhance qualitative data analysis of crowdsourced TK and to combine the analysis of TK and EK.

The actual development of the tool involved user path modelling, piloting crowdsourcing, and the creation of a user interface, including the development of AI functionalities. User path modelling included creation of the strategy for TK collection, processing it with EK, and returning the processed data to the grassroots level. The idea of the crowdsourcing tool was piloted in its intended context using a simple web-based questionnaire form. A small group of employees who regularly encounter children, families, and young people in their work reported their observations regarding a specific district in the city of Tampere. The results of the piloting supported the idea of using crowdsourcing to improve understanding of the phenomena prevailing in the district in question. However, it was discovered that the observations made by others would enhance users' (i.e. crowdworkers) immediate understanding of the crowdsourcing goal. It was also considered important to see if

the observations made would have an effect on decision making. Due to data protection issues, the possibility of having all stakeholders review all incoming observations was not feasible. Nevertheless, these two ideas paved the way for informing stakeholders about phenomena identified in the region. Furthermore, a more informative introduction text for the tool's usage was developed.

The creation of the user interface involved two main stages — the development of a visual mock-up and the creation of a fully functioning prototype of the crowdsourcing IT platform, which also included the development of AI functionalities. A visual mock-up of *Itla View* was developed in 2021 based on the concept of the user path. It was developed in cooperation with a multidisciplinary team. Feedback and insights from various participants played a significant role in shaping its design. The results of the pilot phase, including feedback on the formulation of questions, were also used in the design and implementation of the platform's various user interfaces. Based on the visual mock-up development, a fully functioning prototype of the crowdsourcing IT platform was built in 2022 and 2023. The results of the crowdsourcing pilot and existing quantitative indicators (register data) were used in the development of AI.

3.2. *Description of Itla View*

Itla View is a tool designed to assist public service organizations in their efforts to renew and improve by streamlining various activities related to KM processes. The tool comprises two primary components — a mobile application and a browser-based form for sharing knowledge from the grassroots level to the organizational level, as well as an admin user platform for conducting KM processes at the management level of the organization. The *mobile application and browser-based form* are used by fieldworkers who encounter children, young people, and families in their daily work. They are not limited to the members of the organization, but they can include, for example, local store employees. Through the mobile application and the browser-based form, fieldworkers are invited to (1) report their everyday observations about any issues that challenge the wellbeing of children and families and about any issues or resources that strengthen the resilience of children and families and (2) to share concrete ideas for initiatives to develop the service system. The *admin users' platform* consists of a user interface that provides a collaborative platform for the multidisciplinary group of management decision makers (in the Finnish context, MMT) to analyze the observations, quantitative indicators and to accumulate local news with the aim to identify weak signals pertaining to changes in the daily lives of children and families relevant to a specific district. Moreover, it provides a channel for disseminating the aggregated and refined knowledge back to the fieldworkers.

In addition to technical functions, *the working model* was developed to facilitate the use of the tool. The working model helps management workers to break down the activities of KM into smaller steps and to implement the generated knowledge in the management structures of participating service organizations. A detailed description of the different components of *Itla View* is presented below.

3.2.1. *The mobile application and browser-based form*

The mobile application and the browser-based form contain a questionnaire form for reporting observations about the everyday lives of children, young people, and families. The form consists of five open questions: (1) a title of the observation, (2) a brief description of the observation, (3) proposals for initiatives to solve or improve the issues described in the observation, (4) identifying the group of actors involved in or relevant to the observation, and (5) the physical context (i.e. location) of the observation. In addition, it contains two five-point scales for reporting whether the observation indicates wellbeing or lack of wellbeing (1 = lack of wellbeing, 3 = neutral, 5 = wellbeing) and whether the developmental trend of the observation is positive or negative (1 = undesirable, 3 = neutral, 5 = desirable) (Fig. 2).

Through the mobile application, a user can use the tool to send as many observations as often as they want. They can also receive notifications about information generated by management decision makers (i.e. identified phenomena or initiatives, be they planned or under implementation). Fieldworkers can also be asked for additional information related to phenomena identified by admin users and can be asked for feedback regarding initiatives (be they planned or under implementation). The only difference between the functionality of the mobile application and the browser-based form is that the latter cannot receive notifications. However, new calls for observations or new initiatives are visible whenever a user enters the browser-based form.

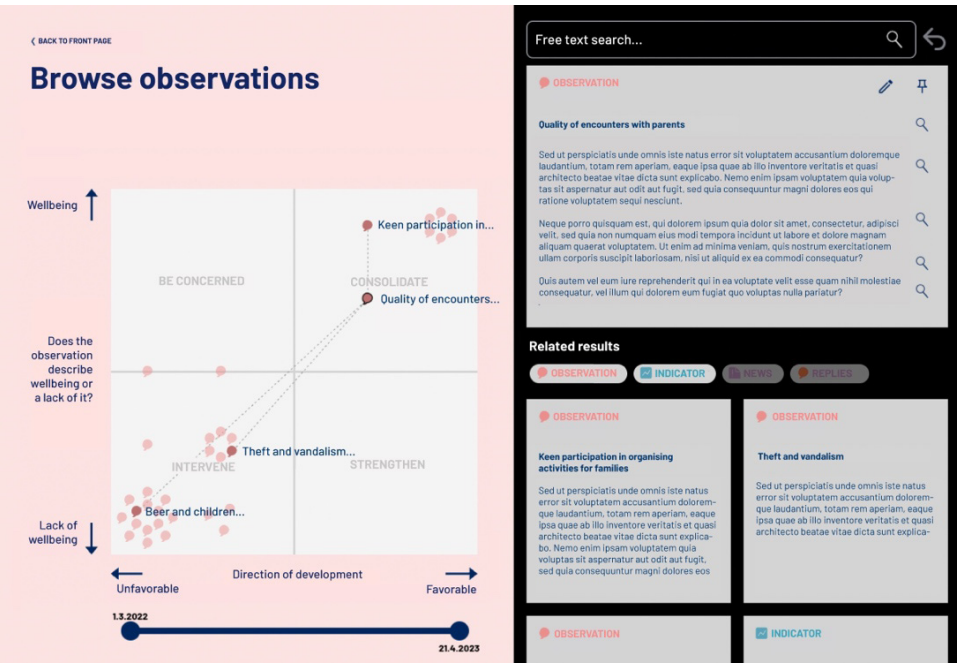

Fig. 2. Screenshot of the admin users' user interface including the four-fielder used in the categorization of the observations and the search function.

The mobile application is designed to be used on an Android smartphone and can be downloaded from the Google Play App Store (the Finnish name of the app is *Nükymü*). Loading the app requires the user to be signed in with a Google account (either their own or that or their organization). The browser-based form works on any type of device and can be found online at web-address itlanakyma.fi. To log in to the mobile application or the browser-based form, users are asked to enter a valid area code so observations can be directly related to the area they are concerned. In addition, users are required to accept the platform's terms of use, which include granting permission for their observations and comments to be used in decision making and research. When submitting an observation or any other content, users are prompted to ensure that they do not report sensitive personal information via the application. The use of the mobile application or the browser-based form does not require entering personal data, and nor is any user information collected automatically in the form of cookies or IP addresses. Although no user information is collected, the platform creates a device-specific identifier that can be used to block abusive or automated use of the application from a specific device if necessary. All collected data is processed in accordance with European data protection legislation [General Data Protection Regulation (2016)].

3.2.2. *The admin users' platform*

The admin users' platform provides three primary functionalities. First, the platform stores observations submitted by grassroots-level actors, key indicators of the well-being of children, youth, and families, and local news and information related to children, youth, and families. Second, it provides a sense-making platform for management decision makers to collaboratively work toward a common agenda and develop joint approaches or initiatives based on continuously updated information. Third, it provides a functionality to communicate with crowdworkers. The admin users' platform has a visual user interface with which selected experts from each area's family center can view the stored information and process it with the help of an AI-based recommendation engine. The platform categorizes all observations and places them in a four-fielder based on the fieldworker's assessment of the nature of the observation (i.e. the desirability of the issue described in the observation and the direction of its development) (Fig. 2). Observations describing wellbeing are placed in the upper part of the four-fielder, and observations describing a lack of wellbeing are placed in the lower part of the four-fielder. Observations whose development over time is unfavorable are placed on the left-hand side of the four-fielder, and observations whose development is favorable are placed on the right-hand side.

The identification of observations similar in content and/or related to each other is done using a process combining an AI-assisted semantic search and human judgment with the aim of forming the phenomena of the collected observation. Clicking on any observation in the four-fielder starts the analysis process, where the semantic search function suggests observations similar in content and indicators and local news items related to the selected observation. The semantic search function captures the meaning of texts and allows the user to query/search using keywords

and whole documents of variable lengths. The search function enables the admin user to search through gathered observations and other information and to identify recurring and cross-cutting themes considerably more quickly than if they had to examine each observation individually. To form phenomena (i.e. groups of interrelated and/or complementary observations, indicators, and local news items; see Fig. 2) worthy of intervention or response, admin users evaluate whether the AI-suggested observations and other information are indeed relevant to each other. Admin users thus either confirm or reject the suggestions offered by the AI-based search function, and thus AI does not make any interpretations of judgments independently of humans.

When a phenomenon is identified from amongst the observations, the observations related to the phenomenon and the description of it can be saved, along with a title and brief description. The phenomenon can be further enriched with municipalities' own local data resources. For example, registry data (e.g. school data or similar information on the economy or environment of the region that relates to the phenomenon) and expert knowledge can be used. If needed, more observations can be requested via the mobile application and browser-based form to enrich or clarify a specific phenomenon. The final phenomenon comprises the selected observations, possibly indicator data and local news related to the phenomenon, and a description of the phenomenon written by the admin user. When the phenomenon is completed, information related to the identified phenomenon can be sent to the users of the mobile application and browser-based form, that is, to the crowdworkers. The admin users' platform also enables the saving and publishing of phenomenon-based initiatives on the platform. A description of the jointly agreed measures to respond to and monitor the phenomenon (i.e. an initiative) can be attached to the phenomenon.

3.2.3. *Algorithmic description of latent semantic analysis*

The platform's AI-based semantic search engine analyzes the words in an observation and identifies semantic similarities between different observations and between observations and other stored data, such as local news and quantitative indicators. This helps admin users to identify clusters of correlated and/or complementary observations that together indicate a noteworthy phenomenon relevant to the district. In practice, LSA starts with textual parsing of a corpus of free-form text passages known as documents into distinct words called terms which are morphologically stemmed into their root forms. With the index of documents and corresponding terms that occur in each, an $i \times j$ term-by-document matrix is constructed consisting of the number of times i occurs in document j. This term-by-document matrix then undergoes weighting to cater for the phenomenon in natural language corpora, as very common terms tend to be general terms that do not contribute as much to the quantitative codification of semantic features compared to more unique terms. The weighting function is called the term frequency–inverse document frequency or TF-iDF weighting (Han and Kamber, 2006) and is aimed at discounting the occurrence of frequent terms logarithmically and promoting the

occurrence of less frequent ones. The weighting function replaces the entries (of row i, column j) in the term-by-document matrix with $w_{i,j}$, such that:

$$w_{i,j} = tf_{i,j} \times idf_i,$$

where $tf_{i,j}$ is the normalized term occurrence in each document, that is, the term frequency of term i in document j, and idf_i is the weighting factor known as the inverse document frequency, as follows:

$$idf_i = \log(N/n_i),$$

where N is the total number of documents in the whole corpus, and n_i is the number of documents in which term i occurs in the entire collection of documents. What results is a TF-iDF weighted term-by-document matrix, which then undergoes the critical operation in LSA called SVD.

SVD is an unsupervised machine-learning method used in many different applications of pattern recognition, such as digital image processing [Kalman (1996); Strang (2003)] and signal processing [De Lathauwer *et al.* (2000)]. SVD is closely related to principle component analysis and factor analysis that are commonly used in bioinformatics and micro-array analysis of gene data [Wall *et al.* (2003)].

SVD is carried out on the term–document matrix after the TF-iDF weighting. In essence, SVD takes any general rectangular matrix $\mathbf{A}$ with m rows and n columns and decomposes it into a product of three matrices so that:

$$\mathbf{A} = \mathbf{U}\mathbf{S}\mathbf{V}^{\mathrm{T}},$$

where $\mathbf{U}$ $(m \times m)$ and $\mathbf{V}^{\mathrm{T}}$ $(n \times n)$ are the left and right orthonormal matrices, respectively, which can be truncated to $\mathbf{U}'$ and $\mathbf{V}'$ for noise reduction. The $\mathbf{S}$ $(m \times n)$ matrix is a rectangular diagonal matrix whose (i, i)th entries are all non-negative singular values $s_{i.i}$ in decreasing order of magnitude, with all other entries being zero.

In terms of LSA, it suffices to note that SVD makes it possible to handle and reduce the noise — that is, inconsistencies and fuzziness — inherent in natural language texts so as to boost the signals of the important patterns that represent the semantic structures within texts. These very semantic structures are the outputs of LSA as vectors associated with each term and document (rows of the $\mathbf{U}'$ and $\mathbf{V}'$ matrices, respectively) that can be used for further processing, combination, and matching operations in an AI use case. The matching — that is, the comparison between semantic vectors or groups of vectors — is by virtue of a measure known as cosine similarity. Cosine similarity measures the difference between two vectors $\mathbf{a}$ and $\mathbf{b}$ by using the cosine of the angle between those vectors via:

$$\cos\theta = \mathbf{a}.\mathbf{b}/|\mathbf{a}||\mathbf{b}|,$$

where $\mathbf{a}$ and $\mathbf{b}$ are two vectors of the same dimensionality, and θ is the angle between them. The cosine is acquired by dividing the dot product of $\mathbf{a}$ and $\mathbf{b}$ by the product of their magnitudes. In practice, this yields a similarity score between -1 and 1 that is used in a variety of different applications, such as ranking semantic search results, clustering related entities, recommendations, and/or other data-linking operations.

3.2.4. *Working model*

Utilizing *Itla View* to support KM is a continuous process that includes four sequential steps (Fig. 3):

(1) Collecting observations from fieldworkers,
(2) Forming the phenomena,
(3) Forming a phenomenon-based initiative, and
(4) Implementation and monitoring of the initiative.

In the first step, observations are collected through the mobile application and the browser-based form. Management decision makers within the organization initiate the call. Fieldworkers are expected to share knowledge that can enhance the organization's ability to adapt to external changes, identify areas requiring reinforcement, and develop interventions that are finely attuned to the specific needs of the community. In the second step, using AI-based search tools, admin users analyze the collected observations and other data sources to identify any phenomena that may warrant a response. The family center's management team considers whether there is a need for initiatives to strengthen the wellbeing of children and families based on

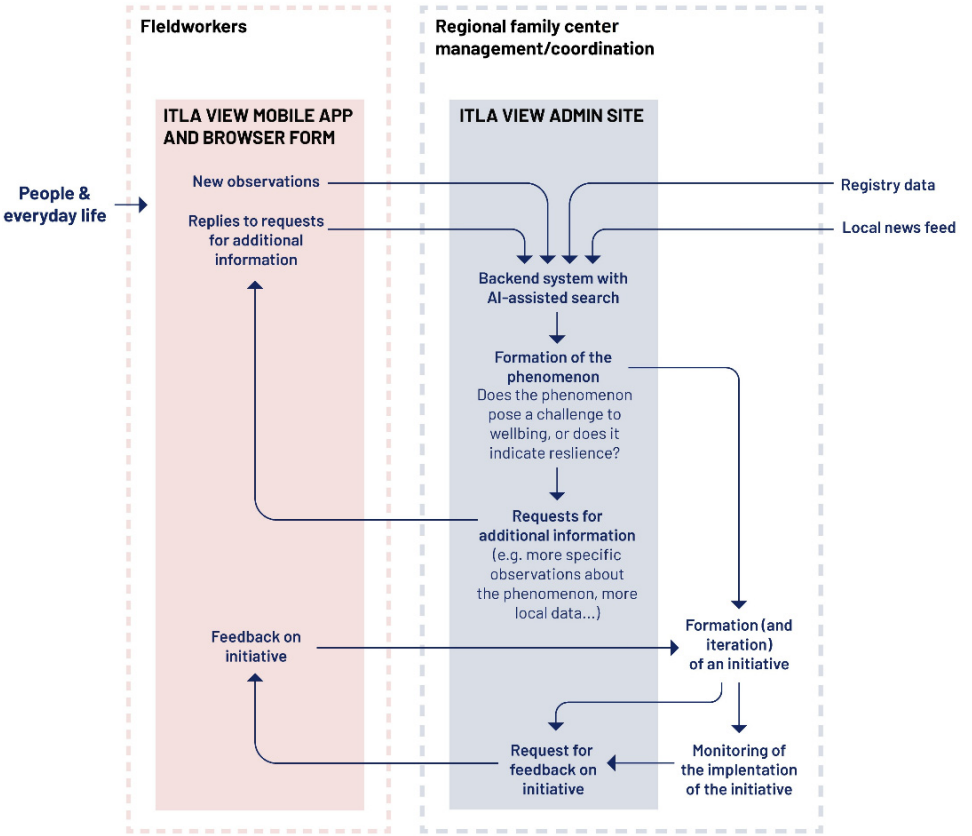

Fig. 3. The process chart and working model of *Itla View*.

the generated historical knowledge. In the third step, an initiative is developed and implemented to address or reinforce the identified phenomenon. This includes determining a common goal and developing appropriate practical actions to address the issue. For example, scenarios of potential future service demands can be created, and resources can be allocated as needed. By actively seeking feedback and informing fieldworkers about the identified phenomena, the management team can engage fieldworkers in the initiative development process. This can further support the successful implementation of the initiative. In the fourth step, continuous monitoring of the initiative is conducted by soliciting feedback on both the initiative itself and on observed changes related to the phenomenon. This feedback loop facilitates ongoing communication between the management team and professionals working with children and families. It enables service adjustments and development based on this feedback, ensuring a responsive and evolving approach to service provision. Even if the steps are presented in chronological order, they may overlap. For example, the collection of observations is an ongoing process that continuously conveys new information from the field to the local management team for forming phenomena and further initiatives, as well as for assessing the effectiveness of initiatives that may have been implemented earlier. Feedback and comments on the phenomena identified can also be requested from the field at every step of the process.

The steps follow the principles of CI that have been used as a framework in the development of the working model. *Continuous communication* creates a basis for the realization of other principles of CI. It involves actors from different levels of the organization to collectively work with *a common agenda* and to develop a joint approach to achieving the agenda (*mutually reinforcing activities*). Additionally, continuously accumulated observations from the grassroots level and statistics reveal whether the work is being done as intended or whether the initiatives have led to positive development, forming *a shared measurement system.* The local management team (in the Finnish context, MMT) is responsible for the use of *Itla View* in the knowledge-based management of services. The work of family centers is supported by the CBRL network and University of Oulu that forms a BSO.

3.2.5. *Concrete example of the potential use of Itla View*

An example of KM processes that the tool could facilitate and enhance comes from one family center area in Finland. The family center runs monthly MMT meetings and regularly gathers feedback from different units to be addressed at the meetings. The feedback is gathered, for example, at schools, where the principals ask during teacher meetings if there are any concerns regarding collaboration with social and health services or observations that might be relevant to pass to the MMT. The principals convey the feedback to the head of the education services, who participates in the MMT meetings.

In May 2021, there was feedback from schools saying that first- and second-grade pupils behave violently towards their classmates and school personnel. The school personnel said the support given by child welfare services was insufficient.

After discussion, the MMT decided that this is a phenomenon that requires attention. The MMT decided to launch an initiative and established a small working group including professionals from education services and social services to respond to this challenge. The group contacted professionals in schools and child protection services. They all confirmed that the topic is relevant and particularly challenging. They also provided ideas about what to do about the issue. One idea was to provide the schools with approaches to deal with behavioral problems in terms of preventing problems in the first place and improving children's social skills.

The group contacted the BSO, which sought the resources required in the area. The BSO sought and reviewed evidence-based interventions to be presented to school professionals. They eventually decided that the Teacher Classroom Management intervention [Wills *et al.* (2019)] will be used at the schools. The implementation process started at the beginning of fall and lasted until the next school year.

Itla View can be used in this kind of CI-based model in four separate ways. First, it can assist in collecting observations from everyday work. In this example, school personnel could have written their observations in the app on their phones/computers. Second, by reviewing the observations with AI assistance, similar observations could have been recognized. Third, with *Itla View* it is possible to compare the observations with registers that include information related to acquired observations. Fourth, when the MMT launches a new initiative, feedback can be collected constantly from those who use the intervention.

4. Discussion

4.1. *Itla view in light of previous research*

The primary aim of this study was to present a description of the new crowdsourcing IT platform *Itla View* with the intention of aiding its successful implementation in the near future and of evaluating its potential to meet the challenges of KM in public organizations. *Itla View* is intended to promote the wellbeing of children, young people, and families by helping public service organizations fulfill their purpose and perform their tasks in a rapidly changing environment. It is a tool for identifying local needs, capabilities, and competences and helping organizations plan their activities accordingly. The aim is to support KM and to bolster the learning capacity of organizations by creating a channel of communication between grassroots-level actors and management decision makers of the organization and between actors from different organizations.

Like other crowdsourcing tools [e.g. Dimitrova and Scarso (2017); Rao and Nayak (2017); Scupola and Nicolajsen (2014)], *Itla View* has been developed to extend traditional IT tools used in the management of the organizations. *Itla View* integrates the processes of knowledge elicitation, sharing, and utilization within a unified IT system [see also Rao and Nayak (2017)]. First, the tool supports making individual-level TK visible and sharing it with the management level by enabling the collection of observations from grassroots-level actors. Second, the tool supports

learning at the organizational level by providing a platform for management decision makers to process TK and EK and to learn from it collectively. Third, by enabling knowledge generated at the organizational level to return to the grassroots level it supports the sharing and use of collected knowledge, thus bolstering the learning capacity of a whole organization. The benefits of crowdsourced knowledge are speed, affordability, and flexibility [Garrigos-Simon *et al.* (2015); Simula (2019)]. These features combined with efficient ways to process and further use information can increase the capacity of an organization to become aware of its own weakness and strengths and can improve the capacity of the organization to learn [e.g. Andreeva *et al.* (2012); Karamat *et al.* (2019)].

Itla View distinguishes itself from previous crowdsourcing IT platforms in various ways. First, a unique aspect of *Itla View* is its ability to combine both TK and EK within the same database, while also employing AI for data analysis. TK can be harnessed to identify relevant indicators from registry data when planning services in specific districts. Previous research has assumed that TK accessed from the grassroots level would assist organizations in identifying the relevant EK needed in decision making [e.g. Alvarado-Valencia *et al.* (2017); Choi and Lee (2003); Magnier-Watanabe and Benton (2017); Pham and Hara (2009)]. However, as far as we know, this is the first platform that allows for the collection of TK and that facilitates its use in the analysis of EK through the assistance of LSA. Second, unlike many crowdsourcing IT platforms [e.g. Hamilton *et al.* (2011); Rao and Nayak (2017)], in *Itla View* crowdworkers do not have access to view raw observations made by others, and they cannot vote or comment on them due to the sensitive nature of the collected data. Only the MMT is authorized to process the raw data. However, AI incorporated into the platform replaces this typical voting phase used in crowdsourcing IT platforms. With the help of AI, qualitative observations and ideas that recur multiple times are highlighted. Based on this AI-assisted knowledge processing, the MMT refines knowledge for the fieldworkers to comment on and use. Third, this study contributes to existing knowledge by providing a crowdsourcing IT platform that simultaneously implements internal and external crowdsourcing. Besides collecting knowledge from within the organization, the tool crowdsources citizen knowledge about regional phenomena related to children, young people, and families. Other crowdsourcing IT platforms have typically focused either on external sources [Hamilton *et al.* (2011)] or internal sources [Ruiz and Beretta (2021)]. The integration of both internal and external crowdsourcing extends the diversity of insights and observations. However, this integration imposed specific demands on the tool. For example, design of the processing of the raw data and the subsequent dissemination of refined knowledge from the MMT to the grassroots level had to be planned in such a way that sensitive knowledge does not spread outside the organization.

In summary, *Itla View* has been developed to address the specific needs and features of public service organizations. With the goal of providing a tool for these needs, it expands upon previous crowdsourcing platforms and introduces an innovative approach to public service organizations that has the potential to enhance their learning capacity and help them adapt to changing circumstances more efficiently.

4.2. *Study limitations*

In this study, design research strategy and co-creation were employed. They have been suggested to be effective methods, particularly in development projects where there is a desire to leverage the diverse expertise, experience, and perspectives of various stakeholders [Alford and Freijser (2018); Cobb *et al.* (2003)]. However, it is important to highlight that a typical phase of design research i.e. theory formation cannot be concluded in this study. In other words, we are not yet able to determine the effectiveness of *Itla View* in promoting KM processes and organizational renewal in cross-sectoral service organizations. However, the pertinence of the tool is indicated by the facts that the idea for it arose from public service organizations' needs and that it has been developed in close cooperation with experts working in service organizations following a design research strategy. The development work mainly involved people from the management level. A small group of grassroots-level actors also participated in the pilot study. In addition, the initial piloting of the tool affirmed the potential value of crowdsourcing in capturing the TK of grassroots-level actors. In future development work, it will be important to engage grassroots-level actors more intensively, particularly as the first version is ready. Acquiring feedback on the use of *Itla View* is the only way to further develop the tool. In addition, if population-level application is to take place, co-creation with service users is essential.

Certain potential challenges associated with the implementation of the tool must be considered. The power of the tool lies in its uptake by a large number of field-workers. If they do not feel they benefit enough from participating, it may be difficult to engage users in the working model and thus to gather enough information to support the knowledge-based development of the organization [Simula (2019)]. To maintain users' motivation and engagement, the implementation of the tool must be done with care. It is important to carefully determine the needs and expectations related to the use of the tool and to openly explain how the information gathered is used in practice. Moreover, it is important to ensure that the communication between grassroots-level actors and the management team is genuinely reciprocal and that the ideas submitted are treated with respect [Iskender and Polzehl (2021); Simula and Vuori (2012)]. However, due to the way the collected TK is processed, a single observation can get lost in the database, and feedback to its sender cannot be provided for every single observation. This can weaken crowdworkers' commitment to using the tool. Therefore, further development is needed to improve the flexibility of feedback mechanisms. In addition, by seamlessly integrating the use of the tool into daily routines, it is possible to boost the commitment of employees within the organization to use the tool effectively [Benbya and Leidner (2018)]. For example, conducting weekly idea or reflection meetings can help incorporate internal crowdsourcing into the work routine, thus making it feel like part of the regular daily job. Additionally, it is crucial to ensure that the tool is always easily accessible from anywhere and to create favorable conditions for its use.

It should also be considered that the management team may need to process hundreds or thousands of observations (or even more). When browsing observations,

indicators, and news using the search function, the user sees a large amount of information, and identifying relevant (i.e. related/complementary) pieces of information can be challenging. In order to effectively manage such a large amount of information, the technology and the user interface used in the application need to be refined. In terms of the scalability of the semantics across linguistic boundaries, it is worth noting that LSA, essentially being a vector space model, is language-independent. For the current use case of *Itla View*, only Finnish language textual content is processed. However, the same LSA technique could be scalable, with some modification, to use different languages in future, should the need arise. Moreover, the accessibility of the app could be improved by making it available for other operating systems beyond Android, including iOS.

In the data collection and processing, it is necessary to consider data protection. Users of *Itla View* have agreed that any information they submit through the tool becomes the property of the organization. In other words, the organization has the right to use the received information as it deems best. Moreover, users of the tool have been instructed not to transmit sensitive identifying information about individuals through it. Nonetheless, there is still a potential risk of sensitive data being sent through the tool, as responses are collected using an open qualitative form. The spread of such sensitive information is prevented by the fact that there is a limited group of employees handling the information, and they come from within the organization and are bound by the organization's confidentiality agreements. Moreover, the database can only be accessed through a secure connection.

4.3. *Future research*

In future studies, it is crucial to investigate the tool's usability during its implementation phase to facilitate further refinements. Such evaluation should not only encompass technical aspects but should also extend to the tool's overall usability, including its alignment with employee needs [see Mirzaee and Ghaffari (2018)]. For instance, it is essential to explore whether the tool enhances KM processes. More specifically, does the platform support management decision makers in shaping a shared understanding of future scenarios, and does the tool provide access to, for example, early signs regarding the development of regional inequality in the well-being of children and families? Future research should also focus on evaluating whether *Itla View* supports grassroots-level contributors participating in organizational development. For example, it should be explored whether the knowledge sharing through *Itla View* has effects on organizational culture [e.g. van den Hooff & De Ridder (2004)], such as on the development of employees' work engagement [Schaufeli *et al.* (2006)], a collaborative culture, innovation efforts [Ahmed *et al.* (2016); Scott and Bruce (1994), and trust between actors from different levels of the organization [Chow and Chan (2008)]. Research methodologies such as open-ended interviews and quantitative surveys would be suitable for this purpose [e.g. Mirzaee and Ghaffari (2018); Scupola and Nicolajsen (2014)].

Another essential area of focus for future research is the long-term effects of *Itla View* on the wellbeing of service users, specifically families, children, and young people.

This could be examined using registry data, for example. Gaining insight into how the tool influences this critical element over time will offer a comprehensive understanding of its value within the organization. However, it is important to acknowledge that this factor is influenced by various aspects. When assessing the tool's impact, it is crucial to consider the broader organizational conditions that shape service users' wellbeing.

Furthermore, as the tool offers a novel means of accessing the knowledge generated in the daily experiences of human agents regarding the wellbeing of children, families, and young people, it presents distinct opportunities for bridging the gap between research and practice. By delving into the knowledge stored in *Itla View*, researchers will have a unique chance to analyze the mechanisms that influence the wellbeing of children, families, and young people and to provide this insight to bolster the organization's developmental efforts.

4.4. *Study implications*

With careful implementation, *Itla View* has the potential to provide many previously untapped benefits of KM in the public service sector. By crowdsourcing TK and creating conditions to manage it alongside EK, this tool provides management decision makers with insight into emerging phenomena related to children, young people and families even if the signals are weak. It helps organizations to anticipate service needs and efficiently organize relevant services for citizens. As the tool involves actors from different organizational levels in collaborative efforts to establish a common agenda and to develop a joint approach or initiatives, it holds the potential to bridge the gap between planned and enacted responses [Kania and Kramer (2011); Rohrbeck *et al.* (2015)]. Moreover, it has the potential to increase local fieldworkers' commitment to their work. As the development work can be based on the knowledge of grassroots-level actors, it can foster their sense of competence and cultivate an environment of appreciation and recognition throughout the entire organization [Iskender and Polzehl (2021); Ulbrich *et al.* (2021); see also Ryan and Deci (2000)]. Furthermore, by establishing conditions for an ongoing feedback loop, it enables the organization to evaluate whether the development work has proceeded in the desired direction and to react accordingly [Kania and Kramer (2011)]. These properties can increase the organization's capacity to become aware of its weaknesses and strengths and improve its ability to learn, which is a crucial capacity for self-renewal [e.g. Andreeva *et al.* (2012); Karamat *et al.* (2019)]. However, it is important to note that despite its holistic KM processes, lots of information still remains outside of this platform. Other platforms and communication methods still need to be maintained and developed.

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Biography

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