Designing Openness-Infusing Socio-Technical Artifacts

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Abstract

Motivation

The diffusion of digital technology evokes open phenomena that affect many facets of business and society. For instance, open resources such as the open content on Wikipedia have redefined access to information and knowledge. Open processes such as open innovation or open-source software development enable novel forms of collaborative value creation. Open phenomena bring about opening effects, removing longstanding obstacles to access as well as participation and revitalizing antiquated norms and structures. The majority of these open phenomena rely on socio-technical artifacts such as online platforms to infuse openness into an otherwise exclusive or restricted context. These artifacts represent assemblages of technical artifacts such as software and social artifacts such as goals, norms, and institutions that govern their use. However, formalized guidance that instructs researchers and practitioners on how to design artifacts with the goal of infusing openness into a system or context remains scarce for many application domains. To address this research gap, this thesis aims to develop validated design knowledge for socio-technical artifacts that infuse openness in the context of two application domains that exhibit potential for benefiting from opening effects.

The first application domain encompasses the software requirements engineering (SRE) process. Traditional requirements engineering (RE) techniques, such as workshops or interviews, struggle to involve large groups of heterogeneous, geographically distributed stakeholder groups due to time and cost constraints. At the same time, software development practices have evolved from infrequent major releases developed waterfall-style to a model of agile and continuous incremental updates. Software users have come to expect and appreciate their feedback being implemented in a timely manner. In this context, crowd-based RE has presented itself as an approach that shows promise in opening the RE process to many diverse and geographically dispersed stakeholders via automated or semi-automated techniques. However, extant research lacks formalized guidance on how to design and implement such crowd-based RE approaches and, in the case of collaborative crowd-based RE, frequently neglects the post-implementation phase of software products as well as intra-organizational crowds of software users.

The second of the application domains examined as part of this thesis are local communities or neighborhoods. Neighborhoods are rife with valuable resources and actors that determine the well-being of their inhabitants. However, these resources are often nontransparent to some potential beneficiaries, hard to take advantage of, or hard to evaluate regarding their trustworthiness. Online neighborhood social networks (ONSNs) are a new class of online social networks (OSNs) that have demonstrated promising results in stimulating neighborly communication and participation. As such, they could serve as a suitable platform for infusing openness into the application domain of local communities. However, despite the rising popularity of publicly available ONSN platforms such as Nextdoor or nebenan, they have received little research interest. Similar to the domain of collaborative crowd-based RE, available research does provide little guidance regarding how to design this type of artifact.

Research Design

This thesis takes a cumulative research approach, reporting on several iterations of an overarching design science research project based on nine individual publications and operationalized using the Design Science Research Methodology (DSRM). Within DSRM, a variety of research methods are utilized. These include a structured literature review as well as taxonomy development to conceptualize both design parameters of ONSNs and the domain of collaborative crowd-based RE. For the development and evaluation of design knowledge in both application domains, empirical data was collected via interviews, focus groups, and during workshops and analyzed using qualitative content analysis. The instantiation of the developed design knowledge to demonstrate and assess its usefulness entailed the development of several web-based software artifacts. In addition to the aforementioned qualitative methods, an online survey and a usage data analysis are utilized as a part of the long-term evaluation of platform usage.

Results

The central result of this thesis is the development of conceptually and empirically validated design knowledge for openness-infusing socio-technical artifacts in two application domains. This design knowledge entails prescriptive knowledge in the form of design principles as well as artifact instantiations. In the SRE application domain, this thesis provides eight design principles for conducting collaborative crowd-based RE as well as an instantiation in the form of the *CrowdCore* artifact consisting of a process and online platform. This design knowledge draws on extant research on RE and crowdsourcing as well as empirical data gained from a public sector case organization. It is validated via an artificial, simulation-based evaluation. In the application domain of local communities, this thesis presents a set of four design principles for ONSNs as well as their instantiation as the *MyNeighbors* artifact, a fully-featured ONSN platform that is validated through a naturalistic long-term evaluation and continues to be used across several urban case neighborhoods. Besides these design-focused core results, this thesis conceptualizes both application domains by developing a taxonomy of design properties of ONSNs and conducting a structured literature review of collaborative crowd-based RE approaches. Additional in-depth evaluation insights are gained by investigating the use of ONSNs by older adults as well as the current suitability and future potential of utilizing ONSNs as a tool for fostering social resilience in times of crisis.

Contribution

By developing validated design knowledge for openness-infusing socio-technical artifacts in two application domains, this thesis contributes to research on openness in information systems. Along with this overall contribution, this thesis contributes to research on crowd-based RE by defining and topically delineating collaborative crowd-based RE approaches. As a central contribution, the developed design knowledge serves as a blueprint for researchers and practitioners aiming to implement approaches of a similar type. This thesis extends the scope of collaborative crowd-based RE across the entire software product lifecycle, including the post-implementation phase. By investigating the use of intra-organizational crowds for crowd-based RE, this thesis also proposes and evaluates a novel use case for internal crowdsourcing. Leveraging the insights generated by this thesis, organizations developing software products are enabled to scale user involvement in RE to large, distributed groups of software users with a manageable expenditure of effort. By receiving access to a more representative picture of user needs, they can make better-informed implementation decisions and improve overall user satisfaction.

In the case of the conducted research on local communities, the developed design knowledge for ONSNs guides researchers and practitioners in implementing and establishing novel artifacts that pursue the similar goal of improving neighborhood well-being. Closely related, the developed taxonomy of design properties of ONSNs enables the assessment and comparison of existing and future ONSN platforms. The proposed implementation of community initiatives contributes to the field of crowdsourcing in local and community contexts. Furthermore, this thesis demonstrates that ONSNs represent a digital technology that can mediate social connectedness and participation and may be more effective in doing so than traditional OSNs. The conducted research guides practitioners such as local governments, local institutions, and non-profit organizations on how ONSNs can contribute to establishing socially sustainable, age-friendly, and resilient local communities. Furthermore, it positions ONSNs as a building block for smart and healthy communities.

Limitations

The research project described in this thesis is faced with limitations arising from its research design, methodology, and evaluation. Due to the largely qualitative research approach and associated methodology, researcher bias and individual skills influenced its outcome. To mitigate this risk, data from a variety of sources and using a variety of data collection techniques were triangulated. The primary result of the research, design knowledge, which was developed based on two selected research settings, possesses a degree of context-specificity that limits its generalizability. Regarding the applied methodology, data collection partially relied on a limited number of subjects and cases, with the research conducted in the SRE domain centering on a single case organization. In the case of the application domain of local communities, this risk is mitigated by involving two separate case neighborhoods with varying socio-demographic characteristics and demographics. Due to limitations of the research context in the case of the application domain of software requirements engineering, a naturalistic long-term evaluation was substituted with an artificial simulation. Finally, evaluating design knowledge in the same setting that it was derived from may limit its generalizability and transferability.

Future Research

The research initiated in this thesis yields multiple impactful avenues for further research. In the SRE application domain, this thesis identifies the integration of crowd-based RE approaches with agile software development practices as an important but unaddressed research issue. Furthermore, the integration of collaborative and data-driven approaches as well as an investigation into the design properties of publicly available tools for collaborative crowd-based RE are poised to yield valuable research results. In the application domain of local communities, the expansion and continued evaluation of the developed ONSN artifact into a larger and more heterogeneous set of case neighborhoods could enable the improvement of design knowledge and the identification of factors determining the success of ONSN establishment. Altogether, observations made during the design of the presented openness-infusing socio-technical artifacts, entailing the integration of existing approaches such as crowdsourcing in both application domains, demonstrate the potential for developing a novel, system-oriented view of multi-actor and multi-goal participation.

Kurzfassung

Problemstellung und Ziel der Arbeit

Die zunehmende Verbreitung digitaler Technologien ruft offene Phänomene hervor, die viele Facetten des gesellschaftlichen und geschäftlichen Lebens beeinflussen. Offene Ressourcen wie Inhalte auf Wikipedia haben den Zugang zu Informationen und Wissen revolutioniert. Offene Prozesse wie Open Innovation oder Crowdsourcing ermöglichen eine neue Form der kollaborativen Wertschöpfung. Offene Phänomene rufen in der Regel öffnende Effekte hervor und beseitigen seit langer Zeit bestehende Zugangs- und Beteiligungsbarrieren und revitalisieren antiquierte Normen und Strukturen. Im Falle einer Vielzahl dieser offenen Phänomene kommen soziotechnische Artefakte zum Einsatz, um einen sonst durch Exklusivität oder Einschränkungen geprägten Kontext mit Offenheit zu durchdringen. Diese Artefakte, beispielsweise Online-Plattformen, stellen Ansammlungen von technischen Artefakten wie Software sowie deren Nutzung bestimmenden sozialen Artefakten wie Normen, Zielen und Institutionen dar. Allerdings bietet der aktuelle Forschungsstand Forschern und Praktikern für viele Anwendungsgebiete nur begrenzt formalisierte und validierte Handlungsempfehlungen für die Gestaltung von Artefakten, die die Durchdringung eines Kontextes mit Offenheit ermöglichen. Um diese Forschungslücke zu adressieren, hat es sich die vorliegende Forschungsarbeit zum Ziel gemacht, validiertes Gestaltungswissen für soziotechnische Artefakte zu entwickeln, die eine Durchdringung zweier Anwendungsgebiete mit Offenheit ermöglichen.

Das erste Anwendungsgebiet umfasst den Prozess des Anforderungsmanagements (AM) im Rahmen der Softwareentwicklung. Traditionelle Methoden des AM wie Workshops oder Interviews sind aufgrund von Zeit- und Kosteneinschränkungen nur bedingt geeignet, große Gruppen heterogener und räumlich verteilter Softwarenutzer in den AM-Prozess einzubinden. Überdies haben sich Methoden der Softwareentwicklung von im Wasserfall-Vorgehensmodell entwickelten, umfangreichen und in großen Abständen durchgeführten Software-Releases zu kontinuierlich, agil, iterativ und hochfrequent durchgeführten Aktualisierungen entwickelt. In diesem Zusammenhang hat sich crowd-basiertes AM als vielversprechender Ansatz gezeigt, der in der Lage ist, über automatisierte und semi-automatisierte Techniken den AM Prozess für große Gruppen diverser und geographisch verteilter Anwender zu öffnen. Jedoch kann der aktuelle Forschungsstand nur wenige Handlungsempfehlungen für die Gestaltung solcher Ansätze liefern und vernachlässigt im Falle von kollaborativem crowd-basierten AM häufig die auf die Implementierung folgenden Phasen des Software-Lebenszyklus.

Das zweite Anwendungsgebiet umfasst lokale Gemeinschaften oder Nachbarschaften. Nachbarschaften sind reich an wertvollen Ressourcen und Akteuren, die das Wohlbefinden ihrer Einwohner maßgeblich beeinflussen. Diese sind jedoch bislang oft nicht für alle potenziellen Begünstigten transparent sichtbar, schwer in Anspruch zu nehmen oder bezüglich ihrer Vertraulichkeit schlecht zu bewerten. Digitale Nachbarschaftsplattformen sind eine neue Klasse sozialer Netzwerke, die vielversprechende Ergebnisse bei der Verbesserung nachbarschaftlicher Kommunikation und Teilhabe aufweisen. Damit sind sie potenziell gut geeignet, Offenheit in das Anwendungsgebiet lokaler Gemeinschaften einzubringen. Trotz der steigenden Popularität von öffentlich zugänglichen digitalen Nachbarschaftsplattformen wurden diese bislang wenig erforscht. Zudem bietet, ähnlich wie im Falle der crowd-basierten AM, die bisher veröffentlichte Literatur kaum Handlungsempfehlungen für die Gestaltung und Reproduktion dieser Art von Artefakt.

Forschungsdesign und -methodik

Diese Forschungsarbeit verfolgt einen kumulativen Ansatz und berichtet basierend auf neun Publikationen über mehrere Iterationen eines übergreifenden Forschungsprojektes, das mit Hilfe der Design Science Research Methodology (DSRM) operationalisiert wird. Innerhalb der DSRM kommen eine Reihe von Forschungsmethoden zum Einsatz. Diese beinhalten ein strukturiertes Literaturreview sowie die Entwicklung einer Taxonomie, um sowohl die Designparameter von digitalen Nachbarschaftsplattformen als auch das Themengebiet des crowd-basierten AMs zu konzeptualisieren. Zur Entwicklung und Evaluierung von Gestaltungswissen in beiden Anwendungsgebieten werden empirische Daten gesammelt und mit Hilfe von qualitativer Inhaltsanalyse ausgewertet. Die Instanziierung dieses Gestaltungswissens mit dem Ziel dessen Nutzen zu demonstrieren und zu prüfen, umfasst die Entwicklung mehrerer webbasierter Softwareartefakte. Zuletzt werden für die naturalistische Langzeitevaluation einer digitalen Nachbarschaftsplattform Nutzungsdaten ausgewertet.

Forschungsergebnisse

Das zentrale Ergebnis dieser Forschungsarbeit ist konzeptuell und empirisch validiertes Gestaltungswissen für soziotechnische Artefakte, die die Durchdringung von zwei Anwendungsgebieten mit Offenheit ermöglichen. Dieses Gestaltungswissen beinhaltet präskriptives Wissen in Form von Gestaltungsprinzipien sowie instanziierte Artefakte. Im Anwendungsgebiet lokaler Gemeinschaften präsentiert diese Forschungsarbeit vier Gestaltungsprinzipien sowie deren Instanziierung in Form des Artefakts *Meine Nachbarn*, einer digitalen Nachbarschaftsplattform, die durch eine naturalistische Langzeitevaluation in mehreren urbanen Nachbarschaften validiert wurde. Im Anwendungsgebiet AM stellt diese Forschungsarbeit acht Gestaltungsprinzipien für die Anwendung kollaborativen, crowd-basierten AMs sowie das *CrowdCore*-Artefakt vor, das aus einer Methode und einer Onlineplattform besteht.

Forschungsbeitrag

Diese Forschungsarbeit leistet einen Beitrag zur Forschung im Bereich Offenheit von Informationssystemen, indem sie validiertes Gestaltungswissen für soziotechnische Artefakte entwickelt, die die Durchdringung zweier Anwendungsgebiete mit Offenheit ermöglichen. Sie trägt zur Forschung im Bereich crowd-basiertes AM bei, indem sie für das kollaborative crowd-basierte AM eine erste Definition und thematische Abgrenzung vornimmt. Als zentralen Beitrag ermöglicht das entwickelte Gestaltungswissen Forschern und Praktikern Ansätze für das crowd-basierte AM ähnlichen Typs zu entwickeln. Diese Forschungsarbeit erweitert zudem den Geltungsbereich kollaborativen, crowd-basierten AMs auf den gesamten Softwarelebenszyklus, einschließlich der auf die Implementierung folgenden Phasen. Indem auch intra-organisationale Crowds für das crowd-basierte AM untersucht werden, präsentiert und evaluiert diese Forschungsarbeit zudem einen weiteren Anwendungsfall für internes Crowdsourcing. Durch die Nutzung der Erkenntnisse dieser Forschungsarbeit werden Unternehmen, die Softwareprodukte bereitstellen, befähigt die Nutzereinbindung in den AM-Prozess auf große, verteile Nutzergruppen zu skalieren. Dadurch erhalten sie Zugang zu einem repräsentativeren Abbild von Nutzerbedürfnissen, können bessere Implementierungsentscheidungen treffen und die Nutzerzufriedenheit steigern.

Auch im Forschungsbereich lokaler Gemeinschaften kann das entwickelte Gestaltungswissen Forscher und Praktiker bei der Gestaltung von Artefakten unterstützen, die das Ziel verfolgen das nachbarschaftliche Wohlbefinden zu verbessern. Daran anknüpfend ermöglicht die entwickelte Taxonomie für Gestaltungseigenschaften von digitalen Nachbarschaftsplattformen die Analyse und Bewertung bestehender und potenzieller zukünftiger Artefakte dieses Typs. Die Umsetzung von Gemeinschaftsinitiativen leistet einen Forschungsbeitrag im Bereich Crowdsourcing in Lokal- und Gemeinschaftskontexten. Die vorliegende Forschungsarbeit zeigt zudem auf, dass digitale Nachbarschaftsplattformen eine digitale Technologie darstellen, die soziale Verbundenheit und soziale Teilhabe von Individuen beeinflussen kann, potenziell auch stärker, als dies bei traditionellen internetbasierten sozialen Netzwerken wie beispielsweise Facebook der Fall ist. Diese Forschungsarbeit unterstützt Praktiker wie Lokalregierungen, lokale Institutionen oder gemeinnützige Organisationen dabei, digitale Nachbarschaftsplattformen für die Gestaltung von nachhaltigen, altersfreundlichen und widerstandsfähigen lokalen Gemeinschaften zur Anwendung zu bringen. Zudem positioniert sie digitale Nachbarschaftsplattformen als Baustein für intelligente und gesunde lokale Gemeinschaften.

Limitationen

Das in dieser Dissertation beschriebene Forschungsprojekt muss im Kontext einer Reihe von Limitationen betrachtet werden, die aus dem Forschungsdesign, der Methodik und der Evaluation hervorgehen. Aufgrund der überwiegend qualitativen Methodik des Forschungsprojektes, haben individuelle Voreingenommenheiten und Fähigkeiten der beteiligten Forschenden das Ergebnis beeinflusst. Um dieses Risiko zu reduzieren, wurden eine Vielzahl von Datenquellen und Erhebungsmethoden trianguliert. Das zentrale Ergebnis dieser Forschungsarbeit, Gestaltungswissen, das auf Basis zweier ausgewählter Forschungssettings entwickelt wurde, besitzt einen Grad von Kontextspezifizität, die seine Generalisierbarkeit einschränkt. Die angewandten Forschungsmethoden konnten zum Teil, insbesondere im Bereich des AM, nur auf eine begrenzte Zahl von Fällen und Subjekten zurückgreifen. Dieses Risiko konnte im Setting der lokalen Gemeinschaften durch die Involvierung zweier sich durch ihre Demographie und sozioökonomischen Charakteristiken unterscheidenden Nachbarschaften reduziert werden. Im Fall der durchgeführten Forschung in Bezug auf AM konnte keine naturalistische

Langzeitevaluation durchgeführt werden und es wurde stattdessen auf eine künstliche Evaluation im Rahmen einer Simulation zurückgegriffen. Schließlich mindert die Evaluation von Gestaltungswissen in der gleichen Umgebung, in der es entstanden ist, dessen Generalisierbarkeit und Übertragbarkeit.

Ausblick

Aus den Ergebnissen dieser Forschungsarbeit lassen sich eine Vielzahl weiterer potenzieller Forschungsansätze ableiten. Im Falle des crowd-basierten AM bietet sich die Integration von crowd-basiertern AM-Ansätzen sowie agilen Ansätzen zur Softwareentwicklung als vielversprechender aber bislang nicht ausreichend adressierter Sachverhalt an. Zudem birgt die Verschmelzung kollaborativer und datengetriebener Ansätze für crowd-basiertes AM Potenzial für weitere Forschungsarbeiten. Die Perspektive der Anbieter kommerzieller Lösungen für crowd-basiertes AM ist bislang ebenfalls in der Forschung nur in Ansätzen berücksichtigt worden und rechtfertigt eine tiefergehende Untersuchung. Im Bereich der lokalen Gemeinschaften können durch die weitere Ausbreitung und Evaluation der entwickelten digitalen Nachbarschaftsplattform potenziell wertvolle Ergebnisse für die Verbesserung des bestehenden Gestaltungswissens gewonnen werden. Die Einbeziehung und Gegenüberstellung einer größeren Menge von heterogenen Nachbarschaften könnte zudem die Identifikation von Erfolgsfaktoren für die Wirksamkeit von digitalen Nachbarschaftsplattformen ermöglichen. In Summe demonstrieren Beobachtungen, die im Zuge der Entwicklung der vorgestellten soziotechnischen Artefakten getätigt wurden, Potenzial für die Untersuchung einer neuen, systemorientierten Sichtweise auf die Partizipation durch mehrere Akteure sowie deren individuelle und gemeinsame Zielsetzungen.

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List of Abbreviations

AGQua	Aktive und Gesunde Quartiere Uhlenhorst und Rübenkamp
AIS	Association for Information Systems
CrowdCore	Crowd-based Continuous Internal Requirements Engineering
DSR	Design science research
DSRM	Design Science Research Methodology
ExTEND	Engineering von Dienstleistungssystemen für nutzergenerierte Dienstleistungen
IS	Information systems
IT	Information technology
ONSN	Online neighborhood social network
OSN	Online social network
RE	Requirements engineering
RG	Research goal
RQ	Research question
SNS	Social network site
SRE	Software requirements engineering

1 Introduction

1.1 Motivation and Problem Statement

The increasing diffusion of digital technology, in particular the widespread availability of broadband internet, has given rise to a variety of open phenomena that affect many facets of contemporary business and society (Nielsen and Sahay 2019). These phenomena can be conceptualized into the mutually non-exclusive categories of open resources, open processes, and opening effects (Schlagwein et al. 2017). Open resources such as knowledge on open content platforms or open educational resources have redefined access to knowledge and information (Carillo and Okoli 2011; Downes 2007). Open processes such as open innovation, crowdsourcing, and open-source software development have enabled collaborative and participative value generation (Chesbrough 2003; Feller and Fitzgerald 2000; Howe 2006). Open government initiatives achieve opening effects, including increased inclusiveness, social mobility, or civic participation (Janssen et al. 2012). Technology-induced openness has brought about entire non-profit and commercial economies, such as the sharing economy, encompassing ride-sharing, accommodation-sharing, and task-sharing (Hamari et al. 2016). Oftentimes, the application of digital technology and the coinciding opening effects allow for the revitalization of antiquated structures and removal of obstacles to participation (Gleasure et al. 2020). Consequently, the effects of openness are not limited to technological or procedural innovation but encompass social change, strengthening the participation and agency of marginalized groups in society (Bentley et al. 2019). These phenomena reveal a multi-faceted concept of openness that is characterized by the principles of transparency, accessibility, participation, and democracy (Schlagwein et al. 2017).

But openness is not a magic bullet and can even provoke detrimental effects. For instance, the sharing economy is struggling to face a discussion on social inequality as well as the legal status and rights of workers, circumventing established regulation and accelerating urbanization and gentrification (Hagiu and Wright 2019; Wachsmuth and Weisler 2018). Open-source software licensing and copyright issues are subject to repeated legal disputes (Alspaugh et al. 2010). In the case of open innovation, organizations are faced with the paradoxical position of opening themselves for an influx of outside innovation but turning ever more protective of their intellectual property (Nielsen and Sahay 2019). Both the benefits of opening effects and potential adverse outcomes have to be carefully considered and gauged in the design of open information systems (IS).

A commonality of the abovementioned examples lies in them typically being enabled by socio-technical artifacts such as online platforms. Socio-technical artifacts represent assemblages of technical artifacts such as software that amplify and constrain opportunities for action, determining what *can* be done, as well as social artifacts such as goals, norms, and institutions that determine what *should* be done (Guarino et al. 2012; Silver and Markus 2013). Socio-technical artifacts mediate openness and "key 'open' aspects – such as resources access and process participation – can be increased or enacted in entirely new ways through IT" (Schlagwein et al. 2017, p. 302). By doing so, socio-technical artifacts apply principles of openness to an otherwise closed context, i.e., one that is secret, limited or exclusive. This process represents an infusion, the permeation of an entity with a principle or quality, altering it usually for the better (Merriam Webster 2020).

This thesis aims to contribute toward improving the understanding of how this infusion of openness via socio-technical artifacts can be invoked. It does so by developing design knowledge for socio-technical artifacts for two distinct application domains, which are ripe to benefit from an infusion with openness. The first application domain investigated by this thesis is the software requirements engineering (SRE) process. Defining software requirements represents an activity that can be decisive for the overall success of a software development project as well as software user satisfaction (Hofmann and Lehner 2001). Software development practices have evolved from sequential, waterfall-style approaches toward a continuous delivery model of frequent, incremental updates. At the same time, the internet enables direct communication between software developers and software users, with users expecting and rewarding responsiveness to their feedback (Fleischmann et al. 2015). In light of these developments, traditional requirements engineering (RE) practices, such as interviews or workshops, have shown themselves to be cost- and time-intensive, sluggish, non-representative, and unable to scale to large groups of stakeholders (Johann and Maalej 2015; Sharma and Sureka 2017). The novel approach of crowd-based RE leverages the collective intelligence of a crowd of software product users to derive validated software requirements by automated and semi-automated means (Groen et al. 2017). By being able to involve large, heterogeneous groups of software users and being time and place independent, crowd-based RE can potentially address some shortcomings of traditional RE techniques. Crowd-based RE comprises both data-driven approaches, which entail the extraction of requirements from data such as app store reviews or software usage data (Maalej et al. 2016a; Maalej et al. 2016b; Stanik and Maalej 2019), and collaborative approaches where software users and developers collaborate to jointly ideate, specify, and prioritize software requirements (Vogel and Grotherr 2020). Crowdsourcing is particularly suitable for collaborative problem-solving (Tavanapour and Bittner 2018; Tavanapour and Bittner 2019), demonstrating the potential of improving the openness of the RE process by making transparent the demands and expectations of software users, fostering participation through user involvement, and improving the representativeness of developed requirements via democratization. While there are a variety of commercial offerings related to collaborative crowd-based RE, these approaches are seldom investigated in research. Existing approaches to collaborative crowd-based RE presented in the literature lack a focus on the post-implementation phase of software development projects, rarely consider the involvement of internal crowds and exhibit a lack of formalized design knowledge. To address this research gap, this thesis develops design knowledge for a continuous and collaborative approach to crowd-based RE that can be applied in an intra-organizational setting.

The second application domain investigated by this thesis is local communities or neighborhoods. Neighborhoods are rife with public and private actors and resources that influence individual and community well-being (Vogel et al. 2019b). Information regarding these actors and resources, however, is not always transparently available, hard to access, or scattered across a variety of media. This represents a particular issue for some disadvantaged groups, such as the elderly, a social group prevalent in urban neighborhoods (UN 2017), who face obstacles in gaining access to digital information due to a lack of competencies and age-friendly means of access (Rockmann et al. 2018). Infusing these traditional structures with openness could serve to make these actors and resources more transparent, improve their accessibility, enable participation in community life, and democratize community-level decision-making. In this context, neighbors are increasingly utilizing localized social media channels to exchange information, for social interaction, or to organize peer-support networks (Bingham-Hall and Law 2015; Turner 2015). Online neighborhood social networks (ONSNs) are a novel type of online social network (OSN) that has demonstrated potential for fostering neighborly relationships and communication (Masden et al. 2014). Neighborhood-related interactions on ONSNs have been shown to evoke an online and offline sense of community and to provide perceived local social support (De Meulenaere et al. 2020a). As such, ONSNs are socio-technical artifacts that represent a potential vehicle for the infusion of openness into the context of local communities or neighborhoods. However, despite the increasing popularity of ONSNs, extant research does not offer formalized guidance on their design and establishment in the form of design knowledge. Furthermore, existing ONSN platforms offer little functionality beyond generic communication capabilities and do not significantly differentiate themselves from traditional social media platforms (Vogel et al. 2020b). This thesis seizes upon this promising potential as well as research gap and develops validated design knowledge for ONSNs.

1.2 Research Goal and Research Questions

While the publications included in this thesis constitute individual research contributions, they are part of a unified research effort. Following the presented motivation, the overarching research goal (RG) of this effort spanning both application domains is defined as follows:

> **RG: Develop validated design knowledge for openness-infusing socio-technical artifacts.**

Following a cumulative approach, this RG is pursued through several research questions (RQs), which are answered by one or more of the included publications. In this dissertation, the application domains and corresponding RQs are presented in the chronological order they were addressed in as part of the overarching thesis research project. At the outset, this thesis investigates how socio-technical artifacts can infuse openness into the application domain of SRE. With the rise of crowd-based RE, this application domain has shown the first potential for profiting from an infusion of openness (Groen et al. 2017; Johann and Maalej 2015). As formalized guidance for designing these crowd-based approaches remains scarce, the following guiding research question is defined:

> **RQ-1: How to design socio-technical artifacts for improving software requirements engineering through the infusion of openness?**

This research question is addressed in two stages. Initially, to identify extant issues with traditional RE practices and to assess the current state of research on collaborative crowd-based RE, Vogel and Grotherr (2020) conduct a structured literature review. By doing so, this research presents a first and systematic overview and conceptualization of the domain of collaborative crowd-based RE, identifies shortcomings of existing design artifacts in this category, and determines promising avenues for further research. Vogel et al. (2019a) build on these identified research gaps as well as objectives for further research and develop design knowledge for a collaborative crowd-based RE approach that spans the entire software product lifecycle and involves an internal crowd of software users in the RE process. This design knowledge is instantiated into a process and web-based platform called *CrowdCore* (short for Continuous Internal Crowd-Based Requirements Engineering).

Local communities represent a second application domain that has demonstrated potential for an infusion with openness. In the case of local communities, this potential arises not only from extant research, which remains exceedingly scarce, but also from observing the rising popularity of publicly available ONSN platforms. And while there is a limited number of studies investigating the effects of ONSNs on local communities, even fewer available publications provide guidance on their design and implementation (Masden et al. 2014; Renyi et al. 2018). Therefore, derived from the overall RG, the research conducted in the application domain of local communities as part of this thesis is guided by the following central research question:

> **RQ-2: How can socio-technical artifacts be designed to improve the well-being of local communities through the infusion of openness?**

As this application domain is explored in more depth and with a higher time expenditure compared to the SRE domain, the overall research question RQ-2 is split into three fine-grained sub-questions. The first research question is closely focused on the development of design knowledge:

> **RQ-2a: What are the design principles for online neighborhood social networks?**

Four included publications address this research question. Vogel et al. (2019b) draw on empirical data from two case neighborhoods as well as the experiences of a limited field test of an ONSN prototype artifact to provide an initial and base set of design principles for

ONSNs. Vogel et al. (2020b) widen the scope of investigation of the research project and conduct an explorative study of the design properties of existing, publicly available ONSN platforms. Based on empirical data collected via a criteria-based online search, a taxonomy of these design properties is developed following Nickerson et al. (2013). As a result, the design objectives of the focal research project are extended and refined.

Neighborhood activism has been identified as a positive influencing factor for community well-being (Gilster 2012). While Vogel et al. (2020b) demonstrated that most ONSN platforms possess functionality for individual and group communication, they lack specific functionality that supports community-level activism and volunteering. Addressing this research gap, Vogel et al. (2020a) conduct a design iteration to develop targeted functionality for conducting community initiatives on ONSNs. The developed design knowledge adds to the functionality proposed as part of the initial set of design principles in Vogel et al. (2019b). Vogel et al. (2020c) present the culmination of research conducted in the context of ONSNs as part of this thesis, drawing on and unifying the previous publications. This publication provides a final state of design knowledge for ONSNs, building on a revised theoretical foundation and a long-term naturalistic evaluation of the web-based *MyNeighbors* ONSN artifact.

Following an ensemble view of technology, IS are embedded in a constantly evolving socio-technical context (Orlikowski and Iacono 2001). Consequently, the value of socio-technical artifacts such as the proposed ONSN platform is dependent on a successful embedding in their context or application domain. The present research context in a local community with a wide variety of stakeholders as well as a wide variety of requirements presents itself as particularly complex. To determine how to successfully embed and establish an ONSN system as an integrator and hub for a local community in this research context, the following research question is posed:

> **RQ-2b: How can online neighborhood social networks be established in local communities?**

This research question is addressed by Grotherr et al. (2020), determining the challenge of establishing an ONSN artifact to be one of multiple levels. Goals that would be observed on the micro-level, such as stimulating social participation, are dependent on the design of engagement-stimulating mechanisms such as socio-technical platforms and their functionalities on the meso-level. Additionally, macro-level actors such as organizations and institutions must be mobilized to build trust and stimulate the engagement of actors. The successful establishment of an ONSN platform is, therefore, dependent on both engagement and institutional design.

Building upon the development of design knowledge for ONSNs as well as its instantiation as the MyNeighbors ONSN artifact in two case neighborhoods, a naturalistic long-term evaluation becomes possible. This allows for the investigation of the following research question:

> **RQ2c: What are the effects of the usage of online neighborhood social networks?**

To answer this research question, Vogel et al. (2021a) investigate the perceptions, challenges, and effects associated with ONSN use. Older adults, for whom the immediate context of their local neighborhood plays an important role and who are prone to social isolation and loneliness following important life events such as retirement or death of a spouse (Yen et al. 2012), stand to profit much from improved access to and transparency of local resources as well as peer-support offered via ONSNs. As such, the user group of older adults stands at the center of analysis by Vogel et al. (2021a).

The COVID-19 pandemic and resulting public health measures such as stay-at-home orders and physical distancing represent a challenge for individual and societal well-being. Similar to other contemporary disasters, OSNs are widely used to counteract some of the pandemic's negative outcomes, with ONSNs being no exception (Chen et al. 2020; Mirbabaie et al. 2020). In this context, Vogel et al. (2021b) investigate how ONSNs are being used to foster social resilience during the COVID-19 pandemic, how they are adapting their design features in light of this challenge, and what future adaptations may prove useful.

1.3 Thesis Outline

This thesis is structured as follows (see also Table 1). Following this introductory section, Section 2 presents the overall research design and applied research methods. Section 3 establishes the theoretical foundations upon which this research project is based. The publications included in this thesis are presented in Section 4. Subsequently, the overall theoretical and practical contributions of the conducted research are discussed in Section 5 and Section 6. Section 7 reflects on the limitations of the selected research design, while Section 8 considers avenues for further research in the context of this thesis. The final part of this thesis contains the nine individual included publications.

Table 1. Thesis outline

Wrapper	**1. Introduction**	**2. Research Design**	**3. Theoretical Foundations**	**4. Publications**
	5. Theoretical Contribution	**6. Practical Contribution**	**7. Limitations**	**8. Further Research**
Included Publications	9. Paper 1	Leveraging the Internal Crowd for Continuous Requirements Engineering: Lessons Learned from a Design Science Research Project		
	10. Paper 2	Healthy, Active and Connected: Towards Designing an Age-Friendly Digital Neighborhood Platform		
	11. Paper 3	Multilevel Design for Smart Communities – The Case of Building a Local Online Neighborhood Social Community		
	12. Paper 4	Conceptualizing Design Parameters of Online Neighborhood Social Networks		
	13. Paper 5	Designing Tool Support for Crowd-Sourced Community Initiatives on Online Neighborhood Social Networks		
	14. Paper 6	Collaborating with the Crowd for Software Requirements Engineering: A Literature Review		
	15. Paper 7	Design and Evaluation of an Online Neighborhood Social Network for Fostering Social Connectedness and Participation: Lessons from Two Urban Neighborhoods		
	16. Paper 8	Older Adults' Use of Online Neighborhood Social Networks: Perceptions, Challenges and Effects		
	17. Paper 9	Fostering Social Resilience via Online Neighborhood Social Networks During the COVID-19 Pandemic and Beyond: Status Quo, Design Dilemmas and Research Opportunities		

2 Research Design

This section outlines the overall research design by which the previously defined RQs are to be addressed. This entails a high-level overview of the applied research strategy, a description of the engaged research contexts, and a detailed look at the utilized research methods.

2.1 Overall Research Strategy and Research Context

To answer the RQs proposed in Section 1, this thesis follows the design science research (DSR) approach. According to Hevner et al. (2004, p. 81), DSR aims to address "important unsolved problems in unique or innovative ways" and "creates and evaluates IT artifacts intended to solve organizational problems" (Hevner et al. 2004, p. 77). The DSR paradigm is well-established in IS research (Gregor and Hevner 2013) and has been applied in a wide variety of high-quality IS publications (e.g., Liu et al. 2020; Meth et al. 2015; Seidel et al. 2017). Hevner and Chatterjee (2010, p. 5) describe the DSR paradigm as one responding to "relevant […] human problems via the creation of innovative artifacts" where these artifacts are "both useful and fundamental in understanding that problem." DSR can be conceptualized as consisting of three closely related cycles of activities (Hevner 2007). The relevance cycle initiates DSR and draws on the research environment to elicit requirements for a solution but also as a proving ground for the evaluation of research results. The rigor cycle grounds design research in state of the art knowledge based on extant research and, in turn, contributes newly gained insights to the body of knowledge. Finally, the design cycle, at the heart of any DSR project, iterates between the construction of an artifact, its evaluation, and its refinement based on the results of this evaluation. As such, impactful DSR distinguishes itself via a synergy between relevance and rigor and balances contributions to both cycles (Hevner 2007). In conducting DSR, this thesis and its included publications follow the seven guidelines for conducting effective design science research in IS proposed by Hevner et al. (2004).

The results of DSR are formalized as design knowledge (Gregor and Jones 2007), constituting the means-end relationship between problem and solution spaces (Venable 2006). Design knowledge can take the form of artifact instantiations, nascent design theory such as design principles, schemas, methods, or fully developed design theories (Gregor and Hevner 2013; vom Brocke et al. 2019). While there is no agreed-upon standard for naming the concepts constituting design knowledge (Cronholm and Göbel 2019), for this thesis, the differentiation between design goals, design principles, and design features is of interest. According to Gregor and Jones (2007), design goals outline the purpose and scope of a design theory, describing *what* a class of artifacts is supposed to achieve. Design principles represent prescriptive knowledge that guides the creation of "other instances of artifacts that belong to the same class" (Sein et al. 2011, p. 39) or "prescriptive statements that show how to do something to achieve a goal" (Gregor et al. 2020, p. 1). Consequently, they represent a "how-to statement" (Niehaves and Ortbach 2016, p. 305), describing *how* design goals can be achieved. Finally, design features represent "specific artifact capabilities to satisfy design principles" (Meth et al. 2015, p. 814). Different designers may implement different design features to satisfy the same set of design principles (Niehaves and Ortbach 2016).

Figure 1 presents a high-level overview of the research conducted as part of this thesis. The overarching DSR project encompasses the two application domains SRE and local communities, each possessing a corresponding research setting. These research settings constitute the environmental pillar of the three-cycle model. Chronologically, the application domain of SRE represents the starting point for the research conducted as part of this thesis. As part of the research project *Engineering von Dienstleistungssystemen für nutzergenerierte Dienstleistungen (ExTEND)*, this research context comprises a public sector case organization responsible for providing port management services for one of Europe's largest seaports. This research project pursued the goal of empowering employees to improve software products that were currently being introduced in their organization through the independent implementation of small software customizations, fixes, and extensions dubbed change initiatives. Addressing RQ-1, the research conducted in the SRE application domain comprises two publications.

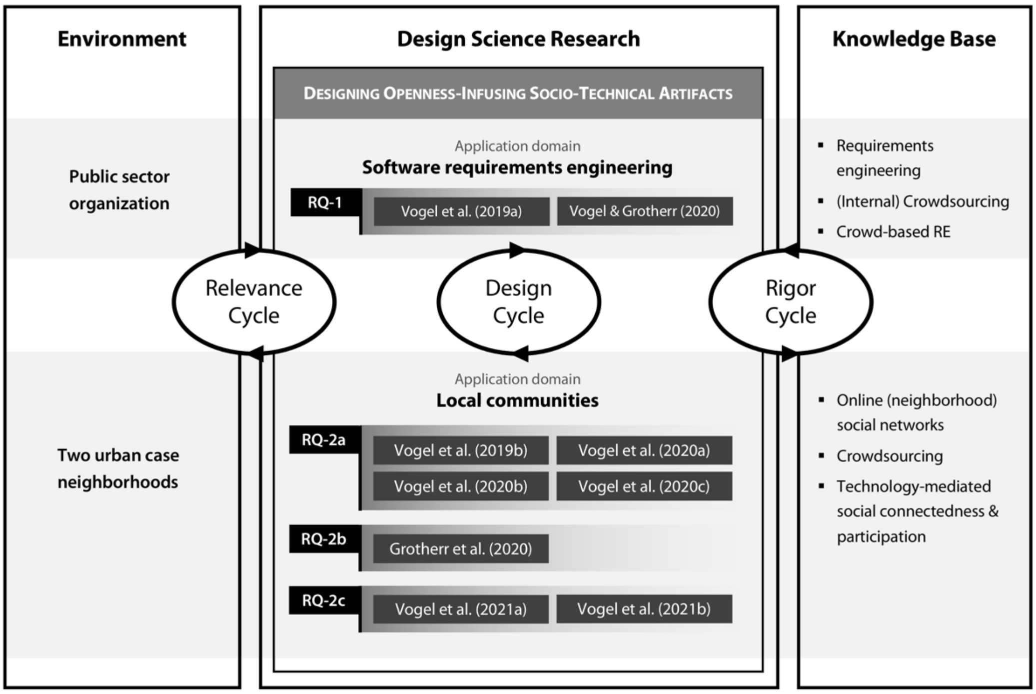

Figure 1. Design Science Research Cycles as applied in this thesis (adapted from Hevner (2007))

Following the conclusion of research in the domain of SRE, this thesis addresses RQ-2 and its sub-questions related to the domain of local communities as part of a multi-disciplinary research project called *Aktive und Gesunde Quartiere Uhlenhorst und Rübenkamp (AGQua)*. Aimed at improving the age-friendliness of local communities, this research project pilots a variety of social and technological innovations, including but not limited to professional neighborhood management services, health counseling, and digital inclusion initiatives. Two case neighborhoods in the metropolitan area of Hamburg serve as a proving ground for the research project. An ONSN platform, developed as part of this thesis under the label MyNeighbors (from the German *Meine Nachbarn*), assumes the role of an integrator and hub in these case neighborhoods. The research conducted in the application domain of local communities comprises seven publications. Table 2 summarizes and contrasts both application domains and the corresponding research settings.

Table 2. Comparison of application domains and research contexts

Application domain	Software requirements engineering	Local communities
Research setting	Public sector organization	Two urban case neighborhoods
Research period	2018	2018 - 2020
Socio-technical artifact	CrowdCore process and web-based platform	MyNeighbors web-based ONSN platform
Research approach	Design Science Research	
Research methods	• DSRM • Structured literature review • Qualitative interviews • Qualitative data analysis	• DSRM • Taxonomy development • Qualitative interviews • Qualitative data analysis • Online survey • Usage data analysis
Evaluation type	Artificial, point-in-time simulation	Naturalistic, long-term piloting
Evaluation methods	• Qualitative interviews • Focus group	• Qualitative interviews • Focus group • Online survey • Usage data analysis
Publications	Vogel et al. (2019a) Vogel and Grotherr (2020)	Vogel et al. (2019b) Grotherr et al. (2020) Vogel et al. (2020a) Vogel et al. (2020b) Vogel et al. (2020c) Vogel et al. (2021a) Vogel et al. (2021b)

2.2 Design Science Research Methodology and Design Iterations

To operationalize DSR, this thesis follows the Design Science Research Methodology (DSRM) proposed by Peffers et al. (2007) (see Figure 2). Peffers et al. (2007) stipulate a nominal process sequence of six process steps. A variety of possible research entry points allow researchers to adapt this sequence to their research context. Design science is an inherently iterative and phased process, a DSR project usually entailing multiple cycles of artifact design and evaluation (Hevner et al. 2004). DSRM integrates this nature of DSR through process iteration, which allows for a refinement of objectives of a solution as well as artifact design based on feedback from evaluation and communication of the research.

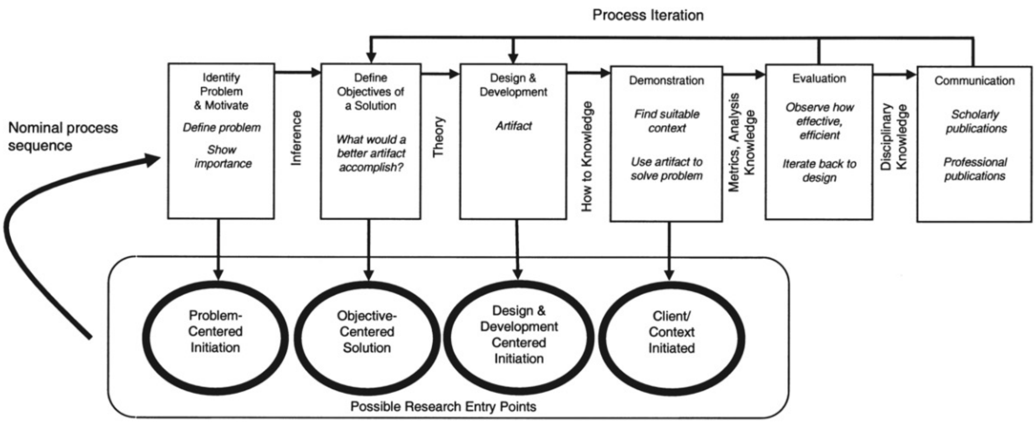

Figure 2. Design Science Research Methodology (Peffers et al. 2007)

Section 1 of this thesis outlined the shared problem-centered initiation of this research project. Both application domains can subsequently be mapped to a pass of the DSRM sequence, with each contained publication addressing one or more process steps. The publications Vogel et al. (2019a), Vogel et al. (2019b), Vogel et al. (2020a), and Vogel et al. (2020c) each represent an independent iteration of the DSRM sequence, ranging from the step of *Identify Problem & Motivate* to *Communication*. Each of these publications develops design knowledge in the *Design & Development* step and assesses its usefulness via *Demonstration* and *Evaluation* of artifact instantiations. Findings are iterated back toward the second and third process steps and inform the objectives and design of subsequent process iterations. By identifying shortcomings of and improvement potential for existing design artifacts based on empirical data or extant literature, the emphasis of Vogel et al. (2020b), Grotherr et al. (2020) as well as Vogel and Grotherr (2020) rests on refining the outcomes of the *Identify Problem & Motivate* as well as *Define Objectives of a Solution* process steps of their respective DSRM sequence. Finally, the publications Vogel et al. (2021a) and Vogel et al. (2021b), which primarily assess the usefulness of the developed design knowledge or artifact instantiations from varying perspectives, contribute toward the *Demonstration* and *Evaluation* process steps. This thesis, in sum, represents the integrated *Communication* of the results of the overall research project.

Due to limitations and shifting priorities in both research contexts, the scope of research and time dedicated to research in the application domain of SRE is smaller than the application domain of local communities (see also Table 2). Therefore, the former only comprises a single design iteration, while in the case of the latter, five distinct iterations of the developed design knowledge can be observed. Table 3 presents important milestones in the evolution of the design knowledge developed in the application domain of local communities. These iterations comprise both instances where novel design knowledge and a novel artifact were presented as well as conceptual iterations that impacted the objectives and scope of design knowledge. Mandviwalla (2015) proposes to present design knowledge iterations based on the characteristics of design, explanation, evaluation, and decisions. In this regard, design and explanation characteristics describe important properties of the design knowledge iteration and their basis in theory. Evaluation and decision characteristics describe the conducted evaluation activities, key observations, and derived learnings for the following iterations. With each iteration, quality criteria such as observability, reproducibility, or validity (Weber 2012) of the developed design knowledge are improved.

Building on research on older adults' use of OSNs as well as available literature on ONSNs, an initial design knowledge iteration was presented in Vogel et al. (2019b). This design knowledge centered on design principles as well as a prototypical web-based artifact with a focus on basic information sharing, communication, and peer-support functionality. An evaluation was conducted via a field test in one case neighborhood, a user experience lab, and an analysis of evaluation diaries. Among the key insights from this evaluation was the sentiment that neighbors' need for locally relevant information outweighed their need for peer-support. Furthermore, a lack of digital competencies, particularly among older users, and the presence of concerns for data privacy and data security were identified as key issues.

Subsequently, a second conceptual design iteration can be attributed to Vogel et al. (2020b). By developing a taxonomy of design properties of ONSNs, state of the art regarding the capabilities of publicly available ONSN platforms was determined. This analysis demonstrated that ONSNs already implement generic communication capabilities analogous to traditional OSNs, revealing a need for feature diversification. This reflection initiated a redefinition of the problem definition and solution objectives of the research project and highlighted the need for novel functionality to be developed. Furthermore, the analysis emphasizes the importance of trust-enhancing mechanisms and the resulting potential to build communities of trust as a key capability of ONSNs, making the development of design knowledge in this regard an additional priority.

Table 3. MyNeighbors artifact and design knowledge iterations

№	Publication	Iteration type	Methodology & evaluation	Result
I	Vogel et al. (2019b) *Healthy, Active and Connected: Towards Designing an Age-Friendly Digital Neighborhood Platform*	Artifact	DSRM • Field test • Evaluation diaries • User experience lab	Initial design knowledge
II	Vogel et al. (2020b) *Conceptualizing Design Parameters of Online Neighborhood Social Networks*	Conceptual	Taxonomy development (Nickerson et al. 2013)	Revised problem definition and solution objectives
III	Vogel et al. (2020a) *Designing Tool Support for Crowd-Sourced Community Initiatives on Online Neighborhood Social Networks*	Artifact	DSRM • Qualitative interviews • Focus group	Design knowledge expanded toward community initiatives
IV	Grotherr et al. (2020) *Multilevel Design for Smart Communities: The Case of Building a Local Online Neighborhood Social Community*	Conceptual	Case study (Yin and Campbell 2018)	Expanded scope of design knowledge objectives
V	Vogel et al. (2020c) *Design and Evaluation of an Online Neighborhood Social Network for Fostering Social Connectedness and Participation: Lessons from Two Urban Neighborhoods*	Artifact	DSRM • Platform usage data • Online survey • Qualitative interviews	Validated design knowledge

Motivated by these previous findings, Vogel et al. (2020a) present the expansion of design knowledge toward the implementation of community initiatives. Building on the available body of knowledge on crowdsourcing and the application of crowdsourcing in local and community contexts, design knowledge was formalized as design goals and principles and instantiated into a prototypical interactive artifact. Beyond the specific focus on community initiatives, this iteration also comprises a complete re-implementation of the MyNeighbors platform as a responsive web application, including additional new trust-enhancing capabilities such as address verification, real-name mandate, and the integration of local organizations via organizational profiles, among others. An evaluation was conducted via qualitative interviews and a focus group of neighborhood managers and neighbors.

In the following conceptual iteration, the MyNeighbors ONSN and its research context were analyzed using a system-oriented lens of multiple levels. As part of this analysis, Grotherr et al. (2020) highlight the need to accommodate institutional actors in the artifact design and to explicate engagement design properties in the developed design knowledge. A stronger embedding of the socio-technical artifact in the case neighborhoods via the involvement of institutional actors as well as training and support activities, such as the conducted smartphone classes, possess the potential to increase the likelihood of achieving the objectives of the developed design knowledge. Following this analysis, the scope of design knowledge was widened to accommodate the identified implications.

Finally, Vogel et al. (2020c) present the culmination of design research conducted in the application domain of local communities as part of this thesis. A final iteration of design knowledge is reached via refinement and expansion. Drawing on research on technology-mediated social connectedness and participation, four design principles are defined. This final iteration of the design knowledge and artifact instantiation is extended with a neighborhood management role and dashboard, smartphone classes, and improved integration of offline resources. Evaluation is conducted via long-term, naturalistic piloting of the MyNeighbors artifact in both case neighborhoods and analysis of platform usage data, an online survey, and qualitative interviews.

Following Nunamaker et al. (2015, p. 11), these iterations show the three-stage path taken on the “last research mile,” which describes how research can achieve an outcome that is able “to address important unsolved classes of problems for real people with real stakes in the outcomes" (Nunamaker et al. 2015, p. 15). In the initial *proof-of-concept* stage, the functional or technical feasibility of a potential solution is presented. In the case of MyNeighbors, the first design iteration corresponds with this stage. The second *proof-of-value* stage intends to investigate whether a solution can be applied by stakeholders to create value across a variety of contexts. The MyNeighbors platform launch as well as its rigorous evaluation correspond with this stage. Finally, a *proof-of-use* stage entails the development of codified design knowledge "encapsulating the knowledge practitioners require to develop successfully their own instances of a generalizable solution" (Nunamaker et al. 2015, p. 23). This stage also envisions self-sustaining communities of practice that continue the operation and development of a solution without the researcher's continued involvement. As the MyNeighbors platform continues to be actively researched, it cannot be considered self-sustained at this point. However, the developed design knowledge codifies the principles of form and function necessary for researchers and practitioners to develop similar solutions.

2.3 Research Methods

2.3.1 Literature review

Reviewing extant literature constitutes a fundamental element of any research endeavor (Webster and Watson 2002). By rigorously researching and referencing the existing state of the art knowledge of theories and methods in a given field, researchers ensure a meaningful contribution of their work (Hevner 2007). The increasing maturity of a scientific discipline and accompanying accumulation of knowledge necessitates a need to repeatedly describe, understand, explain, and test phenomena via literature reviews (Paré et al. 2015). As part of this thesis, structured and unstructured literature reviews were conducted with a variety of goals. These include the problem formulation, the definition of solution objectives, and artifact development as part of the rigor cycle of DSR projects (Vogel et al. 2020a; Vogel et al. 2019a; Vogel et al. 2019b; Vogel et al. 2020c), conceptual iterations during taxonomy development (Vogel et al. 2020b), and a stand-alone research contribution (Vogel and Grotherr 2020). Relevant literature reviews are characterized by systematicity, transparency, and reproducibility (Cram 2019; Paré et al. 2016). The conducted literature reviews aim to adhere to this standard by following well-established methodological guidance specifically tailored to the IS discipline (Bandara et al. 2015; vom Brocke et al. 2009; vom Brocke et al. 2015; Webster and Watson 2002).

2.3.2 Qualitative data collection and qualitative content analysis

IS research is primarily concerned with studying "real people in real organizations" (Myers and Newman 2007, p. 24), necessitating a means of capturing their respective perspectives, experiences, and interpretations (Schultze and Avital 2011). The qualitative interview represents a common research method by which to achieve this goal, allowing researchers "to gather rich data from people in various roles and situations" (Myers 2019, p. 182) and finding widespread use in the IS discipline (Myers and Newman 2007). In particular, face-to-face interviews, as opposed to remote interviews, are suitable for capturing interview subjects' important social cues (Opdenakker 2006). During this thesis, several sets of qualitative interviews were conducted, especially as part of the problem formulation, definition of solution objectives, and evaluation phases of the DSRM (Vogel et al. 2020a; Vogel et al. 2019a; Vogel et al. 2019b; Vogel et al. 2020c). These interviews constitute semi-structured interviews, meaning that they follow a prepared but not binding interview guide, allowing for flexible deviation based on the interview subject and his or her behavior (Myers 2019). The interviews were also conducted following guidelines for qualitative interviewing proposed by Myers and Newman (2007).

Transcripts of these interviews were analyzed using qualitative content analysis (Mayring 2015; Schreier 2014) where appropriate, which allows researchers to systematically describe the meaning of verbal or written data (Schreier 2014) and to comprehend the enclosed social reality (Cho and Lee 2014). As opposed to inductive grounded theory research (Strauss and Corbin 1990; Wolfswinkel et al. 2013), qualitative content analysis encompasses both inductive and deductive elements of data analysis (Cho and Lee 2014). Qualitative content analysis is centered around the iterative development of a coding frame describing overlying categories and themes evident in a set of data. Categories of this coding frame are derived either inductively, i.e., data-driven, or deductively from prior theory, i.e., concept-driven (Schreier 2014). As part of the DSR process, the emerging patterns of themes and categories are particularly suitable for identifying issues and requirements for artifact development. As part of this thesis, this approach is applied in the analysis of interview transcripts in several of the included publications to develop design knowledge in the form of the design goals and design principles (Vogel et al. 2020a; Vogel et al. 2019a).

2.3.3 Taxonomy development

Taxonomies represent a tool for the analysis of complex phenomena through the classification of objects (Nickerson et al. 2013). They leverage a set of unifying constructs for the systematic description and interpretation of an area of interest (Glass and Vessey 1995). In many branches of sciences, such as biology or the social sciences, taxonomies have long represented a prevalent research method (Nickerson et al. 2013). Nickerson et al. (2013) were the first to introduce a dedicated methodology for taxonomy research for the IS discipline. Since then, taxonomy research has steadily gained in popularity and has found application in high-quality IS research (Lösser et al. 2019), including publications in the AIS Senior Scholars' Basket of Journals (e.g., Prat et al. 2015; Siering et al. 2017). IS researchers have proposed taxonomies for a wide variety of subjects, including business models (Eikhoff et al. 2017; Remane et al. 2016), digital platforms (Blaschke et al. 2019; Kutzner et al. 2019), or digital health (Araújo et al. 2020; Greve et al. 2020).

A taxonomy is both a design artifact in itself and a representation of conceptual knowledge for theory development via, for instance, designing artifacts or predicting phenomena (Lösser et al. 2019). Design artifacts require rigorous evaluation to prove their usefulness (Peffers et al. 2007) and taxonomy research in IS is increasingly concerned with identifying suitable evaluation methods (Szopinski et al. 2019). While Nickerson et al. (2013) do not propose evaluation methods; extant research presents cluster analysis or case studies as suitable evaluation methods (Lösser et al. 2019). As part of this thesis, taxonomy research is leveraged to analyze and structure the complex phenomenon of ONSNs. With no structured overview of existing ONSN platforms and their design parameters available in the literature at the time of writing, ONSNs represent a novel phenomenon uniquely suitable for the application of taxonomy development. To do so, Vogel et al. (2020b) propose a taxonomy of the design parameters of ONSNs. Additionally, the developed taxonomy is leveraged to identify four clusters of ONSNs via k-means clustering (Hartigan and Wong 1979).

3 Theoretical Foundation

This section introduces the key theoretical foundations this thesis builds on, describes the current state of research, and identifies extant research gaps. Corresponding to the two investigated application domains, these foundations are laid out as crowd-based RE as well as OSNs and local communities.

3.1 Crowd-Based Requirements Engineering

RE is "the subset of systems engineering concerned with discovering, developing, tracing, analyzing, qualifying, communicating, and managing requirements that define the system at successive levels of abstraction" (Hull et al. 2011, p. 8). It comprises both the development of novel requirements and managing the lifecycle of an existing set of requirements (Wiegers and Beatty 2013). Requirements development can be separated into the phases of elicitation, analysis, specification, and verification (Wiegers and Beatty 2013). The first phase of requirements development, requirements elicitation, consists of identifying the needs and constraints of a system's various stakeholders. The second phase of requirements development, requirements analysis, aims at developing a thorough understanding of the elicited requirements. This is achieved through, among several other activities, the decomposition of high-level requirements into an appropriate level of detail, the negotiation of implementation priorities, and the identification of gaps as well as unnecessary requirements in the requirements catalog (Pohl and Rupp 2015). During the requirements specification phase, the collected requirements are formalized in writing, stored in an organized manner, and made accessible to all relevant stakeholders (Wiegers and Beatty 2013). Finally, requirements validation entails assessing each requirement's readiness for implementation according to quality criteria and the definition of acceptance criteria, which determine the conditions necessary to consider a requirement as implemented (Pohl and Rupp 2015).

User involvement and user participation in the RE process have been shown to positively impact user satisfaction and overall software project success (Kujala 2003; Pagano and Bruegge 2013; Zowghi et al. 2015). While user involvement describes the psychological or need-based attitude of users toward a system and the development process, user participation more broadly describes any observable behavior of users during the development process of the system (Kappelman and McLean 1991). User involvement and participation can improve requirement quality, while a lack of involvement may put software project success in peril (Potts 1993). Fleischmann et al. (2015) indicate that responding to software users' wishes by implementing requested features can positively affect their software use. However, involving users in the RE process can be challenging, as software users may not always be able to accurately articulate their needs (Zowghi et al. 2015). Furthermore, a changed mindset might be required of software developers, who frequently consider themselves the highest authority on users' needs (Wiegers and Beatty 2013).

Traditional techniques employed for user involvement in RE include in-person interviews conducted by requirements analysts, moderated workshops, focus groups, or surveys (Nuseibeh and Easterbrook 2000). Small groups of key users are recruited to provide feedback and to assess novel software features across the software lifecycle. These techniques face a number of shortcomings. As they require co-presence, they are cost- and time-intensive, preventing them from scaling to large numbers of participants, particularly if geographically distributed (Law et al. 2012; Lim et al. 2010). This challenge is intensified in the case of external stakeholders such as customers (Groen et al. 2017). Traditional RE techniques face an inherent selection bias, as, in the case of software used by a large number of users, only a fraction of users can be included in RE-related activities due to cost constraints. As a result, key stakeholders might be excluded from providing valuable feedback, including current and prospective users (Snijders et al. 2015). Similarly, traditional RE approaches run the risk of failing to capture the heterogeneous nature of large software user bases (Adepetu et al. 2012; Snijders et al. 2014). When focusing primarily on a group of dominant key users for elicitation of requirements, less articulate voices in the organization with legitimate requirements may be drowned out and requirements may become biased (Law et al. 2012). Traditional RE approaches frequently show a lack of transparency, with end users being unable to track the status of their proposed requirements post-elicitation (Rashid et al. 2008). Furthermore, traditional RE approaches exhibit a lack of continuity across the software lifecycle post-implementation (Groen et al. 2017).

In recent years, crowdsourcing has presented itself as a potential solution for addressing some shortcomings of traditional approaches to RE via user involvement. Crowdsourcing, "the act of a company or institution taking a function once performed by employees and crowdsourcing it to an undefined (and generally large) network of people in the form of an open call" (Howe 2006, p. 1), has been successfully applied to transform a variety of application areas (Cullina et al. 2016; Estellés-Arolas and González-Ladrón-de-Guevara 2012). It can support organizational value creation by a variety of means, ranging from securing funding via crowdfunding (Bretschneider et al. 2014; Gleasure et al. 2019; Gleasure and Morgan 2018), generating novel product and service innovations via crowd ideation to letting customers provide peer-support to each other via crowd-support (Durward et al. 2016). Potential benefits include cost savings, faster task completion, improved quality of results, increased scalability and flexibility, and an externalization of risk (Buettner 2015; Ye and Kankanhalli 2013). While organizations initially performed crowdsourcing with external crowds such as customers, they are increasingly discovering their workforce as another potential crowd. Zuchowski et al. (2016, p. 168) define this type of crowdsourcing, internal crowdsourcing, as "an IT-enabled group activity based on an open call for participation in an enterprise." Several use cases of internal crowdsourcing have been presented, including internal idea competitions (Benbya and Leidner 2016; Hoeber et al. 2016; Wagenknecht et al. 2017), organizational learning (Zuchowski 2016), employee engagement (Grotherr et al. 2018a), or internal crowdfunding and idea competitions (Feldmann and Gimpel 2016; Muller et al. 2013).

Crowdsourcing, via external or internal crowds, can be applied to solve tasks of varying complexity. Nakatsu et al. (2014) differentiate between contractual hiring, distributed problem-solving, new idea generation, and reciprocal collaboration. Similarly, Blohm et al. (2017) describe open collaboration, broadcast search, information pooling, and microtask crowdsourcing as different crowdsourcing approaches. Geiger et al. (2011) define creating, solving, rating, and processing as tasks that can be solved via crowdsourcing. Reciprocal collaboration, described by Nakatsu et al. (2014) as a form of crowdsourcing where members of the crowd cooperate beyond coordination by interacting with each other and by sharing individual contributions, is particularly fitting for application in the context of RE. Tasks suited for reciprocal collaboration are unstructured and interdependent, necessitating members of the crowd to work together to achieve an overlying goal, such as open content projects like Wikipedia or open-source software development (Nakatsu et al. 2014).

The term crowd-based RE describes "automated or semiautomated approaches to gather and analyze information from a crowd to derive validated user requirements" (Groen et al. 2017, p. 44). In the case of crowd-based RE, the crowd constitutes users of a software product who interact with the entity developing this software product and with each other (Groen et al. 2017). Crowd-based RE aims to address the challenges of traditional RE techniques by involving large, diverse, and geographically distributed groups of software users in the RE process (Groen et al. 2017; Rashid et al. 2008). Two paradigms of crowd-based RE can be identified in the literature: data-driven and collaborative crowd-based RE. In the case of data-driven crowd-based RE, software usage data (e.g., app store ratings and comments, in-app surveys, usage data, or system logs) are analyzed to extract software requirements. From the perspective of an individual software user, the flow of feedback is unidirectional, usually not entailing a response from the entity developing the software. In consequence, the software user may not be aware of her participation in the RE process. As data-driven crowd-based RE needs to process data generated by software users to be useful for RE, these approaches are mainly applicable during the post-implementation phase of a software product's lifecycle. While not the focus of this dissertation, approaches to data-driven crowd-based RE presented in the literature include, for instance, the automated extraction and classification of user feedback from app store reviews and Twitter (Stanik and Maalej 2019) or the combined analysis of user feedback and software usage monitoring data with the goal of identifying novel requirements (Oriol et al. 2018). Recently, this stream of crowd-based RE has gained attention in the context of IS research (Hoffmann et al. 2019; Hoffmann et al. 2020).

In the case of collaborative crowd-based RE, members of a crowd of software users actively interact with one another, each other's feedback and suggestions, as well as the entity responsible for developing the software. Following the abovementioned definition of reciprocal collaboration as a sub-type of crowdsourcing, the definition of individual software requirements represents an interdependent and unstructured task the crowd is intended to perform. The flow of feedback is multidirectional, with the feedback provided by a software user potentially being addressed by other users or the entity developing the software. Users are enabled to collaboratively propose, prioritize, and specify requirements (Vogel and Grotherr 2020). This approach intends to offer an asynchronous, remote, and scalable approach to RE, addressing several shortcomings of traditional RE approaches.

Generally, collaboration among stakeholders as part of the RE process has been shown to positively impact requirement accuracy and quality (Dalpiaz et al. 2017).

Crowd-based RE approaches bring along a set of challenges. Generally, crowdsourcing with the general public can lead to an overwhelming flood of submissions, necessitating effort for activities such as crowd coordination, quality control, and filtering of proposed solutions (Blohm et al. 2013), crowd-based RE being no exception in this regard (Hosseini et al. 2015). Conversely, in contexts where a small crowd of users is involved in crowd-based RE, motivating individuals for participation may become a challenge, necessitating the implementation of suitable incentive structures and mechanics (Hosseini et al. 2015). In the case of data-driven crowd-based RE, the monitoring of context and usage data also invokes considerations for protecting user privacy while still being able to extract actionable insights (Groen et al. 2017).

The extant literature provides contributions that present collaborative crowd-based RE approaches or artifacts. For instance, Snijders et al. (2015) present a method and web-based platform for the gamified elicitation, specification, and prioritization of software requirements, while Seyff et al. (2015) utilize a social media platform to elicit and negotiate requirements with a crowd of software users. These approaches and artifacts are analyzed in detail in Vogel and Grotherr (2020) as part of a literature review of collaborative crowd-based RE (see Section 14). Previous literature reviews in the context of crowd-based RE, such as Khan et al. (2019) or Wang et al. (2019), do not differentiate between data-driven and collaborative crowd-based RE and do not put an explicit emphasis on the latter approach. The current body of knowledge on collaborative crowd-based RE shows that collaborative approaches in the literature are, as yet, geared toward the pre-implementation phase of the software product lifecycle, coming to a close once a software product's first iteration has been successfully introduced. However, the post-implementation phase of software projects is decisive for realizing the long-term benefit of IS (Markus 2004; Semmann and Böhmann 2015). In practice, however, software companies already leverage tools with collaborative crowd-based RE elements to improve software products post-implementation. For instance, Microsoft utilizes the software UserVoice (https://uservoice.com) to collect and prioritize feedback for its Office 365 suite of software products.

Furthermore, while various publications present instantiated artifacts in the context of crowd-based RE, few formalize the developed design knowledge in the form of design principles. In consequence, researchers and practitioners receive limited guidance on how to implement artifacts of the same type. Additionally, extant approaches to collaborative crowd-based RE are primarily focused on involving external crowds of software users in the RE process. However, the contextual experience and expertise of internal crowds (Zuchowski et al. 2016) make them a particularly promising candidate for developing requirements for specific types of software. As part of this thesis, Vogel et al. (2019a) aim to address this research gap by developing design knowledge for a method and platform for conducting collaborative crowd-based RE with an internal crowd of software users that spans the entire software product lifecycle.

3.2 Online Social Networks and Local Communities

Efforts to interconnect the inhabitants of local communities are rooted in community informatics, "the application of information and communications technology (ICT) to enable and empower community processes" (Gurstein 2007, p. 11). As early as the 1990s, initiatives such as the Blacksburg Electronic Village (Carroll and Rosson 1996), the Santa Monica PEN Project (Rogers et al. 1994), and the Netville community in Toronto (Hampton and Wellman 1999) sought to investigate how local community dynamics, both offline and online, were influenced by the availability of broadband internet in general as well as by dedicated community-focused online platforms (Hampton and Wellman 2000). These platforms afforded residents functionality such as online discussion forums, email lists, listings of local businesses and organizations, user groups, photo sharing, and directories of internet links for a variety of topics (Carroll and Reese 2003; Carroll and Rosson 1996; Kavanaugh and Patterson 2001). Figure 3 provides an impression of the Blacksburg Electronic Village user interface in 1996. Community computing initiatives were found to strengthen social ties and improve community engagement as well as attachment (Kavanaugh et al. 2017). They encouraged neighborhood-based interactions, increased the frequency of communication and recognition among neighbors, and fostered public and private participation (Hampton and Wellman 2003; Hampton and Wellman 1999). Furthermore, community computing is described as being able to encourage collective action and a “tool for building social capital in local communities” (Carroll 2003, p. 61).

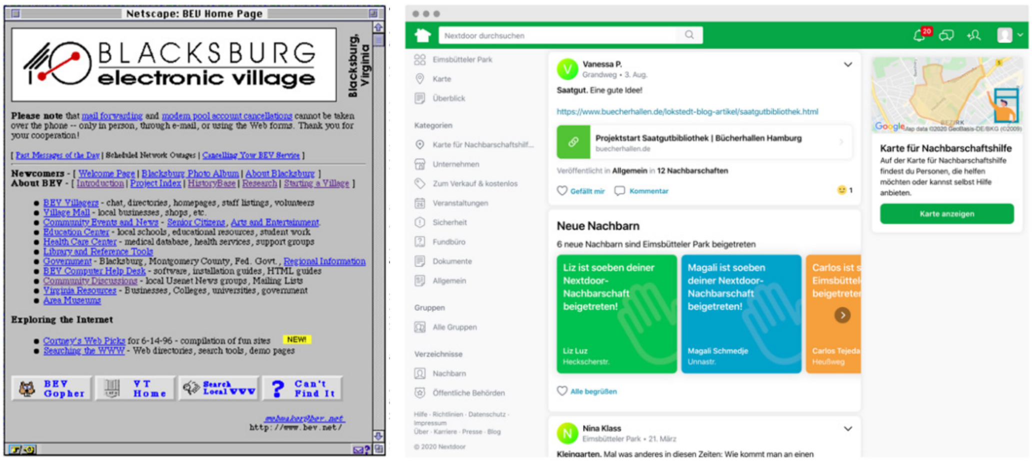

Figure 3. Blacksburg Electronic Village (BEV) homepage (Carroll and Rosson 1996) and Nextdoor ONSN user interface

With the rise of OSNs, neighborhood-centric communities gained new prominence. OSNs are “web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system” (Boyd and Ellison 2007, p. 211). Generally, social media use has been shown to preserve or encourage a sense of community in a neighborhood (Gibbons 2020). On OSNs such as Facebook, segmentive network effects have led to the formation of not only interest-specific but also neighborhood-centric online communities in the form of public and private groups (Johnson and Halegoua 2014). Place-based communities, targeted at the inhabitant of specific geographic areas, serve as platforms for collective problem-solving as well as socialization among neighbors and are based on mutual trust (Ilena et al. 2011; Voskresenskiy et al. 2017). Kwon et al. (2020, p. 1) propose the concept of localized social media, which ranges from “place-based contents to digital spaces that allow geographically bounded membership.” Proximate communities on OSNs serve as integrators between offline and online activities by facilitating tasks such as proposing, planning, and reporting and can, in effect, cultivate and reinforce social ties (Zhang et al. 2011). Localized use of OSNs has also been shown to encourage participation in local community activities and civic participation (Kim and Shin 2016; Kwon et al. 2020).

Starting in the early 2000s, a novel category of OSN with a specific focus on local communities began to gain popularity. As part of this thesis, this category is defined as ONSNs, "a type of OSN whose audience comprises the inhabitants of one or more neighborhoods and whose thematic and functional focus lies on neighborhood-related issues" (Vogel et al. 2020c, p. 3). ONSNs differ from OSNs in a variety of aspects. Most importantly, they separate users into dedicated, neighborhood-level sub-communities based on their physical address. In most cases, this separation is automated or semi-automated, using an identity or address verification mechanism ranging in rigor from sharing one's device location to in-person ID checks. Using the same mechanisms, many ONSNs also enforce the usage of real names instead of pseudonyms or usernames. The combination of these aspects can potentially evoke a community of trust among neighbors of a specific neighborhood-level online community (De Meulenaere et al. 2020b; Vogel et al. 2020b). This community of trust adds value to platform design features also present on traditional OSNs, such as increased trust in a transaction on an online marketplace, a recommendation, or an offer for assistance.

ONSNs further differentiate themselves from traditional OSNs such as Facebook. Most ONSNs lack direct user-to-user relationships, such as friends lists or followers. As a consequence, the social network available to ONSN users is not built on interpersonal relationships between individuals but on affiliation with a geographic area. Furthermore, ONSNs frequently possess a local offline footprint in the form of key users or neighborhood managers and more limited platform availability, often constricted to individual countries, cities, or city quarters. ONSNs also differentiate themselves from neighborhood-level groups on OSNs such as Facebook: users on ONSNs are automatically assigned a neighborhood-level sub-community based on their verified address as opposed to having to identify the correct group (if any) themselves. ONSNs, therefore, offer a means of getting into contact with one's neighbors that is less effort-intensive, more reliable, and more trustworthy than doing so on a traditional OSN. ONSNs also allow only one sub-community per neighborhood and prevent users from being members of more than one of these sub-communities.

While individual ONSN platforms differ in functional aspects, repeating patterns of common design features can be identified (Vogel et al. 2020b). ONSNs are typically free-to-use and can be accessed using web platforms and mobile apps. Users possess a profile page that presents, among other elements, a profile image, contact information, or interests.

They can browse the profiles of other users in their neighborhood-level community via a neighbor directory. Communication between individual neighbors takes place using a private messaging or live chat system. A neighborhood-wide activity stream (see Figure 7) of posts forms the central point of interest on ONSN platforms. Users contribute posts of different categories, such as recommendations, events, questions, announcements, or polls, and can interact with posts of other users via likes or comments. Public and private groups allow users to create further interest-specific sub-communities inside of a neighborhood-level community. On many platforms, an online marketplace allows users to buy, sell, or give away items on a non-commercial level. Beyond this common set of features, individual platforms implement more unique design features, such as business profiles and directories, building-level communities, interactive maps, integrations for local governments and emergency services, and monetization features, such as ads or paid listings.

The separation of neighbors into neighborhood-level sub-communities is not only a key differentiator between ONSNs and OSNs but also a key competence and success factor of any ONSN platform (Vogel et al. 2020b). If neighborhoods are demarcated to include a very high number of inhabitants, the platform may fail to evoke a feeling of trust and security among neighbors. If neighborhoods are demarcated to include a very small number of inhabitants, the platform may fail to reach a critical mass of users, resulting in a lack of activity. Similarly, if neighborhood borders are defined contrary to the way they are perceived by an area's inhabitants, they might sever important real-life relationships between inhabitants. There is no generally agreed-upon definition for the term neighborhood (Payne 2017). Often used interchangeably with community, the term can be defined using a variety of criteria, including an area's history, demographics of its inhabitants, administrative boundaries, or people's perceptions (Diez Roux 2001). Sampson et al. (1997, p. 919) define the term as a "collection of people and institutions occupying a subsection of a larger community." ONSNs have developed various strategies to cope with this important issue (Vogel et al. 2020b). Several platforms utilize publicly available municipal boundaries, such as city quarters, to delimit neighborhoods. Other platforms draw upon the knowledge of inhabitants of an area and employ a crowdsourcing system that lets neighbors define the borders of their neighborhood themselves on an interactive map. Some ONSN platforms define the borders of one's neighborhood community based on a radius of a certain distance drawn around the physical address of each user. Other approaches to delimiting neighborhoods include custom algorithms based on an area's number of inhabitants or arbitrarily selected and defined neighborhoods due to, for instance, limitations of being included in a research or neighborhood development project.

Based on publicly available data, the ONSN *Nextdoor* (https://nextdoor.com), founded in 2008 in San Francisco, USA, represents the largest platform of its category with 248,000 active neighborhoods and an estimated 27 million monthly active users across eleven countries in North America, Europe, and Australia (Nextdoor 2019; Roof 2019). Figure 3 provides an impression of the Nextdoor user interface as of December 2020. Berlin-based *nebenan* (https://nebenan.de) represents the second largest ONSN and has attracted more than 1.6 million users since its founding in 2015 (nebenan 2020). Besides Germany, nebenan is active in several European countries under localized branding variants such as tienes-sal.es, vecinimiei.it or mesvoisins.fr. A further notable ONSN platform is New-Zealand exclusive *Neighbourly* (https://neighbourly.co.nz) with more than 700,000 users in a country of just 4.9 million (Stats NZ 2020). Belgian ONSN *Hoplr* (https://hoplr.com), available in Belgium and the Netherlands, has to date attracted more than 500,000 households to its platform since its founding in 2014 (Hoplr 2020).

Besides the research conducted as part of this thesis, a number of studies with a focus on ONSNs can be identified in the extant literature. Masden et al. (2014) conducted a qualitative interview study of Nextdoor users in three neighborhoods in Atlanta, USA. Their findings show that platform users value Nextdoor as a trustworthy communication channel for certain issues with particular relevance to the immediate neighborhood. They also raise issues such as the separation of neighbors into isolated neighborhoods sometimes having a negative, constricting effect, making the ONSN unsuited for topics that transcend neighborhood boundaries. In turn, this may drive users to use other OSNs. De Meulenaere et al. (2020b) conduct a survey among users of the Hoplr ONSN as well as neighborhood-focused groups on Facebook. They investigate whether micro-level social interaction and collaborative meso-level storytelling can impact community awareness, an online sense of community, and, in turn, a neighborhood sense of community. Their findings show that digital neighborhood storytelling is indeed associated with a neighborhood sense of community via community awareness and an online sense of community. Similarly, De Meulenaere et al. (2020a) find that interaction between neighbors on ONSNs can induce an online and offline sense of community and, in turn, provide perceived local social support. According to them, ONSNs can have a bridging effect, “connecting otherwise distinct local networks and ties” (De Meulenaere et al. 2020a, p. 1).

Antonini et al. (2016) and Boella et al. (2019) present FirstLife, a local social network artifact focused on citizen participation. The presented platform enables citizens, local organizations, and local authorities of a specific city to locate entities such as groups, events, insights, and news on an interactive map. Entities can then be interacted with by users via posts, comments, notifications, and relationship mapping. Evaluation of their artifact shows that users felt empowered by being able to collaborate on projects within a geographic context, valued the locally relevant information gained, and perceived a strengthened sense of local citizenship. Renyi et al. (2018) present an ONSN artifact with a feature set comparable to that of commercial ONSN platforms. They put particular emphasis on the integration with local stakeholders, such as care providers or community workers, and on reaching a cross-generational audience. Evaluation of their artifact determined important burdens to ONSN use, such as a lack of technical competence among many users, competition with other ONSN, OSN, and messaging platforms, privacy concerns, and a lack of a critical mass of users. With ONSN platforms having reached a certain maturity and diffusion in some markets, the first studies referring to the role of ONSNs regarding social resilience and crisis response have been presented, particularly with the onset of the COVID-19 pandemic (Kummitha 2020; United Nations 2020).

4 Publications

This cumulative dissertation comprises nine peer-reviewed publications (Section 9 to 17), which collectively address the RQs introduced in Section 1.2. Table 4 provides an overview of all included publications ordered by time of publication. The content, appendices and references of all included publications are reproduced verbatim. The publications have been reformatted to ensure a consistent appearance as part of this document. At the time of submission of this dissertation, all publications have been published in their respective outlets. Each publication is introduced in this section, including its place of publication, type, methodological approach, RQ, research contribution, and co-authors contributions.

Table 4. List of included publications

No.	Publication	Section
1	Vogel, P., Grotherr, C., and Semmann, M. 2019 **Leveraging the Internal Crowd for Continuous Requirements Engineering – Lessons Learned from a Design Science Research Project** *European Conference on Information Systems (ECIS)*. Stockholm-Uppsala, Sweden.	9
2	Vogel, P., Jurcevic, N., and Meyer-Blankart, C. 2019 **Healthy, Active and Connected: Towards Designing an Age-Friendly Digital Neighborhood Platform** *European Conference on Information Systems (ECIS)*. Stockholm-Uppsala, Sweden.	10
3	Grotherr, C., Vogel, P., and Semmann, M. 2020 **Multilevel Design for Smart Communities: The Case of Building a Local Online Neighborhood Social Community** *Hawaii International Conference on System Sciences (HICSS)*. Grand Wailea, Hawaii, USA.	11
4	Vogel, P., Grotherr, C., Kurtz, C., and Böhmann, T. 2020 **Conceptualizing Design Parameters of Online Neighborhood Social Networks** *International Conference on Wirtschaftsinformatik (WI)*. Potsdam, Germany.	12

5	Vogel, P., Grotherr, C., and Böhmann, T. 2020 **Designing Tool Support for Crowd-Sourced Community Initiatives on Online Neighborhood Social Networks** *European Conference on Information Systems (ECIS).* A Virtual AIS Conference.	13
6	Vogel, P., and Grotherr, C. 2020 **Collaborating with the Crowd for Software Requirements Engineering: A Literature Review** *Americas Conference on Information Systems (AMCIS).* A Virtual AIS Conference.	14
7	Vogel, P., von Mandelsloh, F., Grotherr, C., Gaidys, U. and Böhmann, T. 2020 **Design and Evaluation of an Online Neighborhood Social Network for Fostering Social Connectedness and Participation: Lessons from Two Urban Neighborhoods** *International Conference on Information Systems (ICIS).* A Virtual AIS Conference.	15
8	Vogel, P., Grotherr, C., von Mandelsloh, F., Gaidys, U. and Böhmann, T. 2021 **Older Adults' Use of Online Neighborhood Social Networks: Perceptions, Challenges and Effects** *Hawaii International Conference on System Sciences (HICSS).* A Virtual AIS Conference.	16
9	Vogel, P., Kurtz, C., Grotherr, C., and Böhmann, T. 2021 **Fostering Social Resilience via Online Neighborhood Social Networks During the COVID-19 Pandemic and Beyond: Status Quo, Design Dilemmas and Research Opportunities** *Hawaii International Conference on System Sciences (HICSS).* A Virtual AIS Conference.	17

Table 5. Summary of Publication 1 (Vogel et al. 2019a)

Citation	Vogel, P., Grotherr, C., and Semmann, M. 2019. "Leveraging the Internal Crowd for Continuous Requirements Engineering – Lessons Learned from a Design Science Research Project," in: *European Conference on Information Systems (ECIS)*. Stockholm-Uppsala, Sweden.
Ranking	VBH-JOURQUAL3: B CORE2018: A
Type	Completed Research Paper
Track	Openness and IT
Methodology	Design Science Research
Research question	What are design principles for continuous internal crowd-based requirements engineering?
Research contribution	This paper draws on extant research on crowd-based RE and internal crowdsourcing to develop design knowledge for a transparent, participative, accessible, and representative approach to RE. The developed design knowledge includes design principles as well as artifact instantiations for a process and platform for conducting continuous internal crowd-based RE. Furthermore, recommendations for implementing and conducting such an approach are made. As opposed to previous research, the presented design knowledge spans the entire software product lifecycle, leverages a collaborative as opposed to a data-driven approach, and integrates an intra-organizational crowd of users.
Co-authors' contribution	Christian Grotherr and Martin Semmann co-authored this publication. Christian Grotherr and Martin Semmann contributed to the conceptual design of the paper, advised on the developed design knowledge and artifacts, and provided overall feedback.

Table 6. Summary of Publication 2 (Vogel et al. 2019b)

Citation	Vogel, P., Jurcevic, N., and Meyer-Blankart, C. 2019. "Healthy, Active and Connected: Towards Designing an Age-Friendly Digital Neighborhood Platform," in: European Conference on Information Systems (ECIS). Stockholm-Uppsala, Sweden.
Ranking	VBH-JOURQUAL3: B CORE2018: A
Type	Research in Progress
Track	Health Information Technology and IS for Healthcare
Methodology	Design Science Research
Research question	What are design principles for an age-friendly digital neighborhood platform?
Research contribution	The main contribution of this research-in-progress paper is initial design knowledge for a digital neighborhood platform in the form of seven design principles and a prototypical artifact instantiation. The publication draws on empirical data from two case neighborhoods and literature on online neighborhood social networks and elderly use of online social networks. Initial evaluation results from a field test in two urban case neighborhoods are presented. The developed design knowledge serves as a starting point for further research into leveraging local online platforms for addressing challenges associated with population aging and improving community well-being.
Co-authors' contribution	Natalija Jurcevic and Corvin Meyer-Blankart co-authored this publication. Natalija Jurcevic contributed to evaluation data collection and the evaluation section of the publication. Corvin Meyer-Blankart advised on the conceptual design of the publication.

Table 7. Summary of Publication 3 (Grotherr et al. 2020)

Citation	Grotherr, C., Vogel, P., and Semmann, M. 2020. "Multilevel Design for Smart Communities: The Case of Building a Local Online Neighborhood Social Community," in: Hawaii International Conference on System Sciences (HICSS). Grand Wailea, Hawaii, USA.
Ranking	VBH-JOURQUAL3: C CORE2018: A
Type	Completed Research Paper
Track	Smart and Connected Cities and Communities
Methodology	Case study
Research question	How can design activities be conducted systematically to build smart communities?
Research contribution	This paper has three main contributions. First, it presents the challenge of designing and establishing ONSNs in a local community as one of multiple levels. Second, it formulates concrete design implications regarding the improvement of engagement design as well as the integration of institutional design practices. Third, these implications subsequently informed the continued evolution of the MyNeighbors ONSN in its case neighborhoods.
Co-authors' contribution	Christian Grotherr and Martin Semmann co-authored this publication. Christian Grotherr contributed the analysis of the case based on the multilevel design framework. Martin Semmann revised the introduction and conclusion of the paper.

Table 8. Summary of Publication 4 (Vogel et al. 2020b)

Citation	Vogel, P., Grotherr, C., Kurtz, C., and Böhmann, T. 2020. "Conceptualizing Design Parameters of Online Neighborhood Social Networks," in: International Conference on Wirtschaftsinformatik (WI). Potsdam, Germany.
Ranking	VBH-JOURQUAL3: C CORE2018: C
Type	Completed Research Paper
Track	Social Media in Business and Society
Methodology	Taxonomy development
Research question	What are the conceptually and empirically validated design parameters of neighborhood social networks?
Research contribution	This paper presents a taxonomy of design parameters of ONSNs developed based on a literature review of extant research on ONSNs as well as an internet search and analysis of publicly available ONSN platforms. Furthermore, four distinct clusters of typical patterns of ONSN design properties are identified via cluster analysis. Implications regarding the nature of ONSNs are derived, for instance, their potential ability to create communities of trust. This paper represents the first systematic overview of ONSNs and their differentiating design features. The developed taxonomy serves as a classification scheme for researchers and practitioners analyzing, selecting and designing ONSNs.
Co-authors' contribution	Christian Grotherr, Christian Kurtz, and Tilo Böhmann co-authored this publication. Christian Grotherr contributed to the research design and advised on taxonomy dimensions. Christian Kurtz advised on the implementation of the cluster analysis methodology. Tilo Böhmann provided overall feedback for the paper and contributed to its discussion section.

Table 9. Summary of Publication 5 (Vogel et al. 2020a)

Citation	Vogel, P., Grotherr, C., and Böhmann, T. 2020. "Designing Tool Support for Crowd-Sourced Community Initiatives on Online Neighborhood Social Networks," in: European Conference on Information Systems (ECIS). Marrakech, Morocco.
Ranking	VBH-JOURQUAL3: B CORE2018: A
Type	Completed Research Paper
Track	Openness and IT
Methodology	Design science research
Research question	What are design principles for crowd-sourced community initiatives on online neighborhood social networks?
Research contribution	This paper develops design knowledge in the form of design goals, design principles, and an artifact instantiation for conducting crowd-sourced community initiatives on ONSNs. The presented artifact is integrated with the MyNeighbors ONSN. An artificial evaluation demonstrates the feasibility of applying crowdsourced approaches in local and community contexts via ONSNs. Furthermore, implications regarding the contextual embedding of crowd-based approaches into ONSNs are derived. This research contributes to the literature on crowdsourcing as well as ONSNs, while the developed design knowledge serves as a model for researchers and practitioners aiming to empower local communities to improve their well-being via community initiatives.
Co-authors' contribution	Christian Grotherr and Tilo Böhmann co-authored this publication. Christian Grotherr contributed to the research design for the paper as well as its theoretical framing. Tilo Böhmann contributed to developing the idea for the paper and advised on the development of design knowledge.

Table 10. Summary of Publication 6 (Vogel and Grotherr 2020)

Citation	Vogel, P., and Grotherr, C. 2020. "Collaborating with the Crowd for Software Requirements Engineering: A Literature Review," in: *Americas Conference on Information Systems (AMCIS)*. A Virtual AIS Conference.
Ranking	VBH-JOURQUAL3: D CORE2018: A
Type	Completed Research Paper
Track	Virtual Communities and Collaboration
Methodology	Literature review
Research question	How does collaborative crowdsourcing support requirements engineering activities?
Research contribution	This paper provides a first and systematic overview of the domain of collaborative crowd-based RE by conducting a structured literature review. Sixteen relevant publications are identified and synthesized based on the RE activities supported by the presented approaches as well as artifact design features in support of RE. Furthermore, the paper proposes the integration of crowd-based RE with agile software development practices, a lack of design knowledge, and the combination of data-driven and collaborative crowd-based RE approaches as research gaps.
Co-authors' contribution	Christian Grotherr co-authored this publication. He contributed to the conceptual design as well as the discussion section of the publication.

Table 11. Summary of Publication 7 (Vogel et al. 2020c)

Citation	Vogel, P., von Mandelsloh, F., Grotherr, C., Gaidys, U. and Böhmann, T. 2020. " Design and Evaluation of an Online Neighborhood Social Network for Fostering Social Connectedness and Participation: Lessons from Two Urban Neighborhoods," in: *International Conference on Information Systems (ICIS)*. A Virtual AIS Conference.
Ranking	VBH-JOURQUAL3: A CORE2018: A*
Type	Completed Research Paper
Track	Digitization in Cities and the Public Sector
Methodology	Design science research
Research question	How can online neighborhood social networks be designed and established to foster social connectedness and participation?
Research contribution	Drawing on research on ONSNs and social connectedness and participation, the paper presents design knowledge for an ONSN for fostering social connectedness and participation. A long-term naturalistic evaluation of this design knowledge is conducted. Results implicate potential for improving social connectedness and participation in local communities via ONSNs, including for older adults. The paper contributes to research on ONSNs and technology-mediated social connectedness and participation and provides a starting point for practitioners aiming to improve the well-being of local communities.
Co-authors' contribution	Franziska von Mandelsloh, Christian Grotherr, Uta Gaidys, and Tilo Böhmann co-authored this publication. Franziska von Mandelsloh and Uta Gaidys contributed to the evaluation design, data collection, and data analysis. Christian Grotherr and Tilo Böhmann advised on the conceptual design and design knowledge included in the paper.

Table 12. Summary of Publication 8 (Vogel et al. 2021a)

Citation	Vogel, P., Grotherr, C., von Mandelsloh, F., Gaidys, U. and Böhmann, T. 2020. "Older Adults' Use of Online Neighborhood Social Networks: Perceptions, Challenges and Effects," in: *Hawaii International Conference on System Sciences (HICSS)*. A Virtual AIS Conference.
Ranking	VBH-JOURQUAL3: C CORE2018: A
Type	Completed Research Paper
Track	Seniors' Use of Digital Resources
Methodology	Empirical study
Research question	How do older adults use online neighborhood social networks?
Research contribution	This paper contributes to the understanding of how older adults perceive ONSNs compared to other OSNs, how they are affected by ONSN use, and what challenges they face regarding adoption and use. The paper analyzes empirical data (platform usage data, qualitative interviews, and an online survey) collected from the MyNeighbors ONSN. Results show that MyNeighbors attracted older adults, was used by them as an information and communication platform, and led to some taking part in offline neighborhood activities. The paper demonstrates the potential of ONSNs for improving social connectedness and participation among older adults.
Co-authors' contribution	Christian Grotherr, Franziska von Mandelsloh, Uta Gaidys, and Tilo Böhmann co-authored this publication. Christian Grotherr contributed to the research design and the discussion section. Franziska von Mandelsloh and Uta Gaidys contributed to the evaluation design, data collection, and data analysis. Tilo Böhmann advised on the data analysis and conceptual design of the paper.

Table 13. Summary of Publication 9 (Vogel et al. 2021b)

Citation	Vogel, P., Kurtz, C., Grotherr, C. and Böhmann, T. 2020. "Fostering Social Resilience via Online Neighborhood Social Networks During the COVID-19 Pandemic and Beyond: Status Quo, Design Dilemmas and Research Opportunities," in: *Hawaii International Conference on System Sciences (HICSS)*. A Virtual AIS Conference.
Ranking	VBH-JOURQUAL3: C CORE2018: A
Type	Completed Research Paper
Track	Social Networking and Communities
Methodology	Multiple-case study
Research question	How can online neighborhood social networks be leveraged to foster social resilience in local communities?
Research contribution	This paper contributes to research on social resilience by identifying four core capabilities of ONSNs useful for fostering social resilience. An analysis of user-generated content on the MyNeighbors ONSN demonstrates how the ONSN was used for responding to the COVID-19 pandemic. Through an internet search, three platform design features implemented by publicly available ONSNs in response to the COVID-19 pandemic are identified. The paper highlights potential uses of ONSNs for fostering social resilience and calls on IS research to develop novel creative solutions for fostering social resilience in light of the COVID-19 pandemic and beyond.
Co-authors' contribution	Christian Kurtz, Christian Grotherr, and Tilo Böhmann co-authored this publication. Christian Kurtz contributed to the research design, data analysis, and discussion section of the paper. Christian Grotherr contributed to data analysis and the discussion section of the paper. Tilo Böhmann contributed to the theoretical framing of the paper.

5 Theoretical Contribution

This section presents the theoretical contributions of the research project conducted as part of this thesis. This includes individual contributions attributed to the two application domains of SRE and local communities, as well as an overall theoretical contribution pertaining to the design of openness-infusing socio-technical artifacts.

5.1 Crowd-Based Requirements Engineering

Beyond the overall aim of designing openness-infusing socio-technical artifacts, this thesis also makes a dedicated contribution to research on crowd-based RE. At the outset, this contribution entails a conceptualization of the field of collaborative crowd-based RE and its delineation from data-driven crowd-based RE. The core contribution in the context of crowd-based RE lies in the development of design knowledge for a collaborative crowd-based RE approach. Furthermore, this thesis advances research on crowd-based RE by encompassing the post-implementation phase of a software product's lifecycle and considering an internal crowd of users for involvement.

5.1.1 Conceptualizing collaborative crowd-based requirements engineering

Vogel and Grotherr (2020) provide a first and comprehensive overview of the domain of collaborative crowd-based RE by conducting a systematic literature review. The publication conceptualizes collaborative crowd-based RE as an approach in which "stakeholders of a specific software product propose and jointly develop software requirements supported by tools such as a web-based crowdsourcing platform" (Vogel and Grotherr 2020, p. 2). By way of this conceptualization, the emerging paradigm of collaborative crowd-based RE is contrasted with the dominant data-driven crowd-based RE approach.

With this literature review, this thesis contributes to furthering the understanding of crowd-based RE by closely investigating several aspects of the collaborative crowd-based RE paradigm. First, the review identifies which phases of the RE process are supported by existing approaches to collaborative crowd-based RE, finding comprehensive support for elicitation and parts of analysis but a lack of support regarding specification and validation.

Second, the review identifies and conceptualizes design features of artifacts in the context of collaborative crowd-based RE. Thereby, the review acts as a blueprint for researchers and practitioners aiming to develop novel approaches to collaborative crowd-based RE and allows for the identification of feature gaps. Vogel and Grotherr (2020) propose several issues that warrant further investigation. Generally, a lack of formalized design knowledge can be observed in the extant literature. As the identified approaches to collaborative crowd-based RE lack support for the specification and validation RE phases, future approaches could differentiate themselves by addressing these phases. Other promising research opportunities include systematically analyzing commercial crowd-based RE platforms as well as developing guidance for integrating crowd-based RE with software development methodologies.

5.1.2 Developing validated design knowledge for internal collaborative crowd-based RE

Vogel et al. (2019a) present design knowledge in the form of eight design principles for continuous crowd-based RE with a specific focus on intra-organizational crowds, i.e., an organization's employees. The design principles provide guidance for designing collaborative crowd-based RE approaches, including artifact capabilities previously not presented in the literature. These include decision support tools for facilitating product owner decision-making regarding feature prioritization, functionality for user expectation management via the communication of implementation effort, and the need for a cross-lifecycle process for conducting collaborative crowd-based RE. These design principles are implemented as an artifact instantiation consisting of a process and platform called *CrowdCore*. Figure 4 provides a visual impression of the CrowdCore platform. By following the guidance of the defined design principles, the CrowdCore platform implements a number of design features that have not yet been proposed in the context of collaborative crowd-based RE.

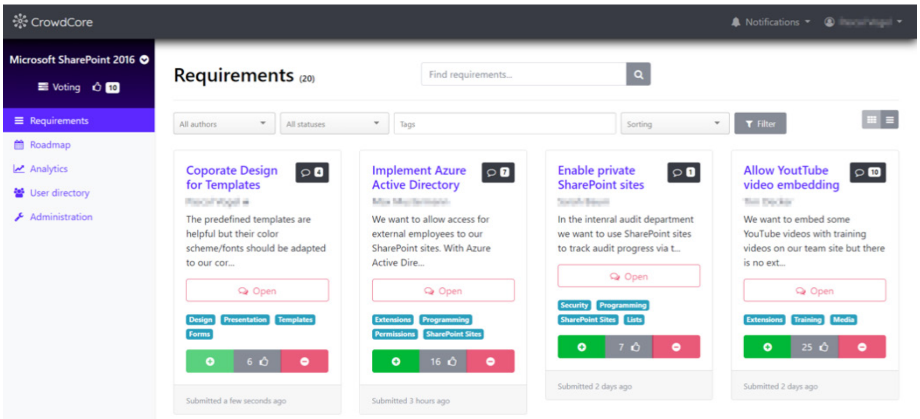

Figure 4. CrowdCore platform (sample data) (Vogel et al. 2019a)

Inspired by internal crowdfunding initiatives (Feldmann et al. 2014; Muller et al. 2013), a novel prioritization mechanism for crowd-based RE is proposed. This mechanism assigns a pre-determined budget of votes to each member of the crowd, which can be freely distributed to show support for proposed requirements. Product owners can leverage this user-provided prioritization by consulting impact and effort matrices generated by the CrowdCore platform based on votes and a requirement's estimated implementation effort. User expectations are managed by providing simplified public product roadmaps via the CrowdCore platform, by stimulating communication between product owners and software users via mandatory requirement status updates, and by presenting users with an implementation effort expectation for their submitted software requirement based on a simple traffic light scale. A user self-assessment also supports quality control and reduces necessary moderation effort. While most crowd-based RE approaches largely consist of an online platform as the core artifact, Vogel et al. (2019a) provide additional guidance for conducting collaborative crowd-based RE with the four-phase CrowdCore process (see Figure 5).

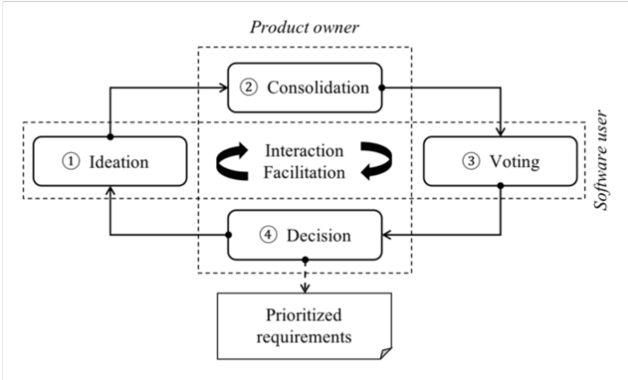

Figure 5. CrowdCore process (Vogel et al. 2019a)

Furthermore, this thesis provides recommendations for conducting continuous internal crowd-based RE as part of Vogel et al. (2019a), which represent preconditions and implementation considerations. These recommendations consider aspects such as a software's suitability for being integrated into collaborative crowd-based RE, organizational resources and interfaces necessary for conducting collaborative crowd-based RE, and governing user submissions on an open platform for crowd-based RE. In sum, these recommendations address contextual factors that are important to embed crowd-based RE approaches in the applying organization.

5.1.3 Exploring intra-organizational settings and the post-implementation phase for crowd-based RE

As a subset of crowdsourcing, internal crowdsourcing initiatives are receiving increasing attention in IS research (Feldmann et al. 2014; Knop et al. 2017). However, the number of diverse real-world cases describing the application of internal crowdsourcing remains limited (Benbya and Leidner 2016). Similarly, there is a lack of design knowledge in the context of internal crowdsourcing (Grotherr et al. 2019). Internal crowdsourcing is particularly suited for solving intelligence, design, and decision-making problems (Zuchowski et al. 2016). In the case of CrowdCore, all three problem types are present, representing a particularly comprehensive application of the internal crowdsourcing approach. Initially, the need for ideating novel requirements represents a design problem that is addressed by allowing members of a crowd of software users to submit their requirements to the CrowdCore platform. Furthermore, the need to specify the proposed requirements represents an intelligence problem that is addressed by allowing the collaborative specification of requirements by software users, who can rely on their internal pool of context-specific knowledge, as well as software product owners on the CrowdCore platform. Finally, the prioritization of software requirements represents a decision problem addressed by the user-based voting system and decisions made by product owners with the help of decision support features of the CrowdCore platform. While previous research in the context of crowd-based RE focused largely on involving external crowds of software users in the RE process, this thesis demonstrates that these problem types provide a good fit for the challenges arising as part of the RE process. In sum, with the detailed investigation of a novel application case for internal crowdsourcing, this thesis contributes to the field of internal crowdsourcing.

Software development practices are increasingly shifting from infrequent but large-scale major releases developed waterfall-style toward a continuous delivery model of frequent updates (Shahin et al. 2017). At the same time, users have come to expect and appreciate software developers to consider their feedback and provide a continuous stream of updates (Fleischmann et al. 2015). Traditional RE techniques such as interviews or focus groups do not fit the scale of some consumer software products, which reach millions of users, from a perspective of time, cost, and representativeness (Lim and Finkelstein 2012; Sharma and Sureka 2017). As a consequence, RE approaches need to adapt to this new, agile way of developing software and adopt a more flexible approach themselves. In particular, the post-implementation phase following the implementation of a software product rises in importance for realizing a software's intended benefits (Semmann and Böhmann 2015). While crowd-based RE approaches show promise in providing a scalable and representative process for involving users in RE, collaborative approaches reported in the literature do not focus on the post-implementation phase of the software product lifecycle. Vogel et al. (2019a) contribute to addressing this research gap with a process for continuous collaborative crowd-based RE spanning the entire software product lifecycle.

5.2 Online Neighborhood Social Networks

5.2.1 Chartering the field of online neighborhood social networks

This thesis provides the first conceptualization of ONSNs as an emerging phenomenon and new type of OSN. Despite the rising popularity of publicly available ONSN platforms, research investigating their use and design remains scarce (see also Section 3.2). In this regard, this thesis provides a comprehensive overview and conceptualization of the field of extant research on ONSNs. Furthermore, this thesis provides the first working definition of ONSNs as “a type of OSN whose audience comprises the inhabitants of one or more neighborhoods and whose thematic and functional focus lies on neighborhood-related issues” (Vogel et al. 2020c, p. 3). This thesis demonstrates ONSNs as differing both from their precursor, community computing initiatives, and contemporary OSNs. ONSNs differ from OSNs in several key aspects, such as the separation of users into neighborhood-level sub-communities based on their residence, lack of user-to-user relationships, or the potential for establishing communities of trust among neighbors. With Vogel et al. (2020b), this thesis provides a first and systematic overview of the domain of ONSNs, integrating the existing body of knowledge as well as empirical data.

With the design parameters of ONSNs as well as the four identified archetypes of publicly available ONSN platforms developed as part of Vogel et al. (2020b), this thesis further develops the understanding of ONSNs as a sub-type of OSNs. To do so, Vogel et al. (2020b) leverage Nickerson et al. (2013) and draw on empirical data as well as the existing body of knowledge on ONSNs. Besides allowing for the contrasting individual ONSN platforms or sets of platforms in the form of archetypes, the taxonomy enables the identification of opportunities for improving the design of ONSNs (see Table 14). Investigating ONSN design properties also contributes to understanding why ONSNs are being used despite the widespread availability of traditional OSN platforms such as Facebook. In this regard, Vogel et al. (2020b) demonstrate commonalities and differences between OSNs and ONSNs based on their design properties. Furthermore, the invocation of a community of trust via properties such as neighborhood-level communities, address and identity verification, and mandated real-name use arises as one of the key differentiators between OSNs and ONSNs.

Table 14. Taxonomy of Online Neighborhood Social Networks

	Dimensions	**Characteristics**				
Operating model	D_1 Availability	Global	Multi-country	Single-country	Selected cities	Selected neighborhoods
	D_2 Ownership	Private company	Public organization			
	D_3 Monetization	Advertising	Advertising + subscriptions	Advertising + paid listings	No monetization/nonprofit	
Neighborhood	D_4 Neighborhood formation	Platform-initiated	Neighbor-initiated			
	D_5 Neighborhood delimitation	Municipal boundaries	Arbitrarily neighbor-defined	Arbitrarily platform-defined	Radius-based	
	D_6 Local facilitation	Key user concept	Neighborhood management service	None		
Trust & identity	D_7 Identity verification	Self-service	Self-service + in-person	None		
	D_8 Invitation mechanism	Online	Online + offline	None		
	D_9 Real-name policy	Enforced	Encouraged	None		
User & content	D_{10} Extra-platform visibility	Fully platform-exclusive	Optionally semi-public			
	D_{11} Intra-platform audiences	Own + bordering neighborhoods	Own neighborhood only			
	D_{12} User-to-user relationships	Available	Not available			
	D_{13} Sub-communities	Groups	Groups + building-level communities	None		
	D_{14} Channels	Website	Mobile app	Website + mobile app		

5.2.2 Advancing crowdsourcing in local and community contexts

Crowdsourcing has been demonstrated to be an impactful approach to mobilizing groups of individuals in local and community contexts. Examples of this phenomenon include citizen science, urban planning, urban design, and policymaking (De Vreede et al. 2021; Lukyanenko et al. 2011; Mueller et al. 2018; Prpić et al. 2015; Seltzer and Mahmoudi 2012). Vogel et al. (2020a) introduce community initiatives, "undertakings which pursue the goal of improving the well-being of a community as a whole but are too complex in scope or require too much effort to be performed by a single individual" (Vogel et al. 2020a, p. 3), as a novel type of crowdsourcing task in the context of local communities. Despite fitting the definition of collaborative crowdsourcing to some degree (Blohm et al. 2017), the implementation of community initiatives requires a combination of online planning and coordination as well as offline action that is rare in collaborative crowdsourcing. More so, community initiatives differ from other instances of crowdsourcing in a local and community context in that a crowd of citizens is not solely tasked with ideation, prioritization, or problem-solving but with the real-world implementation of their proposed ideas. Furthermore, crowd-sourced community initiatives encompass a smaller scale than the vast majority of the abovementioned examples, which usually target city-, state-, or even countrywide outcomes.

These differences have implications that touch on a variety of aspects such as crowd selection, motivation, quality control of submissions, and others. Vogel et al. (2020a) address these implications by presenting design knowledge in the form of four design goals as well as ten design principles that enable the implementation of crowd-sourced community initiatives on ONSNs, which constitute nascent design theory (Gregor and Hevner 2013). Furthermore, Vogel et al. (2020a) demonstrate the usefulness of the developed design knowledge by instantiating it into a situated prototypical artifact. In this context, this thesis demonstrates the general suitability of ONSNs for acting as crowdsourcing platforms and especially for conducting crowd-sourced community initiatives, as they are home to a crowd of neighbors interested in improving the well-being of their local community. By doing so, the feature set of ONSNs, which presently strongly resembles those of OSNs, can be expanded with crowdsourcing-related features uniquely suited to this type of platform.

5.2.3 Developing validated design knowledge for ONSNs

Extant research presents artifacts that fit the definition of ONSNs provided in Section 3.2. (Antonini et al. 2016; Boella et al. 2019; Renyi et al. 2018). Moreover, numerous ONSN platforms are publicly available (Vogel et al. 2020b). While these implementations can guide and inspire designers in the development of similar artifacts, there is a lack of validated design knowledge available in the literature that formalizes this guidance. The development of validated design knowledge for ONSNs, which addresses this research gap, is directly derived from the overall RG of this thesis and RQ-1a (see also Section 1.2). In this regard, this thesis presents design knowledge for ONSNs as part of the publications Vogel et al. (2019b), Vogel et al. (2020a) Vogel et al. (2020c). Founded in the literature on social connectedness and participation as well as extant research on ONSNs, Vogel et al. (2020c) summarize and extend the developed design knowledge to arrive at a final state of eight design goals and four design principles for an ONSN for fostering social connectedness and participation (see Figure 6).

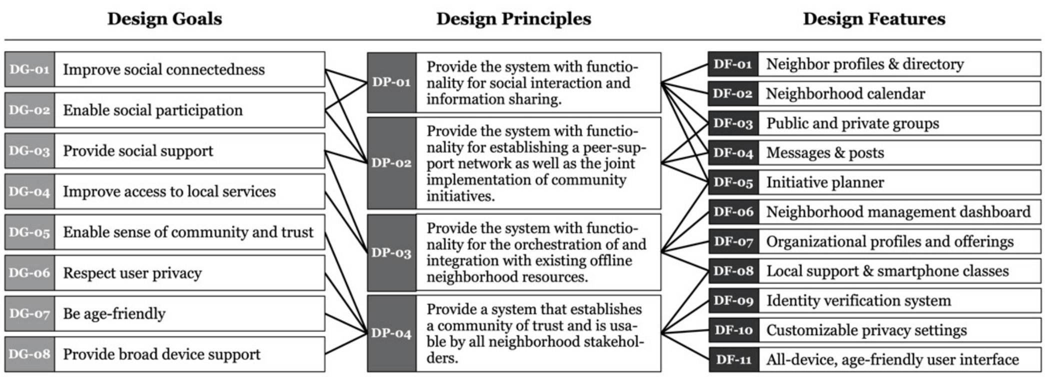

Figure 6. Design goals, principles and features for an ONSN for fostering social connectedness and participation (Vogel et al. 2020c)

Following a socio-technical perspective (Silver and Markus 2013), these design principles aim to prescribe guidance for implementing design features that reflect technical features as well as those which entail real-world interventions, or a combination of both. For instance, while the design feature “DF-04 Messages & posts” represents a feature that requires primarily technical effort to be implemented, “DF-08 Local support & smartphone classes” necessitates the creation of real-world support structures. Socio-technical artifacts require a successful embedding in their social and environmental context in order to achieve their intended effect (Orlikowski and Iacono 2001). The design principles defined by Vogel et al. (2020c) aim to achieve this embedding in a variety of ways, for instance, by offering local organizations or neighborhood initiatives a platform to continue their existing work, by empowering heterogeneous groups of neighbors to participate by supporting a large variety of devices and being age-friendly, and by cooperating with neighborhood management services.

The theoretical propositions enclosed in these design principles are tested via instantiation by implementing and evaluating an artifact (Cronholm and Göbel 2019). This artifact, the MyNeighbors platform, represents the full implementation of an ONSN platform based on design features derived from the previously defined design principles. Figure 7 provides an impression of the implemented platform. The MyNeighbors platform constitutes a fully-featured ONSN with a set of capabilities comparable to the ONSN feature baseline identified in Vogel et al. (2020b). These include functionality for information sharing and social interaction, such as a neighborhood-wide activity stream with posts of different categories, private messages, user profiles, a neighborhood directory, organizational profiles and offerings, and others. Beyond these basic features, the MyNeighbors platform implements several distinguishing capabilities that have not been reported in extant research or are available in publicly available ONSN platforms.

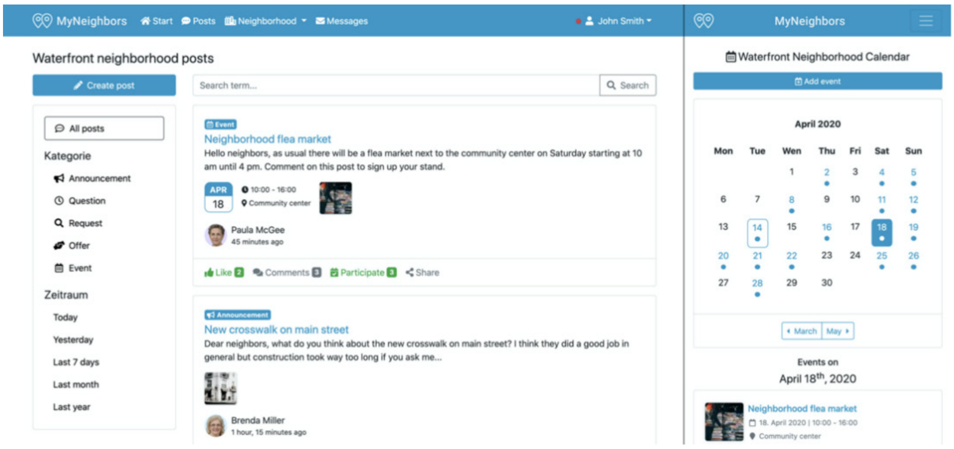

Figure 7. MyNeighbors ONSN platform desktop and mobile user interface (sample content, translated) (Vogel et al. 2020c)

As described in Vogel et al. (2020a), ONSNs have presented themselves as a suitable platform for the implementation of community-level volunteering activities or community initiatives. These types of initiatives, which have been shown to positively influence the social connectedness of involved neighbors (Gilster 2012), are supported by the MyNeighbors platform via tool support for the ideation of new initiatives, the mobilization of potential volunteers, and management of initiative projects, among others. Having undergone an artificial evaluation conducted as part of Vogel et al. (2020a), this functionality remains in an early testing phase and has not been released to all public users due to the COVID-19 pandemic largely preventing initiative implementation, and thereby evaluation opportunities, from taking place. With the integration of professional neighborhood management services in both case neighborhoods and specific supporting functionality such as the neighborhood management dashboard, the MyNeighbors ONSN differentiates itself further from other ONSN platforms, which largely forgo a physical neighborhood presence or rely on volunteer key users to fill this role.

Additional differentiation is offered through the age-friendliness of the MyNeighbors platform. Typically, older adults are hesitant to use OSN platforms due to concerns regarding information privacy, complex user interfaces, and a lack of personally relevant content (Leist 2013). At the same time, one's neighborhood gains in importance as an area of operation with rising age, and older adults are prone to suffer from social isolation and loneliness (Coyle and Dugan 2012). Therefore, they stand to profit from the social connectedness and participation that could potentially be mediated via the MyNeighbors ONSN. By putting special consideration on the needs of older users, the MyNeighbors ONSN intends to represent an age-friendly alternative to traditional OSNs. Initially, this age-friendliness is implemented via features of the technical platform, such as a simple design language, which is considered to be easy to use by elderly users during evaluation (Vogel et al. 2021a), and by implementing standard-compliant HTML syntax and ARIA tags in important sections of the platform, which enable interfacing with accessibility technology. Beyond technical platform features, the MyNeighbors ONSN and the associated design knowledge provide and stipulate smartphone classes for older adults that aim to empower neighbors for platform use by improving their digital competencies as well as the professional neighborhood management services as an offline point of contact for onboarding on the platform and providing continued guidance regarding its use.

In the course of designing the MyNeighbors platform, Grotherr et al. (2020) introduced a system-oriented perspective with multiple levels of analysis to the previously artifact-centered DSR project. The application of the Multilevel Design Framework (Grotherr et al. 2018b) to the research setting of the MyNeighbors ONSN revealed that institutional design activities could yield improvements to the MyNeighbors artifact as well as the associated design knowledge. This guidance was subsequently realized by strengthening the involvement of macro-level actors such as providers of neighborhood management services by adapting the artifact to their needs, for instance, in the case of the neighborhood management dashboard. Furthermore, a clearer formalization of engagement-stimulating practices such as smartphone classes was implemented. In sum, these design activities go beyond socio-technical artifact design, necessitating a form of institutional design. This impact is, furthermore, reflected in the design iterations presented in Section 2, Table 3. By doing so, the scope of the provided design knowledge was expanded beyond the confines of the MyNeighbors artifact and now encompasses aspects such as the introduction, establishment, continued use, and scaling of the platform, which concern actors and resources in the artifact's context.

5.2.4 Investigating the use of ONSNs

Following the public launch of the MyNeighbors platform, a long-term evaluation over one year in two case neighborhoods was conducted to validate the usefulness and effectiveness of the developed design knowledge, reported as part of Vogel et al. (2020c) and Vogel et al. (2021a). This evaluation saw extensive use of the ONSN by neighbors and launched the expansion of MyNeighbors into a total of twelve neighborhoods. At the time of writing, 350 neighbors signed up for the MyNeighbors ONSN in one of its Hamburg neighborhoods, including 148 users from the two case neighborhoods. The evaluation data analyzed as part of Vogel et al. (2020c) and Vogel et al. (2021a) demonstrate the platform's strength in keeping neighbors informed and engaged with neighborhood activities. Similarly, some success in improving social interaction among neighbors could be observed. However, not all design features found equally enthusiastic use by neighbors in the case neighborhoods. In consequence, not all design goals were enacted to the same degree. For instance, neighbors readily utilized MyNeighors as a tool for information sharing and communication. However, they were hesitant to request support from their peers, despite expressing a general readiness to assist others (Vogel et al. 2021a; Vogel et al. 2020c).

This thesis furthers the understanding of the use of ONSNs by older adults by closely investigating their usage behavior as part of Vogel et al. (2021a). Older adults often refrain from using traditional OSNs for a variety of reasons, such as a lack of a desire for self-portrayal, concerns regarding trust and data privacy, complex user interfaces, or a lack of personally relevant content, among others (Leist 2013). The evaluation conducted as part of this thesis with older adults demonstrates that the MyNeighbors ONSN was able to overcome some of these burdens of OSN use for this group of users. However, similar to traditional OSNs, the behavior of older adults differs from that of other age groups (Anderson and Perrin 2017). The analysis of evaluation data presented in Vogel et al. (2021a) shows that in the case of MyNeighbors, older adults did not contribute considerable amounts of publicly visible content, such as posts on the platform. However, contributions that were likely to attract a smaller audience, such as comments to individual posts or which were completely private, such as direct messages, were created by older adults at rates comparable to some younger user groups. Similarly, older adults are on par with some younger user groups regarding their consumption of content produced by other users. Previously, traditional OSNS have been demonstrated to be a suitable tool for improving social connectedness and participation for individuals, including older adults (Grieve et al. 2013; Grieve and Kemp 2015; Srivastava and Panigrahi 2019). This thesis introduces and demonstrates ONSNs as a sub-type of OSNs that may be particularly suitable in this regard.

Stimulated by the emergence of the COVID-19 pandemic, Vogel et al. (2021b) explore how ONSNs can be utilized as a tool for fostering the social resilience of local communities. Already, ONSNs are actively being used to foster social resilience during disasters such as the COVID-19 pandemic (Kummitha 2020; United Nations 2020). Vogel et al. (2021b) investigate this use by analyzing activity on the MyNeighbors ONSN at the outset of the pandemic and by identifying design features of publicly available ONSN platforms that were adapted or newly developed to counter the negative outcomes of the COVID-19 pandemic. By doing so, this thesis demonstrates the unique suitability of utilizing existing ONSN features for maintaining social connectedness, sharing locally relevant information, establishing a peer-support network among neighbors, and supporting local businesses and organizations. In turn, ONSNs can improve the capability for recovery and resistance of local communities, strengthening their social resilience. Furthermore, potential future ONSN adaptations for fostering social resilience during the COVID-19 pandemic and beyond are proposed. With this analysis, this thesis contributes to research on the use of social media in crisis response.

5.3 Overall Theoretical Implications

The core contribution of this thesis lies in the development of validated design knowledge for openness-inducing socio-technical artifacts in two application domains. The developed design goals, principles, and features, as well as the respective artifact instantiations, represent a level two nascent design theory and an improvement type contribution, offering novel solutions for an established problem, following the DSR knowledge contribution framework (Gregor and Hevner 2013). The development of this design knowledge as guiding principles of form and function and its comprehensive evaluation constitute an advance into the last research mile of proof-of-value and proof-of-use, as proposed by Nunamaker et al. (2015). As such, the undertaken investigation into two application domains couples rigorous scientific research with a valuable societal and business impact (Briggs et al. 2019).

By investigating the infusion of openness in two application domains, this thesis contributes to the emerging stream of research into the relationship between IS and open resources, open processes, and opening effects (Nielsen and Sahay 2019; Schlagwein et al. 2017). The developed socio-technical artifacts, namely the CrowdCore artifact in the application domain of SRE and the MyNeighbors artifact in the application domain of local communities, embody and are unified in their infusion of openness in their respective research context. In the case of both application domains, open, participatory processes represent an essential component of the developed artifacts, be it for the collaborative development of software requirements or the joint implementation of community initiatives. Similarly, opening effects such as increased participation, improved transparency, or a reduction of exclusivity represent vital goals of the intended infusion of openness in a research context. Finally, in the case of the MyNeighbors artifact, a planned publication of application source code represents the first step toward developing an open resource.

While both application domains and respective artifacts pursue different goals and operate by different means, the effects of the infusion of openness can be conceptualized based on the principles of transparency, access, participation, and democracy (Schlagwein et al. 2017). Figure 8 provides an overview of the contributions of this thesis per application domain as well as the unifying infusion via the principles of openness. These principles can be observed in both research contexts, albeit with varying emphasis. Similarly, domain-specific guidance in the form of design knowledge was necessary to make an infusion possible. The principles of openness take the role of high-level meta-requirements but cannot be operationalized into actionable design guidance without further domain-specific concretization.

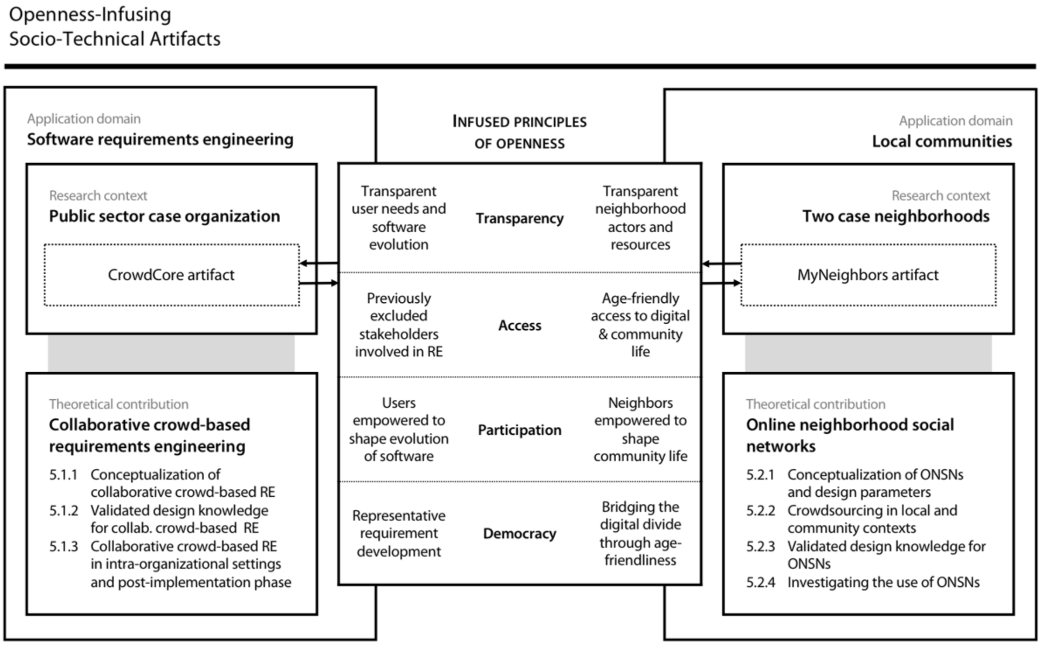

Figure 8. Overall theoretical implications

Both the CrowdCore and MyNeighbors artifacts embody openness following the four principles of transparency, access, participation, and democracy (Schlagwein et al. 2017). On the outset, and as a precondition for other principles of openness, the developed socio-technical artifacts infuse *transparency* into their respective research contexts. In the case of the CrowdCore process and platform, two interest groups profit from this newfound transparency: software users and software product owners, with the latter representing the organization funding and developing the software product in question. The CrowdCore artifact establishes transparency regarding the RE process from the perspectives of both groups. By publishing user requirements on an online platform, software users become aware of the needs and priorities of other users. Public effort estimates and roadmaps maintained by product owners improve the level of information available to software users regarding the availability and utilization of software development capacity, consequently managing user expectations. With mandatory status updates, for instance, following the rejection of a user-submitted requirement, decisions made by product owners become transparent for users. In sum, these elements provide improvements regarding transparency over traditional approaches to RE (Pohl and Rupp 2015) and a qualitative perspective of transparency not afforded by data-driven crowd-based RE approaches (Groen et al. 2017).

Similarly, in the case of the MyNeighbors artifact, the transparency of actors and resources in a neighborhood is improved by making their characteristics, actions, and offerings visible to inhabitants. Information previously distributed face-to-face between individuals, via private information channels, or dispersed on a multitude of media can now be openly and centrally published and accessed via the MyNeighbors platform. This entails posts to the neighborhood-wide activity stream, organizational profiles, a directory of organizational offerings, or the neighborhood calendar. However, transparency is not improved exclusively for neighbors who gain a better understanding of the activities and offerings of local organizations and institutions. Neighbors also receive information regarding neighborhood life in general, for instance, in the form of actions of their peers, by following posts of other neighbors and inspecting neighbor profiles and the neighbor directory. Likewise, organizations gain access to a novel channel for communicating and interacting with inhabitants of local neighborhoods. Design features such as the neighborhood management dashboard support neighborhood managers in providing effective and targeted community support in their respective neighborhoods. They gain insights into the issues and needs relevant to the inhabitants of their service area and are enabled to focus their efforts effectively by developing appropriate measures that address locally relevant topics.

Improved *access* represents a further principle of openness evoked by the artifacts developed for both application domains. The principle of access usually implies and builds on transparency, as what is hidden cannot be accessed (Schlagwein et al. 2017). In the case of the CrowdCore artifact, this improved access is evoked through the restructuring of existing processes and rules stemming from traditional RE approaches. These approaches often limit access to information and process participation to RE professionals such as requirement analysts and a select group of software users such as key users (Pohl and Rupp 2015). Most software users are not able to gain access to information regarding planned requirements or to participate in the requirements development process in general. This mode of operation entails several shortcomings, such as selection bias, lack of representativeness, inability to scale, and others (Groen et al. 2017). The CrowdCore process and platform contribute to overcoming these shortcomings by providing equal access to the RE process for every software user and, in consequence, reducing its exclusivity. In the case of the MyNeighbors artifact, improved access is evoked in a manner that differs from the CrowdCore artifact. Access to actors and resources in a local community is prohibited less by process restrictions or rules but by a lack of transparency, awareness, and accessibility. Conversely, traditional RE practices simply do not allow for broad user involvement. Consequently, the MyNeighbors artifact aims to overcome a different set of burdens compared to CrowdCore and improves access via enhanced transparency and accessibility of the neighborhood ecosystem, by raising attention to elements of this ecosystem and by providing trustworthy information thereof. Design features of the technical platform itself, such as age-friendly design as well as smartphone classes and neighborhood managers acting as personal support contacts, contribute to this accessibility. Similarly, the potential to evoke communities of trust via design features such as neighborhood-level sub-communities, address and identity verification, and real-name mandate can increase neighbors' willingness to access and interact with community actors and resources.

By empowering and stimulating individuals, CrowdCore and MyNeighbors manifest the principle of *participation* in their respective research contexts. In the course of the CrowdCore process, software users evolve from mere providers of ideas during requirements elicitation to active participants shaping the content of software requirements as part of a collaborative requirement analysis and specification. In turn, software product owners gain a more representative and holistic perspective on the requirements of their product's users. The possibility of involving large numbers of stakeholders in a time and place independent manner in the RE process enables the participation of stakeholder groups that could previously not be reached due to geographic distance, limitations regarding time and budget, or simply because they were unknown. Similarly, with the help of the MyNeighbors ONSN, inhabitants of local communities can evolve from observers and consumers to active shapers of neighborhood life by engaging with their peers, by promoting their contributions to the community, such as events, or by launching community initiatives. Dedicated functionality for the implementation of community initiatives allows neighbors to mobilize their peers around common causes and, thereby, actively improve community well-being (Gilster 2012). Neighbors can also become participants in a neighborhood-level peer-support network. In this regard, MyNeighbors provides neighbors with access to a crowd of potential volunteers and encourages community-level participation.

The infused transparency, access, and participation afforded by the CrowdCore and MyNeighbors artifacts, in turn, bring about a *democratization* of both research contexts, albeit with varying emphasis. In the case of the CrowdCore artifact, democratization can be characterized by a strengthening of representation and the enabling of a novel form of group decision-making in the context of RE. As envisioned by Johann and Maalej (2015), the RE process offers ample opportunity for democratization, crowd-based RE improving key factors such as scalability of involvement, representativeness, and decision objectivity. The crowd-based voting mechanism based on the concept of internal crowdfunding (Muller et al. 2013) implemented in the CrowdCore platform can, if applied consequently, democratize decision-making regarding a software product's upcoming features and improvements by providing each software user with equal decision-making authority. However, the decision-making power of software users should not be overstated, as the CrowdCore process still considers software product owners as the final decision-makers. The MyNeighbors artifact manifests democratization in a manner more focused on minority inclusion, the pursuit of equality, and the breaking-up of restrictive structures. Older adults stand to profit in particular from the improved transparency and age-friendly combined online and offline access to local actors and resources afforded by MyNeighbors. The intended inclusion of older adults through measures pertaining to age-friendliness represents a breaking-up of exclusionary structures, one aimed at bridging the digital divide (Rockmann et al. 2018) between neighbors of all ages and at instilling digital equality. In sum, these efforts contribute to the democratization of the digital community space.

The presented socio-technical artifacts evoke the principles of openness in their respective application domains. The research contained in this thesis also represents an advance toward demonstrating that this evocation relies on similar mechanics in both cases, formalized in the developed design knowledge. At the core, both artifacts empower individuals for participation by allowing for open, equal communication, and the exchange and discussion of suggestions, ideas, and needs. In the case of CrowdCore, these are represented by software requirements, while the MyNeighbors artifact envisions the ideation of community initiatives. Collaboration tools, such as threaded discussion systems, voting systems, and others offered by both artifacts, allow individuals and groups to work toward jointly implementing these ideas. Both rely on a form of guided participation, establishing a set of rules, processes, and procedures that steer idea implementation. The CrowdCore artifact goes as far as to formalize the CrowdCore process (see Figure 5) with predefined milestones and timeboxes. Community initiatives, albeit less formalized, provide guardrails in the form of initiative phases, roles, and access controls. Transparent decision-making and tracking of progress in the context of ongoing community initiatives and software requirements, enabled by status updates, effort estimations, and other mechanics, contribute to managing participant expectations. In sum, these mechanics empower individuals to continuously take part in and co-determine the evolution of the respective artifact context, be it a software product they use or a neighborhood they inhabit.

Besides these central empowering mechanics, the socio-technical artifacts implement a variety of enabling mechanics. Participation, in the case of both artifacts, is dependent on a trustworthy community of peers. In the case of CrowdCore, interaction takes place between members of the same organization, while MyNeighbors leverages neighborhood-level sub-communities. User profiles, community guidelines, or mechanisms such as identity verification and real-name mandates mediate individuals' readiness to participate based on trust (Boyd 2012; De Meulenaere et al. 2020b; Schwämmlein and Wodzicki 2012). In both application domains, professional facilitation plays a key role in enabling openness. In the case of the CrowdCore artifact, software product owners moderate user interactions and steer the participation process. Similarly, in the case of MyNeighbors, neighborhood managers ensure access by neighbors and promote individual contributions and neighborhood life. Finally, artifact mechanics such as peer-rating and peer-voting, self-assessment, and platform moderation contribute toward ensuring the quality of submissions as part of the participation process. In conclusion, with the application of these and other mechanics and their formalization in the developed design knowledge, this thesis advances the understanding of how socio-technical artifacts can be deliberately designed with the intention of infusing openness into an otherwise restricted or exclusive context.

Apart from the infusion of openness, research on crowdsourcing and collaborative crowdsourcing, in particular, represent a research area where both application domains contained in this thesis provide a contribution. Both cases apply the collaborative crowdsourcing approach that lies at the center of the CrowdCore artifact and represents an important element of the MyNeighbors artifact in the case of the community initiatives feature. In both domains, members of the crowd pursue goals that outreach the skills or capacity of an individual, necessitating a form of collaboration (Pedersen et al. 2013), the development of requirements and the implementation of community initiatives, respectively. The collaboration of members of the crowd is a decisive element of crowdsourcing, as it allows for the joint development, improvement, and quality control of a solution (Tavanapour and Bittner 2019). The developed socio-technical artifacts provide procedural and functional support for conducting this collaboration. By investigating novel cases for collaborative crowdsourcing and developing design knowledge in both instances, this thesis contributes to research on collaborative crowdsourcing.

6 Practical Contribution

This research project was deeply embedded into an environment of two application domains, consisting of people, organizations, and technical systems (Hevner 2007). This environment is leveraged to identify relevant research problems as well as opportunities and to ensure that the solutions developed as part of this thesis are applicable in and useful for practice. As a result, this thesis has several implications that guide practitioners in the design of crowd-based RE approaches and open local communities.

6.1 Improving the Development of Software Requirements with Collaborative Crowd-Based Requirements Engineering

With RE techniques such as workshops, surveys, or interviews struggling to keep up with contemporary fast-paced, agile, and incremental software development practices, organizations require novel approaches to RE. The CrowdCore process and platform instantiation, as well as the associated design knowledge in the form of design principles, provide a starting point for organizations seeking to increase user involvement in the RE process and capture the associated benefits, such as improved requirement quality and overall software development project success (Pagano and Bruegge 2013; Zowghi et al. 2015). The CrowdCore process and platform allow organizations to reap the benefits of collaborative crowd-based RE approaches. By choosing a web-based, asynchronous, and geographically independent approach, organizations can save time and money compared to traditional RE techniques such as interviews, workshops, or focus groups. CrowdCore, furthermore, enables organizations to scale user involvement to include a large number of software users in the RE process, achieving a more representative mode of user participation and avoiding selection bias inherent in traditional RE techniques (Law et al. 2012). By doing so, the developed requirements are tailored more closely to software user needs, in turn improving user satisfaction (Fleischmann et al. 2015).

While the CrowdCore process and platform are not limited to an intra-organizational application, this use case guided their design and implementation. In the case of internal application settings, collaborative crowd-based RE approaches are suitable to be used to accompany the development of proprietary software with primarily internal users but also for standard software with high potential for customization, such as SAP or Microsoft SharePoint. In this context, CrowdCore can, furthermore, contribute to the overall goals of employee empowerment and employee engagement (Anitha 2014). By making the internal software development process more transparent, accessible, and participative, CrowdCore can empower employees in their role as software users to shape the future development of the tools they use for their work.

The CrowdCore process and platform propose novel design features that can be adapted for and integrated with existing RE tools. For stakeholder communication and product owner decision-making, these include public product roadmaps, effort estimate communication, and impact and effort matrices. Using these decision support mechanisms, product owners are enabled to make informed decisions and to choose features for further development that are best aligned with their goals. The continuous nature of the CrowdCore process, stretching the entire software product lifecycle, can offer product owners a better understanding of customer needs even as they change over time. By stretching into the post-implementation phase, the CrowdCore process also enables organizations to follow through on the intended benefits of a software product after its implementation, a lifecycle phase frequently neglected from a benefits management perspective (Semmann and Böhmann 2015).

Besides proposing a process and platform for continuous internal crowd-based RE, this thesis also offers actionable guidance and recommendations for implementing and establishing such an approach as part of Vogel et al. (2019a). These recommendations cover topics such as a software's suitability for conducting continuous internal crowd-based RE, the establishment of organizational interfaces, and handling of user-generated content on a crowd-based RE platform.

6.2 Developing Age-Friendly, Sustainable, and Resilient Communities

Since its launch, the MyNeighbors ONSN platform has attracted more than 350 neighbors and is used in twelve neighborhoods across the metropolitan area of the city of Hamburg. With the MyNeighbors platform and the associated design knowledge, this thesis makes a practical contribution useful for a variety of stakeholder groups in the context of cities and local communities, including local authorities and governments, local institutions, nonprofit organizations, local businesses, and citizen groups. By firmly grounding the motivation, design, and evaluation of the design principles and artifact instantiation in the research context of two case neighborhoods, the practical relevance of the research project is ensured. The evidence-based and formalized design knowledge resulting from this practice-oriented research can serve as a blueprint for the construction of similar artifacts and their transferability to different community contexts.

This thesis presents ONSNs such as MyNeighbors as a tool for addressing challenges associated with an aging society, such as social isolation and loneliness. With the populations of many European countries aging at an unprecedented pace (EU 2018), governments are aiming to develop age-friendly cities and communities that can accommodate the particular needs of older adults regarding accessibility, security, and participation (Buffel et al. 2012). ONSNs represent a building block for enabling older adults to stay healthy and socially connected by stimulating social interactions and social participation. As explored in Vogel et al. (2020c), the increased transparency of and access to local actors and resources, such as offerings and events organized by neighbors or local organizations, can contribute to facilitating the social participation of older adults. Being integrated into a local peer-support network could enable older adults to age in place by partly substituting professional care activities with reliable community support where possible.

In line with the United Nation's 11th Sustainable Development Goal (United Nations 2015), cities around the globe are seeking to leverage digital technologies to become inclusive, safe, resilient, and sustainable (Righi et al. 2015). To achieve this goal, cities invest heavily in smart city technologies, investments reaching an estimated 97 billion USD in 2019 (Navigant Research 2019). By leveraging digital infrastructure and devices, cities aim to improve parameters such as quality of life, civic participation, and human capital (Marrone and Hammerle 2018). Among these technologies, OSNs have presented themselves as a building block for improving social connectedness and participation (Srivastava and Panigrahi 2019). Likewise, ONSNs, such as the MyNeighbors platform, represent a type of digital technology useful for improving the social sustainability, inclusiveness, and resilience of local communities. ONSN platforms can make transparent and improve access to local resources, establish a local peer-support network, and enable social sustainability through social and public participation. By providing design knowledge for this type of artifact, the focal research supports practitioners in addressing challenges such as increasing urbanization and population aging. In designing these types of artifacts, this thesis, furthermore, highlights the need to consider both individuals such as neighbors and intuitional actors (Grotherr et al. 2020). Local authorities and governments can leverage ONSNs such as MyNeighbors as a tool for community building and as a communication channel for the distribution of locally targeted information as well as for the establishment of a citizen dialogue that can serve as the foundation for a variety of citizen participation processes.

With the research conducted as part of Vogel et al. (2021b), this thesis proposes ONSNs as a tool for fostering the social resilience of local communities. The social resilience of a community describes its ability to respond to and cope with disasters (Maguire and Hagan 2007). The COVID-19 pandemic represents a particularly complex disaster due to its global scale and the necessity for public health measures, such as strict physical distancing or stay-at-home orders. While these countermeasures are effective in curtailing the spread of the pandemic (Cowling et al. 2020), they bring along negative outcomes such as social isolation, loneliness, and other mental health issues (Usher et al. 2020). Where communities usually would pull together when faced with a crisis, the COVID-19 pandemic penalizes this togetherness due to the distinct infectiousness of the SARS-CoV-2 virus (Cevik et al. 2020). Already, citizens and governments are leveraging OSNs and ONSNs in response to this crisis (Kummitha 2020). As part of the publication Vogel et al. (2021b), this thesis demonstrates how the MyNeighbors ONSN and publicly available platforms, such as Nextdoor (https://nextdoor.com) or nebenan (https://nebenan.de), can be utilized to support local businesses and organizations, substitute neighborhood activities online, and maintain community well-being during the COVID-19 pandemic and beyond. Practitioners can leverage the developed design knowledge to design and implement novel ONSN artifacts or take advantage of existing publicly available ONSN platforms.

7 Limitations

This thesis is faced with some limitations resulting from its research approach, the applied methodology as well as application domains and evaluation contexts, which reduce the generalizability of its results.

Due to the largely qualitative *research approach* and associated methodology, this thesis is subject to personal biases and idiosyncrasies as well as dependent upon the involved researchers' skill in applying the selected methodologies (Myers 2019). This subjectivity strongly influenced conceptualizations and interpretations made as part of the thesis (De Villiers 2012). To alleviate these risks, multiple sources of data were used and compared to triangulate the results. Data were collected from a variety of research subjects and perspectives in order to gain a comprehensive picture of the investigated phenomena. For instance, in the case of research conducted in the local communities application domain, neighbors, neighborhood managers, and organizational representatives were each interviewed to comprehensively cover the local community ecosystem. Furthermore, rigorous evaluation episodes were conducted. Where appropriate, multiple researchers were involved in data analysis and frequent review of findings with other researchers instituted. The overall DSR approach applied as part of this thesis entails further limitations. Generally, the natural setting, limited control, and close researcher involvement inherent to design research bring about the threat of low rigor and validity (De Villiers 2012). The unstructured nature of DSR invites criticism regarding its rigor and generalizability (Hevner et al. 2004; Kuechler and Vaishnavi 2008). As design knowledge is developed in specific research settings or contexts, it possesses a degree of context-specificity (Hong et al. 2013), which may lead to it being short-lived and hinder its application in other settings. The context of the research conducted as part of this thesis, i.e., its cultural and institutional properties as well as the boundary conditions they impose, determines the balance between universality and particularity of the developed design knowledge (Davison and Martinsons 2016). To address these risks, this thesis follows established methodological guidance in the form of the DSRM (Peffers et al. 2007) and FEDS (Venable et al. 2016). Furthermore, the guidelines for conducting effective DSR proposed by Hevner et al. (2004) serve as a blueprint for the conducted research and presentation of results. As such, this thesis aims to provide a detailed description of results, an accurate account of conducted research steps and artifact iterations, as well as rigorous evaluation.

The applied *methodology* for data collection and analysis evokes further limitations. For most data collection episodes, such as interviews, workshops, and focus groups, subjects were recruited from a limited number of organizations and contexts. In the case of the conducted research on crowd-based RE (Vogel et al. 2019a), data were primarily collected in a single case organization. In the case of the conducted research regarding local communities, the selection of case neighborhoods with varying demographics and socio-economic characteristics mitigates this issue (Vogel et al. 2020a; Vogel et al. 2019b; Vogel et al. 2020c). The conducted qualitative interviews face risks to their validity from issues such as artificial interview situations, a lack of trust between interviewer and subjects, the Hawthorne effect, or ambiguity of question language (Myers and Newman 2007). Following the guidance of Myers and Newman (2007), this thesis employs techniques such as mirroring, semi-standardized interview guides, the involvement of various actor roles, and transparent situating of the interviewer to counter these risks. In the case of the conducted literature review and developed taxonomy (Vogel and Grotherr 2020; Vogel et al. 2020b), it cannot be ruled out that the personal judgment of the involved researchers concerning, for instance, inclusion criteria or search terms impacted the outcome of the work. However, this thesis followed established methodological guidance (Nickerson et al. 2013; vom Brocke et al. 2009; vom Brocke et al. 2015; Webster and Watson 2002) and transparently reported conducted research steps, interim results, and decision criteria to ensure reproducibility and validity.

Rigorous *evaluation* represents an essential element of effective DSR (Venable et al. 2016) and how it is conducted has implications regarding a research project's limitations. In the case of the design artifact developed in the SRE application domain (Vogel et al. 2019a), a long-term naturalistic evaluation in its intended usage environment would have yielded a stronger internal validity (Venable 2006) but could not be conducted due to time constraints and limitations imposed by the case organization. As a substitute, a summative artificial evaluation was conducted via a simulation, following the CrowdCore process as closely and comprehensively as possible and with the involvement of a variety of CrowdCore roles. In the case of the research conducted regarding ONSNs (Vogel et al. 2020c), long-term naturalistic evaluation data from two case neighborhoods is leveraged to validate the developed design knowledge. Including more diverse and a larger number of neighborhoods in the evaluation would likely result in the refinement of the developed design knowledge. To ensure the validity of the results, several evaluation methods, such as interviews, an online survey, and website usage data, are triangulated and confirm evaluation findings from multiple perspectives despite the limited number of case neighborhoods. In the case of both application domains, evaluating the design knowledge in the same environments in which it was conceived represents a further limitation (March and Smith 1995).

8 Further Research

In the course of conducting this thesis, several promising and impactful avenues for further research could be identified regarding both research on openness in IS and the investigated application domains of local communities and SRE.

8.1 Research Outlook: Toward a System-Oriented Perspective of Participation

This dissertation presents design knowledge for openness-infusing socio-technical artifacts. To realize these artifacts, a variety of theoretical concepts are integrated, among which crowdsourcing takes a prominent role in the case of both application domains. The process of adapting crowdsourcing mechanics for utilization in the focal research project, in particular in the case of the local community application domain (Vogel et al. 2020a), resulted in observations that point toward a potentially novel phenomenon distinct from existing crowdsourcing practices, which warrants further investigation.

Following the initial definition of crowdsourcing by Howe (2008), crowdsourcing is based on the outsourcing approach, the contracting of a task previously performed inside of an organization to an external party (OED 2021a). In the case of crowdsourcing, a crowd of individuals constitutes this external party. This perspective seems to only partially fit the socio-technical artifacts developed as part of this thesis. In the case of the CrowdCore artifact, which aims to shift the task of requirements development to a crowd of employees, it seems largely appropriate. However, the community initiatives ideated and implemented by members of a local community on the MyNeighbors platform represent novel undertakings that were not previously performed by an entity other than initiative participants and, in particular, not by an organization. Furthermore, viewing crowdsourcing as a form of outsourcing also brings along a transactional perspective. Considering approaches such as microtasking (Nakatsu et al. 2014), crowdsourcing can be viewed as highly transactional, with tasks possessing quantifiable success criteria, inputs, and outputs, assignees and compensation. In contrast, community initiatives on the MyNeighbors ONSN, as proposed by Vogel et al. (2020a), possess mostly qualitative success criteria, entail collaborative task definition and fulfillment, and flexible task assignment, and do not entail any explicit compensation.

Established perspectives on crowdsourcing distinguish between the roles of a crowdsourcer, often an organization, and members of a crowd, in most cases the general public (Blohm et al. 2017; Geiger et al. 2012; Nakatsu et al. 2014). In this context, the crowdsourcer is a paying customer of a crowdsourcing platform or operates such a platform herself, while members of the crowd are not customers but users of this platform. Conversely, in the case of community initiatives as envisioned on MyNeighbors, both the author of an initiative and the individuals participating in an initiative originate from the same group of members of a local community or neighbors. Novel initiatives arise from inside the community of neighbors and are not introduced to the platform by an external party. Initiative authors and participants possess an equal relationship with the MyNeighbors platform, with no distinction such as customer or user roles being made.

The implementation of community initiatives on the MyNeighbors platform also raises novel issues regarding the goals and motivations of the involved actors, which warrant further investigation. On the level of individual neighbors, participation in community initiatives is not financially motivated but likely initiated by factors such as anticipated reciprocity, increased recognition in the community, or a sense of efficacy (Kollock and Smith 1999). In this regard, community initiatives resemble other not-for-profit applications of crowdsourcing, such as citizen crowdsourcing for urban planning or policymaking (De Vreede et al. 2021; Mueller et al. 2018; Prpić et al. 2015). However, as opposed to these existing instances of crowdsourcing, community initiatives are not limited to ideation, prioritization, and decision-making tasks but crucially also the physical implementation of an idea. This more direct and comprehensive participation in the implementation of an initiative and, in consequence, greater influence and responsibility regarding its success may impact the motivations and goals of the involved participants.

Considering the insights derived from analyzing the MyNeighbors platform from a multi-level perspective (Grotherr et al. 2020), the MyNeighbors platform, its organizational and institutional partners as well as its users pursue shared and individual goals. For instance, the MyNeighbors platform, as formalized in the developed design knowledge, aims to improve social connectedness and participation across its case neighborhoods. In the case of community initiatives specifically, the platform aims to empower individuals to improve the well-being of their local community (Vogel et al. 2020a). Groups of participants in community initiatives may pursue more concrete goals related to their specific neighborhood, and individual neighbors may be more inclined toward the abovementioned goals, such as improved recognition in their community. Participation, individuals taking part in or becoming a part of a joint endeavor (OED 2021b), represents a core activity of both the CrowdCore and MyNeighbors platforms and demonstrates how various actors align their interests to work toward shared goals. To analyze the characteristics of and relationships between these individual and shared goals, further research may aim to move from the transactional and process-oriented perspective of crowdsourcing to a more continuous and system-oriented perspective of the participation taking place in the context of initiatives on the implemented platforms.

Collectively, these observations raise the question of whether a new type of system, one centered specifically on participation beyond generic openness, can be observed in the present research. Analyzing and defining these potential systems of participation could also provide an avenue toward raising the level of abstraction of the design knowledge presented in this thesis. As is inherent to design principles, the design knowledge developed as part of this thesis is domain-specific (Sein et al. 2011) and not readily applicable to contexts beyond the ones it was developed in. At the same time, it must be defined on an adequate level of abstraction to not be restricted to a single instantiation and to be able to guide the design of artifacts of a similar type (Chandra et al. 2015). Despite this domain-specificity, both application domains are interconnected in their infusion of openness, with each domain exhibiting different characteristics of the four principles of transparency, access, participation, and democracy (see also Figure 8). Identifying and analyzing additional application domains and cases in which socio-technical artifacts infuse openness into a restricted or exclusive context represents a promising avenue for further research. Identifying and comparing these cases could allow for the determination of similarities and differences regarding the suitability and feasibility of domains for being infused with openness. The adaptation of the design knowledge developed as part of this thesis to these additional domains could result in its further refinement. Beyond adapting the developed design knowledge to other domains, further research may attempt to develop unifying cross-domain design knowledge that applies to two or more application domains. Raising the level of abstraction of design knowledge by developing meta-level guidance for designing openness-infusing socio-technical artifacts could make an impactful contribution to research into openness in IS. However, striking a sensible balance between a sufficient domain-specificity to simultaneously provide actionable design guidance and a level of abstraction suitable for a cross-domain impact could prove challenging.

8.2 Crowd-Based Requirements Engineering

As part of Vogel et al. (2019a), this thesis provides the first formalized design knowledge for conducting collaborative crowd-based RE in the form of design principles and an artifact instantiation. Further research may utilize, expand, and improve this developed design knowledge by developing artifacts of a similar type and adding back to the body of knowledge on collaborative crowd-based RE. Concretely, the CrowdCore process and platform have been evaluated in an artificial setting and from a product owner perspective. Expanding this evaluation into a naturalistic, long-term setting as well as including the software product user perspective could yield valuable new insights for refining the developed design knowledge.

The literature review on collaborative crowd-based RE conducted as part of this thesis (Vogel and Grotherr 2020) reveals several further avenues for developing collaborative crowd-based RE approaches. These include embedding crowd-based RE with agile software development practices such as Scrum, Kanban, or Extreme Programming and integrating with respective tooling, the first steps in this direction being present in Snijders et al. (2015) or Law et al. (2012). Furthermore, the combination of collaborative and data-driven approaches holds promise for further research. While research on collaborative crowd-based RE remains scarce, especially compared to research on data-driven crowd-based RE, a variety of publicly available or commercial platforms for conducting collaborative crowd-based RE can be observed (see also Section 3.1). Further research should systematically identify, analyze, and compare these artifacts and their design features. This analysis could yield valuable insights for developing novel and improving existing design knowledge for collaborative crowd-based RE. Similarly, collecting empirical data from these publicly-available platforms could yield valuable new insights.

8.3 Online Neighborhood Social Networks

The design knowledge for ONSNs developed as part of this thesis can be readily transferred to and adapted for different community contexts in future research, leading to its expansion and improvement. Similarly, future research may also aim to raise the maturity of the design knowledge or the developed prototypical artifact instantiations. By developing new functionality, ONSNs could also achieve a clearer separation from traditional OSN platforms. The developed functionality for implementing community initiatives via an ONSN presented in Vogel et al. (2020a) can be seen as one instance of the development of differentiating functionality taking place. This differentiation between ONSNs and OSNs represents an interesting area for further research on its own. Despite ONSNs and OSNs sharing many similarities, it can be observed that ONSNs have continued to attract new users over recent years (see also Section 3.2). It can be speculated that this is due to potential communities of trust among ONSN users enabled by automatic segmentation of users into neighborhood-level sub-communities, address and identity verification mechanisms, and real-name usage, among other reasons. However, concrete research in this regard is still lacking.

The evaluation of the MyNeighbors platform based on empirical data from two case neighborhoods conducted as part of this thesis has demonstrated the potential of ONSNs to improve social connectedness and participation. In the future, evaluating the MyNeighbors ONSN or similar ONSN platforms in a more heterogeneous set of case neighborhoods could yield further valuable implications for improving and expanding the developed design knowledge. Furthermore, it could enable the identification of success factors for the establishment of ONSNs resulting from varying socio-demographic characteristics, organizational and institutional support, and other differences between neighborhoods. Besides evaluating the usefulness and effectiveness of ONSNs, as was done as part of this thesis, the process of introducing and establishing such platforms in neighborhoods warrants closer investigation. Formalizing suitable practices and interventions for gaining attention and acceptance as well as fostering usage of an ONSN platform in a neighborhood context could prove valuable, particularly for practitioners seeking to improve the well-being of local communities through ONSNs.

With Vogel et al. (2020b), this thesis presents a first and systematic overview of existing publicly available ONSN platforms and their design properties. However, this analysis is based primarily on an outside perspective of these ONSN platforms. Future research should integrate the perspective of ONSN platform providers, which could potentially reveal valuable insights regarding aspects such as business models, challenges for expansion, usage patterns, and others. Collecting empirical data from ONSN platform providers could serve to evaluate, improve and expand the taxonomy created as part of Vogel et al. (2020b) but also represent a relevance cycle useful for extending the design knowledge developed as part of Vogel et al. (2020c).

As presented in Vogel et al. (2021b), ONSNs show promise as a tool for fostering social resilience during disasters, such as the COVID-19 pandemic. Beyond the analysis of user-generated content on the MyNeighbors ONSN and the design features of publicly available ONSNs, areas for further research could be identified. The analysis of larger sets of data concerning the COVID-19 pandemic could offer additional insights into the ability of ONSNs to foster social resilience. From a design perspective, future research should investigate how ONSN platforms can be further adapted to counteract the negative consequences of the COVID-19 pandemic, for instance, by developing functionality for collective usage of shared community spaces, improving peer-support in a local community, and integrating with public services and authorities.

9 Leveraging the Internal Crowd for Continuous Requirements Engineering: Lessons Learned from a Design Science Research Project

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Abstract

Open phenomena including open resources, processes such as crowdsourcing and their effects have initiated fundamental shifts in the way organizations conduct their business. With increasing recognition of the value of openness, represented by principles such as transparency, access, participation and democracy, crowdsourcing has established itself as a suitable mechanism for various use-cases ranging from decision-making to idea generation, microtasking and problem-solving. Increasingly, organizations have begun to crowdsource to their employees instead of external crowds. However, few studies analyze concrete use-cases of internal crowdsourcing and further research is needed. We propose that internal crowdsourcing is particularly useful for software requirements engineering (RE) within organizations. Crowd-based RE alleviates shortcomings of traditional RE approaches such as requiring copresence or lacking representativeness. Research on crowd-based RE remains scarce, particularly concerning intra-organizational settings and the post-implementation phase of software projects. Defining high-quality requirements demands contextual expertise as well as experience and internal crowds seem to be decidedly well-suited for solving RE-related tasks as they exhibit these exact traits. Following a design science research approach, we develop design principles for internal crowd-based RE and instantiate them in a public-sector organization leading to a holistic evaluation. Subsequently, we formulate recommendations for establishing crowd-based RE in intra-organizational settings.

Keywords: internal crowdsourcing, requirements engineering, crowd-based requirements engineering, design principles, design science research

9.1 Introduction

In recent years, open phenomena including open resources, open processes such as crowdsourcing and their opening effects have set in motion fundamental shifts in the way organizations conduct their business (Schlagwein et al., 2017). Moreover, with organizations increasingly recognizing the value of openness, represented by principles such as transparency, access, participation and democracy, crowdsourcing has established itself as a suitable mechanism for a variety of use-cases ranging from decision-making to idea generation, microtasking and problem-solving (Schlagwein et al., 2017; Prpic and Shukla, 2016). Crowdsourcing, the act of an organization outsourcing a task formerly performed by its employees to an undefined group of people via an open call (Howe, 2006), enables organizations to flexibly access a large workforce of individuals including its knowledge, creativity and experience (Blohm et al., 2013). Increasingly, organizations have begun to crowdsource to their own employees instead of an external crowd (Benbya and Leidner, 2016; Zuchowski et al., 2016). Internal crowdsourcing gives employees a voice and enables them to actively engage in debates and share their perceptions and ideas to improve current work practices (Zuchowski et al., 2016). This form of employee empowerment fosters competitiveness in organizations due to enhanced decision making capabilities and heightened innovativeness (Zhu et al., 2016).

However, studies analyzing various use-cases of internal crowdsourcing are still scarce and further research in this area is needed (Zhao and Zhu, 2014; Zuchowski et al., 2016). We propose that internal crowdsourcing mechanisms are particularly useful for software requirements engineering (RE) within organizations. As defining high-quality requirements requires contextual expertise and experience, internal crowds seem to be decidedly well-suited for the tasks the RE process entails as their members exhibit these exact traits (Zuchowski et al., 2016). Past research demonstrates the ability of crowdsourcing to tap into the collective intelligence of large, distributed, heterogeneous groups of individuals to engineer requirements for customer-centered information systems (Renzel et al., 2013; Johann and Maalej, 2015; Groen et al., 2017). Involving users in the RE process has a positive effect on requirements quality as well as user satisfaction and general system success (Zowghi et al., 2015). Crowd-based RE approaches attempt to alleviate shortcomings of traditional RE approaches such as a need for co-presence, selection bias as well as a lack of scalability due to their effort and time intensiveness and promise to involve large, heterogenous groups of stakeholders in the RE process (Sharma and Sureka, 2017). However, as with internal crowdsourcing in general, there is little design knowledge available for crowd-based RE concerning both internal and external crowds (Knop et al., 2017). Also, as of yet, most studies on crowd-based RE are focused on the integration of external crowds of users, and studies concerned with internal crowds remain scarce (Snijders et al., 2015). Moreover, studies in the context of crowd-based RE which integrate internal crowds do not extend their scope into the post-project phase of the software product lifecycle. The post-project phase does, however, represent an important crossroads when it comes to the long-term realization of benefits of software projects, an area in which organizations exhibit deficiencies (Markus, 2004; Semmann and Böhmann, 2015). With increasing openness and user empowerment (Rashid et al., 2008), research calls for improving traditional RE approaches to be able to elicit requirements for entire software ecosystems, spanning multiple organizations and covering several application domains (Villela et al., 2018). This lack of design knowledge and applications of internal crowdsourcing within organizations lead us to the following research question:

RQ: What are design principles for continuous internal crowd-based requirements engineering?

In this study, we therefore follow a design science research (DSR) approach to develop nascent design theory (Gregor and Hevner, 2013) in the form of design knowledge. We propose design principles for crowd-based RE approaches that are continuous, i.e. stretch into the post-project phase of software projects and integrate an internal crowd of employees. To demonstrate and evaluate our design principles, we develop a process and corresponding platform for continuous internal crowd-based RE within a public organization. We arrive at a socio-technical artifact embedded in a context-aware process which strikes a balance between transparency and participation enabled by applying internal crowdsourcing to the RE process and the limited organizational resources available for implementing these requirements.

The remainder of this paper is structured as follows. Following this introduction, we summarize related work on internal crowdsourcing and crowd-based RE (Section 2). Subsequently, the applied DSR approach and related methodology are presented (Section 3). We then define design principles for continuous internal crowd-based RE (Section 4) which we apply by developing design artifacts (Section 5). We evaluate these artifacts

(Section 6), derive recommendations for conducting continuous internal crowd-based RE and discuss the implications of our findings (Section 7). This paper concludes with a summary of its results, contribution and limitations (Section 8).

9.2 Related Work

9.2.1 Internal Crowdsourcing

The term crowdsourcing was first popularized by Howe (2006, p. 1) who defined it as "the act of a company or institution taking a function once performed by employees and crowdsourcing it to an undefined (and generally large) network of people in the form of an open call". Crowdsourcing can enable organizational value creation in a variety of areas (Durward et al., 2016), for instance generating new product ideas via crowd ideation (Leimeister et al., 2009; Ebner et al., 2008), financing these ideas via crowdfunding (Bretschneider et al., 2014) or evaluating them via crowd testing (Zogaj et al., 2014; Leicht et al., 2016). Increasingly, organizations have begun to crowdsource tasks to their own employees rather than an external crowd. This form of crowdsourcing – internal crowdsourcing – is defined as "an (a) IT-enabled (b) group activity based on an (c) open call for participation (d) in an enterprise" (Zuchowski et al., 2016, p. 168). Recent studies have investigated a variety of application domains for internal crowdsourcing such as internal crowdfunding (Muller et al., 2013; Feldmann and Gimpel, 2016), organizational learning (Schlagwein and Bjørn-Andersen, 2014; Zuchowski, 2016), employee engagement platforms (Semmann and Grotherr, 2017) and internal innovation platforms and competitions (Benbya and Leidner, 2016; Wagenknecht et al., 2017b; Hoeber et al., 2016). Internal crowdsourcing seems to be suited for solving a variety of problems which include accessing, integrating and improving internal knowledge (intelligence problems), communicating and developing new ideas (design problems) as well as making decisions and prioritization (decision problems) (Zuchowski et al., 2016).

Internal and external crowdsourcing are distinguishable through several characteristics that go beyond the composition of their respective crowds (employees as opposed to the general public). While in case of internal crowdsourcing the identities, formal relationships and abilities of members of the crowd are usually known, external crowds stay largely anonymous and the abilities of their members can only be assumed (Hetmank, 2014).

Consequently, internal crowds can be assigned and are able to perform complex, knowledge-intensive tasks and external crowds are often limited to performing predominantly simple tasks (Hetmank, 2014). In case of internal crowdsourcing, monetary incentives may not be viable due to corporate policy or difficulty in securing a dedicated budget and crowdsourcers need to leverage other incentive mechanisms such as increase in reputation, alignment of personal objectives with the objectives of the crowdsourcing initiative or goodwill and personal fun (Vukovic and Bartolini, 2010). In contrast to external crowdsourcing in which crowdsourcers may struggle to handle large amounts of user-contributed data (Blohm et al., 2013) and insecure intellectual property rights (Hetmank, 2014), internal crowdsourcing faces its own set of challenges. These include a smaller number of participants, a lack of time for participation besides the existing day-to-day workload and a hesitation to participate due to fear of being judged by colleagues or superiors (Malhotra et al., 2017). Anonymous participation or optional anonymity may serve to mitigate these negative effects (Semmann and Grotherr, 2017; Wagenknecht et al., 2017c). Furthermore, internal crowdsourcing initiatives face scrutiny from organizational governance and worker representation bodies due to legal and social implications. Malhotra et al. (2017) recommend granting dedicated slack time to employees to use for participation in internal crowdsourcing, possibly formalized via company directive, to mitigate these issues.

9.2.2 Crowdsourcing in Software Requirements Engineering

The IEEE (2017) defines the term requirement as either a "condition or capability needed by a user to solve a problem or achieve an objective" or a "condition or capability that must be met or possessed by a system […] to satisfy an agreement, standard, specification, or other formally imposed documents". Requirements engineering can be defined as "the subset of systems engineering concerned with discovering, developing, tracing, analyzing, qualifying, communicating and managing requirements that define the system at successive levels of abstraction" (Hull et al., 2011, p. 8). RE is a decisive success factor for software projects (Hofmann and Lehner, 2001). Traditional RE approaches employ techniques such as stakeholder interviews, joint workshops or focus groups to elicit stakeholder requirements (Wiegers and Beatty, 2013). These techniques share several shortcomings. Their need for co-presence of all participants makes them cost and time intensive. Consequently, they do not scale well to settings with a high number of stakeholders (Lim and Finkelstein, 2012). As only a selection of stakeholders can participate in these activities, geographically distributed, heterogeneous and diverse stakeholder groups can't be representatively integrated in the RE process (Law et al., 2012). Representative integration is further hindered by dominant participants and biased opinions or stakeholder selection (Fernandes et al., 2012). These shortcomings are also reflected in the tools supporting traditional RE approaches. These are targeted towards a small number of experts, not approachable for untrained users and offer limited collaboration support throughout the requirements development sub-activities (Lohmann et al., 2009).

Crowd-based RE approaches aim to address the aforementioned challenges of traditional RE approaches and to provide additional benefits of their own. Crowd-based RE comprises "automated or semiautomated approaches to gather and analyze information from a crowd to derive validated user requirements" (Groen et al., 2017, p. 1). The crowd in case of crowd-based RE consists of current or potential users of a particular software product who interact with each other or members of the organization responsible for developing the software product (Groen et al., 2017). Software users are empowered to influence the future development of the software they use (Rashid et al., 2008). Crowd-based RE approaches are able to integrate highly diverse groups of stakeholders with different "fields of interest, knowledge and experience" (Adepetu et al., 2012, p. 3), fostering creativity and ultimately leading to more relevant and meaningful requirements (Dalpiaz et al., 2017). As they do not require co-presence they tend to be less expensive and scale better for large stakeholder groups (Lim and Finkelstein, 2012). Both participatory and data-driven approaches to RE label themselves "crowd-based". In case of participatory crowd-based RE, members of the crowd actively suggest and jointly develop requirements through collaboration (Snijders et al., 2015). In case of data-driven crowd-based RE, passively collected software usage data and unidirectional feedback such as app store reviews are analyzed to extract requirements (Maalej et al., 2016). With crowd-based RE, RE can evolve into a process of ample interaction between users, developers and requirements analysts (Johann and Maalej, 2015), opening up the RE process through transparency, participation, accessibility and democratized decision making (Schlagwein et al., 2017).

9.3 Research Design

Our study followed the design science research methodology (DSRM) (Peffers et al., 2007). Figure 1 depicts the research activities we performed for each DSRM step as well as their outcomes. To ensure the practical relevance of this research project, it was conducted cooperatively with a public-sector organization that served as a source of issues and objectives as well as a proving ground for a real-world evaluation. The case organization is responsible for providing port management services for one of Europe's largest seaports. Its 1,800 employees perform tasks such as expansion and maintenance of marine and land infrastructure, property management, running a railway network and operating the harbor master's office. In this case organization, we focus on research on two internally used software products: an internally developed railway management system and the standard software Microsoft SharePoint. For the first two DSRM steps *problem formulation* and *objectives for a solution*, we conducted a structured literature review, an internet search and qualitative interviews. Our structured literature review on crowd-based RE contributed to both the clarification of our research problem and serves as the theoretical foundation for our objectives for a solution: design principles for continuous internal crowd-based RE. We conducted our literature review based on guidance by Webster and Watson (2002) and vom Brocke et al. (2009). As recommended by vom Brocke et al. (2015), we performed a full-text search in citation indexing services (Google Scholar, Web of Science) and bibliographic databases (ABI/INFORM Complete, ACM Digital Library, AISeL, Business Source Complete, IEEE Explore and Springer Link), filtering for peer-reviewed results where possible. After several search iterations, we identified the following search terms as being most productive (number of hits in parenthesis): "crowdsourcing AND 'requirements engineering'" (236), "crowd-based AND 'requirements engineering'" (108) and "social requirements engineering" (124). Other terms such as continuous, collaborative or participatory requirements engineering yielded no significant results. Backward and forward search revealed two more relevant papers (excluding duplicates). Criteria for inclusion in our literature review were that (1) crowdsourcing is employed in the RE process and (2) the particular RE process encompasses not only requirements elicitation but also their specification, negotiation or prioritization. Including backward and forward search results and after the exclusion of duplicates, we arrived at 19 relevant articles. The last iteration of this search took place in September of 2018. We employed iterative open coding (Flick, 2014) using the qualitative content analysis software MAXQDA to analyze the full-text of these references. The resulting literature concept matrix of 16 concepts (Webster and Watson, 2002) included activities, outcomes and roles in the specific crowd-based RE process implemented in the study, motivational and prioritization mechanisms, properties of the participating crowd, properties of the platform on which crowd-based RE takes place and other concepts.

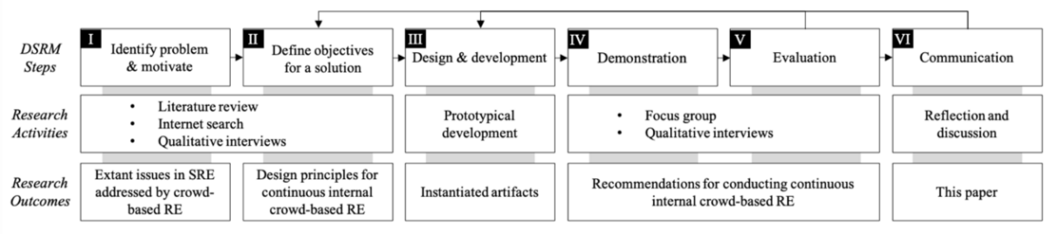

Figure 1. Research design (based on Peffers et al. (2007))

The internet search was focused on existing, real-world solutions for participative crowd-based RE. Relevant platforms exist under various labels and market themselves as customer feedback management software (e.g. UserVoice) or as idea management platforms (e.g. IdeaScale). Criteria for inclusion in our internet search were that (1) the platform is operated and moderated by an organization for a crowd of software users, (2) the platform elicits software improvement suggestions from users and (3) users can discover and interact with suggestions of other users. Consequently, mere ticketing or unidirectional feedback systems were excluded from the search. We uncovered a total of 12 relevant offerings which we subsequently analyzed for their functionality, resulting in a matrix listing general platform mechanics (e.g. commenting, filtering, voting) and specific RE features (e.g. roadmaps, portfolios or requirement merging and splitting). The findings of this internet search contributed to both the definition of our design principles and the development of our artifacts. We further conducted 8 semi-structured interviews based on recommendations by Myers and Newman (2007) with employees of the case organization to discover issues with their RE process and to elicit their requirements for continuous internal crowd-based RE. The interviews lasted 45 to 90 minutes and included three individuals with roles similar to a software product owner, three members of the internal IT consulting department and the case company's head of RE. Interview recordings were subsequently transcribed and analyzed using qualitative content analysis (Schreier, 2014) using the software MAXQDA and resulted in a coding scheme of 22 codes pertaining to the concepts in our literature concept matrix, the specific RE process in our case organization as well as its shortcomings an potentials for crowd-based RE.

Based on the findings of our literature review, internet search and qualitative interviews, we formulate design principles for continuous internal crowd-based RE. To ensure consistency and precision of our design principles, we apply the template for formulating design principles proposed by Chandra et al. (2015). Design principles pursue the goal of informing designers on how to effectively design artifacts of a certain type (Niehaves and Ortbach, 2016). Consequently, the evaluation of design principles must be concerned with an assessment of their suitability for being instantiated into concrete artifacts and the ability of these artifacts “to proffer the action described by the design principle” (Chandra et al., 2015, p. 4046). In the *design and development* step, we therefore apply our design principles to develop a prototypical platform and corresponding process for continuous internal crowd-based RE. We subsequently *demonstrate* and *evaluate* these prototypical artifacts in a focus group interview (Krueger and Casey, 2014) with 5 participants and three additional qualitative interviews with a total of 4 participants. For our evaluation, based on the framework for evaluation in design science research proposed by Venable et al. (2016), we draw upon the same participants as with our initial set of interviews. Both the focus group interview and the qualitative interviews represent artificial evaluation episodes (Venable et al., 2012), consisting of a presentation of our prototypical artifacts and a hands-on session where participants assess the artifacts in real-time. Based on evaluation criteria proposed by Prat et al. (2015), we aim at assessing both the instantiated artifacts and the underlying design principles. Our interview guide was structured based on our developed design principles and design elements of our artifacts. The focus group interview as well as the individual qualitative interviews were again transcribed and subsequently coded according to elements of our developed artifacts and our design principles. This leads us to make recommendations for establishing the internal crowd-based RE approach within organizations.

9.4 Design Principles for Continuous Internal Crowd-based Requirements Engineering

Based on our literature review, internet search and qualitative interviews, we define eight design principles for continuous internal crowd-based RE (Table 1).

Table 1. Design principles for continuous internal crowd-based requirements engineering

DP1	Provide functionality for submitting and retrieving software requirements for users to be able to communicate their own needs and understand the needs of other users.
DP2	Provide collaboration tools for users and product owners to be able to jointly specify software requirements.
DP3	Provide functionality for tracking the status of a requirement throughout its lifecycle for users to be able to transparently trace the progress of submitted requirements.
DP4	Provide decision support tools for product owners to be able to identify requirements with maximum impact on user satisfaction given that implementation resources are limited.
DP5	Provide a prioritization system in order for users to rank individual requirements.
DP6	Provide functionality to communicate the implementation effort associated with a requirement in order for user expectations to be managed.
DP7	Provide quality assurance mechanisms to reduce product owner effort.
DP8	Provide a structured process that spans the entire software product lifecycle in order to steer user and product owner activity and to bring about actionable outcomes.

Traditional RE approaches lack the ability to involve large numbers of users, especially if they are geographically distributed (Groen et al., 2017). Further, the involvement of stakeholders in traditional RE approaches is often selective and may exclude key stakeholders such as current software users (Snijders et al., 2015). This results in a lack of representativeness in the elicited requirements. An approach for internal crowd-based RE should alleviate these drawbacks and offer a standardized channel for all users of a software to participate in the RE process without requiring their co-presence. Each user should therefore be able to communicate his or her needs by submitting software requirements (**DP1**). This corresponds to the RE activity of requirements elicitation, i.e. the identification of individual stakeholders' requirements (Wiegers and Beatty, 2013). Once requirements are elicited from stakeholders, they need to be specified, i.e. defined in written form. While in traditional RE approaches, specification would be the responsibility of requirements analysts and a select number of stakeholders (Wiegers and Beatty, 2013), crowd-based RE enables all software users to discuss, refine and clarify requirements collaboratively.

Software users express their particular needs and work on their realization with a community of other users (Renzel et al., 2013). Software users are afforded "social spaces" (Law et al., 2012, p. 206) to meet and jointly specify requirements. Efficient collaboration among stakeholders is also shown to lead to higher requirement quality and accuracy (Dalpiaz et al., 2017; Unkelos-Shpigel and Hadar, 2015). Therefore, an approach for continuous internal crowd-based RE should provide users and product owners with the tools necessary to undertake this collaborative specification (**DP2**). In this context, the term product owner corresponds to the instance inside an organization responsible for determining a software product's future development. Although traditional RE approaches are concerned with transparency relating to requirement traceability and documentation, this information is ordinarily only available to IT or RE professionals and not to software users (Rashid et al., 2008). Consequently, software users lack the ability to track the status of requirements post submission. Transparent handling of user submissions may, however, positively affect motivation of software users during requirements elicitation (Rashid et al., 2008) and may also support the management of user expectations. An approach for continuous internal crowd-based RE should therefore offer software users the ability to transparently trace their submitted requirements (**DP3**).

As a product owner's resources for improving a software and developing new features are limited, it is impossible to implement all requirements a software product's users may have. As a crowd of software users may be able to propose large numbers of valuable ideas, selecting the right ones for implementation represents a significant challenge (Merz, 2018). Presented with different options, the product owner must decide which requirements may yield the highest increase in user satisfaction if implemented (Groen et al., 2017). An approach for continuous internal crowd-based RE should offer decision support tools that enable product owners to make the best possible implementation decision (**DP4**). A product owner may consider criteria such as the business value if implemented or business penalty if not implemented, implementation cost and associated risks (Dalpiaz et al., 2017) as well as strategy fit and dependencies between requirements (Daneva et al., 2013) when making an implementation decision. Crowd-based RE aims at augmenting this implementation decision with a direct, representative, user-based prioritization (Groen et al., 2017). An approach to continuous internal crowd-based RE should therefore implement user-based prioritization (**DP5**). This corresponds to the RE activity of negotiation, i.e. the definition of implementation priorities within a set of requirements

(Wiegers and Beatty, 2013). To support users in making their prioritization, it may be constructive to help them understand the implementation effort associated with the requirements they propose. An untrained user may not be able to correctly assess the implementation effort of his or her proposed requirement. However, grasping the implementation effort of one's own requirements and those of other users may contribute to the management of user expectations. Without awareness about an organization's limited implementation resources, a user-based prioritization could raise expectations that the company might not be able or willing to meet (Snijders et al., 2014). However, if a user recognizes that many high-effort requirements have been proposed, he or she may better understand that it is not possible for the product owner to implement all of them. An approach for continuous internal crowd-based RE therefore needs to communicate a requirement's implementation effort to software users (**DP6**). Furthermore, software users with no training in RE specification cannot be expected to submit high-quality and fully specified requirements on an open platform without any assistance. While requirement quality may improve through collaborative specification and with support of product owners, at least initially there is a danger of low-quality requirements being submitted. As users of a particular software are likely to have similar needs, large numbers of duplicate requirements can be expected if no preventive measures are taken. Crowd-based RE approaches are efficient in discovering and preventing redundant requirements, contributing to quality assurance (Ninaus et al., 2014). We therefore define the implementation of quality assurance mechanisms with the goal of reducing product owner effort as a design principle (**DP7**).

Groen et al. (2017) identify a lack of continuity in current RE approaches and call for the continuous collection of feedback from a group of heterogenous stakeholders. As the work practices and work context of members of an organization are subject to constant change, the software they use to perform their work has to keep up by continuously evolving and adapting (Law et al., 2012). If an organization fails to continuously improve a software product after its implementation, the realization of its envisioned benefits is at risk (Semmann and Böhmann, 2015). We therefore define a process that extends into the post-project phase of a software product's lifecycle as a design principle for continuous internal crowd-based RE (**DP8**). This process should provide some form of structure to the approach in form of a breakdown of steps that have to be performed, time limits for each step and pursued intermediary and end results. Without this structure, the process may lack momentum which could ultimately result in a lack of participation and actionable results.

9.5 CrowdCore Process and Platform

We apply the design principles to develop a process and platform for **Crowd**-based **Co**ntinuous Internal **R**equirements **E**ngineering (*CrowdCore*). The overall objective of these artifacts is to ensure long-term realization of a software product's intended benefits post-implementation. It does so via elicitation and collaborative specification of requirements directly from software users and by support software product owners in selecting those requirements which promise maximum impact on user satisfaction. The *CrowdCore process* (DP8) consists of four distinct, deadline-bound phases that are grounded in open innovation and crowdsourcing practice (Wagenknecht et al., 2017a): ideation, consolidation, voting and decision (Figure 2). Two roles are active in this process: users of a software product and a product owner, the role responsible for determining the future development of that software product. We model this role according to the product owner in agile software development whose key responsibilities include maximizing the value delivered by the development team to the organization, management and prioritization of the product backlog and communicating with all stakeholder groups (Cohn, 2005). Throughout all four phases, interaction takes place between software users, the product owner, and requirements submitted by software users. Letting users interact freely on an open platform necessitates some form of oversight and guidance (Lohmann et al., 2009) which in case of CrowdCore falls under the responsibilities of the product owner. In his capacity as a facilitator, the product owner motivates members of the crowd to interact and participate by providing incentives such as praise and encouragement (Leimeister et al., 2006), by managing expectations and by advising software users in the specification of requirements. Feedbacking crowdsourcing participants on their submissions is an important quality control mechanism (Tavanapour and Bittner, 2018). The *ideation phase* represents the entry point to the CrowdCore process cycle, in which software users can submit their requirements (DP1). Further, it affords software users time to discover and interact with the submissions of other users with the goal of collaborative requirements specification (DP2).

The consolidation phase allows a product owner to determine which requirements he or she wants to let proceed into the voting phase. Requirements which at this point in the CrowdCore cycle do not comply with quality criteria such as feasibility, correctness, uniqueness, verifiability, clarity or consistency (Hull et al., 2011), should be closed with appropriate and transparent feedback in form of a status update (DP3). A product owner may also want to merge overlapping requirements into one or split large requirements into multiple ones. During the voting phase, users prioritize the remaining requirements (DP5). For our employed prioritization mechanism, we draw on enterprise crowdfunding mechanisms (Feldmann et al., 2014). At the beginning of the voting phase, each user receives a budget of votes on a per-software basis that he can distribute to requirements. This vote budget can be adjusted by a software's product owner. Users can spend any number of votes on a single requirement but voting negatively, i.e. reducing the net amount of votes a requirement possesses, is not possible. However, votes that have been spent can be taken back as long as the voting phase is active. Voting for one's own requirements is not possible and voters remain anonymous. We choose this voting system for a number of reasons: first, it allows users to grade their degree of support by spending more than one vote on a single requirement. Being able to customize the vote budget in each CrowdCore process cycle allows product owners to assign a vote budget to users of a software that is smaller than the number of proposed requirements. Such a scarce vote budget suggests to software users that implementation resources are not unlimited and forces them to make a prioritization decision.

In the *decision phase*, a final set of prioritized requirements is selected by the product owner. This set of requirements should present those requirements which promise a maximum impact on user satisfaction (DP4). While the consolidation phase was focused on filtering out requirements which do not meet quality criteria, the decision phase is focused on selecting requirements based on the value they provide for software users. The prioritization made by software users during the voting phase plays an important role in this decisions, but a product owner will also want to consider other prioritization criteria such as the strategic fit and business value of a requirement as well as dependencies and risks associated with a requirement (Daneva et al., 2013) in his or her decision. Each requirement receives individual feedback concerning the reasoning behind the product owner decision (DP3). The last phase of the CrowdCore process results in a set of prioritized requirements. These requirements can then be introduced into the software development process of the software product in question. As a result of the flexibly adaptable CrowdCore process cycle duration, the CrowdCore process can be adapted to match both agile software development approaches such as SCRUM which are able to manage a high cadence of requirements input and more traditional approaches with infrequent large-scale releases. Subsequently, the CrowdCore process starts anew by transitioning into the ideation phase. Requirements which did not get selected for implementation can still be accessed on the CrowdCore platform and may be reintroduced during the next CrowdCore process cycle. Phase-changes are initiated at fixed deadlines defined by the product owner. The ideation phase is afforded the longest amount of time to ensure all software users get the opportunity to voice their opinion and to allow sufficient time for interaction with and collaborative specification of requirements. The consolidation and decision phases are short to keep product owners from dragging out decisions and to keep the entire process cycle from stalling. Based on an analysis of the software development and release process in our case organization, we assume four twelve-week CrowdCore process cycles per year with the ideation phase taking 8 weeks, voting 2 weeks and consolidation and decision one week each. This duration should only be considered a default which can and should be adapted to the specific context in which the CrowdCore process is applied.

The *CrowdCore platform* is implemented as a single-page web application and was developed using the web development framework Django which allows for rapid software prototyping. The platform initially presents users with an overview of all requirements that have been submitted during the ideation phase and their associated meta-information such as title, author, date of creation and tags. In our exemplary screenshot (Figure 2), the CrowdCore platform is used to develop requirements for the software product Microsoft SharePoint 2016. Requirements can be submitted to the platform by entering an initial specification and assigning tags (DP1). A prefilled submission template provides guidance to users submitting a requirement. Users on the CrowdCore platform are labeled with their real name and possess a profile page which displays their individual activities on the platform, statistics on how many votes they have received for their proposed ideas and their competencies. For some users, being able to demonstrate their competency in a certain field can be an important motivator and predictor of quality of submitted ideas (Bretschneider et al., 2012).

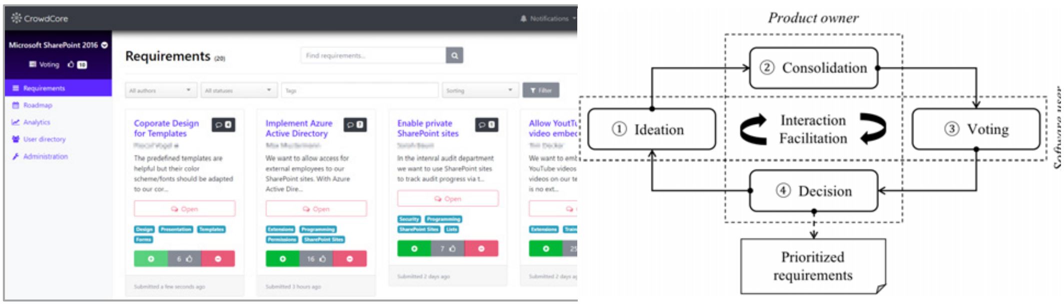

Figure 2. CrowdCore platform in use for the software product Microsoft SharePoint (voting phase, sample data) and CrowdCore process

The submission entails a self-assessment test (Figure 3) consisting of five questions that compel users to reflect on their requirement before submission with the goal of ensuring requirement quality and reducing product owner effort (DP7). Similar to the criteria used by the product owner for assessment in the consolidation phase, the assessment uses quality criteria such as feasibility or verifiability. The questions are formulated as to be comprehensible to software users without RE knowledge and are answered on a simple three-point Likert-type rating scale (Lehmann and Hulbert, 1972) of 'Agree', 'Unsure' and 'Disagree' to allow for a neutral answer. Each question answered as 'Agree' increases the test score by one while each question answered as 'Don't agree' decreases the test score by one. Questions answered 'Unsure' have no effect on the test score. If the test score is higher than or equal to three, a message of encouragement is shown to the user, inviting him to submit his requirement. A score below zero advises the user to refrain from submitting his requirement and seek support while a score from zero to two produces a warning message, asking the user to carefully review his requirement before submitting it. With just five questions and instant feedback, the optional test is kept simple and as lightweight as possible. Requirements can be discovered on the CrowdCore platform in a number of ways (DP1). Aside from browsing the paged list of submitted requirements, users can perform a full-text search on requirement specifications and metadata. Further, filtering and sorting via tags, author and implementation status are supported. Users can also subscribe to requirements and receive notifications for any new votes, discussion entries or status changes and share requirements via email. Each requirement's detail view consists of the requirements specification, metadata and a discussion system which is the primary tool for collaboration on the platform (DP2). The discussion system allows software users to weigh pros and cons of an individual requirement, express support or disapproval and to contribute additional specification information. Individual discussions are structured into threads which keeps complexity at an acceptable level even in case of multiple parallel conversations concerning the same requirement. Product owners can provide a public effort estimate for a requirement to give software users a rough assessment of the effort associated with its implementation. This effort estimation uses a simple three-point scale of low, medium and high and a complementary textual description to communicate implementation effort (DP6).

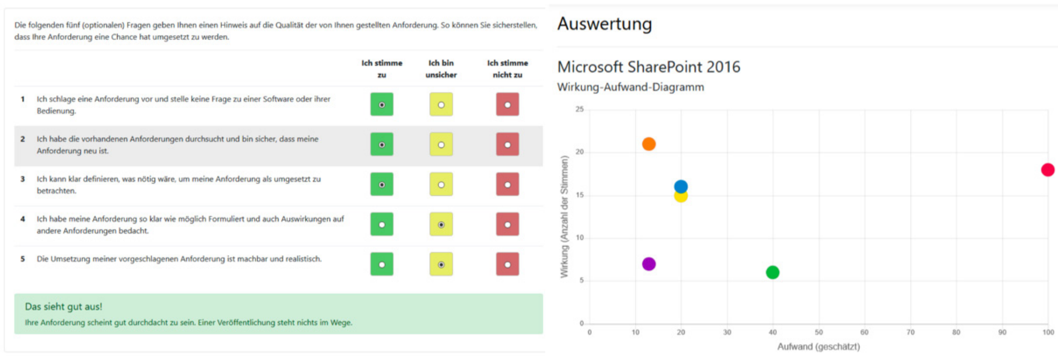

Figure 3. CrowdCore platform user self-assessment and impact effort matrix

The CrowdCore platform uses a status system consisting of the five statuses 'Open', 'Backlog', 'In progress', 'Implemented' and 'Closed' to transparently communicate the implementation status of a requirement to software users (DP3). Statuses are set by product owners and must be accompanied by a status update message describing the reasoning behind the status change. They are visible on the overview screen and each requirement's individual detail view. Users can also access a simple software roadmap that displays requirements with the status 'Open', 'In progress' and 'Implemented' for a software product. We do not choose a more precise time scale for the roadmap (e.g. Release 2 or Q2 2018) as product owners may be reluctant to make such binding commitments. Fuzzy categories such as 'In progress' do not require a discouraging degree of commitment from product owners. Further, the software roadmap displays the public effort estimation for each requirement. Besides being a planning and decision-making tool, a product roadmap can also serve as an outward-facing communication channel, intended to let software users know which features to expect in the future and when, contributing to expectation management (DP6). At the same time, the roadmap ensures commitment from product owners, as each implementation decision is transparently communicated to all software users. The CrowdCore platform offers decision support in the form of dynamically generated impact and effort matrices that can be accessed by the product owner (DP4). An impact and effort matrix maps potential projects or products by the effort required to implement them and their expected impact (Gray et al., 2010). In case of CrowdCore, these matrices display the votes a requirement has received during the voting phase as well as the effort necessary for its implementation (Figure 3). This effort estimation used for generating impact and effort matrices is not visible to software users and is based on an assessment by the product owner on the planning poker scale (Cohn, 2005). Based on this assessment, the product owner can identify those requirements which promise the highest impact by selecting those with a high number of votes in relation to their estimated effort (DP4). Evaluating requirements using the impact and effort matrices can assist in prioritization and serve as an input for roadmap planning (DP3).

9.6 Evaluation of CrowdCore Process and Platform

In this section, we present a selection of the most meaningful insights regarding the effectiveness of our developed artifacts and underlying design principles gained during our evaluation. As a general conclusion from the evaluation with experts from our case organization, participants seem to consider our approach a suitable tool for representatively involving and empowering software users in the RE process. Our case company's head of RE summarized: "Generally, it is well-suited to integrate users. And to not only give them the feeling but also to visualize that their opinion matters". Evaluation participants stated that status updates and corresponding notifications as well as the simple product roadmap represent a suitable tool for informing software users of the status of their submissions (DP3). A product owner described: "A lack of transparency is a central topic in IT. We often hear: 'Why don't we get any feedback, why aren't we notified of anything?' With this we would have a good way of providing transparency". Product owners appreciated the decision support (DP4) provided by impact and effort matrices, one stating that "for the product owner it is not only a decision support, but it opens up an information source he would otherwise not have". Further, product owners approved of the vote budget distributed to software users (DP5) on a per-software basis which allows them to roughly scale the vote budget to their available implementation resources with the abstraction layer of votes shielding them from having to precisely disclose their monetary budget. Evaluation participants did, however, question if internal crowd-based RE can be applied for all types of software products: "The software does by itself have to be somehow customizable in a way that when a requirement is defined, or a proposal made, that these things can be realistically implemented". If an organization collects a large number of requirements for a software from its users but is unable to implement these requirements in a timely manner, there might be severe backlash from software users, ultimately resulting in a decrease in crowd participation. Financing the implementation of requirements developed via crowd-based RE was subject to discussion during evaluation. After a software is successfully implemented in the case organization, there is usually no dedicated budget available for the implementation of new features. Even if a customer, such as a department inside the organization, would be willing to pay for new features, capacity for developing such features inside the IT department is limited.

A product owner for a software product accessible by all members of the case organization expressed that he strongly believed the capabilities of the crowd of software users would be an important predictor for the success of internal crowd-based RE: "You need a certain suitability and competence of the crowd". He further stated that while it is to be expected that untrained software users will not produce high quality requirements on their own, this would not constitute a "deal-breaker". An organization should rather "empower people and give them an understanding of requirements" to achieve crowd-based RE's intended result. The case organization's head of RE described internal crowd-based RE as a "double-edged sword". He expects that the establishment of internal crowd-based RE would necessitate an initial investment in terms of technology, personnel, training and internal communication as well as a warm-up phase until first actionable outcomes are produced. Yet, a representative source of information on user needs, the potential to discover synergies between requirements and the elimination of duplicates are desirable benefits from a RE perspective. In his opinion, the success of internal crowd-based RE is strongly dependent on software users trusting product owners to commit to implementing the user-prioritized requirements. Consequently, he deems it essential to define a well-structured process with defined outcomes and deadlines (DP8) that is complied with by software users and product owners alike. The evaluation demonstrates that our CrowdCore artifacts seem to be able to effectively and representatively integrate software users in the requirements engineering process via elicitation and collaborative specification of software requirements. Product owners are empowered to select the most promising requirements for implementation. While these results also point towards potential improvements of a software product's benefit realization post-implementation, a naturalistic long-term evaluation is be necessary to confirm such an effect.

9.7 Discussion

9.7.1 Recommendations for conducting continuous internal crowd-based RE

Based on the feedback collected during our focus group interview and individual interviews, we formulate recommendations for conducting crowd-based RE in an intra-organizational setting. Continuous internal crowd-based RE is not a suitable approach for collecting requirements for every type of software product. As a precondition for implementing such an approach, it is therefore necessary to **assess a software's suitability**. As one of the goals of crowd-based RE is to involve large numbers of geographically distributed users in the RE process (Lim and Finkelstein, 2012), software products with small and geographically concentrated user bases are less suited. Further, in case of standard software developed by a third party, granting users the opportunity to communicate their needs will inevitably result in disappointment as the organization has no way of following up on requirements. Software that is suitable consequently includes software that is developed by the organization itself (or by a third party on behalf of the organization) as well as extendable or customizable software. Similarly, organizational demand and readiness for a crowd-based RE approach are needed. Our case organization showed openness towards embracing our proposed crowd-based RE approach because it fits in with an ongoing overall paradigm shift affecting the entire organization. As one evaluation participant explained: "We are in the middle of this cultural change. The [case organization] came from 'no one is allowed to say anything' to 'everyone can say something'. And right now we are working on integrating this participation or this dialogue process." Our evaluation further demonstrated that software users may struggle to differentiate between software requirements and question and answer (Q&A) type topics related to software errors or usage instructions. As the publication and discussion of Q&A type topics would divert user attention from requirement submission and specification and cause significant product owner effort, organizations need to strictly **enforce content**

delineation between requirements and other types of submissions through preventive communication and moderation. Organizations need to **provide adequate resources** to execute crowd-based RE and implement its outcomes. Personnel resources for facilitation by the product owner are necessary to execute crowd-based RE. Depending on the specific organizational context, software users need to be granted dedicated time during which they can participate in crowd-RE, possibly formalized via a company directive (Malhotra et al., 2017). Implementing requirements elicited through crowd-based RE necessitates securing a dedicated budget. In case of the hitherto dominating use-case of crowd-based RE, software companies collecting feedback from external customers, budgets for developing new features could always be assumed to be readily available. However, especially in case of internally used software, development budgets are often constrained or mainly allotted for maintenance and security fixes. As previous research demonstrates, it is particularly difficult to secure budgets for software improvement post-implementation (Semmann and Böhmann, 2015; Markus, 2004; Wagner and Newell, 2007). Transferring crowd-based RE into intra-organizational settings therefore requires organizations to secure budgets for implementing outcomes of crowd-based RE.

A frictionless integration of crowd-based RE into an organizational context requires organizations to **establish organizational interfaces**. If implemented, crowd-based RE is likely to take over some of the responsibilities formerly held by a different unit or role inside an organization. To avoid confusion and conflicting responsibilities, interfaces in form of intra-organizational agreements need to be defined, an observation in line with previous research (Grotherr et al., 2018a). In our case company, the service desk represented – for lack of other options – the primary channel for users to submit software requirements which were then forwarded to the IT or requirements management department. Establishing crowd-based RE would shift that responsibility away from the service desk. One evaluation participant explained: "If you really want to introduce this into [organizational] culture, I would define clear rules concerning expectations towards [the service desk]. And then I would explicitly take receiving improvement suggestions out of the scope of work [of the service desk] and point towards the platform instead". Consequently, the service desk needs to be instructed on how to handle incoming requirements in the future, likely by agreeing that the service desk should refer users to the crowd-based RE platform. Furthermore, if tightly integrated with internal IT via mechanisms such as single-sign-on, internal crowdsourcing initiatives benefit from lower entry barriers (Rohrbeck et al., 2015).

9.7.2 Implications

Based on our application of internal crowdsourcing for RE in an intra-organizational setting, we were able to develop important design knowledge. Internal crowdsourcing has the ability to address a number of problem types, including intelligence, design and decision problems (Zuchowski et al., 2016). While some applications of internal crowdsourcing leverage the ability to solve one of these problem types, applying internal crowdsourcing to RE necessitated solving all three problem types. CrowdCore's ideation phase is aimed at solving both a design and an intelligence problem. Eliciting new requirements can be considered a design problem as users present novel ideas in an enterprise-wide brainstorming while the collaborative specification of these proposed requirements represents an intelligence problem, accessing and integrating a pool of internal knowledge. The voting phase represents a decision problem as in this phase users select the requirements of their preference for implementation through voting. Therefore, our research demonstrates that while crowdsourcing mechanics can be scaled up to serve as the prime design element of an IT artifact, e.g. crowdfunding in the case of Kickstarter, it is also possible to flexibly adapt and implement these individual mechanics as building blocks for artifacts with a diverging overall objective. In our case, CrowdCore's voting system represents a building block influenced by internal crowdfunding mechanisms (Feldmann et al., 2014; Muller et al., 2013). Each software user is assigned a vote budget per software product and can subsequently spend these votes on requirements to show their support in the voting phase of the CrowdCore process. However, the CrowdCore process puts a stronger emphasis on collaborative development of an idea before it is put up for funding as compared to the crowdfunding process, as proposed for example by Beaulieu et al. (2015). In fact, the ideation phase of the CrowdCore process in which software users collaboratively specify requirements, is granted the highest amount of time during a process cycle out of all phases. As opposed to CrowdCore, crowdfunding also features a publicly visible funding goal that once it is reached implies that all necessary resources for implementing an idea have been collected. Furthermore, CrowdCore does not offer tangible rewards to software users who vote for a requirement. However, both approaches value transparency, in case of crowdfunding via regular updates during and after a crowdfunding campaign and in case of CrowdCore via status updates and a public roadmap. In public crowdfunding campaigns, this need for transparency likely arises from the fact that individuals spend their own money to fund ideas. In case of internal crowdfunding where each employee receives “virtual” spending money, this effect may be less pronounced (Muller et al., 2013).

As information systems are multilevel in nature (Bélanger et al., 2014; Grotherr et al., 2018b), our proposed recommendations highlight the importance of an ensemble view of technology, one of the information systems artifact being embedded in a constantly evolving social and environmental context (Orlikowski and Iacono, 2001). While an information systems artifact may possess each capability its designer envisioned, it is of equal importance to consider training, support services, organizational arrangements and policies as well as incentives to enable its continued effective management and use (Orlikowski and Iacono, 2001). For instance, while the commercial platforms discovered during our internet search can be a source of inspiration for the IT-enabled platform, these offerings do not bring along a process with predefined roles, activities or outcomes. Without such a process, these platforms represent tools which fulfill an envisioned purpose but do not consider the organizational needs they will be embedded in. Not assuming this holistic perspective and focusing on the design of the artifact itself and not its surroundings may result in artifacts that are hard to integrate in a social context.

9.8 Conclusion

In this study, we followed a DSR approach to develop design principles for continuous internal crowd-based RE. We ground these design principles in existing literature on internal crowdsourcing as well as crowd-based RE and draw on qualitative data collected from a public-sector case organization. We present eight design principles and apply them by developing a process and platform for continuous internal crowd-based RE. Issues discovered in our evaluation of the developed artifacts enable us to make recommendations for conducting internal crowd-based RE. This paper contributes to the field of internal crowdsourcing by developing design principles for one of its application areas: improving an organization’s approach to RE. We further contribute to knowledge on crowd-based RE by proposing design principles that focus on intra-organizational settings and extend into the post-project phase of the software product lifecycle. We offer valuable insights to practitioners seeking to leverage crowdsourcing to continuously improve the software used inside their organization, especially in the post-project phase. Our recommendations address important preconditions and implementation considerations for continuous internal crowd-based RE. In their entirety, our proposed design principles and developed artifacts demonstrate how internal crowdsourcing enables a new form of open requirements engineering; one establishing transparency concerning effort, support among peers and status of a requirement, equal access to the RE process for all software users, participatory specification of requirements and their democratic prioritization. Our study is faced with several limitations. Although our research is rigorously grounded in the extant literature on internal crowdsourcing and crowd-based RE, our empirical data is limited to qualitative interviews within a single case organization. And while we did evaluate our design principles and the effectiveness of our artifacts via a focus group and qualitative interviews, a naturalistic long-term evaluation is necessary in order to substantiate the effectiveness of our work.

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10 Healthy, Active and Connected: Towards Designing an Age-Friendly Digital Neighborhood Platform

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Abstract

Due to declining fertility rates and rising life expectancy, the world's population is ageing at an unprecedented pace. This demographic change is expected to exert pressure on social security as well as healthcare systems and poses the risk of social exclusion of the elderly. As urban areas are home to the majority of the global elderly population, they are disproportionately affected by this development. Cities have begun responding with strategies ranging from policy and regulation reform to investments in innovative healthcare technologies with the goal of becoming "age-friendly". Enabling the elderly to live a socially active, healthy and self-determined lifestyle past retirement are among the prime objectives for alleviating the challenges of an ageing society. With increasing urbanization, human, technological and infrastructural resources of urban contexts or neighborhoods have presented themselves as important determinants of elderly well-being. We propose that an age-friendly digital neighborhood platform can activate and leverage these resources to the benefit of the elderly population, contributing to the mitigation of the challenges of an ageing society. Following a design science research approach, we develop design principles for such an age-friendly digital neighborhood platform and evaluate a prototypical instantiation in two case neighborhoods in a German metropolitan area.

Keywords: digital neighborhood platforms, neighborhood social networks, age-friendly design, design principles, design science research

10.1 Introduction

The world's population is ageing. In 2017, the global population aged 60 years or older amounted to 962 million and is expected to double again by 2050 (Leeson, 2018). Already, the world's current population is the oldest it has ever been (UN, 2017). With more and more people leading longer lives, the age structure of countries in the rich developed world is undergoing a shift – from pyramids to columns – with the ratio of people above retirement age to those of working age rising, necessitating pension system reform (Turner, 2009). Besides putting increasing pressure on health and social security systems, population ageing brings about various cultural, economic, social and medical challenges (Sander et al., 2015). As people aged 70 or older spend around 80% of their time in their home or their immediate environment, their neighborhood plays an important role in determining their well-being (Wahl et al., 2012). In this regard, social isolation and loneliness, established as being comparable to risk factors for mortality such as obesity, alcohol consumption and smoking (Holt-Lunstad et al., 2010; Coyle and Dugan, 2012), are particularly common among older adults and negatively impact other health-related behaviors such as inactiveness and smoking (Shankar et al., 2011). Population ageing is more prevalent in urban than in rural areas, leading to high concentrations of the elderly in urban agglomerations (UN, 2017; EU, 2017). Therefore, cities see themselves as on the forefront of meeting the challenges of an ageing society and are increasingly implementing solutions such as neighborhood management services or innovative healthcare technology for ensuring a high quality of life for an increasing elderly population with the goal of becoming "age-friendly" cities (Buffel et al., 2012). According to Plouffe and Kalache (2010), age-friendly cities are characterized by features such as inclusiveness, service proximity, security and accessibility. Neighborhoods are rife with public and private actors, resources and infrastructure (Meyer-Blankart et al., 2013). For the elderly, being able to access these features has a significant influence on shaping the experience of inclusion and exclusion (Buffel et al., 2013).

In an ageing society, information technology such as ambient assisted living, wearable devices and telemedicine can help ensure that the elderly enjoy a self-determined and self-sufficient lifestyle (Koch, 2010) and using information technology and the internet has been shown to positively influence elderly social well-being (Hasan and Linger, 2016; Chopik, 2016). Usage of online social networks (OSNs) is rising among the elderly (Pew Research

Center, 2018; Anderson and Perrin, 2018). OSNs can potentially support the elderly in overcoming loneliness, enhance feelings of self-efficacy and offer the opportunity for receiving and provisioning social support (Leist, 2013). Despite the organic formation of local social networks being evident on established OSNs in the form of groups or sub-communities (Ilena et al., 2011), research on community or neighborhood-level social networks is scarce. When implemented, neighborhood social networks can serve as a natural bridge between digital and local connectivity (Hampton, 2007). Meanwhile, commercial neighborhood social networks such as Nextdoor or nebenan.de are attracting large amounts of users who perceive them as more personal, private and relevant as opposed to public OSNs such as Facebook (López et al., 2015). However, existing OSNs do not consider the needs of elderly users and there is a lack of design knowledge for designing artifacts in the context of OSNs for the elderly (Boll et al., 2017; Goswami et al., 2010; Keijzer-Broers et al., 2014). As the elderly dislike the lack of privacy and the triviality of public exchanges on public OSNs, private communities could allow for more intimate and meaningful social interaction (Harley et al., 2014). This leads us to the following research question:

RQ: What are design principles for an age-friendly digital neighborhood platform?

In this research project, we propose that an age-friendly digital neighborhood platform can contribute towards mitigating the challenges of an ageing society. With this digital platform, we aim to go beyond a mere online social network. Akin to the concepts of resource liquefaction and resource density (Lusch and Nambisan, 2015), we aim to use our digital platform to make the available actors and resources of a neighborhood such as its inhabitants, institutions and service providers, available and accessible in an age-friendly manner. As an intermediary, our platform provides the preconditions for self-organization (Hamari et al., 2016) of these actors. Therefore, we consider the term *platform* as more descriptive in the context of our design principles and instantiated artifact. Based on recommendations by Gregor and Hevner (2013), we structure the remainder of this paper as follows. In Section 2 we outline related work on the relationship of the elderly towards OSNs and neighborhood social networks. In Section 3 we present our research approach including completed and planned activities. Our initial design principles as well as their instantiation as a website and mobile application are presented in Section 4. First results of our evaluation in two case neighborhoods are presented in Section 5. We conclude with a summary and expected contribution of our research project.

10.2 Related Work

10.2.1 Online Social Networks and the Elderly

The term elderly is somewhat ambiguous, often used synonymously with other terms such as seniors, senior citizens or older people (Rockmann et al., 2018) and varies widely between different viewpoints such as biology, employment and retirement, demography or sociology (Encyclopedia Britannica, 2018). An age of 65 and above is considered a widely accepted definition for the term elderly, as this age coincides with the occupational retirement age in most developed countries (WHO, 2015). The post-retirement age is characterized by significant changes concerning factors such as one's social network, income and daily life in general which in turn may have effects on health (Coe and Zamarro, 2011; Behncke, 2012) and is therefore chosen as a working definition in this research project. Online social networks, "web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system" (boyd and Ellison, 2007), are becoming increasingly popular among the elderly (Anderson and Perrin, 2018). In the United States, 41% of people aged 65 years or more use Facebook, representing 4% of Facebook's total U.S. audience (Pew Research Center, 2018). Among the elderly, adoption of OSNs is often driven by utilitarian as opposed to hedonic outcomes while non-adoption can often be traced back to fear of technology (Maier et al., 2011). A lack of consideration of age-related changes such as declining vision, coordination skills or memory further contribute towards non-adoption, necessitating a more age-friendly design of OSNs (Boll and Brune, 2016; Boll et al., 2017).

Regarding adoption of OSNs and internet use, elderly people in the same age group cannot be considered a homogenous group as they exhibit varying behavior depending on factors such as education or income (Niehaves and Plattfaut, 2014; Hunsaker and Hargittai, 2018), leading to a digital divide (Rockmann et al., 2018). Just like their younger counterparts, the elderly can derive feelings of social connectedness from OSNs (Sinclair and Grieve, 2017). OSNs afford people which lack an opportunity to make face-to-face contact with others the possibility of gaining social connectedness (Grieve et al., 2013). According to Leist (2013, p. 382), OSNs enable the elderly "to provide and receive social support, overcome loneliness as well as to enhance feelings of control and self-efficacy". Goswami et al. (2010) propose using OSNs as a means of increasing social connectedness and social support of the elderly. Active participation in online communities for seniors which promote leisure activities and expand their social network are suggested to improve overall well-being (Nimrod, 2010). In this context, Keijzer-Broers et al. (2014) develop requirements for an online platform which, under the overall goal of facilitating "ageing in place", supports the elderly in matchmaking with healthy and smart living products and services.

10.2.2 Neighborhood Social Networks

The term *neighborhood*, often used synonymously with *community*, can be defined from a variety of perspectives based on criteria such as an area's history, administrative boundaries, people's perceptions or characteristics of its inhabitants, with the boundaries of each criterium not necessarily overlapping (Diez Roux, 2001). In this paper, we assume a spatial definition of a neighborhood as "a collection of people and institutions occupying a subsection of a larger community" (Sampson et al., 1997), as it applies both of our case neighborhoods, one being defined by municipal boundaries and the other being defined by being serviced by a specific neighborhood management institution. With the rise of social network sites, cumulative and segmentive network effects have resulted in the organic formation of city and neighborhood-level social networks on traditional OSNs such as Facebook (Ilena et al., 2011). However, literature on OSNs or other artifacts with a specific neighborhood scope is scare. Early research reports on the implementation of a neighborhood email list as well as discussion board and demonstrates effects such as an increase in volume and range of neighborly relationships, more recognition of neighbors, increased online and offline communication as well as participation in common activities (Hampton and Wellman, 2000; Hampton and Wellman, 2003). These artifacts were able to overcome spatial, temporal and social barriers to communication. At the same time, the internet did not substitute but complement offline communication in-person or via phone. In a different research project, Hampton (2007) expand on this concept and implement a neighborhood website with features such as a neighbor directory, private messages, community calendar, classified ads and polls. In a non-research context, a new breed of OSNs, best described as local, private or neighborhood social networks is on the rise. Since its launch, San Francisco-based neighborhood social network Nextdoor has expanded to every fourth neighborhood in the United States (Popper, 2014). Berlin-based nebenan.de registers 800,000 neighbors in 6,500 neighborhoods across Germany and recently launched derivatives in France, Spain and Italy (Tönnesmann, 2018). These neighborhood social networks share a number of common traits. They are generally free-to-use and require users to verify their real name and address. They delineate neighborhoods into individual sub-communities with their content being visible exclusively for verified neighbors. Per default, each user is identifiable by his or her full name and address. However, these platforms put little weight on the needs of elderly users, lack integration with local service providers as well as institutions and are not linked to existing efforts in the context of age-friendliness.

10.3 Research Design

Our research project follows the design science research methodology (DSRM) as proposed by Kuechler and Vaishnavi (2008). Figure 1 presents our overall research approach consisting of two consecutive design cycles, including completed, ongoing and planned activities. To ensure practical relevance of our design principles for an age-friendly digital neighborhood platform, we interact with two case neighborhoods situated in a large metropolitan area in Germany which serve as a source of issues and opportunities as well as a proving ground for our evaluation throughout the design process. One case neighborhood, defined by the municipal boundaries of a city quarter, featured an elderly population of 19.4% at the end of 2017 (Statistik Nord, 2017). As the other neighborhood is not defined by municipal boundaries but by being serviced by a specific neighborhood management institution, there is as of yet no precise age-related data available. Both neighborhoods are already undertaking steps towards becoming more age-friendly. These include but are not limited to social workers and neighborhood management personnel which engage neighbors by organizing a variety of leisure, health and educational events, infrastructure and housing improvements towards accessibility including ambient assisted living technology and partnerships with health service providers such as elderly care services, physicians or nutritionists. During the *awareness of the problem* phase, we conducted a literature review on neighborhood social networks and the relationship of the elderly towards social networks. Based on the results of the literature review as well two workshops, one with 3 representatives of neighborhood management of one case neighborhood and one with 12 inhabitants of this neighborhood aged between 55 and 85, we defined design principles for an age-friendly neighborhood platform in the *suggestion* phase of the DSRM process (see Table 1). Design principles pursue the goal of informing designers on how to effectively design artifacts of a certain type (Niehaves and Ortbach, 2016). In consequence, the evaluation of design principles must assess their suitability for being instantiated into a concrete artifact and this artifact's ability "to proffer the action described by the design principle" (Chandra et al., 2015, p. 4046). In the *development* step, we therefore instantiated these design principles into a prototypical age-friendly digital neighborhood platform (see Figure 2). We draw on techniques inspired by human-centered design (ISO, 2010) and design thinking (Brown, 2009) to iteratively develop prototypes with increasing functionality. As part of this process, we defined user personas and stories to identify problems and to develop suitable solutions. We began with low-fidelity, paper-based prototypes and culminated the first design cycle with a website and mobile application based on the open source technology ReactJS (Facebook, 2018).

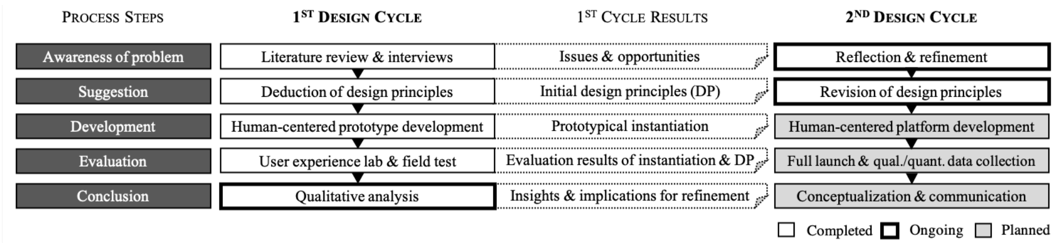

Figure 1. Research approach and activities (based on Kuechler and Vaishnavi (2008))

We conduct several *evaluation* episodes throughout the DSR cycle, both artificial and naturalistic (Venable et al., 2016). First, we conducted a user experience lab, a workshop focused on assessing how our prospective users perceive the system's utility, ease of use and efficiency (Pannafino and McNeil, 2017). During this workshop, 20 prospective users of our platform aged between 53 and 85 were able to gain hands-on experience with our prototype and had the opportunity to provide feedback. Upon implementation of these first suggestions for improvement, we launched a field test of the mobile application in our two case neighborhoods. In the course of our field test, 35 inhabitants of our two case neighborhoods were given access to the mobile application for a limited period of three months. Their feedback was collected via several channels. Weekly on-site consultation hours were offered in both neighborhoods to provide in-person support and to collect improvement suggestions. Further support was provided via e-mail and phone. Each participant of the field test was also provided with an evaluation diary which served as a cultural probe, "designed to provoke inspirational responses from elderly people in diverse communities" (Gaver et al., 1999, p. 22; Maaß et al., 2016). Using these diaries neighbors were prompted to provide both quantitative and qualitative data such as age, living situation, technology proficiency, involvement in neighborhood life as well as degree of physical and social activity. Neighbors were also afforded the opportunity to chronicle experiences with our platform and could provide textual and graphical feedback on platform design and functionality using wireframes. Having concluded our first evaluation episodes, we are in the process of analyzing the collected qualitative data as well as revising and extending our proposed design principles which will in turn inform the design of our final digital neighborhood platform. With the full public launch of the platform in our case neighborhoods during the second design cycle, we plan to conduct a mixed-methods evaluation (Venkatesh et al., 2013), combining several further qualitative evaluation episodes in the form of workshops and interviews, quantitative analysis of platform usage and the distribution of digital surveys directly via our neighborhood platform to assess its effects.

10.4 Initial Design Principles and Instantiation

In the following, we define an initial set of seven design principles for an age-friendly digital neighborhood platform (Table 1) and present their corresponding design elements in the current version of our prototypical instantiation (Figure 2). Maintaining social relationships is regarded as one of the key elements of ageing well (Leist, 2013). Also, increasing social ties and civic participation in their neighborhood contributes to senior's feeling of security (De Donder et al., 2012), increases their quality of life and minimizes the risk of social isolation (OECD, 2015). An age-friendly digital neighborhood platform should therefore afford its users the ability to form and maintain social relationships (**DP1**). Our prototypical instantiation identifies neighbors with a profile image and their full name and a detailed profile page introduces neighbors with further information such as their address (depending on individual privacy settings) or their interests. A searchable neighborhood directory lists all registered neighbors. To enable communication among neighbors, we implement a private messaging system. Access to timely, relevant and local information to manage life and meet personal needs is a vital component for active ageing (WHO, 2007). Besides providing social support, information sharing has been identified as an important enabler of social trust in online communities (Choi et al., 2014). As a perceived lack of meaningful occupation and loss of social context post retirement has been shown to negatively impact seniors' well-being and can even cause depression (Lee and Smith, 2009), an age-friendly digital neighborhood platform should afford its users the ability to access and share information that allows them to remain active in neighborhood life at an old age (**DP2**). Our prototype allows users to share information via "contributions" of various categories which are then displayed for consumption in a neighborhood news stream. This includes information such as asking for and making recommendations or organizing and being invited to events. Search and filter functionality allow users to find relevant content. Contributions with a related location such as an event venue are also presented on a neighborhood map. Users can engage with these contributions via likes and comments. A dedicated neighborhood calendar provides an overview of events in the neighborhood.

Table 1. Initial design principles for an age-friendly digital neighborhood platform

DP1	Provide the age-friendly digital neighborhood platform with functionality for discovery and engagement of neighbors in order to enable social interaction among the elderly.
DP2	Provide the age-friendly digital neighborhood platform with functionality for information sharing and retrieval in order for the elderly to remain engaged with neighborhood life.
DP3	Provide the age-friendly digital neighborhood platform with functionality for requesting and provisioning voluntary support services in order to establish a local peer-support network.
DP4	Provide the age-friendly digital neighborhood platform with motivational mechanisms in order to encourage continued usage.
DP5	Provide the age-friendly digital neighborhood platform with security and privacy mechanisms in order to ensure trust towards the platform and between platform users.
DP6	Provide the age-friendly digital neighborhood platform with functionality for integrating organizations in order to improve elderly access to local organizations.
DP7	Provide the age-friendly digital neighborhood platform with a user interface that allows for age diversity in order to attract an all-age user base while remaining age-friendly.

Encouraging the elderly to engage in volunteer work can support them in maintaining an active lifestyle and strengthen cross-generational linkages in neighborhoods (OECD, 2015). Maintaining a supportive social network enables older adults to lead an independent as well as self-sufficient life and improves overall well-being of the elderly (Avlund et al., 2004). Improving social support among the elderly can also increase physical activity and in turn contribute to the prevention of all-cause mortality and chronic illnesses (Lindsay Smith et al., 2017). As neighborhood connectedness is a predictor for older adults' willingness to volunteer (Dury et al., 2014), an age-friendly digital neighborhood platform should contribute to connectedness and facilitate requesting and provisioning peer-support (**DP3**) with the goal of providing "social support in areas with definable close geographical boundaries" (Meyer-Blankart et al., 2013, p. 2). Our prototype implements this design principle via a request and offer contribution type. Users can request assistance, e.g. for assembling furniture, or make an unsolicited offer, e.g. offering free tutoring. Besides functionality such as affording neighbors the formation of social relationships or offering access to relevant information which are in themselves motivating for the elderly (Jung and Sundar, 2016), an age-friendly digital neighborhood platform must possess motivational mechanisms to ensure continued usage (**DP4**). Divulgence of personal information on a user profile can be motivating for other users (Antikainen et al., 2010; Leimeister et al., 2009; Porter et al., 2011). On our platform neighbor profiles present full name, picture, interests and an "About me" text for each neighbor. We further enable neighbors to "Like" contributions of other neighbors visualized via a thumbs-up symbol and to comment on contributions (Koh et al., 2007; Bretschneider et al., 2015). Web and mobile notifications are implemented to inform users of private messages and comments on their contributions. Research on sensitivity for information privacy among the elderly remains inconclusive with some studies describing the elderly as exhibiting less concern for privacy than other age groups (Lorenzen-Huber et al., 2011; Kwasny et al., 2008) and others describing them as particularly sensitive (Maaß, 2011). AS illustrated by recent irresponsible behavior concerning data privacy on public OSNs such as Facebook and with pressure of legislation such as GDPR (Kurtz et al., 2019), any OSN has a duty to emphasize privacy mechanisms to realize trust in the platform itself and between platform users (**DP5**). Our platform is exclusively available for inhabitants of a case neighborhood and cannot be accessed without registration. Neighborhoods are strictly separated from each other. Users have to sign up with their real name and address but can customize if their real name and address or only a part thereof are visible to other neighbors. Furthermore, users can disable notifications and choose not to add a profile picture.

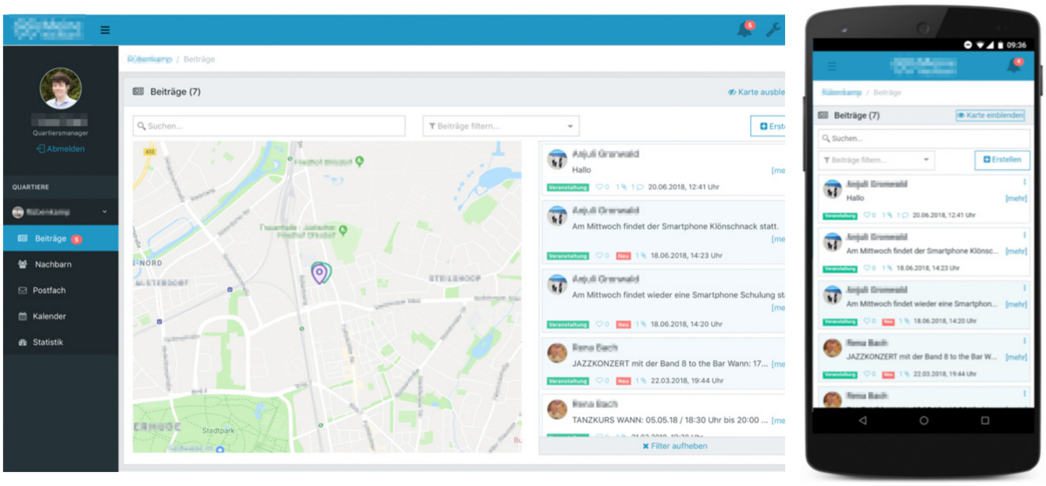

Figure 2. Prototypical instantiation of DPs as age-friendly digital neighborhood platform

The elderly prefer to age in place, meaning that they prefer to remain living independently within their community and not in residential care (Wiles et al., 2012; Gitlin, 2003). Access to local services is a key enabler of this independence (Phillipson, 2011; Lui et al., 2009). These services entail necessities such as health service providers but also institutions such as church, police, community management or non-profit organizations and clubs. Organizations seek to come into contact with neighbors to promote their offerings and events or to find members and volunteers, similarly to what they already do on public OSNs (Waters et al., 2009; Lovejoy et al., 2012). To facilitate access to local services, an age-friendly digital neighborhood platform should therefore be able to integrate local service providers (**DP6**). Our prototypical instantiation implements access for organizations which can use contributions to promote events in the neighborhood and allows them to create organizational profiles with information such as their location or opening hours. While the user interface of an age-friendly digital neighborhood platform must consider the particular needs of older OSN users (Boll et al., 2017), it must also be designed in a way not to alienate younger neighbors or neighbors who do explicitly not perceive themselves as members of the elderly population. Similar to an age-friendly city, which is not a city exclusively inhabited by the elderly but one that strives to offer a high quality of life to everyone, including the elderly (Buffel et al., 2012), an age-friendly digital neighborhood platform should aim for an all-age audience (**DP7**). Like the elderly, non-elderly neighbors can also profit from a digital neighborhood platform, e.g. a single parent finding a babysitter in an elderly neighbor or a retired piano teacher giving free lessons to children next door. In case of our platform, we do not advertise it as being age-friendly but as a general neighborhood platform while at the same time considering factors such as accessibility (Leitner et al., 2009) and support multiple access paths via web and mobile apps. We consider this a necessity as our envisioned peer-support network relies on the participation of users of various ages and as our fieldwork has shown that the elderly do not want to be separated into a platform exclusively for old people.

10.5 Discussion and Initial Evaluation

Based on the evaluation results from our workshops and field test, we present and reflect on some of our initial findings. In general, neighbors reacted positively to the idea of our age-inclusive digital neighborhood platform and highlighted several functionalities as useful. They appreciated the ability to keep in touch with neighborhood events and having a feeling of not "missing out" (Jung and Sundar, 2016, p. 29) on any important occurrences. In line with previous research, they further valued the ability to discover and engage with neighbors with similar interests (Goswami et al., 2010). Contrary to our expectations, neighbors requested almost no support services from their peers, despite stating that they welcome the idea of a peer-support network and stating their willingness to participate. The reasons for this could be both cultural and age-related and as previous research has shown, particularly the elderly are hesitant to request support services as they are reluctant to surrender responsibility and in fear of giving up independence (Dunér and Nordström, 2005). We also face a causality dilemma: the willingness to participate in the peer-support network may very well be genuine but without any open support requests, there is no opportunity for neighbors to volunteer help. Some stimulation, potentially in the form of contributions and events by neighborhood management, may be needed to initialize the peer-support network. Vast differences regarding technology proficiency of different neighbors, even between those inside the same age group were evident, emphasizing a digital divide (Rockmann et al., 2018). Some elderly users were quickly frustrated with using the mobile app and required close support to use the platform. We have therefore begun to offer training sessions on basic smartphone usage to improve proficiency among potential elderly platform users. Neighbors also had varying expectations regarding technical support and usage advice. While younger users mainly chose email as a support channel, elderly neighbors expected to be able to receive in-person or at least phone support. We therefore plan to expand our offline support structures in cooperation with neighborhood management in both case neighborhoods to offer on-site consultation hours for onboarding and platform usage. Concerning our implemented motivational mechanisms, neighbors reported that relevant content and the chance to form new relationships inside the neighborhood were main drivers for their usage of the platform. Profile pages with detailed information about other neighbors and knowing that this information is verified were described as enablers of trust. We are currently considering the implementation of gamification elements as additional motivational mechanics as previous research has shown promising results in using gamification to engage seniors (Altmeyer et al., 2018; Minge et al., 2014). Privacy and security concerns presented themselves as some of the most vocal feedback during our evaluation sessions as neighbors wanted to be ensured that the information they share on the platform can only be accessed by actual neighbors. The full public launch of the digital neighborhood platform will necessitate a registration process which ensures the neighborhood platform remains private. We plan to ensure this by initially mailing all inhabitants of our case neighborhoods a personal sign-up code which will confirm their address inside their neighborhood at sign-up. Neighbors registering at a later time via website or app will also be mailed a personalized sign-up code before being able to use the neighborhood platform.

Overall, our research project highlights the multilevel nature of IS (Bélanger et al., 2014; Grotherr et al., 2018) and the need for an ensemble view of technology which considers the IS artifact as being embedded in a constantly evolving social and environmental context (Orlikowski and Iacono, 2001). Therefore, while the design of our artifact may be age-friendly, it is of equal importance to consider the way it is integrated into the specific usage context of our case neighborhoods via measures such as training, support by neighborhood management and integration with age-friendly initiatives. Organizations situated in our case neighborhoods have expressed great interest in participating on our neighborhood platform. Discussions with institutional actors such as a local church and community police officers revealed an appreciation for features such as the planned address and real name verification and the ability to specifically target a local audience in the neighborhood. They further considered a local not-for-profit platform such as our age-friendly digital neighborhood platform as more appropriate for use by institutional actors than anonymous, for-profit social network sites such as Facebook.

10.6 Conclusion and Expected Contribution

With our research project we aim to contribute nascent design theory (Gregor and Hevner, 2013) in the form of design principles for age-friendly digital neighborhood platforms and the situated implementation of our prototypical artifact. Our research is motivated by the challenges of the ageing society and based on extant literature on the relationship of the elderly with OSNs and neighborhood social networks. Based on a literature review, we define an initial set of design principles and interviews in two case neighborhoods. In a human-centered development approach, we instantiate these design principles into a prototypical website and mobile app which we evaluate during several evaluation episodes. In this paper, we report on our ongoing DSR project and present initial findings from this evaluation. We determine a distinct interest for the platform by neighbors as well as organizations active in the context of our case neighborhoods and highlight security and privacy as well as integration of organizations as priorities for future development. Further research may aim to evaluate, expand or customize our design principles for different application contexts.

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11 Multilevel Design for Smart Communities – The Case of Building a Local Online Neighborhood Social Community

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Abstract

Smart cities and communities aim for social well-being. Mobilizing and integrating various institutions, actors, and resources are crucial when building and instantiating smart community initiatives. The design of such an arrangement is a complex phenomenon, difficult to conduct systematically and to observe empirically. We address this challenge by applying a multilevel design framework for service systems to an ongoing design science research project. The research project pursues the goal of building a neighborhood community as an instantiation of smart communities by activating and leveraging local institutions, actors, and resources on an IT-enabled engagement platform. We demonstrate how this multilevel perspective informs the design process for building smart communities. Based on micro-level observations, the interdependence of engagement-stimulating mechanisms related to the platform's design at the meso-level, and design implications for the institutional arrangement at the macro-level are emphasized as inseparable design activities for mobilizing and integrating actors and resources.

Keywords: design science research, engagement platform, microfoundation, multilevel design

11.1 Introduction

Developing smart cities, which are driven by new technology to enhance citizen well-being, has become a major priority for urban and rural governments [1]. Local governments invest heavily in exploring new ways to become smarter, connected, and more sustainable [2]. Although the broader concept of smart cities has been investigated in previous research [3], current research seeks to dig deeper into the design of smart communities, which are connected to improve well-being [4]. Thus, we focus on neighborhoods as instantiations of smart communities in smart cities. Social exclusion is an increased risk which affects the aging population, especially in growing metropolitan regions, and leads to increasing anonymity in residential neighborhoods [5]. This cycle of growing anonymity is overcome by initiatives that integrate infrastructure, technical and human resources, into social neighborhood communities [6]. In this context, cities have begun to address the challenge of an aging society by implementing neighborhood services, which are facilitated by information technology [7]. Technological advancements can help increase social inclusion and improve accessibility to urban environments. The positive effect on social well-being of integrating various actors with information technology has been shown in previous studies [7, 8].

Although extant research recognizes that building smart communities is a multidimensional effort [9], little is known about how to utilize this concept. Designing smart communities is even more abstract, and designing collaboration between actors challenging [10]. From a sociotechnical perspective, mobilizing and integrating various actors requires more than technological advancements [11]. Individuals are shaped by technological design, and at the group level by social control, norms, and values [12, 13]. This results in integration activities of technological advancements, institutions, and infrastructures with human interests. Diverse interests and changing environments lead to uncertainties when building smart communities. In turn, building smart communities should not be a matter of coincidence, but systematically coordinated and supported by institutional arrangements.

As knowledge of how to manage and systematically conduct design actions for building smart communities with the use of technology is scarce [14], new approaches are required which adapt to varying circumstances. This leads us to the following research question: *How can design activities be conducted systematically to build smart communities?*

To investigate this research question in detail, we analyzed a social community building project that aims to improve peer-support services and access to resources of local service providers. By applying mechanisms of local neighborhood communities, we aim to capture insights into building smart communities by engaging multiple actors, ranging from institutions to individual actors (citizens). Specifically, we build on an IT-enabled neighborhood service platform, which facilitates mobilization and integration of resources, and aims to ensure a high quality of life for citizens.

The aim of the ongoing research project is to ramp up and build conditions for an emergent smart community. Especially among an aging population [5], individual needs must be captured, to facilitate a rethinking of mental models toward an open, networked, and informed smart community. Based on this research project, we enhance our understanding of building smart communities in smart cities by adopting a service systems perspective, with an emphasis on peer-support services, facilitated by technology use. We adapt a multilevel perspective for service systems design that helps to operationalize and manage design activities to build a smart community. We conclude that smart cities, smartness, and related components are not only multidimensional [9] but also relate to a multilevel perspective. The proposed multilevel model helps to manage complexity on (1) multiple levels and (2) with dynamics in changing environments, by pointing out the path to social well-being with corresponding design activities and elements. This means engaging citizens at the micro-level, facilitated by intermediaries, such as engagement platforms at the meso-level, which leads to value co-creation at the macro-level. This perspective extends beyond the adaption of information technology by integrating actors and institutions as designable elements and results in a systematic approach to build smart communities. We further derive recommendations for engagement-facilitating mechanisms, and provide a novel perspective on social community building.

The remainder of this paper is structured as follows: Section 2 summarizes related work on smart and neighborhood communities, and service systems conceptualizations. Section 3 describes the methodology and the research project. Section 4 provides an in-depth research project description according to the multilevel framework. Section 5 discuss the evaluation results, followed by implications in section 6. Finally, section 7 summarizes the research results and identify future research work.

11.2 Theoretical background

11.2.1 Smart and neighborhood communities

The technological, institutional, and human dimensions of smart cities are frequently discussed [9]. Institutional aspects relate to regulations, governance, and policies, while social dimensions aim to respond to human interests, such as health or education issues [15]. Technology components range from smart infrastructure to the application of information technology to integrate citizens within an engagement process via engagement platforms [10, 16]. Previous research on citizen engagement aimed at creating participatory innovation platforms, on which the democratic culture is reflected in shaping policy decisions and open innovation approaches [17, 18]. This reflects the integrated perspective of technology as a key enabler for smart cities to engage citizens in the decision process with the aim of increasing environmental sustainability [19].

Recent research extended citizen engagement to the concept of smart communities, in which the community members and infrastructures are connected via technology to improve well-being [15, 20]. Smart communities can be defined as "a community broadly ranging from a small neighborhood to a nation-wide community of common or shared interest, whose members, organizations and governing institutions are working in partnership to use IT to transform their circumstances in significant ways" [9, p. 286]. In this sense, smart communities connect local governments and institutions, and inhabitants to impact life and work in the local region positively [9].

Engaging citizens via technology to increase geographic and social proximity is key to the success of smart communities [21]. A strategy for engaging in local communities is to build on online social networks (OSNs) [22, 23]. Online social networks provide the opportunity to connect organizations, and citizens among themselves. Thus, bridging access to local actors and resources by using online social network technology, such as engagement platforms, raises the opportunity to integrate offline and online activities into one unified instance [16]. However, although online social networks are not limited to regional boundaries, the networks do not address the specific needs of local communities [24].

Establishing neighborhood communities is a challenging process, due to the focus on localness. Stricter requirements regarding trust and privacy among participants, in conjunction with a limited number of actors, may hamper the formation of a critical mass of neighbors.

11.2.2 Service systems and engineering

Service systems have emerged as a service research priority, are defined as “complex sociotechnical systems that enable value co-creation” [25, p. 73], and focus on actors, resources, and institutional arrangements for value co-creation [26]. Value is created through an interactive process of engaging actors, and resource mobilization is key for service systems interaction [27]. Adapting information technology, such as engagement platforms, emerged as a phenomenon that facilitates communication and coordination of relationships between actors and the creation of new service systems [28, 29]. Finding the right configuration of actors, resources, and information technology is a key activity for interactive value co-creation [30]. The systematic design is addressed by the service systems engineering discipline [25], which focuses on the design of (1) service architecture, (2) service systems interaction, and (3) resource mobilization with models, methods, and artifacts [25].

From a service systems perspective, smart communities are sociotechnical systems [31] that comprise various actors, ranging from the government, organizations, and institutions to individual citizens, as well as their resources, such as local infrastructures. The shift of the actors’ role from passive consumers to active contributors to co-create value in service research [26, 30] is reflected in smart community initiatives, which aim to transform the role of the citizen as a passive inhabitant into an active contributor to policy decision making or data-generation, or as an actor in a local, connected community, by using information technologies [32]. Despite thorough conceptualizations of smart cities and smart communities [15, 32], knowledge of how to operationalize value creation and related design activities is scarce [33]. Solely addressing an abstract level of smart communities is not sufficient, as this perspective lacks consideration of actor engagement on an individual level. Therefore, we apply a multilevel design framework as part of the service systems engineering which enhances our understanding of design decisions, and the resulting effects on actor engagement [34]. We demonstrate the applicability of the multilevel framework by applying it to our research project for building a neighborhood community as an instantiation of smart communities.

11.3 Methodology

Realizing value in smart communities is difficult to plan and observe, due to the time gap between the initial design and the realized value for the smart community initiative. Building on the micro-foundation movement, and actor engagement as a micro-foundation for value co-creation [27, 35], drilling down to a granular and empirical observable level bridges the gap between the abstract concept of value co-creation at the macro-level with empirically observable actor engagement at the micro-level. We build on a multilevel conceptualization of service systems design to link the abstract goal of building smart communities, to achieve social well-being with manageable and observable design activities (see Figure 1). The framework provides an analytical perspective, and helps to address the dynamics in smart community building and evolution. The framework increases understanding of value co-creation outcomes by analyzing the effects of the design decision at each level, and enables a systematic derivation of design knowledge for non-deterministically plannable actor engagement [36].

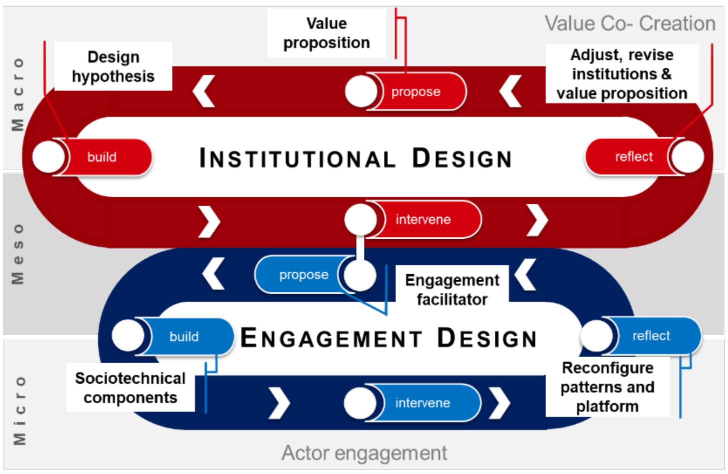

Figure 1. Multilevel design framework for service systems (based on [34])

The multilevel framework is conceptualized by (1) a multilevel perspective with macro-, meso-, and micro-levels and (2) two iterative design processes [34]. The three-level model entails a macro-level institutional setup, which incorporates the value proposition and a configurations of actors and resources. The meso-level mediates with sociotechnical components that facilitate engagement. The micro-level is represented by actor engagement, which "is conceptualized both the disposition to engage and the activity of engaging in an interactive process of resource integration within the institutional context provided by a service ecosystem" [27, p. 3008]. Actor engagement can be empirically observed by temporal, informational and relational engagement properties [37]. Actor's interaction and willingness to engage is shaped by the social context and platform's design [36]. This is in line with the sociotechnical perspective, which defines the technology and social behavior of individuals as an inseparable instance of analysis [11]. Finally, actor engagement activities are transitioned back to the macro-level as an aggregated unit of value co-creation [27].

Due to the contextual nature of value co-creation and the simultaneous interaction of the actors, a dynamic perspective is required. Therefore, the design process is conceptualized as a sequence of design activities at all levels. The designable components are linked within two intertwined design cycles: (1) institutional design and (2) engagement design. We distinguish with the multilevel perspective between the individual encounter design of engagement platforms and supporting interventions (engagement design), and the design of the institutional setup related to the configuration of the engaged actors and resources, and the guiding value proposition (institutional design). This requires different methods and measurements. The engagement design relates components to engagement-facilitating mechanisms, such as engagement platforms [34]. User experience with a sociotechnical perspective is crucial for the design of the artifact, which can be captured through user-oriented methods, such as design thinking, and low-fidelity prototypes [38]. Further, piloting of engagement platforms is crucial to achieve progress in building smart communities. This approach provides tangible results, evaluates the impact of smart community initiatives, and keeps motivation high for further engagement [39]. Based on the evaluation results, indications of the impact and further actions can be derived for engagement or institutional design.

To derive design implications for smart communities, we apply this framework by conducting a case study based on Yin's work [40] within one of our design science research (DSR) projects in the context of smart communities (see Table 1). As part of this DSR project, we build an engagement platform within a neighborhood (online) communities as described in the following section.

Table 1. Case research project for building smart communities

Service system: Neighborhood community comprising of several actors and guided by value propositions
Actors: institutions, neighbors, service providers
Resources: infrastructures and services of actors
Value proposition: Engaging actors and resources in a local and social neighborhood community for improving social well-being
Applied principle: Local (online) neighborhood social networks
Tool support: Engagement platform
Research approach: Design science research
Data collection and analysis: Thinking aloud, interviews, focus groups, evaluation diaries

11.4 Case description: research project for building smart communities in neighborhoods

In the following, we describe and analyze our DSR project (see Table 1) and the multilevel design framework (see Figure 1). We first describe within the institutional design cycle our research context, and *propose* the guiding value proposition, which is based on challenges, as well as opportunities, for smart communities (section 4.1). We *build* a design hypothesis to improve the social well-being in smart communities and *intervene* in the natural environment of two neighborhood communities by *proposing* and *building* an engagement platform as an intermediary for collaborative interactions in a neighborhood community as part of the engagement design (section 4.2). We *intervene* in a neighborhood environment by using a prototype, and *reflect* the design decisions, leading to implications for further design activities for engagement and institutional design (section 5).

11.4.1 Overall research context and objectives

Smart cities shift the focus from the technical equipment of infrastructures to building social systems and evolving ecosystems [14, 41]. Building on the smart community concept, local governments have recognized the need to facilitate social capital and the formation of smart communities. In 2016, the public health authority of a large German metropolitan region funded this smart community initiative to respond to the social and healthcare needs of an aging society in urban environments [6]. To ensure relevance and applicability in practice, we have been carrying out a DSR project for three years in a naturalistic environment. We engaged in two urban neighborhoods with 1200 and 4800 inhabitants in a large metropolitan area in Germany. Due to our piloting approach [42], these two quarters provide a rich set of intervention and evaluation activities.

As the first step, we identify the current issues and opportunities for smart communities as part of the institutional design. Building on a literature review on neighborhood social networks [43], we extended our insights by conducting two workshops. As engaging the potential users is crucial in smart city projects [44], the workshops were conducted with 3 representatives of a neighborhood management service (quarter 1) and with 12 citizens (quarter 2).

Despite the presence of increased anonymity issues in metropolitan regions, participants confirmed a lack of transparency concerning services offered by local organizations, as well as opportunities to provide services by neighbors for neighbors along the lines of peer-support services [45]. Limited access to online platforms leads to limited access to services of local service providers and institutions, such as the police or church. Consequently, the primary goal of the project is to build on mechanisms that support integrating services and volunteering, which increase citizens' quality of life and well-being [6]. This entails connecting younger citizens and the elderly population with each other, as well as with local infrastructures, to increase social inclusiveness, accessibility, and service proximity [46]. This leads to the following value proposition, which guides further design activities: "Engaging actors and resources in a local and social neighborhood community to improve social well-being".

11.4.2 Applied mechanism and artifact for intervention in the actor's environment

Our research is motivated by the aim of increasing the social inclusion and accessibility of local actors and infrastructures. This faces the challenge of an aging society [5]. Therefore, we applied OSNs and neighborhood social network mechanisms. Prominent examples of online social networks, such as Facebook, serve as mechanisms for building local social networks [24]. A specific type of local social networks is neighborhood social networks, which aim to enhance social support and increase self-efficacy [47]. However, knowledge of how to design local neighborhood social networks by using online social network technology is scarce [43]. In addition, (online) social networks and existing neighborhood services do not consider the needs of the elderly population [48, 49].

Encouraging technologies as intermediaries unlocks new solutions from which inhabitants can benefit. The goal is to utilize the community's ability to provide peer-support services, local service provider offerings, and institutions as facilitators with technologies, such as engagement platforms. This platform thinking is gaining more importance since the platform economy emerged as a promising opportunity to adapt collective intelligence and resources [45]. Engagement platforms are defined as "physical or virtual touch points designed to provide structural support for the exchange and integration of resources, and thereby co-creation of value between actors in a service system" [50, p. 596]. Thus, engagement platforms provide a promising design hypothesis for engaging local neighbor actors in a social community.

As value co-creation in smart communities depends on individual contextual factors, an empirical investigation into an actor's natural environment is essential to observe the effects of design decisions in certain contexts [51]. This reflects the transition from institutional design to engagement design. Actors' disposition to engage is difficult to determine in advance, and is related to multiple possible design decisions [52]. Thus, building sociotechnical artifacts requires human-centered approaches to gain insights into human behavior. For instantiating the engagement platform, we first used human-centered design approaches, such as design thinking, personas, and user stories, to identify a suitable solution design [53]. Then, we developed the engagement platform in several propose, build, intervene, and reflect iterations, starting with low-fidelity, paper-based prototypes, leading to a technical instantiation. In general, the platform implements technical features to stimulate peer-support services in the neighborhood community. This is done with features, which enable inhabitants to request and offer assistance, for example, for replacing incandescent lights or offering a service to conduct daily shopping. Further functionality to stimulate engagement is implemented, such as detailed profile information to discover other peers, contribution functions, such as likes and comments, and notifications to inform users about updates [54].

Service providers and local organizations are integrated on the engagement platform to make offline services visible and accessible to the community members. Therefore, the engagement platform implements features to create an organization profile with relevant information, such as opening hours, and promote offerings in the neighborhood.

As engaging actors are limited to the design of the platform, the underlying constraints must be gathered, and analyzed regarding the effects on individual behavior, which, in turn, leads to adjustments of design decisions. Therefore, we conducted naturalistic evaluation activities according to Venable, et al.'s work [55]. First, we conducted a user experience workshop with 20 potential users. Users aged between 53 and 85 years were selected to examine the needs of elderly users. Second, we conducted a field test with 35 inhabitants over a period of three months. Participants were granted access to the mobile application. Data were collected via evaluation diaries [56], as well as via personal support. As the artifact is placed within the naturalistic environment, we apply a sociotechnical perspective with an "ensemble view" to derive insights into the use and social effect of the artifact [57].

11.5 Findings and insights

Table 2 provides a brief reflection based on the observed micro-level results and implications for the sociotechnical components as part of the engagement design at the meso-level, and the institutional setup as part of the institutional design at the macro-level.

Trust and privacy concerns are emphasized during the evaluation. Fake accounts and information sharing outside the platform are issues, which must be addressed during the design process (Table 2, #1).

Table 2. Findings and insights of evaluation

#	Micro-level results	Meso-level implication	Macro-level implication
1	Trust and privacy concerns	Providing and verifying real user profiles information	Engaging trust-supporting actors
2	Lack of access	Establish offline support and training	Mobilize actors and resources
		Age-friendly platform design	
3	Need engagement stimulation	Provide initial contributions	

		Engage neighborhood community management	Employ neighborhood community management
4	Facilitate engagement of various actors	Integrate local institutions and service providers	Mobilize and commit actors
		Install spaces and screens to promote exchange between actors	

We decided to register users with their real names and addresses, and restricted access to the platform with a registration process to improve trust in the neighborhood community [58]. This requires a process to confirm user profiles, and institutions of trust, such as local churches or police stations, have to be mobilized and integrated, to mediate as non-profit organizations in verifying real names and addresses.

The evaluation results further indicate various necessary interventions to provide access to the platform for older actors in particular (Table 2, #2). Young actors expect technical support via electronic channels, such as e-mail, but older actors chose to receive in-person support. For providing support structures, actors have to be mobilized to meet the inhabitants' expectations. This requires resources and responsibilities; specifically, we coordinate neighborhood community management to offer on-site support. In addition, some older users struggle when using the platform on mobile devices. To this end, we provide bi-weekly smartphone usage training to prepare older actors to use the mobile application. For future technology training support, public libraries may serve as anchor institutions to provide basic technology courses [59].

However, even if the research project aims to build an age-appropriate platform (see Table 2, #2), the design and guiding value proposition may not deter younger and older actors. This is also reflected in previous studies, which indicates that older inhabitants prefer to live within the community instead of residential care [60]. The inclusion of the elderly in the neighborhood networks inevitably requires the entire community be connected, older and younger. Solely restricting and actively promoting age-appropriate functions, thus, would be a signal for forcing older communities exclusively, and would negate the integrative approach. Therefore, the inclusion of older people is the focus, and supported by features and services. However, the overall goal is to improve well-being in the overall urban space, and to eliminate boundaries between younger and older citizens.

Therefore, we enforce peer-support services on the platform. However, peer-support services may be restricted due to lack of engagement by actors (Table 2, #3), as we also faced a causality dilemma: The actors' willingness to participate in peer-support services may be genuine, but without any open support requests, there is no opportunity to volunteer help. As previous research demonstrates [34], initial contributions and events populated by neighborhood management reduce engagement barriers. To facilitate interaction, neighborhood community managers are employed, to support inquiries between individual actors and local service providers.

Further, as previous research highlights, the role of institutional actors, such as public libraries, as facilitators in building smart communities is recognized [59]. Access to local service providers, institutions, and infrastructures is a prerequisite for facilitating actor engagement (Table 2, #4). Key enablers are among others, churches, police stations, and non-profit organizations, which enhance trust within the neighborhood community. Thus, we link local service providers, neighborhood managers and institutions on the engagement platform to stimulate engagement via events, and create a marketplace for peer-support services. They organize leisure and health education events, as well as increase accessibility for older citizens by partnerships with health and elder care services. Additionally, to promote neighbor relationships outside the engagement platform, cross-generational spaces and large outdoor touchscreens are available, which facilitate the exchange between the engaging actors. Health-promoting offerings in the neighborhood, such as Nordic walking, and other inhabitant-relevant information, such as cultural events or building sites are provided. Consequently, several dedicated actors and resources must be engaged to stimulate activity in the neighborhood community.

11.6 Discussion

Our research contributes to the realm of building smart communities, as we investigate design activities on multiple levels. Decomposing smart community building on multiple levels, and applying iterative design cycles, captures dynamics in context and turns the process into manageable activities for the researcher and the practitioner. Second, we derive design implications based on the ongoing DSR project, which aims to build an online neighborhood community as a manifestation of smart communities.

We conclude that smart communities can be referred to as fluid organizational forms, which must be managed as such. The formation of smart communities is a complex process, as various actors simultaneously engage on a voluntary basis and try to satisfy their goals. These goals are guided by the actors' disposition to engage. This leads to possibly conflicting goals and values. Even if actors engage in collaboration activities, individual actions can be contrary to collective action, and thus, hinder joint value creation, ultimately leading to value de-construction [61]. Therefore, the interests of individuals must be aligned with the interests of the smart community. In this sense, actors should not be treated as recipients of a designed artifact, but actively engaged in the design project, which requires human-centered methods [62].

As our results shows, applying a service system perspective is particularly useful to grasp the objectives of smart community building. Local (online) social neighborhoods as an instantiation of smart communities integrate technology, humans, institutions and local service providers, and physical components as resources. Previous research on smart cities focuses on technology [63] and governance [64], but we propose to apply an integrative, multilevel perspective, which enhances our understanding of the interrelations of sociotechnical components and engaging actors, ranging from individual engagement to institutional actors' engagement. This perspective bridges macro-level goals with micro-level observations and explanations [65]. Especially, as information systems are multilevel [66], we explore how this perspective support analysis of sociotechnical artifacts and organizational and institutional boundaries, affecting the actors' engagement and technology use.

In particular, the multilevel framework helps to decompose a value proposition into manageable and measurable steps, and connect them. We propose a guiding value proposition of smart and connected communities for social well-being as a strategic improvement at the macro-level, which is based on the basic concept of collaborative and interactive value co-creation [26]. These objectives are reflected by neighborhood (online) social networks, and are incorporated by engagement platforms as facilitators to generate peer-support services at the meso-level. Intervening in the actor's environment helps to observe the effects of design decisions at the micro-level, which, in turn, must be reflected at the meso- and macro-levels. As the results indicate, the actors' engagement is limited due to the functions of the platform. At the same time, several engagement-supporting interventions, such as promotions and training, affect actors' willingness to engage, and have to be applied to the engagement platform. This is in line with the sociotechnical perspective, which describes technical elements and social practices as inseparable elements when analyzing and designing artifacts [11, 57].

However, designing sociotechnical artifacts is not solely related to the design of the system. Even if platforms design assumes to address the target group needs, the design implications are twofold. We propose that engaging individual actors requires engagement-stimulating mechanisms, such as sociotechnical platforms and functions (e.g., communication and peer-support requests), as well as supporting institutions and organizations, which stimulate engagement and enhance perceived value expectation. The need for an age-friendly design of the smart community is not mainly fulfilled by the design of an age-appropriate platform, but by specific interventions, such as training, or incorporation of trust-building institutions, such as churches (see Table 2, #2). These institutions should be mobilized and integrated, and reflect the (re-)configuration of the institutional setup of the actors and resources at the macro-level.

To sum up, to get smart and connected individual and institutional actors, the resources and infrastructures must be mobilized and integrated. By engaging service providers, local organizations, institutions, and non-profit organizations, we emphasize their role as intermediaries of values such as trust. This requires the engagement of multiple actors in the institutional design of smart communities. Therefore, creating the institutional setup with corresponding design elements, such as the guiding value proposition and the configuration of engaging actors and resources, is crucial for building the preconditions of successful actor engagement and value co-creation [34]. At the same time, refinements of the institutional setup are required to find the right configuration of actors and resources. These design activities facilitate resource mobilization, help to increase local smart community growth, and reduce, for example, the identified engagement barriers of individual actors at the micro-level [34]. Thus, the value proposition and the configuration of engaging actors and resources must be adapted, and evolve over time. However, these developments require a long-term effort to reinforce the new structures and increase public value. These continuous refinements and adjustments of the institutional setup require a long-term commitment of several actors, and to measure the achieved value. This, in turn, leads to transformation results for engaging individual and institutional actors.

However, there is no silver bullet to increase smartness. Various engaging actors, different infrastructures and institutional arrangements, as well as rapidly changing contexts, make it difficult to systematically plan and operationalize design initiatives [67]. One central requirement for building smart communities is the ability to react to these dynamics, and reconfigure actors, resources, institutions, and information technology. An explorative approach is required to understand the design decisions about the networked value co-creation of multiple engaging actors, and to understand how this community evolves over time. The proposed iterative design and validation cycles create a continuous process of change, which includes experiments and improvements, and leads to a deeper understanding of anticipated and unanticipated implications of the design decisions.

11.7 Conclusion

Smart communities have emerged as a priority for local governments and researchers. Building smart communities necessitates a focus on human behavior. The effects of design decisions and engaging actors on perceived trust and usefulness is central to an actor’s willingness to engage, and must be analyzed and translated into implications for actions. However, little is known about how to systematically conduct design activities for building smart communities.

This paper contributes in two respects: It provides (1) a case discussion of how engagement platforms serve as a mediator of actors and resources with corresponding design implications based on an ongoing DSR project and (2) a multilevel perspective for analyzing and systematically deducing design implications. We provide two implications for practitioners and researchers. First, considering individual citizens when designing technology-mediated engagement is crucial for building smart communities (engagement design). Second, institutions as facilitators and promoters play a role in initiating and scaling up smart communities (institutional design). Linking both design activities with an engagement platform as an intermediary is the key to scale and sustain actor engagement.

We draw on insights from an ongoing DSR project that aims to build a smart community. By applying local (online) social neighborhood mechanisms and engagement platforms, we seek to integrate physical resources, services of local organizations, and peer-support services within a local neighborhood context. This enables the exploration of the evolution of smart communities, and prompts implications for mobilizing and integrating resource.

Informed by a service systems perspective, smart communities as a system of engaging actors and resources are guided by the value proposition of social well-being. However, engagement may be restricted due to sociotechnical issues and the institutional setup, which lead to limited expectations for the value contribution. We emphasize the multilevel process that comprises several measuring and reflection stages. Thus, the ramping-up phase revealed the need for several interventions and engagement of institutions to set up the conditions for smart communities. We conclude that building smart communities entails the task of designing and refining sociotechnical components, as well as the institutional setup, to stimulate engagement of individual and institutional actors. Several actors, resources, infrastructures, and institutions should be integrated while considering institutional arrangements, trust, and privacy issues. However, knowledge of how to manage such a complex undertaking is scarce.

The applied multilevel perspective shed light on building smart communities, which helps decompose abstract design goals into manageable and observable design implications. The two intertwined design cycles seek to bridge the gap between designing sociotechnical components at the meso-level and integrating the engagement of supporting actors and institutions at the macro-level. From a managerial perspective, this framework offers an explanatory framework and prescriptive guidance to systematically plan and conduct design activities, and contribute to the management of smart cities and communities.

Future research should investigate the roles of institutional actors, such as universities, schools, and libraries, and measurements of the value achieved. Therefore, we plan to conduct a full public launch of the platform, combining several further qualitative evaluations and quantitative analysis of platform usage.

11.8 Acknowledgements

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12 Conceptualizing Design Parameters of Online Neighborhood Social Networks

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Abstract

Online neighborhood social networks (ONSNs) represent an emerging phenomenon among a growing number of niche social networks. These platforms afford users the ability to engage in activities such social interaction with neighbors, sharing of information on local issues or neighborhood volunteering and exhibit promising effects, including improved relationships between neighbors and an increase in neighborly communication. Despite the mounting popularity of platforms such as Nextdoor or nebenan, extant research on ONSNs remains scarce. In this paper, we aim to alleviate this research gap by developing a conceptually and empirically validated taxonomy of ONSNs with a particular focus on their differentiating design properties. We further leverage this taxonomy to derive four distinct archetypes of ONSNs based on a cluster analysis. With our research we provide a first and structured overview on the domain of ONSNs and support researchers and practitioners in analyzing, designing and selecting ONSNs.

Keywords: online neighborhood social networks, local social networks, social media, taxonomy research, cluster analysis

12.1 Introduction

Social network sites (SNS) are ubiquitous in our everyday use of information technology. More than forty percent of the world's population and more than seventy percent of all internet users are active on social media [1]. Besides the continuous growth of behemoths such as Facebook [2], there is an increasing number of niche social networks which enjoy rising popularity. These SNS cater to specific audiences, ranging from academics (ResearchGate, Academia) to designers (Behance, Dribble) or athletes (Runtastic, Strava), among others, and offer thematic features, focus as well as a community of likeminded individuals. Specialized sub-communities can also be observed on traditional SNS, for example in the form of Facebook groups, evoked by segmentive and negative network effects [3]. Online neighborhood social networks (ONSNs) represent a type of social network which affords users the ability to engage in activities such social interaction with neighbors, sharing of information on local issues and neighborhood volunteering [4]. Among niche social networks, they are unique not only in their topical focus on neighborhood-related issues but also because they consist of several sub-communities, each representing the inhabitants of a delimited geographic area. Previous research has demonstrated promising effects of ONSNs such as improved relationships between neighbors or an increase in neighborly communication and activities [5]. With 236,000 registered neighborhoods [6], San Francisco-based Nextdoor is the largest among these platforms. In Europe, Berlin-based nebenan has recently surpassed the one million user mark [7]. Despite this increasing popularity, extant research on ONSNs remains scarce. While some studies investigate ONSNs and related issues [4, 8, 9], academic literature lacks a comprehensive framework for their classification. We aim to contribute to closing this research gap by providing a systematic overview of the domain of ONSNs. As we observe a lack of design knowledge on ONSNs, we focus on principal differences in their design, i.e. their differentiating design properties. We formulate the following research question:

RQ: What are the conceptually and empirically validated design parameters of neighborhood social networks?

To answer this research question, we develop a taxonomy of ONSNs based on the methodology for taxonomy development presented by Nickerson et al [10]. Taxonomies are particularly useful to shed light on emerging phenomena [11] such as ONSNs. In line with previous taxonomy research in information systems (IS) [12, 13], we further leverage our developed taxonomy to derive a set of archetypes which represent repeating patterns of platforms among ONSNs. In the course of our research, we develop a first and comprehensive taxonomy of ONSNs, identify four distinct clusters of platforms and derive implications regarding the design of ONSNs. The contribution of our research is twofold. We support researchers and practitioners in the fields of social media, community and neighborhood research as well as smart cities and communities in analyzing, designing and selecting ONSNs. Our research sheds light on the quickly evolving topic of niche social networks and OSNS which have received little attention in previous research on social media. In the following Section 2, we present related work on ONSNs as well as taxonomy research in IS. Section 3 details our methodology, including taxonomy development and cluster analysis. In Section 4, we present our taxonomy and describe its dimensions and characteristics. We define archetypes of ONSNs in Section 5. Finally, we discuss theoretical and practical implications of our research in Section 6 and conclude with a summary and limitations of our work in Section 7.

12.2 Related Work

12.2.1 Online Neighborhood Social Networks

Connecting neighborhoods via the internet has a long tradition in the form of community informatics, 'the application of information and communications technology (ICT) to empower community processes' [14, p. 11]. Projects such as the Blacksburg Electronic Village provided neighbors with functionality for chat, email lists, discussion boards and local business listings as early as 1993 [15]. These artifacts were able to overcome spatial, temporal and social barriers to communication and enabled civic engagement among neighbors. Today's SNS harbor significant potential for increasing neighborliness through localized usage [16]. On SNSs such as Facebook, cumulative and segmentive network effects have resulted in the organic formation of city and neighborhood-level communities in the form of groups [3]. These groups can serve as grounds for discussion of local issues while restricted access groups enable neighbors to establish communities of trust among themselves [17].

ONSNs aim to provide a dedicated space for these neighborhood-centric communities. As to avoid confusion between ONSNs and the existing term of neighborhood social networks used in the social sciences, we choose *online neighborhood social networks* as a suitable term to describe the focal phenomenon. ONSNs can be classified as a private and local type of SNS [18]. They are private in that they restrict access to a specific group of individuals – neighbors – and are not open to the general public. They are local as they relate to a spatially delimited area or place, the neighborhood. The term *neighborhood* can be defined from various perspectives based on criteria such as administrative boundaries, an area's history or characteristics and perceptions of its inhabitants [19, 20]. We define an ONSN as a social network site whose intended audience comprises the inhabitants of one or more neighborhoods and whose thematic focus lies on neighborhood-related issues. Most ONSNs seem to share a common set of features and traits. They are free-to-use but often require users to verify their address to confirm their neighbor status. Each neighborhood represents a separate sub-community, limiting user-generated content to an audience of neighbors. Users possess a profile page and can access a directory of neighbors, exchange information on local issues, request and provide recommendations regarding local service providers as well as offer goods and services on a marketplace. However, literature on ONSNs remains scarce. Vogel et al. [4] propose an age-friendly digital neighborhood platform which aims at increasing social connectedness of the elderly. Masden et al. [8] analyze the ONSN Nextdoor and attest potential for fostering community connectedness. Further studies on ONSNs propose an app-based platform for fostering co-production in the neighborhood and a cross-generational neighborhood network [9, 21].

12.2.2 Taxonomy Research in Information Systems

Taxonomies, defined as 'conceptually or empirically derived groupings of dimensions and characteristics' [11, p. 13], enable researchers and practitioners to structure and analyze complex domains and the ordering of disorderly concepts [10]. While the IS discipline lacked thematic methodological guidance for taxonomy development for a long time, Nickerson et al. [10] presented a method for taxonomy development for IS research. They base their methodology on existing approaches from information systems, computer science and business research. Widespread use of this method can be observed, including cases in the context of social media research. Notable examples include taxonomies of organizational social media use [22], and social reading platforms [12]. Nickerson et al.

[10] define a taxonomy as a set of dimensions each consisting of a set of mutually exclusive and collectively exhaustive characteristics that sufficiently describes objects in a specific domain of interest. Characteristics are considered mutually exclusive and collectively exhaustive if each object has one and only one characteristic in each dimension. Development kicks off by determining a meta-characteristic as a foundation for all other characteristics in the taxonomy. Next, ending conditions for the taxonomy development are to be determined. Nickerson et al. [10] provide a set of subjective and objective ending conditions. Characteristics and dimensions are determined iteratively using a conceptual-to-empirical or empirical-conceptual approach. The conceptual-to-empirical approach entails the deduction of characteristics based on a researcher's notions regarding a particular domain, supported for example by extant literature. In the empirical-to-conceptual approach, a set of objects is selected and common characteristics among these objects are identified based on the meta-characteristic. The combination of conceptual and empirical phases suits our case of ONSNs where extant literature remains scarce. These characteristics can in turn be grouped, leading to the formation of new or revision of existing taxonomy dimensions. The taxonomy development concludes once all ending conditions are met.

12.3 Methodology

12.3.1 Research Design

Our overall research design consists of (1) a literature review on ONSNs, (2) the identification of real-world ONSNs, (3) the development of a taxonomy of ONSNs and finally (4) the definition of archetypes of ONSNs via cluster analysis (see Figure 1). In the following sections, we provide a description of our conducted research steps.

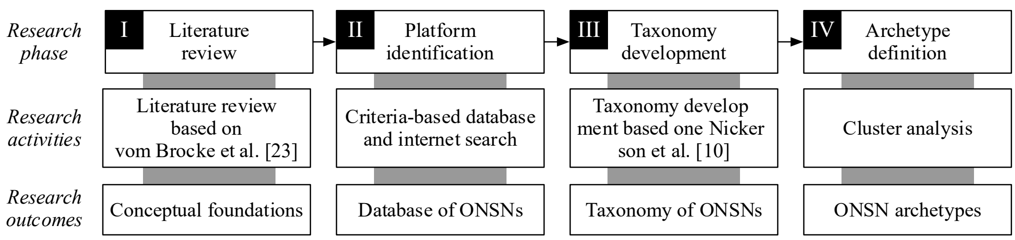

Figure 1. Overall research design

12.3.2 Literature Review

We conduct a structured literature review on ONSNs in order to gain an understanding of the subject and as input for the taxonomy development process. We follow guidance by vom Brocke et al. [23] and search citation indexing services (Google Scholar, Scopus, Web of Science) and bibliographic databases (ACM Digital Library, AISeL, Business Source Complete, IEEE Xplore, ProQuest ABI Inform and Springer Link), limiting our search to peer-reviewed results where possible. After a cursory search, we choose combinations of *neighborhood*, *community*, *social media*, *social network* and *platform* as the most productive terms. Articles included in our review analyze or implement artifacts fitting our definition of ONSNs presented in Section 2.1. Including backward and forward search and excluding duplicates, we identify 8 relevant articles (see also Section 3.4). The final iteration of our review was conducted in July 2019.

12.3.3 Platform Identification

In order to identify relevant objects for classification in our taxonomy, we perform a criteria-based search using online databases and the Google search engine. We search the crunchbase (crunchbase.com) and CB Insights (cbinsights.com) company databases as well as the iOS App Store and Google Play Store. We utilize combinations of the search terms *neighborhood*, *community*, *local*, *social media*, *social network*. For each identified platform we also perform a web search for corresponding competitors. We shortlist platforms which (1) fit our definition of ONSNs as presented in Section 2.1 and (2) are in operation at the time of analysis. We thereby exclude platforms which have a neighborhood focus but do not fit our definition of ONSNs (e.g. security-only platforms such as Neighbors by Ring) and local social networks without a specific neighborhood focus (e.g. local shopping apps such as Wiva). Where possible, we create user accounts and make direct observations. We supplement this data by analyzing the platforms' knowledge databases, FAQs as well as publicly available materials such as presentations and media reports. Based on these criteria, we identify a total of fifteen ONSNs which are listed as part of our description of ONSN archetypes in Section 5.

12.3.4 Taxonomy Development

Following the methodology presented by Nickerson et al. [10] as well as recommendations made by Oberländer et al. [11], we aim to provide a comprehensive account of our rigorous taxonomy development process. Figure 2 displays an overview of the evolution of our taxonomy of ONSNs across its five iterations. Initially, we define *design properties of online neighborhood social networks* as the meta-characteristic for our taxonomy as it is aimed at researchers and practitioners who intend to analyze, design or use ONSNs. We adopt both the objective and subjective ending conditions proposed by Nickerson et al. [10]. We commence the taxonomy development process by using the conceptual-to-empirical approach and leverage the results of our previously conducted literature review to determine an initial set of dimensions.

We extract the dimensions *neighborhood delimitation* [4], *local facilitation* [4, 5, 9, 15, 24, 25], *identity verification* [4, 9], *real-name policy* [4, 8, 9, 21], *sub-communities* [5, 8, 9, 15, 21, 24] and *channels* [4, 9]. Subsequently, we analyze our sample of ONSNs using the empirical-to-conceptual approach. In the second iteration, we analyze the largest ONSNs based on number of users, Nextdoor and nebenan. By contrasting these ONSNs with each other and the artifacts described in literature, we can identify several differentiating characteristics and group them into the dimensions *availability*, *ownership*, *neighborhood formation* and *invitation mechanism*. In both the third and fourth iteration, we include the entirety of our identified platforms in the analysis. We are able to define *monetization*, *intra-platform audiences, user-to-user relationships* and *extra-platform visibility* as novel dimensions as they provide differentiating characteristics for our taxonomy. In the fifth and last iteration, all ending conditions were met and we therefore concluded the taxonomy development process.

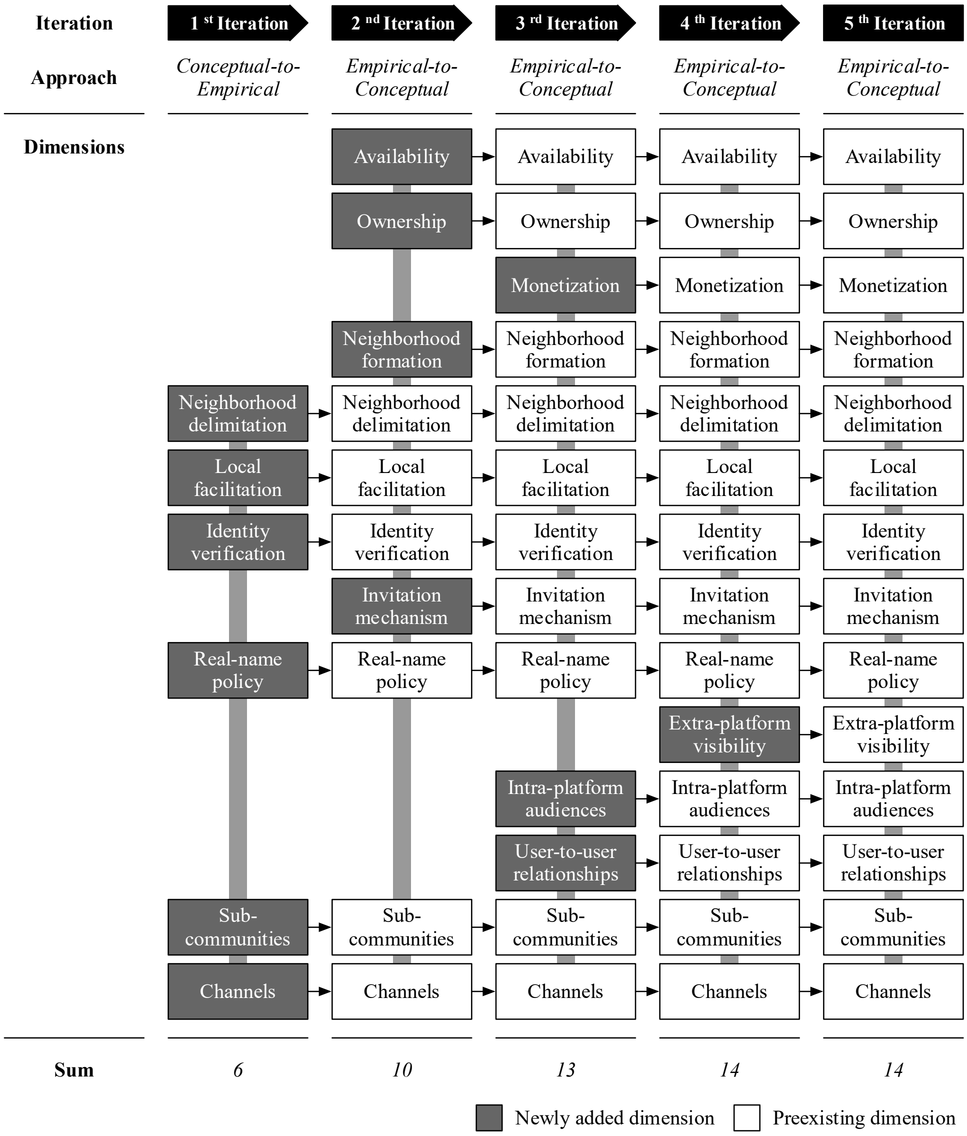

Figure 2. Evolution of taxonomy dimensions (adapted from [13])

12.3.5 Archetype Development

Archetypes represent typical or ideal configurations of object characteristics [26], in our case the design properties of ONSNs. In the last step of our research process, we empirically determine archetypes of ONSNs by performing a cluster analysis using our developed taxonomy. Via cluster analysis, a set of objects is grouped in a way so that objects in the same cluster are more similar to each other than to objects in other clusters [27]. We first calculate the Euclidian distance between our ONSNs to determine their similarly. Subsequently, we apply hierarchical clustering using Ward's method in order to ascertain an appropriate cluster count by observing the resulting cluster dendrogram. Additionally, we inspect the silhouette scores for various potential cluster counts in a preliminary k-means [28] clustering. Based on this pre-analysis, we choose four clusters as the most promising cluster count and perform our final k-means clustering using the k-means++ algorithm [29], resulting in the clusters presented in Section 5. We performed all data analysis actions using the Orange Data Science Toolkit.

12.4 Taxonomy of Online Neighborhood Social Networks

Our taxonomy consists of forty-one mutually exclusive and collectively exhaustive characteristics grouped into fourteen dimensions (see Table 1). We further induce the four overlying meta-categories *Operating model*, *Neighborhood*, *Trust & identity* and *User & content* from the final set of dimensions. In the following, we provide a description of each of our defined taxonomy dimensions.

D_1 Availability – ONSNs in our sample pursue varying approaches regarding their availability. While some platforms are available only in selected neighborhoods, other platforms have a national or multi-national presence. A small number of platforms possesses no restrictions regarding availability and is available globally.

D_2 Ownership – Our analyzed ONSNs are either owned and operated by a private, for-profit company or by a public organization or institution.

D_3 Monetization – Monetizing SNSs represents a complex challenge with ONSNs being no exception [30]. While most analyzed platforms are either nonprofit or funded by venture capital, endeavors towards monetization can be observed. These include advertising in the form of sponsored posts, paid listings (e.g. real estate listings), subscriptions for local businesses and neighbors or combinations of these options.

D_4 Neighborhood formation – New neighborhoods are initialized on the initiative of either neighbors or platform providers. Most platforms initialize a new neighborhood only on the request of a neighbor located outside of the boundaries of all preexisting neighborhoods. Other ONSNs proactively initialize neighborhoods themselves and subsequently engage neighbors in order to generate interest in the platform.

D_5 Neighborhood delimitation – We observe a variety of neighborhood delimitation strategies. A number of platforms relies on neighbor's contextual knowledge on neighborhood boundaries and entrusts them with the task of delimiting new neighborhoods. Other platforms arbitrarily define neighborhood boundaries without neighbor input based on considerations such as population density or simply follow municipal boundaries. The remaining platforms in our dataset provide each neighbor with an individual, radius-based neighborhood.

D_6 Local Facilitation – Local facilitation can take the form of marketing activities, neighbor-onboarding or community management. Some ONSNs institute a key user concept of 'Founding Members' or 'Leads' in each neighborhood to perform the aforementioned tasks. Others are tightly integrated with professional neighborhood management services which provide local facilitation.

D_7 Identity verification – ONSNs may require users to verify their identity (name and address) as a precondition for sign-up. Self-service options include verification by submitting a copy of a photo ID or a copy of an official invoice, sharing one's device location, entering a code provided via a mailed letter or postcard and other options. Some platforms offer in-person verification by providing government ID in a local neighborhood management office.

D_8 Invitation mechanism – Some ONSNs offer verified users the ability to invite neighbors onto the platform, sometimes circumventing the need for identity verification for the new user. While most platforms offer a simple online invitation mechanism via sharing a customized link (e.g. via email or instant messenger), more sophisticated mechanisms include printable flyers which can be distributed by users in their building or neighborhood as well as an automated dispatch of postcards to specific neighbors.

Table 1. Taxonomy of online neighborhood social networks

	Dimensions	Characteristics				
Operating model	D_1 Availability	Global	Multi-country	Single-country	Selected cities	Selected neighborhoods
	D_2 Ownership	Private company	Public organization			
	D_3 Monetization	Advertising	Advertising + subscriptions	Advertising + paid listings	No monetization/nonprofit	
Neighborhood	D_4 Neighborhood formation	Platform-initiated	Neighbor-initiated			
	D_5 Neighborhood delimitation	Municipal boundaries	Arbitrarily neighbor-defined	Arbitrarily platform-defined	Radius-based	
	D_6 Local facilitation	Key user concept	Neighborhood management service	None		
Trust & identity	D_7 Identity verification	Self-service	Self-service + in-person	None		
	D_8 Invitation mechanism	Online	Online + offline	None		
	D_9 Real-name policy	Enforced	Encouraged	None		
User & content	D_{10} Extra-platform visibility	Fully platform-exclusive	Optionally semi-public			
	D_{11} Intra-platform audiences	Own + bordering neighborhoods	Own neighborhood only			
	D_{12} User-to-user relationships	Available	Not available			
	D_{13} Sub-communities	Groups	Groups + building-level communities	None		
	D_{14} Channels	Website	Mobile app	Website + mobile app		

D_9 **Real-name policy** – There are a number of tradeoffs between anonymity and identifiability on SNS. While anonymous usage may provide a sense of privacy and encourage users to freely and honestly express their views, being identifiable on SNS may lead to stronger social connections, allows for reputation building and serves as a trust-enhancing factor between peers [31]. ONSNs which require identity verification (see D_7) automatically implement a real-name policy. Platforms which are more lenient regarding identity verification typically lack the means to enforce a real-name policy although some encourage usage of one's real-name in their community guidelines and reserve the right to remove accounts with false names. A third group of platforms explicitly has no real-name policy and remains neutral towards name usage.

D_{10} **Extra-platform visibility** –Some analyzed platforms allow neighbors to optionally expose their user-generated content to the general public, for example via link-sharing or by rendering the content traceable on search engines. This allows users to share for example event invitation with contacts which are not registered on the ONSN. In case of this extra-platform sharing, privacy-sensitive information such as the identities of users who liked a submission are not visible outside of the ONSN.

D_{11} **Intra-platform audiences** – A number of analyzed platforms pursue a concept of 'bordering neighborhoods'. Neighbors can optionally scale the audience of their submissions to include neighbors in bordering neighborhoods on the same platform, for example when trying to reach a larger audience when promoting an event with cross-neighborhood relevance.

D_{12} **User-to-user relationships** – Although user-to-user relationships and the resulting traversable social network are principal in the definition of SNSs [18], the functionality for establishing direct, one-to-one relationships by for example adding neighbors as contacts, friends or by following neighbors is not available in all ONSNs.

D_{13} **Sub-communities** – Most ONSNs enable neighbors to create sub-communities in the form of groups which provide a public or private space related to specific topics of interest. A number of ONSNs automatically creates a sub-communities for all registered neighbors living inside of the same building.

D_{14} Channel –The majority of platforms in our sample provides both a website and mobile app as means of access, however we observe some instances in which platforms are website or app-only.

12.5 Archetypes of Online Neighborhood Social Networks

Based on our cluster analysis described in Section 3.5, we identify four archetypes amongst our fifteen analyzed objects. The crosstab analysis presented in Table 2 illustrates the incidence of characteristics inside each cluster.

Archetype A: Strong neighbor-integration, growth-oriented: ONSNs in this cluster employ advanced monetization strategies, including subscriptions for neighbors and businesses, paid advertising and paid listings for classifieds or real estate. They further exhibit a growth-orientation and leverage their registered neighbors in plentiful ways to this end: they enable neighbors to initialize new neighborhoods, to define neighborhood boundaries and employ a key user concept for local facilitation. Thereby, much of the effort required for growing the platform's audience is crowdsourced to neighbors. Numerous offline and online invitation mechanisms contribute further to this growth-orientation. They strike a compelling balance between user trust, privacy and content reach: they do require identity verification and enforce usage of real-names but also implement a bordering neighborhood concept and allow content to be published semi-publicly if desired. By doing so, neighbors can choose to address a wide audience inside the ONSN itself and also do not run the risk of locking their content to the platform with non-neighbors being unable to access it. ONSNs in this cluster: nebenan (nebenan.de), Neighbourly (neighbourly.co.nz) and Nextdoor (nextdoor.com).

Table 2. Crosstab analysis results based on cluster analysis

	Dimension	Characteristic	Archetypes (# ONSNs) A (3)	B (3)	C (5)	D (4)
Operating model	D_1 Availability	Global	0%	0%	0%	25%
		Multi-country	67%	0%	0%	25%
		Single-country	33%	0%	100%	0%
		Selected cities	0%	0%	0%	50%
		Selected neighborhoods	0%	100%	0%	0%
	D_2 Ownership	Private company	100%	0%	100%	100%
		Public organization	0%	100%	0%	0%
	D_3 Monetization	Advertising	0%	0%	20%	50%
		Advertising + subscriptions	67%	0%	0%	0%
		Advertising + paid listings	33%	0%	60%	0%
		No monetization/Nonprofit	0%	100%	20%	50%
Neighborhood	D_4 Neighborhood formation	Platform-initiated	0%	100%	0%	50%
		Neighbor-initiated	100%	0%	100%	50%
	D_5 Neighborhood delimitation	Municipal boundaries	33%	0%	0%	100%
		Arbitrarily neighbor-defined	100%	0%	0%	0%
		Arbitrarily platform-defined	0%	100%	20%	0%
		Radius-based	0%	0%	80%	0%
	D_6 Local facilitation	Key user concept	100%	0%	0%	0%
		Neighborhood management service	0%	100%	0%	0%
		None	0%	0%	100%	100%
Trust & identity	D_7 Identity verification	Self-service	100%	33%	80%	0%
		Self-service + in-person	0%	67%	0%	0%
		None	0%	0%	20%	100%
	D_8 Invitation mechanism	Online	0%	0%	60%	50%
		Online + offline	100%	0%	0%	25%
		None	0%	100%	40%	25%
	D_9 Real-name policy	Enforced	67%	100%	60%	0%
		Encouraged	33%	0%	20%	25%
		None	0%	0%	20%	75%
User & content	D_{10} Extra-platform visibility	Fully platform-exclusive	0%	100%	80%	75%
		Optionally semi-public	100%	0%	20%	25%
	D_{11} Intra-platform audiences	Own + bordering neighborhoods	100%	0%	20%	0%
		Own neighborhood only	0%	100%	80%	100%
	D_{12} User-to-user relationships	Available	0%	0%	40%	25%
		Not available	100%	100%	60%	75%
	D_{13} Sub-communities	Groups	67%	0%	60%	75%
		Groups + building-level communities	33%	0%	20%	25%
		None	0%	100%	20%	0%
	D_{14} Channels	Website	0%	33%	60%	50%
		Mobile app	0%	33%	40%	25%
		Website + mobile app	100%	33%	0%	25%

Archetype B: Publicly-owned, professional facilitation: ONSNs in this cluster are operated by public organizations or institutions such as city governments and universities. Consequently, no monetization strategy is pursued. Their availability is restricted to a handful of specifically selected and delimited neighborhoods. In case of these platforms, local facilitation is provided by professional neighborhood management services and the ONSN represents one element of a broader endeavor related to age-friendliness or smart cities and communities. Trust and privacy features are strictly implemented on these platforms, requiring self-service or in-person identity verification and usage of real-names. User-generated content is locked tightly into the ONSN, with no bordering neighborhood concept or optionally semi-public content being implemented. Included ONSNs: Meine Nachbarn (meinenachbarn.hamburg), Remishueb (remishueb.stadt.sg.ch), wirRauner (wir-rauner.de).

Archetype C: Radius-based, country-specific: ONSNs in this cluster are active in only one specific country, oftentimes possessing country-specific naming and branding. They predominantly use a radius-based approach to delimit neighborhoods, resulting in individual neighborhood boundaries which do not correspond with any traditional neighborhood delimitation concepts such as municipal boundaries. They mostly require some form of identity verification and enforce or encourage usage of real-names. While they do initialize neighborhoods on request of neighbors, they do not implement any local facilitation concept, be it using key users or professional services. User-generated content is restricted to one's own neighborhood and cannot be made visible outside of the ONSN. Platforms in this cluster include FragNebenan (fragnebenan.com), fürenand.ch (fuerenand.ch), JustMyNeighbors (justmyneighbors.com), Nachbarschaft.net (nachbarschaft.net) and ScoopLoop (scooploop.com).

Archetype D: Open, municipal boundaries: ONSNs in this cluster are characterized by their high degree of openness and low neighbor-involvement. They implement low barriers for signup as they abstain from requiring identity verification and enforcing or encouraging real-name usage. While this choice makes it easy for new neighbors to create accounts, it may also fail to create a culture of trust among members of the online community. Furthermore, these ONSNs do not require neighbors to define the boundaries of neighborhoods themselves and instead opt for adopting municipal boundaries to delimit neighborhoods. ONSNs in this cluster include GoNeighbour.Org (goneighbour.org), kiekmo (kiekmo.hamburg), lokalportal (lokalportal.de) and Meet the Neighbors (meettheneighbors.org).

12.6 Discussion

Based on our taxonomy and identified clusters, we derive implications regarding the nature and design of ONSNs along the three central themes of *openness* of ONSNs as well as *neighbor empowerment* and *neighborhood delimitation* on ONSNs. We further discuss the differences between SNS and ONSNs and highlight the role of ONSNs as socio-technical artifacts.

In the context of ONSNs, *openness* characterizes the ease of access to a platform as well as how tightly user-generated content is restricted to one's own neighborhood and the platform itself. ONSNs need to find the right balance between encouraging users to join their platform and restricting access to real neighbors in order to build trust. This trust represents a major advantage for ONSNs over traditional SNS. As a consequence, functionality which is present on both traditional SNSs and ONSNs may receive additional value, for example in case of increased trust between sellers and buyers on a local online marketplace, increased trust in recommendations made by neighbors regarding local businesses or in an increased readiness to request and provide neighborly assistance.

Neighbor-empowerment plays a critical role in ONSN design and is used extensively by some of our analyzed platforms to crowdsource tasks such as marketing, user acquisition or community management to neighbors. While this strategy may enable high growth, it in turn requires platform providers to implement robust platform governance including rules, policies and procedures which ensure the retention of control over factors such as the scope of expansion and quality of content [32].

In this context, letting neighbors define the boundaries of neighborhoods may also improve the chance of capturing already existing offline-communities of neighbors which would otherwise be at risk of being split up in case of platform-defined boundaries. As is already apparent from the discussion of possible definitions of the term neighborhood presented in Section 2.1, *neighborhood delimitation* is not a trivial task. For ONSNs, delimiting or scoping neighborhoods represents a core competency. If neighbors find boundaries on an ONSN which do not correspond with their understanding of their real-life neighborhood for example by being too extensive or too confined, they may not be inclined to use the platform. This challenge is intensified by the need of ONSNs to find an automated or semi-automated way of delimiting new neighborhoods if they hope to achieve scale. Here, our taxonomy shows that platform providers have found a variety of solutions to deal with this issue ranging from neutral, radius-based systems, directly adapting municipal boundaries or letting users delimit their own neighborhood.

We are further able to identify two properties of ONSNs which differentiate them from traditional SNS. First, when comparing our analyzed ONSNs with each other and with traditional SNSs, we find that most high-level functionality (e.g. existence of a timeline, direct messaging, user profiles or events, etc.) does not vary significantly between platforms. Therefore, features on this level were not included in our taxonomy. In consequence, however, this means that the main feature differentiating ONSNs from SNSs is the creation of a community of trust in a limited local area, realized through a combination of identity verification, neighborhood delimitation and real-name policy. If this is indeed the core competency of ONSNs, a central goal when designing ONSNs should be the further exploitation of this trust and identity management, for example in the form of third-party integrations which allow neighbors to transfer their established community of trust to other contexts and services.

Second, as a further differentiator between ONSNs and SNSs, we find that most ONSNs do not implement direct user-to-user relationships such as “friends” or “contacts” which are a defining characteristic of traditional SNS [18]. As opposed to SNS, relationships between users on an ONSN are not primarily based on their social network but on the proximity of inhabiting a common neighborhood. A closed community of neighbors may simply have no need for user-to-user relationships. However, most ONSNs do enable users to create sub-communities such as groups, allowing a further segmentation of neighbors inside the closed neighborhood.

Among our defined archetypes, Archetype B demonstrates an interest of public organizations and institutions to implement their own platforms despite the availability of solutions offered by private companies. Most likely, this is a result of a distinct need to control platform design and development, concerns regarding data privacy and the wish for tighter integration of an ONSN with existing efforts regarding neighborhood development for example via professional neighborhood management services.

Our research highlights the role of ONSNs as socio-technical artifacts whose success is determined to a large extent by the way they are embedded in their environment [33]. Considering this ensemble view of technology, ONSN providers must adequately embed their platforms into the constantly evolving social and environmental context of the neighborhood. Therefore, while the design of an ONSN may be technically sound, it is equally important to consider factors such as local facilitation, integration of organizations and institutions as well as the delimitation of neighborhoods which affect contextual integration [34], which is supported by a multilevel perspective [35]. Our taxonomy serves as a starting point for these considerations.

With our research on ONSNs, we provide a first and comprehensive overview of an increasingly relevant domain within social media which has received little attention in previous research. Our research contributes to understanding the nature of these ONSNs and enables their differentiation based on a set of conceptually grounded and empirically validated design properties. Thereby, our taxonomy can facilitate the design of new as well as the analysis and selection of existing ONSNs for researchers and practitioners. ONSN providers can utilize our defined archetypes to classify and compare their own platform with competing or alternative operating concepts. With our taxonomy and derived archetypes, we provide a common understanding and shared language for the future scholarly discussion of ONSNs.

12.7 Conclusion

Motivated by the potential of ONSNs for improving neighborhood life, their increasing popularity and a lack of research in the field, we develop a conceptually and empirically validated taxonomy of ONSNs. We leverage this taxonomy to derive four archetypes of ONSNs via cluster analysis. Based on these results, we induce implications regarding the nature and design of ONSNs. Our research is faced with several limitations. Our sample of ONSNs used for taxonomy building is biased towards English and German-language platforms, as those were the languages our search was conducted in. Furthermore, despite our cluster analysis following established procedure by employing Ward's method and the k-means algorithm [12, 13], a different clustering approach may have produced slightly varying results. Future research can utilize our taxonomy as well as archetypes and aim to extend our taxonomy with additional characteristics and dimensions based on novel conceptual and empirical insights.

12.8 Acknowledgements

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13 Designing Tool Support for Crowd-Sourced Community Initiatives on Online Neighborhood Social Networks

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Abstract

The social connectedness of a community, characterized by aspects such as social support, social trust and civic engagement, plays an important role in determining the well-being of its inhabitants. Neighborhood activism and volunteering through community initiatives can improve this social connectedness. Online neighborhood social networks (ONSNs) afford users functionality for social interaction, information sharing as well as peer-support and aim to improve community connectedness with platforms such as Nextdoor exhibiting rapid growth in recent years. However, as of yet, ONSNs do not provide specific tool support for implementing community initiatives beyond generic communication capabilities. We propose crowdsourcing as a suitable approach for mobilizing neighbors to ideate, participate in and collaboratively implement community initiatives on ONSNs. Using a design science research approach, we develop design goals and design principles for crowd-sourced community initiatives based on literature and empirical data from two case neighborhoods. We instantiate these design principles into a proof-of-concept artifact in the context of an existing ONSN. Based on our evaluation, we derive implications for establishing crowd-sourced community initiatives on ONSNs. We contribute to research on crowdsourcing and ONSNs with nascent design knowledge which guides researchers and practitioners in designing crowd-based artifacts in the context of local communities.

Keywords: online Neighborhood Social Networks, Local Social Networks, Crowdsourcing, Community Connectedness, Design Science Research, Design Principles

13.1 Introduction

The social connectedness of a community, alongside factors such as livability and equity, plays an important role in determining the well-being of its inhabitants (Hancock, 1993; Lenzi et al., 2013). This social connectedness is determined by the availability of social support, social trust, civic engagement among neighbors and community empowerment (Miller et al., 2011). Neighborhood activism and volunteering can improve social connectedness among neighbors and, in turn, boost neighborhood well-being (Gilster, 2012). Community initiatives represent one instance of neighborhood community participation. These local initiatives can be characterized as undertakings which pursue the goal of improving the well-being of a community as a whole but are too complex in scope or require too much effort to be performed by a single individual and are, therefore, implemented by a group of local volunteers. Examples can range from the organization of neighborhood festivities, a neighborhood cleanup or urban gardening day to a local flea market. Albeit active on a smaller scale, community initiatives bear similarity to grassroots movements, characterized by self-organization, the need for gaining volunteer support, self-funding and the shared goal of transforming the local community (Kuznetsov et al., 2011). While local governments may support the goals of community initiatives, they are inherently bottom-up undertakings, ideated, planned and implemented by an autonomous group of citizens.

Online neighborhood social networks (ONSNs) represent a category of social network sites (SNS) which aims to improve the connectedness of communities, affording their users functionality for information sharing, social interaction and peer-support (Vogel et al., 2019). Typically, an ONSN houses several separate sub-communities, each representing one geographically delimited neighborhood and its inhabitants. The popularity of ONSNs is on the rise globally, San Francisco-based Nextdoor.com leading the charge across North America, Europe and Australia with more than 247,000 active neighborhoods as of 2019 (Nextdoor, 2019). Despite community initiatives lying in the target domain of ONSNs, as of yet, these platforms do not offer any specific tool support for their ideation, organization or implementation beyond generic communication capabilities (Vogel et al., 2020).

In a local and community context, crowdsourcing has presented itself as a suitable approach for mobilizing a local group of individuals, for example in case of participative urban design (Mueller et al., 2018), urban planning (Seltzer and Mahmoudi, 2012) or citizen science (Lukyanenko et al., 2011). Defined as the outsourcing of a task previously performed by a designated agent to a large group of individuals via an open call (Howe, 2006), crowdsourcing has been demonstrated to be able to produce innovative ideas and to enable collaborative problem-solving (Hammon and Hippner, 2012). The implementation of community initiatives via ONSNs exhibits characteristics which make them particularly well-suited for a crowd-based approach (Brabham, 2013): (1) the existence of a task in need of being performed, (2) the availability of a crowd willing to perform the task voluntarily, (3) an online platform for interaction between members of the crowd and (4) a mutual benefit for the crowd and platform provider. Therefore, we propose that ONSNs represent an appropriate environment for implementing a crowd-sourced approach to community initiatives and that these initiatives stand to profit from principles of openness, such as strengthened transparency, access, participation and democracy (Schlagwein et al., 2017). As in existing cases of community crowdsourcing, members of the crowd are tasked primarily with ideation, prioritization or problem solving but not with the implementation of solutions, we further determine a lack of design knowledge in this regard. Consequently, we formulate the following guiding research question:

RQ: What are design principles for crowd-sourced community initiatives on online neighborhood social networks?

We answer this research question by defining ten design principles for crowd-sourced community initiatives based on four design goals and instantiating these design principles into a proof-of-concept artifact in the context of a case ONSN. By doing so, we contribute to research on crowdsourcing and ONSNs by providing nascent design knowledge (Gregor and Hevner, 2013) to address the important real-world issue of improving community connectedness and community well-being through crowd-sourced community initiatives. The remainder of this paper is structured as follows: Section 2 provides an overview of related work on ONSNs as well as crowdsourcing in a local and community context. Section 3 describes our applied research methodology, including our case ONSN and research design. In Section 4, we define design goals and design principles for crowd-sourced community initiatives. We implement an instantiation of these design principles in Section 5 and present insights from our evaluation in Section 6. We discuss the results of our research and its contributions and limitations in Section 7 and conclude with a summary and outlook in Section 8.

13.2 Related Work

13.2.1 Online Neighborhood Social Networks

Online neighborhood social networks are social network sites whose audience is restricted to the inhabitants of a single or multiple spatially delimited neighborhoods and whose thematic focus lies on issues related to these neighborhoods (Vogel et al., 2020). ONSNs enable social interaction between neighbors, encourage peer-support and provide a platform for the sharing of information on local issues (Vogel et al., 2019). Neighborhood-centric online communities originated in the 1990s with the field of community computing (Carroll and Rosson, 1996) and have found renewed interest in the form of groups on SNS such as Facebook, affording members the possibility to discuss local issues with like-minded individuals (Ilena et al., 2011; Voskresenskiy et al., 2017). Today, the largest ONSN platforms include Nextdoor.com with more than 20 million monthly active users globally (Hwong, 2017), nebenan.de and its derivatives across several European nations with more than one million members (Magazin, 2018) and Neighbourly.co.nz with almost three-quarters of a million members in New Zealand (Lovell, 2019).

The term neighborhood can be defined from a variety of perspectives based on an area's municipal boundaries, its history or socio-economic factors (Sampson et al., 1997). Similarly, ONSNs employ varying mechanisms when defining neighborhood boundaries, including radius-based approaches, administrative boundaries, neighbor-defined boundaries and platform-defined boundaries (Vogel et al., 2020). Potential users are allocated to a neighborhood via their residential address, often in combination with mandatory address verification. In their functionality, ONSNs are very similar to traditional SNS (Vogel et al., 2020). Accessible for free via web and mobile apps, they offer a news feed to which users can make contributions and interact with contributions of other users, user profiles, private messaging between members, neighbor directory and calendar, marketplace, public and private groups, organizational and business profiles as well as other minor features. The central differentiating feature between SNS and ONSNs lies in the segmentation of users into delineated sub-communities on a per-neighborhood basis (Vogel et al., 2020).

A number of studies which analyze or propose artifacts fitting the definition of ONSNs can be identified in literature. Addressing the challenges of an ageing population, Vogel et al.

(2019) conceive an age-friendly digital neighborhood platform while Renyi et al. (2018) propose a cross-generational neighborhood network. Antonini et al. (2016) propose a platform for fostering local co-production on a neighborhood level while Masden et al. (2014) investigate the commercial ONSN Nextdoor and attest potential for increasing community connectedness. Both commercial ONSNs and those proposed in literature lack specific, enabling functionality for the implementation of community initiatives. While they provide generic communication support and do enable publishing of and interacting with calls to such initiatives in the form of textual posts or event invitations, there are no capabilities for collaboration between neighbors to develop these initiatives from ideation to implementation.

13.2.2 Crowdsourcing in Local and Community Contexts

Crowdsourcing describes the combination of a "bottom-up, open and creative process with top-down organizational goals" (Brabham, 2013, p. 15). It can be defined as the process of (1) a requestor identifying a specific task to be performed, (2) the requestor broadcasting the task online, (3) the crowd performing the task and finally (4) the requestor selecting the best solution or synthesizing the crowd's results in a meaningful way (Nakatsu et al., 2014). Crowdsourcing offers various potential benefits, such as access to heterogeneous, valuable knowledge, a reduction in cost and time for task execution as well as externalization of risk (Ye and Kankanhalli, 2013). Popularized by Howe (2006), crowdsourcing has found a variety of applications, ranging from crowd-sourced innovation contests (Blohm et al., 2013), microtask crowdsourcing (Deng et al., 2016) to crowdfunding as an alternative to traditional financing mechanisms (Gleasure et al., 2019; Gleasure and Morgan, 2018), among others (Durward et al., 2016). Despite well-known crowdsourcing platforms being operated by for-profit organizations (Blohm et al., 2017), the approach has disseminated into non-commercial contexts, such as charities, research institutions or governments (Cullina et al., 2016; Estellés-Arolas and González-Ladrón-de-Guevara, 2012).

Blohm et al. (2017) propose four types of crowdsourcing platforms: microtasking, information pooling, broadcast search and open collaboration. Similarly, Nakatsu et al. (2014) propose a taxonomy of crowdsourcing, differentiates between contractual hiring, distributed problem-solving, new idea generation and reciprocal collaboration while Geiger et al. (2012) propose crowd processing, rating, solving and creation as categories.

The implementation of community initiatives does not represent an ideal fit for any of these categories outright. Considering the example of a neighborhood festival, the tasks constituting this initiative are highly heterogeneous and performed both online and offline: while parts of the ideation and planning can be performed online, the actual implementation is an inherently local task, takes place offline in the neighborhood and is not information-intensive. Furthermore, while the tasks may be too effort-intensive to be performed by a single individual, they are not complex compared to, for example, the realization of some innovative products proposed on crowdfunding platforms. Regarding the planning aspects of an initiative, open collaboration as proposed by Blohm et al. (2017) may represent the most fitting category. In case of ONSNs, individuals inhabiting a particular neighborhood – neighbors – constitute the crowd that participates in the crowdsourcing process. Due to access restrictions such as address and identity verification, the crowd is a specific group of individuals as opposed to the general public (Cullina et al., 2016), characterized by its geographic location.

Crowdsourcing with a crowd of citizens or in the context of issues tied to a certain geographic area has been applied for a variety of goals in previous research. Lukyanenko et al. (2011, p. 1) describe the concept of citizen science, "the voluntary participation of amateur scientists in scientific endeavours". Mueller et al. (2018) engage a crowd of citizens for participatory urban design. Brabham et al. (2010) and Seltzer and Mahmoudi (2012) employ crowdsourcing to involve citizens in public planning processes. Roth et al. (2013) describe the successful application of crowdsourcing for regional and urban development while Royo and Yetano (2015) describe the application of crowdsourcing to address municipal environmental issues. Furthermore, crowds of citizens have been involved in the process of policymaking by various means (Prpić et al., 2015). When compared to the focal case of crowd-sourced community initiatives, these studies have a much larger scale and their outcomes often have implications far beyond the neighborhood on a city, regional or national level. Members of the crowd are envisaged as providers of ideas, data and information, perform prioritization, make decisions or solve problems. However, they are usually not involved in the local, real-world implementation of their proposed ideas as it is the case with crowd-sourced community initiatives.

13.3 Methodology

13.3.1 Project setting: the MyNeighbors ONSN

Our research is situated in the context of the ONSN *MyNeighbors*. MyNeighbors is being developed and evaluated as part of an ongoing research effort in the context of improving the connectedness and age-friendliness of local communities (Grotherr et al., 2020; Vogel et al., 2019). The ONSN platform integrates with professional services regarding neighborhood management, health counseling and digital inclusion. Neighborhood managers act as facilitators on the platform while other project partners engage with neighbors to promote relevant offerings. In the current state, MyNeighbors is available in two case neighborhoods in a large German metropolitan area and possesses around 150 registered users after its launch in the late summer of 2019. One case neighborhood is located roughly seven kilometers from the city center, possesses around 3,000 inhabitants and is predominantly residential in nature. The other case neighborhood is considerably more urban, featuring a mix of residential and commercial zoning with around 7,000 inhabitants and is located roughly three kilometers from the city center.

Signup on MyNeighbors necessitates an address verification. MyNeighbors's set of functionality is typical for ONSNs (Vogel et al., 2020): neighbors possess a profile page where they can provide a profile picture, contact data and can use a tag-based system to specify hobbies and interests to identify like-minded neighbors. A neighbor directory lists registered neighbors in one's neighborhood that can be contacted via a messaging system. Neighbors can make posts to an activity stream, for example announcements or requests for peer-support. Neighbors and professional actors are furthermore able to create events that are listed in a neighborhood calendar. Local organizations present themselves and their health-related offerings on the platform. Figure 2 provides an impression of the look and feel of MyNeighbors. Embedding our research on crowd-sourced community initiatives into the context of the MyNeighbors ONSN provides us with two benefits. First, we get access to a real, active user base of neighbors, neighborhood managers and other actors on an established ONSN platform which we can leverage as a source of relevant empirical data and gain a proving ground for our evaluation. Second, we can utilize existing features of the MyNeighbors ONSN, such as user roles and profiles or a notification system and conceptually integrate them with our proof-of-concept artifact instead of developing these features ourselves or establishing a dedicated platform.

13.4 Research design

We follow a design science research approach (March and Storey, 2008) to engage a meaningful but unaddressed issue by constructing purposeful artifacts (Hevner et al., 2004), in the focal case represented by crowd-sourced community initiatives on ONSNs. Our research design follows the six-step design science research methodology proposed by Peffers et al. (2007) (see Figure 1).

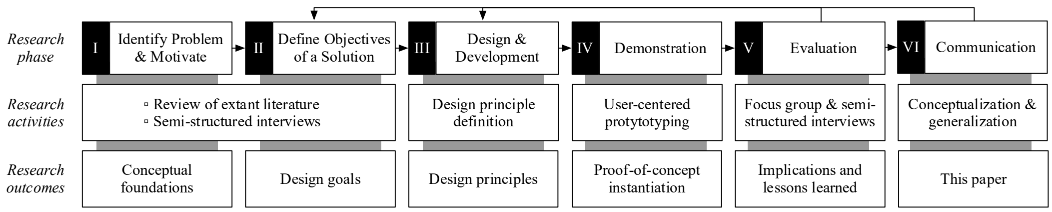

Figure 1. Research design, activities and outcomes based on Peffers et al. (2007)

For the **(I) Identify problem & motivate** as well as **(II) Define objectives for a solution** step, we draw on literature on crowdsourcing, particularly in a local and community context, and on ONSNs as well as semi-structured interviews (Myers and Newman, 2007). In a first round of interviews, subjects included five neighborhood managers, one neighborhood health counselor and two case neighborhood inhabitants. All subjects were familiar with the MyNeighbors ONSN and were recruited based on their previous participation in the larger research project. Each interview followed a predefined interview guide which covered (1) the current state of organizing community initiatives in the case neighborhoods, (2) potential uses of information systems for supporting the organization of community initiatives and (3) feedback regarding first design elements of a potential tool for crowd-sourced community initiatives which were presented in the form of low-fidelity mockups. The interviews lasted 58 minutes on average and were transcribed semi-verbatim as well as analyzed using qualitative content analysis (Schreier, 2014) using the MAXQDA software. In an iterative open coding approach (Flick, 2014) we deductively and inductively derive codes from our interview transcripts. We arrive at a coding scheme consisting of 19 codes covering, among others, elements of current community initiative practice, challenges regarding community initiatives and potential uses of IS for community initiatives. In addition, we analyze documents provided by neighborhood managers in our case neighborhoods, such as manuals, checklists, marketing material and meeting protocols related to the implementation of community initiatives. Utilizing the results of our semi-structured interviews and extant research, we define four design goals that represent the overarching objectives of our solution. Design goals, alternatively referred to meta-requirements or design requirements (Cronholm and Göbel, 2019), describe the purpose and scope of a design theory (Gregor and Jones, 2007) and represent "generic requirements that any artifact instantiated" from a design theory should meet (Meth et al., 2015, p. 807).

Guided by these design goals, we define ten design principles for crowd-sourced community initiatives, again relying on our semi-structured interviews and extant research, in the **(III) Design & Development** step. The development of design knowledge possesses high scholarly and practical relevance (Kuechler and Vaishnavi, 2008) and design principles allow the capturing of such design knowledge related to one specific class of artifacts (Chandra Kruse et al., 2016). To maintain consistency and precision among our design principles, we follow the template presented by (Chandra et al., 2015). We perform the **(IV) Demonstration** by implementing an instantiation (Gregor and Jones, 2007) based on the defined design principles in the form of a proof-of-concept prototype, conceptually embedded in our case ONSN. With our prototype, we adopt the idea of the minimal viable product, allowing us to quickly gather insights from potential users and reducing the risk of misspending effort before validating our design knowledge. We, therefore, implement a web-based prototype based on the MyNeighbors design framework forked from Bootstrap and use JavaScript for interactive functionality. As such, our prototype is visually indistinguishable from other MyNeighbors functionality and exhibits all affordances resulting from instantiating our defined design principles (Wang et al., 2018).

Our **(V) Evaluation** follows a Human Risk & Effectiveness strategy (Venable et al., 2016) consisting of several evaluation episodes. By steadily collecting feedback on low-fidelity mockups, we present to interview subjects in our first round of interviews, we achieve a formative ex-ante evaluation. For our summative ex-post evaluation, we conduct several artificial evaluation episodes in the form of a focus group interview and further semi-structured interviews with a total of five neighbors and one neighborhood manager from both case neighborhoods. The focus group interview and semi-structured interviews are structured in three parts: (1) context, (2) demonstration and (3) feedback. In the context phase, participants are presented with a short primer on the goal of our research in the form of a simplified version of our defined design goals and principles. In the demonstration phase, subjects follow the lifecycle of one community initiative through our proof-of-concept prototype from ideation to successful implementation and follow-up communication. Features of our proof-of-concept which cannot be finally implemented in the prototype, such as recommendation algorithms or notifications, are presented as mock-ups. In the feedback phase, we engage in an open discussion with all evaluation participants following a set of guiding questions based on the ten design principles for crowd-sourced community initiatives. By doing so, we aim to assess the utility, feasibility, understandability and adaptability of our proposed design principles and instantiation (Prat et al., 2015). We conclude our research project via **(VI) Communication** of our results with this publication.

13.5 Design Goals and Design Principles for Crowd-Sourced Community Initiatives

Based on our semi-structured interviews and extant research, we define design goals (DGs) and design principles (DPs) for crowd-sourced community initiatives (see Table 1).

Any community initiative originates from an innovative idea. Jointly developing this idea into a concept that accommodates the goals and desires of all involved stakeholders and subsequently breaking down this initiative into tasks that can be performed by individual volunteers, presented itself as a key challenge in our semi-structured interviews. While crowdsourcing is particularly well-suited to produce such innovative ideas (Majchrzak and Malhotra, 2013), actions of the crowd which contribute towards implementing these ideas must be guided by achievable tasks (Zogaj et al., 2015). Our first design goal calls to ***enable the ideation and definition of achievable tasks (DG1)***. As community initiatives are too large in scope or require too much effort to be implemented by a single individual, attracting potential volunteers is necessary for their implementation. These volunteers can emanate from varying origins. In many communities, including our case neighborhoods, existing groups of volunteers are already implementing initiatives independent from any digitized approaches on ONSNs. In addition to this core group of volunteers, an open call (Howe, 2006) can activate hitherto idle neighbors. Following both avenues, the second design goal seeks to ***mobilize volunteers for initiative participation (DG2)***. Besides the fundamental challenge of attracting volunteers to a cause, subsequently motivating these volunteers to act and implement a community initiative represents a separate issue. Furthermore, looking beyond the single initiative, nurturing and maintaining a group of volunteers which continually participates not only in one but many initiatives over an extended period of time, contributes towards a culture of civic volunteering and community participation (Miller et al., 2011). Generally, identifying suitable means of motivation is paramount in any crowdsourcing endeavor (Zhao and Zhu, 2012). In consequence, our third design goal aims to ***motivate towards continuous volunteering (DG3)***. As with any project-like undertaking, the success of community initiatives is threatened by numerous risks. These can include potential interpersonal conflicts, cost and time overruns, legal liabilities and even health hazards (Gaskin, 2006). In case of crowd-sourced approaches, overall success is determined by the quality of individual contributions made by members of a crowd working towards a shared goal. In consequence, it is necessary to implement mechanisms for quality assurance (Allahbakhsh et al., 2013), leading to our fourth design goal which seeks to ***ensure success and quality of initiative implementation (DG4)***.

Table 1. Design principles and design goals for crowd-sourced community initiatives

Design Principle	Design Goals
DP-1a: Provide functionality for proposing community initiatives in order for users to be able to publish their own initiatives and to discover initiatives to participate in.	DG1
DP-1b: Provide functionality for the decomposition of community initiatives into individual tasks in order to create manageable and achievable assignments.	DG1, DG3, DG4
DP-1c: Provide collaboration tools in order for initiative supporters to jointly develop an initiative from ideation to implementation.	DG1
DP-2a: Provide functionality for the identification of potential volunteers in order for initiatives to receive sufficient support for their successful implementation.	DG2

DP-2b: Provide functionality for integrating offline planning activities and supporters in order to prevent digital exclusion and to enable trust-building episodes among supporters.	DG2, DG3
DP-3a: Provide functionality for demonstrating active initiative participants to the community in order for them to be rewarded through recognition and reputation-building.	DG2, DG3
DP-3b: Provide functionality for communicating the outcome of community initiatives in order for neighbors to be stimulated towards participating in future initiatives.	DG2, DG3
DP-4a: Provide functionality for flexible integration of professional facilitators as enablers of volunteer activity in order to overcome burdens to initiative success and to mitigate risks.	DG2, DG3, DG4
DP-4b: Provide functionality for securing the commitment of task assignees in order to ensure tasks are performed reliably and in turn initiatives are successfully implemented.	DG3, DG4
DP-4c: Provide functionality for initiative-level peer-assessment in order to ensure task quality.	DG3, DG4

Having established the objectives of our solution by defining four overarching design goals, we now define ten design principles as the principles of form and function and abstract blueprint (Gregor and Jones, 2007) for crowd-sourced community-initiatives on ONSNs. Proposing community initiatives as well as discovering and interacting with the ideas of other members of the crowd of neighbors represents the core functionality of a system for crowd-sourced community initiatives (DP-1a). To ensure achievability and manageability of an initiative, the system should support its decomposition into individual, workable tasks (DP-1b). This process is akin to task-based crowdsourcing, i.e. microtasking, where tasks are divided into fine-grained subtasks using task modularization (Zogaj et al., 2015). To accomplish tasks which surpass an individual's skill or capacity, a crowdsourcing platform needs to empower members of the crowd with collaboration capabilities (Pedersen et al., 2013). Collaboration is key to value creation in crowdsourcing as it improves outcome quality by filtering, assessing, and jointly improving contributions (Tavanapour and Bittner, 2019). We determine that a system for crowd-sourced community initiatives should entail collaboration functionality for the joint planning and execution of community initiatives (DP-1c). Crowdsourcing's ability to mobilize a large group of individuals via an open call serves as a mechanism for gaining volunteer support for ideating and implementing community initiatives. One neighbor described: *"When it's about getting information out that I'm planning something and that I need help, then such a platform with a large reach is the most important aspect."* On crowdsourcing platforms, this call can be relayed to all members, a specific subset (Cullina et al., 2016) based on its skills, demographics or past actions (Zogaj et al., 2015) or a combination of both. A tailored call based on specific criteria may increase the chance of participation and quality of results contributed by a member of the crowd. A system for crowd-sourced community initiatives should, therefore, entail functionality for identifying and activating specific members of the crowd of neighbors (DP-2a).

As community initiatives are inherently a local phenomenon and supporters likely live in close proximity to each other, offline meetups represent an important part of the planning process, serve as trust-building rituals and motivate participants through the opportunity for social interaction. Similarly, mutual trust between crowdsourcing participants is key in collaborative crowdsourcing and is a predictor of outcome quality (Pedersen et al., 2013). Crowd-sourced community initiatives offer a novel, digitized approach to organizing community initiatives. Nevertheless, in cases where community initiatives are already being successfully implemented offline, it must integrate sensibly with existing structures (DP-2b) and enhance them by attracting novel volunteers and offering an improved process for ideation and collaborative implementation. Thereby, a transfer of the trust built during offline meetups into the online collaborative space can be achieved. In the context of an ONSN, integrating offline elements such as meetups and participants may also be necessary as initiative supporters without access to the internet or the ONSN may run the risk of being excluded from participation. One neighborhood manager expressed: *"You have to keep [existing volunteers] in the loop and do offline meetups so that they don't feel excluded […]. You have to consider that if you are active online and offline in parallel."*

Crowds are activated and motivated for participation through incentivization (Brabham, 2010; Leimeister et al., 2009). While in case of organizations crowdsourcing to the general public, monetary incentives are common, in case of crowd-sourced community initiatives on ONSNs, no sponsor for this type of remuneration is available. A system enabling crowd-sourced community initiatives must, therefore, find non-monetary incentivization mechanisms, such as framing, feedback and socialization which are suitable incentivization mechanisms for open collaboration crowdsourcing (Blohm et al., 2017). Possessing a civic mindset and the opportunity to improve one's social standing and influence among a group of peers (Vianna et al., 2019) are motivating factors to build on when crowdsourcing to a community of neighbors. In this regard, one neighborhood manager stated: *"For me it's always about self-efficacy. The chance to achieve something, being proud of it and also receiving recognition for it"*. A system for crowd-sourced community initiatives should, therefore, afford members of the crowd to form a positive reputation among their peers and to obtain recognition for their efforts (Zheng et al., 2011) (DP-3a). The desire to maintain a good reputation among peers can serve as a powerful motivator (Jain, 2010), particularly with a crowd of neighbors where relations may exist outside the crowdsourcing platform. In case of traditionally organized initiatives, the successful implementation may only be known to a limited audience of neighbors or supporters. However, appealing to the altruism of crowdsourcers by publicizing implemented initiatives community-wide and framing them as success stories serves as an additional motivator and encourages participation in future initiatives (Zhao and Zhu, 2012). A system for crowd-sourced community initiatives should advertise successfully implemented initiatives to motivate neighbors for participation (DP-3b). Communicating the successful outcome further contributes towards the recognition and reputation-building of initiative supporters (DP-3a).

Open interaction of individuals on online platforms necessitates facilitation, for instance to explain and enforce platform mechanics, to encourage participation or to resolve conflicts (Leimeister et al., 2006). In the context of our case ONSN, neighborhood managers adopt this role. Regarding community initiatives, neighborhood managers can support the planning and execution (e.g. securing event permits or event locations) phases and profit from topical experience and a network of organizational and institutional partners. While facilitation may not be necessary for all types of initiatives, depending on their nature and scale it can prove a vital success factor for some and prevent adverse consequences, such as financial, legal or even health and safety incidents. Consequently, crowd-sourced community initiatives should allow for the flexible integration of facilitators when necessary to overcome burdens to initiative success and to manage risk associated with initiatives (DP-4a).

In case of traditional community initiatives, the commitment of supporters is built through personal relationships in face-to-face meetings. This process does not automatically take place in an IT-mediated context. One neighborhood manager expressed: *"Ensuring commitment online is likely much harder [on an ONSN] as the social control and social pressure to deliver is not as high as offline"*. A system for crowd-sourced community initiatives must, therefore, secure the commitment of initiative supporters through suitable mechanics (DP-4b). The quality of contributions made by members of a crowd can be assessed in a variety of ways, including manual checks by the crowdsourcer, automated checks or peer-assessment (Zogaj et al., 2015). In case of crowd-sourced community initiatives, automated checks are not feasible and manual checks or peer-assessment represent suitable candidate approaches. As in the focal case the initiator of a community initiative, the crowdsourcer, represents a peer of members of the crowd (Cullina et al., 2015), both approaches can be implementing in parallel through a feedback system which allows both the crowdsourcer and initiative participants to assess the tasks performed by their peers (DP-4c). In addition to contributing to quality assurance, implementing this feedback system serves as an additional motivational mechanism (Tavanapour and Bittner, 2018) (DP-3b).

13.6 Artifact Instantiation

The goal of our instantiated prototypical artifact is to provide users of the MyNeighbors ONSN with functionality for the collaborative implementation of community initiatives. In the following, we present this proof-of-concept artifact (see Figure 2) and the corresponding design principles.

The creation of a novel initiative takes place in a guided two-step process (DP-1a). In the first step, the creator of an initiative, henceforth called initiative manager, provides meta-data, including a title and description of the initiative and can attach images and files. He or she can designate additional MyNeighbors users as managers. Additionally, an optional target date and time as well as a location for the initiative can be specified. Next, the individual tasks which make up the initiative are added (DP-1b). However, this is not mandatory at this point in the initiative lifecycle, as tasks can also be added after an initiative has been created, for example in case all tasks are to be developed collaboratively. For each task, a title and description are provided. The description field contains a skeleton description template to ensure the initiative manager includes vital details of the task. Images and files can be attached to each task. In the second step of initiative creation, the manager can select potential volunteers from the MyNeighbors neighbor directory and invite them to join the initiative (DP-2a) that, in turn, triggers a MyNeighbors notification. In case the initiative manager has added tasks to the initiative in the previous step, he or she can also directly invite users from the MyNeighbors neighbor directory to become an assignee for specific tasks. The system automatically recommends neighbors for each task by matching task title and description with the interests of MyNeighbors neighbor profiles, based on proximity to the initiative manager and based on participation in past initiatives (DP-2a). Users that are selected will receive a notification asking them to become an initiative supporter and task assignee. During both steps of initiative creation, contact details and competencies of the responsible neighborhood managers are displayed as an offer for assistance (DP-4a). Published initiatives are displayed in the MyNeighbors activity stream and start page of the respective neighborhood where they appear alongside contributions from other categories, such as events, announcements and questions (DP-1a). Initiatives are highlighted with green color coding in order to attract the attention of neighbors.

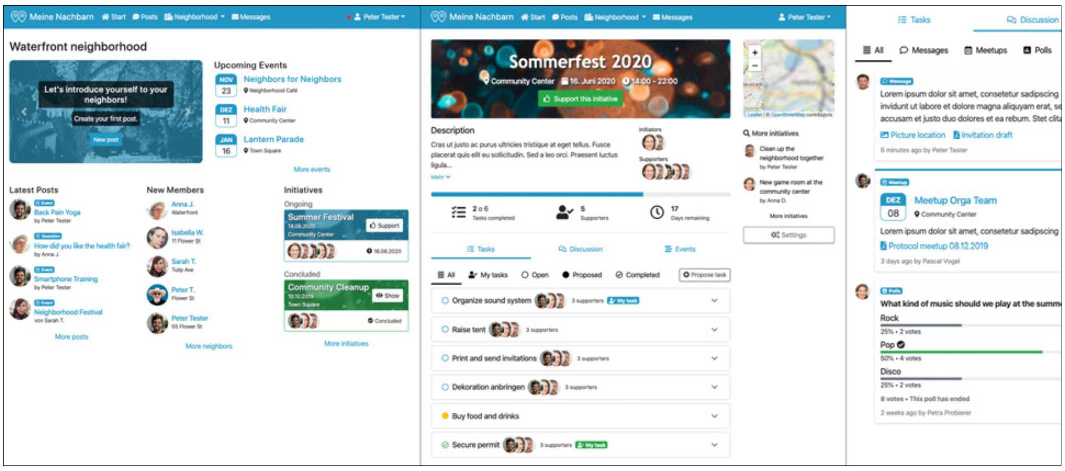

Figure 2. Community-wide call and outcome communication (left), initiative overview (middle) and collaboration functionality (right); sample data, translated for publication

The initiative detail view presents neighbors with initiative meta-data, managers and supporters and tasks (see Figure 2). Neighbors who access the active community initiative can choose to become initiative supporters by clicking the respective button. Tasks appear in a filterable list below the initiative meta-data that provides a quick overview. Each task displays its title, task assignees and its current status (proposed, open, completed). Expanding a task reveals additional information such as its description and attached files, creator, assignees as well as date of creation. After becoming an initiative supporter, neighbors can become task assignees by selecting one or more tasks and committing to their implementation. Task assignees are identified by their image, name and address (DP-4b). After performing a task, a task assignee can mark the task as completed. Initiative supporters can propose additional tasks which are subsequently added to the list of tasks with the status proposed. An initiative manager can accept or refuse the addition of this proposed task.

Collaboration functionality can be accessed by initiative supporters by clicking on the *Discussion* tab (DP-1c) (see Figure 2). A flat discussion system provides a basis for initiative-level collaboration between supporters, enabling peer-communication and contributing to motivating members for participation (Zogaj et al., 2015). Initiative supporters can add three types of messages to the discussion forum: a generic *Messages* type, *Meetup & Meeting Minutes* as well as *Polls*. The *Messages* type represents a simple text message with the addition of images or files. The *Meetups & Meeting Minutes* type allows initiative managers to announce the next initiative meetup and to upload meeting minutes after the meetup has concluded (DP-2b). Optionally, meetups can be synced to the MyNeighbors calendar to attract supporters. *Polls* provide a quick and easy decision-making tool which can be used for example to determine the date of the next meetup or which location should be used for an event. Under the *Events* tab, an automated event log lists actions performed in the context of the initiative, such as a new task being added, a neighbor committing to a task or revoking commitment. This allows initiative managers and supporters to keep an overview of the history of an initiative.

We implement a number of motivational and incentivizing mechanics. The MyNeighbors ONSN into which our artifact is embedded provides functionality for socialization, such as direct messaging between users (Blohm et al., 2017; Bretschneider et al., 2015) and user profiles which serve as a motivational factor (Leimeister et al., 2006). The availability of verified addresses and real names can serve as trust-enhancing factor on social network sites (Kang et al., 2013). We further implement a progress bar which at any point in the initiative lifecycle, displays the current progress based on completed versus outstanding tasks. A countdown timer displays the days remaining until the date set during initiative creation. These mechanics serve as additional motivational elements (Liu et al., 2017). We plug into the MyNeighbors notification system in order to reactivate initiative supporters by notifying them of significant events, such as a new message being added to the discussion forum (DP-4a). Initiative managers receive additional notifications for newly proposed tasks and new initiative supporters.

A settings page, accessible exclusively to initiative managers, holds a number of administrative functions. It allows enabling and disabling the progress bar, countdown, the possibility for proposing new tasks and displaying the initiative in the MyNeighbors neighborhood calendar. Initiative supporters can be elevated to initiative managers. Furthermore, an initiative can be marked as completed by an initiative manager. Marking an initiative as completed freezes all tasks and posts in the discussion forum. In turn, feedback can now be provided on the initiative level, consisting of text, images and files (DP-4b, DP-4c). Concluded community initiatives are communicated platform-wide on the MyNeighbors start page where they are highlighted with prominent color coding (DP-3b) (see Figure 3). A post-implementation detail view of an initiative displays a single page summary of performed tasks, initiative managers, task assignees, supporters and feedback (DP-3a).

13.7 Evaluation

During our evaluation focus group and interviews, we were able to identify a multitude of insights, which we subsequently incorporated in our design principles and artifact. In the following, we present a selection of the most meaningful observations made during the evaluation.

In general, evaluation participants described crowd-sourced community initiatives as a useful functionality and a good fit for the MyNeighbors ONSN. One neighbor summarized: *"The biggest benefit is the possibility for joint planning and to reach people specifically from your own neighborhood. It makes it easier to get into contact and to actually get ideas done."* Neighbors with experience in implementing community initiatives also valued having a single place for communication and the functionality for assigning clear responsibilities to tasks (DP-1c). Furthermore, decomposing initiatives into individual tasks (DP-1b) was seen as a motivator, as it allows volunteers to commit to smaller, achievable tasks which fit their set of skills and frees them from having to take responsibility for the initiative as a whole.

While participants recognized the value of crowd-sourced community initiatives as transparent and democratic, finely tuning who and what roles are able to access and influence different aspects of initiatives was highlighted as an issue. Transparency and democracy can motivate for participation by making tasks approachable, but some evaluation participants also feared a loss of authority. One neighbor stated: *"I think tasks should be visible to everyone […] I can decide if I am inclined and suitable to participate in this task […] Otherwise it becomes a black box where I just see a task but don't see who is participating."* However, regarding the ability to propose new tasks, some neighbors with experience in offline community initiative planning were cautious: *"This presumes a democratic way of thinking of the initiative creators […] Some may want to make top-down decisions without anyone influencing them."*

Integration with existing offline structures (DP-2b) was of high importance to evaluation participants and offline meetups were described as a key element of organizing community initiatives. One participant explained the importance of meetups: *"Something arises [at these meetups] which doesn't work digitally. A form of obligation […] A good old shake-of-hands, you can't recreate that digitally yet."* In turn, this obligation would also impact the commitment of task assignees (DP-4b) and the motivation of participants. Organizing community initiatives via MyNeighbors was seen as a useful counterpart but not a replacement of existing offline structures (DP-2b): *„If we say we will organize everything [via MyNeighbors] then that would be a meaningful complement or simplify existing processes."*

Communicating successfully implemented initiatives to the entire neighborhood was seen by participants as a motivator for current supporters and an inspiration for future ones (DP-3a, DP-3b). Evaluation participants also described seeing both the tasks and participants of past community initiatives as a template for similar new initiatives, saving time on identifying all necessary tasks and suitable supporters. As one neighbor put it, this would *"enable a form of continuity"* for recurring initiatives. Neighborhood managers saw an ambiguity in their involvement as facilitators (DP-4a). On the one hand: *"We should of course be a point of contact and initiative supporters. And maybe also take care of certain administrative or institutional tasks such as advising on fire safety."* But on the other hand:

"The neighborhood should carry and organize itself, that's kind of the whole point of neighborhood management."

Peer-assessment (DP-4c) was discussed highly controversially amongst our evaluation participants, particularly regarding the unit of assessment. On the one hand, there was a consensus that assessing individual initiative supporters or their performed tasks may result in disgruntled supporters, but on the other hand, eliciting initiative-wide feedback may lack specificity necessary for concrete improvement. One neighborhood manager expressed: *„I think rating individual [task assignees] would go a step too far. […] I wouldn't do that. The initiative in its entirety yes but individual people […] that would take the focus away from the idea of strengthening neighbourly volunteering."*

Inhibiting factors for participation were identified by evaluation participants as technological literacy and acceptance of the platform. Neighbors expressed: *"The biggest obstacle right now I would say is the number of users and intensity of [MyNeighbors] in general."* and "*The problems I see lie with the user base. Their affinity for technology. All these things require the desire to get involved. […] And you have to possess a minimum amount of skill to communicate [via MyNeighbors]."*

13.8 Discussion

Based on our findings, we derive implications for conducting crowd-sourced community initiatives on ONSNs. With the present research project, we infuse the focal phenomenon of local community initiatives with the core principles of openness: transparency, participation, democracy and access (Schlagwein et al., 2017). We make the process of organizing community initiatives transparent as we enable neighbors to propose initiatives of their own to their neighbors and to discover initiatives of others to participate in. We encourage participation through an open call and enable the participative implementation of initiatives through collaboration. This participation, in turn, empowers neighbors to actively influence life in their community and thereby democratizes the process of shaping neighborhood life. ONSNs provide fertile soil for crowd-sourced community initiatives as they house a crowd of neighbors with the shared goal of improving neighborhood well-being, matching that of neighborhood initiatives. Attracting a similarly motivated crowd to participate in community initiatives, for example via a separate, dedicated single-purpose platform, would require effort and hold challenges which can be circumvented by integrating with an existing ONSN. Furthermore, ONSN platforms provide a rich set of features, such as user profiles, identity verification, calendar and notification system which can be leveraged for crowd-sourced community initiatives. In case of the MyNeighbors ONSN, neighborhood managers proved to be valuable facilitators which transfer their existing offline role as shepherds of community life into the ONSN. Based on these findings, we consider it imperative to ensure a deep embedding of crowd-sourced community initiatives into the ONSN as well as existing real-world structures pertaining to the implementation of community initiatives. Our findings are in line with previous research stating that openness-related technologies such as crowdsourcing cannot simply be "bolted onto existing systems" (Gleasure et al., 2017, p. 339) but may depend on the ability to achieve compatibility between novel open and existing practices. Taking an ensemble view of sociotechnical artifacts (Orlikowski and Iacono, 2001), the value of an IT artifact such as the proposed system for crowd-sourced community initiatives is dependent on successful contextual embedding (Chandler and Lusch, 2015).

In our interviews and focus group, the need to design for adaptability became apparent. Community initiatives in our case neighborhoods are currently being implemented using a variety of modes of work with some groups of supporters preferring offline meetups, others relying mainly on communication via online messengers or a combination of both. While the proposed system for crowd-sourced community initiatives enables a novel, IS-supported mode of implementing community initiatives, for it to gain widespread support, it must be able to accommodate these preexisting structures. As a consequence, we propose functionally for bridging the gap between online and offline efforts, as defined in design principle DP-2b and through features, such as support for offline meetup planning. In our proof-of-concept artifact, we enable initiative managers to customize various properties of their community initiative, such as the ability of initiative supporters to propose additional tasks which may be suitable for some initiatives but not for others. Adaptability is not only paramount to accommodate different modes of work but also to include diverse types of members of a crowd. When it comes to the desire to include as many neighbors as possible in the process of implementing community initiatives, failing to design for adaptability might put certain groups, such as elderly neighbors without access to the internet or ONSN at a disadvantage, furthering the digital divide (Rockmann et al., 2018) and resulting in digital exclusion (Holgersson and Söderström, 2019). With the emergence of publicly owned ONSNs (Vogel et al., 2020), the relationship between grassroots community initiatives, which feature bottom-up, democratized decision making, and this novel type of platform provider may require reevaluation. Support by local governments may yield an increase in resources and provide novel means of expanding an ONSN's audience and thereby the number of potential initiative participants. It may, however, also result in a different type of top-down goal setting and increased oversight which may ultimately constrain open and autonomous nature of community initiatives.

With our research, we demonstrate the feasibility of crowdsourcing for a local and community context and are able to present promising evaluation results. However, we observe that successfully embedding crowd-based approaches in a community context requires specific design knowledge not yet present in literature that we aim to provide with our defined design principles and instantiation. Our design principles represent a blueprint for case-specific elements, such as addressing the crowd of neighbors on ONSNs with an open call for participation, identifying suitable volunteers via recommendations based on proximity, interests and past actions, integration of existing offline community initiative structures and facilitation via neighborhood managers, among others. We further observe that community initiatives represent a type of task with some degree of novelty when viewed in light of present crowdsourcing literature. The implementation of community initiatives somewhat fits the category of collaborative crowdsourcing (Blohm et al., 2017), yet the combination of both online and local offline activities necessary for their implementation can be viewed as a novel phenomenon. While the call, ideation, collaborative planning and follow-up for a community initiative can take place online, its actual implementation must be is primarily performed offline in the neighborhood. As discussed previously, this necessitates the design of an adaptable system which integrates these offline elements.

Throughout our research, we are met with similarities between crowdsourcing in the delineated sub-communities of ONSNs and the intra-organizational settings of internal crowdsourcing, the crowdsourcing of tasks to a crowd of employees via an open call (Zuchowski et al., 2016). Considering characteristics of internal crowdsourcing (Hetmank, 2014), in both internal and community-based crowdsourcing tasks are not crowdsourced to the general public but to a specific group of individuals. In case of internal crowdsourcing this group is characterized by affiliation to an organization while in our case of community-based crowdsourcing members of the crowd are affiliated with a certain geographic area. In both cases, this results in a limited crowd size compared to external crowdsourcing, making the approach a better fit for larger organizations and communities, respectively. Additionally, in both contexts, members of the crowd may also be better acquainted with each other compared to external crowdsourcing. This can result in positive effects, such as an increase in trust between participants but may also cause participants to refrain from participation in fear of humiliation or judgment by their peers (Grotherr et al., 2018), making a case for anonymous participation (Wagenknecht et al., 2017). Similarities are also evident regarding the design of reward systems: incentives are seldomly financial in nature but based on non-monetary rewards, personal recognition and reputation-building (Knop et al., 2017). We believe the question of whether research on internal crowdsourcing can further inform the design of community-based crowdsourcing and vice versa and warrants further investigation.

ONSNs do not differentiate themselves significantly from traditional SNS when comparing their high-level features (Vogel et al., 2020). Their key value besides a topical focus on local issues lies in the formation of a community of trust among neighbors of a particular neighborhood, enabled by neighborhood delimitation and identity verification mechanisms. Our developed design knowledge is uniquely suited for implementation on ONSNs as it leverages their inherently local user base and its shared goal of improving neighborhood well-being. Practitioners can leverage our design principles and instantiation for implementing crowd-sourced approaches in the context of local communities, particularly the implementation of community initiatives on ONSNs. In the context of smart communities, we guide in the design of crowd-based approaches aiming to improve community well-being. Furthermore, ONSN platform providers can utilize our research to enhance their own platforms with crowd-sourced elements.

13.9 Conclusion

Motivated by the potential of ONSNs to improve community connectedness and well-being as well as their fitness for crowd-based approaches, we design tool support for crowd-sourced community initiatives on ONSNs using a design science research approach. Initially, we define four design goals and ten design principles based on literature and empirical data collected from two case neighborhoods. We demonstrate the utility of these design principles via a proof-of-concept instantiation implemented in the context of a case

ONSN. Based on our evaluation, we further derive several implications, including regarding the contextual embedding and adaptability of any system for crowd-sourced community initiatives on ONSNs. With our research, we demonstrate the feasibility of crowd-sourced approaches in a local and community context and contribute design knowledge for implementing community initiatives on ONSNs. Additionally, we contribute to research on ONSNs by proposing a unique, novel functionality and support researchers and practitioners in the field of smart communities with an innovative approach to enhancing neighborhood connectedness and well-being. This research is faced with a number of limitations. Our empirical data is grounded in two case neighborhoods and gathered from a limited sample of interview and focus group participants. For the first prototypical design cycle presented in this paper, we consider this number of participants as sufficient as we plan to transition into a final design cycle with a large-scale naturalistic evaluation in combination with the MyNeighbors ONSN in the future. Such an evaluation is necessary in order to thoroughly analyze and affirm the usefulness of our proposed design principles and artifact. As the next step in our research, we plan to finalize our proof-of-concept prototype into a production level feature of the MyNeighbors ONSN and to integrate it with the ongoing holistic quantitative and qualitative evaluation of the platform.

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14 Collaborating with the Crowd for Software Requirements Engineering: A Literature Review

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Abstract

Requirements engineering (RE) represents a decisive success factor in software development. The novel approach of crowd-based RE seeks to overcome shortcomings of traditional RE practices such as the resource intensiveness and selection bias of stakeholder workshops or interviews. Two streams of research on crowd-based RE can be observed in literature: data-driven approaches that extract requirements from user feedback or analytics data and collaborative approaches in which requirements are collectively developed by a crowd of software users. As yet, research surveying the state of crowd-based RE does not put particular emphasis on collaborative approaches, despite collaborative crowdsourcing being particularly suited for joint ideation and complex problem-solving tasks. Addressing this gap, we conduct a structured literature review to identify the RE activities supported by collaborative crowd-based approaches. Our research provides a systematic overview of the domain of collaborative crowd-based RE and guides researchers and practitioners in increasing user involvement in RE.

Keywords: crowdsourcing, requirements engineering, crowd-based requirements engineering, literature review

14.1 Introduction

Requirements engineering (RE) represents a decisive success factor in software development projects (Hofmann and Lehner 2001). Traditional approaches to RE, which frequently involve techniques such as interviews of stakeholders by requirement analysts, joint workshops, participant observation or focus groups, "are inherently complex in nature – both effort and time intensive" (Sharma and Sureka 2017, p. 1) and quickly turn costly with rising stakeholder numbers. As they require co-presence, these techniques struggle to involve groups of stakeholders which are large in number or geographically distributed (Lim and Finkelstein 2012), fail to represent the diversity of heterogenous stakeholder groups (Snijders et al. 2015) and are prone to selection bias (Fernandes et al. 2012). However, the involvement of stakeholders in the RE process has been shown to be an important determinant of requirement quality and in turn overall software development project success (Zowghi et al. 2015). To overcome these shortcomings, the novel approach of crowd-based RE leverages a crowd of software users to derive software requirements using data-driven and collaborative variants or a combination of both (Groen et al. 2017). This approach enables a representative involvement of large groups of stakeholders, increases the volume and diversity of elicited requirements and enables a continuous user involvement in the RE process (Hosseini et al. 2015). In data-driven crowd-based RE, requirements are extracted by analyzing user reviews, bug reports or logfiles (Maalej et al. 2016). In collaborative crowd-based RE, stakeholders of a specific software product propose and jointly develop software requirements supported by tools such as a web-based crowdsourcing platform (Snijders et al. 2015). This collaborative approach goes beyond eliciting uni-directional feedback from software users and enables users to interact with each other and each other's proposed requirements for their joint specification or prioritization. As these collaborative approaches can be conducted asynchronously, remotely, and scale to large numbers of participants, they harbor the potential for cost and time savings.

Generally, crowdsourcing enables access to heterogenous, valuable knowledge and facilitates ideation, distributed decision making and problem-solving tasks (Ye and Kankanhalli 2013), representing a good fit for the task of defining software requirements which requires the contextual expertise and experience of software users. Collaborative crowdsourcing shows particular promise as efficient collaboration among stakeholders is also shown to lead to higher requirement quality and accuracy (Dalpiaz et al. 2017; Unkelos-Shpigel and Hadar 2015). Implementing new software features based on the wishes of software users has been shown to positively impact acceptance and user satisfaction (Fleischmann et al. 2015). In practice, software companies already leverage crowdsourcing for user involvement in RE. For example, Microsoft uses the software-as-a-service UserVoice to collect feedback from its customers on the Office 365 suite of software products (https://office365.uservoice.com/). As yet, research which surveys the state of crowd-based RE (Khan et al. 2019; Wang et al. 2019) does not focus specifically on collaborative approaches but focuses on data-driven variants instead. However, collaborative crowdsourcing seems particularly suited for RE as it excels at generating innovative ideas and enables multidisciplinary groups to work jointly on complex, knowledge-intensive tasks (Nakatsu et al. 2014). We address this research gap by formulating the following guiding research question:

RQ: How does collaborative crowdsourcing support requirements engineering activities?

To answer this research question, we conduct a structured literature review aimed at identifying (1) the RE activities supported by collaborative crowdsourcing and (2) the artifact design features affording this support and discuss our findings in light of extant research on collaborative crowd-based RE. Our findings show that while there is broad support for the RE activities of elicitation and analysis, specific functionality for requirements specification and validation is scarce. We further able to identify several artifact design features such as game elements or decision support tools which highlight different intended goals and audiences of collaborative approaches. In the following section, we briefly introduce the topics at the center of this review and present related research. Subsequently, we provide a detailed account of our applied methodology. Next, we present the results of our review and discuss their implications and identified research opportunities. We conclude this paper with a summary of results, contributions and limitations.

14.2 Related Work

14.2.1 Collaborative Crowdsourcing

Crowdsourcing can be defined as "the act of a company or institution taking a function once performed by employees and crowdsourcing it to an undefined (and generally large) network of people in the form of an open call" (Howe 2006, p. 1). Its process generally consists of (1) a requestor identifying a task to be performed, (2) broadcasting of this task online, (3) performance of the task by a crowd and (4) the selection of the best solution or synthetization of crowd-provided solutions by the requestor (Nakatsu et al. 2014). For organizations, crowdsourcing has demonstrated a variety of benefits such as the ability to remain specialized in core areas of business, cost and time reduction for task execution, access to heterogenous creative knowledge and the externalization of risk (Ye and Kankanhalli 2013). Crowdsourcing has been applied for a variety of use-cases, including the generation of innovative ideas via idea competitions, acquisition of capital via crowdfunding or for analyzing large amounts of data via microtask crowdsourcing (Brabham 2013). Among these use-cases, Nakatsu et al. (2014) describe the crowdsourcing archetype of reciprocal collaboration, a form of crowdsourcing which requires members of the crowd to cooperate beyond simple coordination by interacting with each other and sharing their individual contributions. According to them, reciprocal collaboration is suited for addressing unstructured and interdependent tasks which cannot be completed by members of the crowd single-mindedly pursuing their own self-interests. This type of crowdsourcing corresponds with the general premise of collaboration: to create value which the individual effort a of a member is not able to achieve (Briggs et al. 2009). Examples of this form of crowdsourcing include open source software and hardware development or open content projects (Nakatsu et al. 2014). Similar and related archetypes in extant literature include open collaboration (Blohm et al. 2017) or solution crowdsourcing (Prpic and Shukla 2016).

14.2.2 Crowd-Based Requirements Engineering

Requirements engineering can be defined as "the subset of systems engineering concerned with discovering, developing, tracing, analyzing, qualifying, communicating and managing requirements that define the system at successive levels of abstraction" (Hull et al. 2011, p.

8). RE comprises the two core activities of requirements development and requirements management (Wiegers and Beatty 2013). While the goal of requirements development is the definition of novel requirements, requirements management is concerned with the lifecycle of existing requirements post definition. Involving users in the RE process has been demonstrated to positively impact factors such as requirements quality, user satisfaction and the overall success of software projects (Kujala 2003; Pagano and Bruegge 2013; Zowghi et al. 2015). Crowd-based RE represents an approach for user involvement in RE which comprises “automated or semiautomated approaches to gather and analyze information from a crowd to derive validated user requirements” (Groen et al. 2017, p. 1). In case of crowd-based RE, the crowd consists of a specific group of individuals, the “current and potential users of a software product who interact among themselves or with representatives of a software company” (Groen et al. 2017, p. 1). Crowd-based RE aims to alleviate some of the challenges faced by traditional approaches to RE which rely on costly and time-consuming interviews, workshops and fail to involve large, diverse and geographically distributed groups of stakeholders (Law et al. 2012). Crowd-based RE follows a data-driven or collaborative approach. Dalpiaz et al. (2018) propose a data-driven approach by outlining the usage of natural language processing for the extraction of software requirements from a variety of data sources. In contrast, Snijders et al. (2015) present an approach for collaborative crowd-based RE by developing a method and web-based software artifact which enable stakeholders, software engineers and requirements analysts to collaboratively develop software requirements. Research on collaborative-crowd based RE is closely aligned with the definition of collaborative crowdsourcing presented above, with the definition of individual software requirements representing the unstructured and interdependent tasks to be performed by the crowd. As data-driven approaches rely on usage data, they are predominantly applied in the post-implementation phase of software products, i.e., when software users have access to a finished version of the software product. Conversely, considering the current body of research, we observe collaborative approaches to crowd-based RE to be focused on the pre-implementation phase of software products.

14.3 Methodology

We conduct our structured literature review based on established guidance by Webster and Watson (2002), vom Brocke et al. (2015) and Bandara et al. (2015), aiming to produce a systematic, transparent and reproducible review (Cram 2019). We commence with the extraction of relevant literature from a selection of databases which includes ABI/INFORM Complete (via ProQuest), ACM Digital Library, AIS Electronic Library (AISeL), Business Source Complete (via EBSCO), IEEE Xplore, ScienceDirect and Springer Link, covering important publications in IS and related fields such as software engineering. Based on an iterative scoping search (Booth et al. 2012), we identify the combination of *CROWD* AND REQUIREMENT** as the most promising search term. Other terms and term combinations such as social or collaborative RE lacked an IT-mediated focus or did not lead to relevant results. Where possible, we filter for peer-reviewed results only. Searching the fields title, abstract and keyword, we arrive at 770 hits across our selected databases. Table 1 presents our raw search results ahead of any filtering and deduplication while our final selection of included articles is available as part of a literature matrix presented in Table 2.

Table 1. Raw search hits per database (relevant articles in parenthesis, incl. duplicates)

Database	ABI/ INFORM	ACM DL	AISeL	EBSCO BSC	IEEE Xplore	Science Direct
Hits (relevant)	107 (0)	14 (3)	23 (1)	165 (1)	319 (7)	142 (1)

Based on the previously presented definitions and related work, our search is targeted at scholarly articles discussing approaches or design artifacts which (a) support one or more sub-activities of RE, (b) leverage crowdsourcing, (c) follow a collaborative approach and (d) are IT-mediated. Filtering the identified articles based on these inclusion criteria and after the removal of duplicates, we are presented with 11 relevant articles. Additionally, we conduct a backward search by analyzing each paper's references and a forward search using both the Google Scholar and Web of Science citation indexing services, adding 5 relevant articles. The last iteration of our search was conducted in December of 2019. In the analysis phase of our literature review, we perform qualitative data analysis (Bandara et al. 2015) using MAXQDA. Initially, we perform a deductive coding phase based on the RE sub-activities elicitation, analysis, specification and validation. In a second phase, we follow the

Wolfswinkel et al. (2013), conducting of open, axial and analytical coding iterations. For open coding, we analyze each article and induce themes based on artifact design features, for instance “comments” or “votes”. In the context of this work, we define design features as the individual capabilities of a design artifact (Hevner et al. 2004). During axial coding, we identify interconnections between codes and group them into higher-level categories, for instance “tags” and “full-text search” into a “information retrieval” sub-category. Finally, using selective coding, we integrate and refine the identified sub-categories, for example grouping “game roles“ and “game mechanics” into the “game elements” category. We aim to ensure the validity and reliability of our research by each coding step being performed independently by two researchers and in two iterations before results are integrated.

14.4 Results

In the following, we present the results of our qualitative data analysis regarding both (1) the RE activities supported by approaches and artifacts presented in the articles included in our review as well as (2) significant artifact design features for collaborative crowd-based RE. Table 2 provides an overview of the included articles and addressed aspects in the form of a literature concept matrix.

14.4.1 Requirements Engineering Activities

Requirements **elicitation** describes the activity of identifying the needs and constraints of a software product’s stakeholders as well as the relevant stakeholders themselves (Wiegers and Beatty 2013). As functionality for eliciting requirements was defined as a criterium for inclusion in our review, all presented artifacts support the elicitation of requirements from a crowd of software users. However, Lim et al. (2010) and Lim and Finkelstein (2012) do not directly support the elicitation of requirements but the collaborative identification of relevant stakeholders which subsequently can be queried for requirements. Elicitation in case of our analyzed artifacts takes place via software users actively and autonomously communicating their needs and requirements on a crowdsourcing platform. Most analyzed articles implement a custom web-based software artifact as the crowdsourcing platform. Seyff et al. (2015) represent a notable exception as they leverage private groups on the online social network Facebook as the basis for their crowd-based approach. Rashid et al.

(2008) complement their web-based platform with a software annotation tool which allows users to directly relate requirements to software screenshots.

Requirements **analysis** is concerned with the refinement of requirements including ensuring their quality, decomposing or merging requirements into appropriate levels of detail, identifying dependencies between requirements and negotiating their priority (Wiegers and Beatty 2013). We identify a number of quality assurance mechanisms among the analyzed artifacts. Vogel et al. (2019) prompt software users to perform a self-assessment survey during requirement submission which considers requirements quality properties such as feasibility or completeness and provides users with feedback depending on their answers. Ninaus et al. (2014) leverage model-based diagnosis (Reiter 1987) to identify inconsistencies among sets of requirements and recommended actions for restoring consistency. A number of artifacts implement functionality for branching out one requirement into several (sub-)requirements (Dalpiaz et al. 2017; Lim and Finkelstein 2012; Snijders et al. 2015) with similar functionality for merging overlapping requirements into one. In this regard, Lohmann et al. (2009) afford users the functionality to map relationships between requirements such as one requirement's correct implementation being dependent on another requirement being implemented first. Ninaus et al. (2014) use dependency detection to indicate relationships between requirements, albeit the concrete assertion of a semantic relationship falls to the stakeholders. Most artifacts support the qualitative negotiation of implementation priorities in a set of requirements via a commenting or discussion system. Offering a more structured form of negotiation, we also observe a variety of crowd-based prioritization systems. Snijders et al. (2015) and Dalpiaz et al. (2017) implement a simple binary agree/disagree scheme while Seyff et al. (2015) leverage the like mechanism of a popular online social network in similar fashion. Fernandes et al. (2012), Lim and Finkelstein (2012) and Lohmann et al. (2009) use a five-star rating system for crowd-based requirement prioritization. Klamma et al. (2011) complement a five-star rating with a price-finding mechanism which allows software users to pledge financial rewards for the implementation of a requirement. Closely related to this price-finding approach, Law et al. (2012) allocate each member of the crowd a limited budget of abstract votes which can be distributed on one or more requirements. Both approaches share resemblance to enterprise crowdfunding (Feldmann and Gimpel 2016). Other articles present a multi-criteria prioritization system: Kolpondinos and Glinz (2017) and Kolpondinos and Glinz (2019) let users rate requirements on a three-point-scale for each of the two criteria relevance (relevant, neutral, irrelevant) and popularity (like, neutral, dislike). Similarly, Yang et al. (2008) poll their users on the criteria business importance and ease of realization for each requirement.

During requirements **specification**, software requirements are documented in a structured, standardized and accessible manner that is readily understandable by all stakeholders (Wiegers and Beatty 2013). In case of Kolpondinos and Glinz (2019), requirements are submitted using a simple user story template. Vogel et al. (2019) pre-filled their submission form with a template for submitting requirements based on standard requirement specification documents. As opposed to the majority of analyzed cases where artifacts are submitted and subsequently edited only by their initial author, Lohmann et al. (2009) and Yang et al. (2008) enable a wiki-style collaboration where multiple users can work on specifying a single requirement in parallel. Most articles do not provide examples of requirements specified using the presented approaches but based on the available information it can be assumed that these requirement do not meet the standards of traditional requirements specification documents (Wiegers and Beatty 2013). This is not surprising, considering the target crowd for most artifacts are stakeholders untrained in requirements specification who cannot be expected to produce such fully specified requirement specification documents. In our literature matrix in Table 2, we only mark those articles which offer support for requirements specification which goes beyond the most basic specification of requirements in form of free text as to highlight the most insightful contributions among the analyzed artifacts. Requirements **validation** entails the reviewing and testing of requirements by various stakeholders, the definition of acceptance criteria and ensuring stakeholder satisfaction in general (Wiegers and Beatty 2013). It can be argued that in case of the analyzed collaborative platforms, a constant implicit review process takes place by members of the crowd which are able to screen and comment on the requirements submitted by their peers. Adepetu et al. (2012) implement a requirements review method which enables a client user role to perform an acceptance review on requirements submitted by a crowd of users. Klamma et al. (2011) and Law et al. (2012) provide another form of acceptance validation by linking requirements on their platform to implemented software features and providing monitoring data on their usage. As with the requirements specification, we only mark articles which explicitly present functionality targeted towards requirements validation as providing support for this activity in our concept matrix in Table 2.

14.4.2 Artifact Design Features

Besides offering crowd-based prioritization, some articles present further **decision support tools** aimed at facilitating the selection of high impact requirements. Klamma et al. (2011) implement a dashboard which aggregates several indicators per requirement such as user-provided ratings, communication and development activity, usage statistics for implemented requirements as well as its estimated financial value. Ninaus et al. (2014) apply a majority voting strategy based on group decision heuristics (Ninaus 2012) in order to combine the diverging priorities of individual users into one consistent and actionable prioritization result. In doing so, they not only let users determine the priority of the requirement but multiple additional criteria such as feasibility, risk and relevance. Vogel et al. (2019) allow product owners to compare submitted requirements using impact and effort matrices based on user-provided votes and an effort estimation on the Planning Poker Scale (Cohn 2005). Identifying and implementing suitable motivational mechanisms represents a central challenge for any crowdsourcing initiative (Blohm et al. 2017), collaborative crowd-based RE being no exception. Several of the analyzed articles leverage **game elements** as a motivational mechanic, albeit with varying degrees of comprehensiveness. Snijders et al. (2015) and Dalpiaz et al. (2017) complement the RE approach with game mechanics such as points, leaderboards and resources. Other artifacts such as those presented by Fernandes et al. (2012) and Kolpondinos and Glinz (2019) exhibit a deeper integration of gamification, adding additional game elements such as multiple types of points, progress bars, levels, rewards and game roles with associated capabilities. Beyond game elements, most articles explicitly or implicitly describe the opportunity to gain social recognition as a further motivational mechanic. In their internal crowdsourcing setting, Vogel et al. (2019) afford users to position themselves as domain experts and thereby gain the recognition of peers. Similarly, Adepetu et al. (2012) describe a potential “sense of prestige” while Dalpiaz et al. (2017) identify social influence and reciprocal benefit as motivators.

Table 2. Literature concept matrix

	Supported RE activities				RE-relevant design features				
REFERENCES	Elicitation	Analysis	Specification	Validation	Decision support tools	Game elements	Stakeholder relationship management	Recommender systems	Retrievability & traceability
Adepetu et al. (2012)	✓			✓					✓
Dalpiaz et al. (2017)	✓	✓				✓			✓
Fernandes et al. (2012)	✓	✓				✓			✓
Klamma et al. (2011)	✓	✓		✓	✓				✓
Kolpondinos and Glinz (2019)	✓	✓	✓			✓			✓
Kolpondinos and Glinz (2017)	✓	✓	✓			✓			✓
Law et al. (2012)	✓	✓		✓			✓		✓
Lim and Finkelstein (2012)		✓						✓	
Lim et al. (2010)		✓							
Lohmann et al. (2009)	✓	✓	✓					✓	✓
Ninaus et al. (2014)	✓	✓			✓			✓	
Rashid et al. (2008)	✓						✓		✓
Seyff et al. (2015)	✓	✓							✓
Snijders et al. (2015)	✓	✓				✓			✓
Vogel et al. (2019)	✓	✓	✓		✓		✓		✓
Yang et al. (2008)	✓	✓	✓						
	14 (88%)	14 (88%)	5 (31%)	3 (19%)	3 (19%)	5 (31%)	3 (19%)	3 (19%)	12 (75%)

Several analyzed artifacts implement functionality for **stakeholder relationship management**. This includes features which enables developers or product owners to communicate the status of requirements to users, provide reasoning for implementation decisions, or for managing stakeholder expectations. For example, Rashid et al. (2008) or Law et al. (2012) allow for the assignment of statuses such as Backlog, Implemented or Closed to requirements in order to communicate its lifecycle state to software users. In case of Law et al. (2012), software users are informed of status changes via a notification system, triggered for example once a requirement has been implemented by developers. The artifact presented by Vogel et al. (2019) further affords product owners to illustrate the lifecycle status of requirements to software users via a configurable software roadmap and forces product owners to provide reasoning when a requirement status is changed. Features of this category are relevant only in specific role constellations, i.e. when there is a clear distinction between the crowd of stakeholders as proposers of requirements and an organization or its representatives deciding on their implementation.

Recommender systems are a useful building block in automating and scaling RE practices to large crowds of software users (Castro-Herrera et al. 2008). Ninaus et al. (2014) use content-based filtering to recommend requirements based on user preferences. Similarly, the system proposed by Lim and Finkelstein (2012) recommends relevant requirements to users based on their preferences and previous rating behavior. Lohmann et al. (2009) use a recommender system during the requirement submission process which alerts users to similar existing requirements to prevent submission of duplicates and stimulate their interest in collaboration. Several analyzed artifacts implement user-generated tagging systems to enable the **retrievability and traceability** of requirements. In case of Lohmann et al. (2009), project managers provide an initial taxonomy as the basis for classifying submitted requirements in addition to a user-generated tag system. This results in both a top-down taxonomic as well as bottom-up folksonomic classification of requirements. By prompting users to add a definition for their newly created tags, Lohmann et al. (2009) further build up a shared glossary of project relevant terms. Most artifacts such as Klamma et al. (2011), Adepetu et al. (2012) or Kolpondinos and Glinz (2017) implement search functionality for the retrieval of requirements.

14.5 Discussion and Future Research

Our review shows that approaches to collaborative crowd-based RE as yet do not address the entire spectrum of activities which comprises the RE process. While there is comprehensive support for elicitation and analysis activities, specification and validation are not universally supported with specific functionality However, one must acknowledge that the intended goal of the majority of included articles is to increase user involvement in the RE process in the hopes of improving requirements quality (Zowghi et al. 2015). This goal can be achieved via crowd-based elicitation of user needs and requirements as well as crowd-based analysis, e.g. via crowd-based prioritization. Therefore, the comprehensive and in-depth specification of requirements or their exhaustive validation could be deemed as out of scope for some artifacts depending on their underlying goals and intentions. Considering the RE-relevant design features reveals, a number of artifacts seek to gamify the RE process (Snijders et al. 2015) or go even further resulting in RE-as-a-game approaches (Kolpondinos and Glinz 2017). Other artifacts put emphasis on the software product owner role as the intended audience, making intelligent decision making and communication with stakeholders the primary goals (Vogel et al. 2019). The gaps in RE process coverage and feature support can serve as a blueprint for developing more comprehensive approaches and artifacts for collaborative crowd-based RE.

As a general observation, most analyzed articles regard RE as detached or isolated from the greater software engineering practices it is embedded in. However, the effectiveness of the proposed approaches for collaborative crowd-based RE likely depends heavily on the ability of the software-providing organization to deliver the requirements elicited from software users, necessitating a smooth interplay between the development of requirements and their implementation in software. This issue becomes even more significant when viewing the elicitation of software requirements not as a one-off step in a waterfall-style development model but as a continuous process which accompanies agile software development such as Scrum, Kanban or Extreme Programming. Among our analyzed papers, we can see some initial efforts towards achieving this goal. Snijders et al. (2015) and Dalpiaz et al. (2017) envision a development sprint as the last step in their crowd-based RE method. Likewise, Rashid et al. (2008) specify a final 'Implement' process step as part of their process. Law et al. (2012) integrate their collaborative crowd-based RE artifact with the JIRA issue tracking software via its application programming interface. In this regard, previous research has demonstrated that crowd-based approaches cannot simply be "bolted onto existing systems" (Gleasure et al. 2017, p. 339) underlining the need for an adequate embedding of novel artifacts and practices into existing contexts (Orlikowski and Iacono 2001). Future research should focus on investigating possible avenues for tightly integrating collaborative crowd-based RE with software engineering practices as well as the organizational context as a whole.

Considering the type of contribution made by the articles included in our review from a design science perspective (Gregor and Hevner 2013), all articles present situated implementations of artifacts in the form of instantiations of software products and in some cases associated processes. Kolpondinos and Glinz (2019) and Vogel et al. (2019) go one step further towards providing more abstract design knowledge and present design principles for one specific domain of crowd-based RE. Assessing the set of analyzed articles as a whole, we determine a lack of explicit design knowledge such as constructs, methods, design principles or even design theories (Gregor and Hevner 2013) which guide researchers and practitioners in designing their own collaborative crowd-based RE approaches. Although this lack of formalized design knowledge may be explained by most included articles not originating from information systems literature, future research should nevertheless seek to develop mature design knowledge which guide researchers and practitioners in designing approaches to collaborative crowd-based RE.

Only a very limited number of analyzed articles combines collaborative and data-driven variants to RE as envisioned by Groen et al. (2017). For example, Klamma et al. (2011) integrate a usage data monitoring of implemented requirements which originate from their collaborative crowd-based RE artifacts. As can be observed in our literature matrix, some artifacts also complement the collaborative approach with data-driven recommender systems. Generally, from the perspective of collaborative crowd-based RE, data-driven elements could be integrated following two avenues. First, needs identified automatically via data analysis could serve as an input to and starting point for collaborative requirements development. Second, data-driven elements could be used to validate collaboratively developed requirements by monitoring their real-world usage and related feedback. In practice, this combination of collaborative and data-driven approaches is more pronounced, again looking at for example the platform UserVoice or other offerings such as UseResponse[1] which both integrate qualitative and quantitative approaches. Future research should expand its focus beyond extant literature and survey existing platforms for collaborative crowd-based RE, for example using taxonomy development.

14.6 Conclusion

Collaborative crowdsourcing's ability to effectively address ideation and complex problem-solving tasks has drawn the attention of crowd-based RE researchers. However, studies surveying the state of crowd-based RE do not focus on collaborative but on data-driven

[1] https://useresponse.com

variants. We conduct a structured literature review of extant research on collaborative crowd-based RE to identify both the supported RE activities and significant RE-relevant design features of artifacts presented by included studies. Among 16 relevant articles, we observe support for the elicitation and analysis of requirements while the specification and validation are beyond the scope of the majority of presented artifacts. We identify the integration of collaborative crowd-based RE with software development processes, development of design knowledge and the integration of data-driven and collaborative variants as avenues for future research. The contribution of our work is twofold. We contribute to research on crowdsourcing and crowd-based RE by providing a systematic overview of literature in the domain of collaborative crowd-based RE. Second, our work can guide researchers and practitioners in designing their own collaborative crowd-based approaches by providing an overview of existing design features and identifying research gaps for novel ones. Our review is faced with some limitations. Our keyword selection strongly determined the included articles and thereby the results of our work. Due to the relative novelty of the topic we include a wide variety of publication in our review and are not able to exclusively limit our search to established, peer-reviewed outlets. Furthermore, despite our data analysis being independently performed by two researchers and following a standardized and structured approach, human error and selection bias may have influenced the outcome of our analysis.

14.7 References

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15 Design and Evaluation of an Online Neighborhood Social Network for Fostering Social Connectedness and Participation: Lessons from Two Urban Neighborhoods

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Abstract

Increasing urbanization and population aging, as well as associated adverse outcomes such as social isolation or exclusion, imperil the well-being of local communities. Online neighborhood social networks (ONSNs) represent a novel type of online social network that exhibits promising effects on the social connectedness and social participation of inhabitants of urban neighborhoods. Following a design science research approach, we draw on empirical data from two case neighborhoods as well as extant literature and develop design principles for an ONSN for fostering social connectedness and participation. We instantiate this design knowledge into the MyNeighbors ONSN and conduct a long-term naturalistic evaluation. Based on platform usage, an online survey and qualitative interviews, we determine that ONSNs harbor the potential to improve the social connectedness and participation of neighbors. Our validated design knowledge contributes to research on ONSNs as well as technology-mediated social connectedness and participation.

Keywords: online neighborhood social networks, social connectedness, community well-being, design science

15.1 Introduction

Increasing urbanization has placed the world's cities at the forefront of the grand challenge of ensuring a sustainable future for our planet and society. The United Nations has defined sustainable cities and communities as one of seventeen central elements of this future (United Nations 2015). In 2018, 55.3 percent of the world's population lived in urban areas, a number that is expected to rise to 60 percent by 2030 (United Nations 2018). Besides environmental and economic sustainability, social and community sustainability play an important role in determining the quality of life and well-being in cities (Magee et al. 2012). Social sustainability requires healthy and livable communities for all inhabitants, putting particular emphasis on the most vulnerable segments of society, such as the poor or the elderly (WHO 2017). With the world's population aged 65 and older growing at an unprecedented pace, the elderly have moved towards the center of attention of policymakers (WHO 2017). Urban areas are disproportionately affected by population aging, resulting in an agglomeration of the elderly in cities (Leeson 2018). Endeavors aiming to improve the well-being of local communities must, therefore, pay particular attention to the needs of the elderly. Cities respond to this need by becoming age-friendly, characterized by accessibility, inclusiveness, security and service proximity (Plouffe and Kalache 2010; WHO 2007).

Across the globe, governments have identified smart city initiatives as a potential avenue for alleviating challenges associated with urbanization and population aging (Righi et al. 2015). The concept of smart cities is multi-faceted and can entail a broad range of technological, institutional and human efforts (Nam and Pardo 2011). Viewed from a technocentric perspective, a smart city concept focuses on the enhancement of city activities by leveraging digital infrastructure and devices (Lombardi et al. 2012). From a human-centric perspective, by contrast, it emphasizes dimensions such as the social and human capital, civic participation and quality of life (Marrone and Hammerle 2018). Information technology has presented itself as a viable mediator of social connectedness and participation (Rainie and Wellman 2012; Srivastava and Panigrahi 2019). A lack of social connectedness and participation can come with severe negative implications for one's health and well-being as they represent important determinants of quality of life (Grieve et al. 2013). Following life events such as retirement and age-related decline in motor function, the elderly, in particular, are often faced with social isolation and loneliness

(Heaven et al. 2013). Social media, smartphones and the internet can facilitate the formation of social ties and increase participation in society (Grieve et al. 2013; Srivastava and Panigrahi 2019). Accordingly, such technologies can contribute to the reduction of negative outcomes such as social withdrawal, isolation and loneliness, which exhibit health impacts comparable to obesity or smoking (Holt-Lunstad et al. 2010).

Online neighborhood social networks (ONSNs) are a novel type of online social network (OSN) that affords inhabitants of a local community the ability for social interaction with neighbors, sharing of information on local issues and volunteering (Vogel et al. 2019). As a sub-class of OSNs, they are potential mediators of social connectedness and participation (Grieve et al. 2013). ONSNs are increasingly popular, with platforms such as Nextdoor attracting millions of monthly active users (Hwong 2017). First studies have determined promising potential regarding the ability of ONSNs to improve social connectedness and social participation (Masden et al. 2014). However, this potential has not yet been confirmed via a long-term naturalistic evaluation. And while ONSNs differ from OSNs such as Facebook by, among other attributes, establishing neighborhood-level sub-communities as communities of trust, they do not yet offer specific features for integration with and governance of offline community structures such as local citizens groups, organizations, institutions or ongoing community initiatives (Vogel et al. 2020b). Furthermore, despite the rising importance of the neighborhood as the preferred range of activities of the elderly (Yen et al. 2012), ONSNs do not pay particular attention to this group's special needs. Generally, research on this type of OSN remains scarce, both regarding descriptive knowledge concerning the effects of ONSNs on local communities as well as prescriptive design knowledge guiding the implementation of these platforms. We aim to alleviate this research gap by providing conceptually and empirically validated design knowledge for an ONSN for fostering social connectedness and participation in a local community. Correspondingly, we define the following guiding research question:

RQ: How can online neighborhood social networks be designed and established to foster social connectedness and participation?

We approach this research question as follows. Initially, we present conceptual foundations on ONSNs as well as technology-mediated social connectedness and participation. Next, we outline our research design and methodology. Subsequently, we present our developed design knowledge in the form of design principles for an ONSN for fostering social connectedness and participation. We demonstrate the effectiveness of this design knowledge by implementing an instantiation and a long-term naturalistic evaluation in two case neighborhoods. As part of this evaluation, we analyze platform usage data, an online survey and qualitative interviews. We determine promising effects of our ONSN instantiation on improving the social connectedness and participation of neighborhood inhabitants. Finally, we derive implications and contributions of this research project and address limitations as well as avenues for further research.

15.2 Conceptual Foundations

15.2.1 Online Neighborhood Social Networks

Online neighborhood social networks are a type of OSN whose audience comprises the inhabitants of one or more neighborhoods and whose thematic and functional focus lies on neighborhood-related issues (Vogel et al. 2020b). The roots of neighborhood-centric information systems can be traced back to community computing initiatives such as the Blacksburg Electronic Village (Carroll and Rosson 1996) or Netville (Hampton and Wellman 2003), which leveraged early internet access to provide neighbors with access to discussion boards, local news, email lists and local business listings. With the rise of social network sites such as Facebook, cumulative and segmentative network effects led to the formation of neighborhood-focused sub-communities in the form of groups (Ilena et al. 2011). Among ONSNs, San Francisco-based Nextdoor represents the largest platform with 236,000 active neighborhoods and an estimated 23 million monthly active users across North America, Europe and Australia (Nextdoor 2019). Other relevant examples include Berlin-based nebenan.de with more than 1.4 million and the platform Neighbourly in New Zealand with 730,000 users (Lovell 2019; nebenan 2020).

Most ONSNs share a common set of features similar to that of OSNs such as Facebook (Vogel et al. 2020b). Users sign up for free and possess an individual profile page. Posts can be made to a neighborhood activity stream. Commonly discussed topics include asking for recommendations, discussion of local issues, event invitations or the non-commercial buying and selling of goods. Neighbors communicate via a chat or direct messaging system. As opposed to traditional OSNs, many large ONSNs do not implement direct user-to-user relationships such as friends lists, often possess local facilitators in the form of neighborhood managers or key users and are only available in selected countries, cities or city quarters (Vogel et al. 2020b). The decisive differentiating characteristic of ONSNs when compared to OSNs, is the segmentation of users into isolated sub-communities based on their neighborhood of residence. This mechanic, usually enabled via an identity or address verification, leads to the formation of a community of trust (Vogel et al. 2020b). Verification variants range from sharing one's device location or receiving an activation code via physical mail to in-person ID checks. Besides these sub-communities, as yet, ONSNs do not offer specific design features for integration with existing local and offline neighborhood structures such as community or neighborhood management initiatives for urban social development, which could differentiate them from OSNs. Elderly individuals, in particular, often refrain from using OSNs due to factors such as an aversion towards self-disclosure, privacy concerns, a lack of relevant content and complex user interfaces (Leist 2013). With small sub-communities, identity verification, real-name policies, locally relevant content and simple user interfaces, ONSNs may represent a more attractive option for the elderly.

As user-generated content is restricted to an audience of neighbors per neighborhood sub-community, delimiting neighborhoods is a key competence of ONSNs. Neighborhoods that are too constricted in scope may fail to attract a critical mass of users or divide existing offline communities. Conversely, an overly large scope may not be able to evoke a sense of trust and community among neighbors. The term neighborhood itself is notoriously hard to define and a variety of conceptual perspectives such as geographical points of reference or an area's socio-economic composition can be identified in literature (Sampson et al. 1997). ONSNs adopt diverse approaches to resolving this issue, ranging from letting neighbors determine the boundaries of their neighborhood themselves via crowdsourcing, platform-dictated boundaries determined by custom algorithms, adherence to municipal boundaries or radius-based approaches (Vogel et al. 2020b). First studies analyze the effects of ONSNs, such as an increase in neighborly communication and activities as well as improved neighborly relations (Masden et al. 2014). Regarding design knowledge, some instantiations of ONSNs or related artifacts are evident in literature (Antonini et al. 2016; Renyi et al. 2018). However, these studies do not explicate the presented design knowledge in the form of, for example, design principles and lack a long-term evaluation with a significant number of users. As part of our own ongoing research, we present a taxonomy of design parameters of ONSNs as well as first design knowledge in the form of preliminary design principles for ONSNs (Vogel et al. 2020b; Vogel et al. 2019). With the exception of Renyi et al. (2018), the elderly do not find special consideration in literature on ONSNs.

15.2.2 Technology-Mediated Social Connectedness and Participation

Social connectedness can be defined as "an internal sense of belonging […] the subjective awareness of being in close relationship with the social world" (Lee and Robbins 1998, p. 338). It describes the perception of being respected, valued, cared for as well as understood (Phillips-Salimi et al. 2012) and evokes a feeling of belongingness by satisfying the need to perceive the availability of interpersonal bonds or relationships (Baumeister and Leary 1995). Feeling connected through social relationships can have a variety of positive outcomes regarding one's psychological and physiological health and well-being such as reducing anxiety and evoking a sense of comfort (Hagerty et al. 1993; Yoon et al. 2012). Maintaining social networks is also crucial to successful aging as they ensure "embeddedness in systems of norms, control and trust" (Cornwell et al. 2008, p. 186) and access to information and social support (Cornwell et al. 2008). Social connectedness is determined based on a variety of dimensions such as the frequency of social gatherings, the number of close relationships or satisfaction with social contacts (Toepoel 2013). Social participation describes the "socially oriented sharing of individual resources" (Bukov et al. 2002, p. 510), entailing a variety of activities such as sharing one's time, effort or money in groups of family, friends, social groups or the general public (Hsu 2007). This can comprise actively collaborating with others to reach a common goal, interacting with others without a specific goal or simply being in the vicinity of others (Levasseur et al. 2010). Social participation is an important determinant of quality of life and life satisfaction (Li et al. 2018). For the elderly, better functional skills and health-related quality of life are reported (Dahan-Oliel et al. 2008). Generally, a variety of definitions as well as interpretations of the relationship between social connectedness and social participation are present in literature. For the purpose of this research, we utilize the term social connectedness to describe an individual's need for close interpersonal relationships and social participation to describe an individual's desire for a sense of belonging to larger groups or communities (Chipuer 2001), as presented above.

Both social connectedness and participation can be mediated through technology. Social connectedness represents a common concept in research related to internet usage, mobile communication and OSNs (Grieve et al. 2013). OSNs such as Facebook can serve as a source of social connectedness for the general population as well as the elderly (Grieve et al. 2013; Sinclair and Grieve 2017). The social connectedness and social support derived from OSNs is associated with improved psychological health and well-being (Grieve and Kemp 2015). The elderly may be more successful in deriving social connectedness from OSNs and less likely to suffer from negative consequences of social media use than younger adults as they possess greater emotional stability (Barbosa Neves et al. 2019; Grieve and Kemp 2015; Leist 2013). Goswami et al. (2010) propose utilizing OSNs to improve the social connectedness and social support of the elderly. Srivastava and Panigrahi (2019) determine that social participation can be mediated via technologies such as social media as well as computer and internet use in general. Improving social participation through technology can alleviate social withdrawal, isolation and loneliness (Hsu 2007). As extant literature on technology-mediated social connectedness and participation follows a generalist approach, there is a need for research to analyze the effectiveness of specific technologies and their effects on specific groups of society (Srivastava and Panigrahi 2019). Furthermore, while extant research analyzes the relationship between technology and social connectedness and participation, prescriptive research guiding the design of these technologies is scarce (Spagnoletti et al. 2015).

15.3 Methodology

To answer the focal research question, we apply the design science research (DSR) paradigm as it is particularly suitable to address important and prevailing issues in a real-world setting (Hevner 2007), such as improving the social connectedness and participation in local communities. Following the three-cycle view of DSR (Hevner 2007), we aim to ensure the rigor of our design activities by grounding them in state-of-the-art research on ONSNs as well as social connectedness and participation. For relevance, we draw on data from two case neighborhoods, situated in one of the largest urban agglomerations in Germany. Our research is embedded in a larger research effort in the context of connected and age-friendly communities, aimed at developing guidance for policymakers seeking to improve community well-being and to alleviate the adverse effects of an aging society. To this end, technologies and interventions such as professional neighborhood management, local health consulting, ambient assisted living and smart signage are evaluated by a conglomerate of private and public organizations. Our main research outcome is four design principles, which provide prescriptive knowledge "about creating other instances of artifacts that belong to the same class" (Sein et al. 2011, p. 39) and an expository instantiation to represent and assess this nascent design theory (Gregor and Jones 2007). We operationalize DSR following Peffers et al. (2007), conducting two consecutive design cycles (see Figure 1). Our first design cycle, which we report on in detail as part of Vogel et al. (2019), can be summarized as follows. We commence by conducting a structured literature review on ONSNs, qualitative interviews and a quantitative survey in our case neighborhoods in order to gain an understanding of the inhabitants' attitudes and requirements towards an ONSN. Based on these insights, we define an initial set of design principles for our platform. We instantiate these design principles in a series of prototypes of varying fidelity ranging from paper, mock-up to click-dummy prototypes, constantly obtaining feedback from local stakeholders. We arrive at a minimal viable product in the form of a website and Android app. We conduct a three-month field test in one case neighborhood with 35 participants for demonstration. We evaluate by collecting feedback in-person during weekly on-site consultation hours, by letting users compile evaluation diaries and by conducting a user experience lab with neighbors and neighborhood managers. Conducting this first design cycle resulted in valuable insights regarding neighbors' assessment of individual platform design features and the conceptual foundations of our design knowledge.

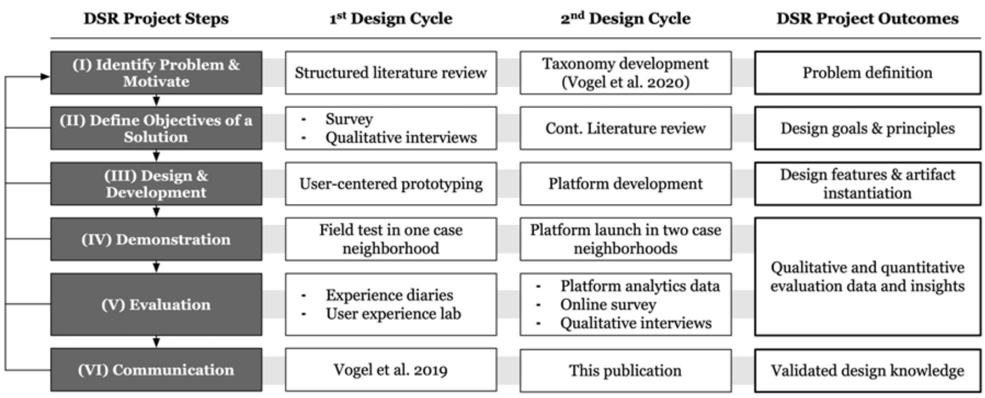

Figure 1. Research design based on Peffers et al. (2007)

The second design cycle is the focus of this publication. We return to the **(I) Identify Problem & Motivate** step by thoroughly reevaluating the topical orientation, functionality and technology choices made regarding our artifact. We identify existing ONSN design artifacts and their design features relevant to our research goals by developing a taxonomy of design features of existing ONSNs. By doing so, we identify features suitable to support our defined design principles and identify gaps in the feature set of existing ONSNs. We report on this taxonomy in Vogel et al. (2020b). In the step **(II) Define Objectives of a Solution**, we develop design knowledge in the form of design principles, building and expanding upon the preliminary design principles from our first design cycle. Each design principle is based on several design goals that outline the purpose and scope of our nascent design theory (Gregor and Jones 2007). We base these design goals and principles in the extant literature on ONSNs as well as technology-mediated social connectedness and participation. Furthermore, we leverage the empirical data collected during the evaluation phase of our first design cycle. During the **(III) Design & Development** phase, we implement a situated instantiation of our design principles. We derive a set of eleven design features which represent "specific artifact capabilities to satisfy design principles" (Meth et al. 2015, p. 814). Based on these design features, we develop a software artifact called MyNeighbors, implemented using the Django web development framework (djangoproject.com).

For the **(IV) Demonstration** and **(V) Evaluation** in our second design cycle, we launch the latest version of MyNeighbors in our two case neighborhoods. We follow a Human Risk & Effectiveness strategy, demonstrating and evaluating the final design artifact by conducting a naturalistic, long-term evaluation with real users in their real context (Venable et al. 2016). We include both ex-ante evaluation episodes, which inform the conceptualization and design of our artifact, and a comprehensive ex-post evaluation to assess the utility, quality and efficacy of our design artifact. For the ex-ante evaluation, we leverage the continuous exchange with stakeholders such as neighborhood managers, organizational and institutional partners, as well as feedback from neighbors during bi-weekly smartphone classes, project meetings, platform introduction workshops and interactions during marketing activities. For the ex-post evaluation, we utilize three sources of empirical data: (a) an analysis of platform content and usage data, (b) an online survey of platform users and (c) qualitative interviews with inhabitants of our case neighborhoods. Tracking of platform content and usage data is conducted via capabilities of the MyNeighbors platform itself and via the self-hosted web analytics tool Matomo (matomo.org). By doing so, we can track a wide variety of data points regarding platform usage data. Platform activity generated by the authors were excluded from the statistics. Our online survey comprised 50 questions primarily based on the defined design principles as well as design features and used a four-point rating scale, with some free-text answer options. Also, we include a standard instrument for determining barriers to social participation (Deck et al. 2011) as well as questions regarding socio-demographic variables such as age, sex, education, income and others. Participation in the survey was open to all MyNeighbors users, which were prompted to participate after login and via an email newsletter. Additionally, we conduct eight qualitative interviews with platform users from both case neighborhoods, which were selected by messaging MyNeighbors users directly via the platform. The interviews are semi-structured and based on a pre-defined interview guide, which opens with general questions on offline community life and subsequently centers on questions based on our defined design principles and artifact design features. We approached interviewees via the MyNeighbors platform or by recommendation of neighborhood managers. Researcher field notes refined with audio recordings were used to formalize evaluation learnings gathered during these in-person interviews.

15.4 Design Goals and Design Principles

In the following, we present design goals and design principles based on extant literature on ONSNs, technology-mediated social connectedness and participation, as well as evaluation data of our first design cycle (see Figure 2). Social connectedness is an important predictor of individual well-being (Cohen 2004). Conversely, social isolation limits social relationships and, in turn, access to resources (Toepoel 2013). Technology such as OSNs can serve as a valuable supplement, albeit not substitute, for offline relationships for the elderly (Barbosa Neves et al. 2019). As social connectedness relates strongly to personal well-being (Goswami et al. 2010), we define its improvement as a primary design goal of our ONSN (**DG-01**).

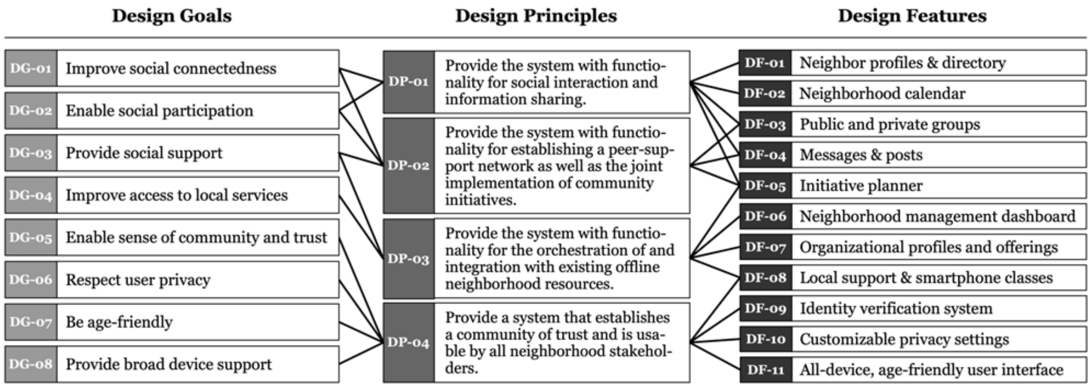

Figure 2. Design goals, principles and features: ONSN for fostering social connectedness and participation

OSNs can serve as an effective tool in facilitating offline activities, including their proposal and planning (Zhang et al. 2011). Social participation via both volunteering in one's neighborhood and neighborhood activism can support individuals in building social ties and improves psychological well-being (Gilster 2012). Especially for the elderly, voluntary work, such as supporting other members of their community, is a predictor for social participation (Toepoel 2013). At the same time, the elderly are at particular risk of social exclusion after significant life events such as retirement, death of a spouse or loss of motor function (Coyle and Dugan 2012). To address these issues, an ONSN should, as a further primary design goal, enable the social participation of its users (**DG-02**). Being able to build new and maintain existing social relationships as well as effective information exchange between members of a community are necessary to enable social connectedness and participation. Consequently, we define the following first design principle:

DP-01: *Provide the system with functionality for social interaction and information sharing.*

Providing support to others is linked to higher self-esteem and a greater sense of control (Thoits 2011). Similarly, feeling assured that help is available in a time of need provides a sense of security (Marmot and Wilkinson 2011). Goswami et al. (2010) propose that social support can be derived via OSNs and, in turn, can contribute positively towards user health and well-being. To reap these benefits and to provide utility not readily available via traditional OSNs, an ONSN should be able to afford its users social support (**DG-03**). Social cohesion, the extent of connectedness and solidarity among members of a community, can contribute to increased physical activity and to the feeling of safety in a neighborhood (De

Jesus et al. 2010). The prevalence of neighborhood activism and civic engagement contributes to the perceived availability of social support (Albanesi et al. 2007). ONSNs are uniquely suited as a platform for community volunteering as they are home to a user base of potential local volunteers who share the common goal of improving neighborhood well-being (Vogel et al. 2020a). This leads us to define the following second design principle:

DP-02: *Provide the system with functionality for establishing a peer-support network as well as the joint implementation of community initiatives.*

Urban neighborhoods exhibit plentiful public and private actors, infrastructure and resources. The degree to which inhabitants of a neighborhood can access these resources influences their feeling of inclusion or exclusion (Buffel et al. 2013). Being able to access goods and services in one's community serves to promote health and well-being (Miller et al. 2011). Leveraging the offerings provided by actors in a neighborhood can improve the social connectedness of the elderly, for example, by participating in leisure activities such as sports, vacations, shopping or cultural activities (Toepoel 2013). Our case neighborhoods already exhibit a diversified set of local service offerings as well as offline community structures such as citizen groups and initiatives. An ONSN should aim to integrate with these offerings, make them visible and accessible to platform users and motivate local actors such as organizational representatives or neighborhood managers to become active platform users. Combining OSNs and the provisioning of local services has been presented as a promising concept in previous research, particularly for elderly OSN users (Boll and Brune 2016). An ONSN should, therefore, improve access to such local service offerings (**DG-04**). ONSNs are inherently local platforms, focusing on specific neighborhood sub-communities, and possess the potential to capitalize on a neighborhood's existing local resources and actors, offering distinct utility not available on traditional OSNs. Making these offline resources transparent, accessible and available via intelligent orchestration is defined as our third design principle:

DP-03: *Provide the system with functionality for the orchestration of and integration with existing offline neighborhood resources.*

A central benefit of ONSNs, as well as a key differentiator to traditional OSNs, lies in their ability to establish communities of trust (Vogel et al. 2020b). Generally, a sense of community is represented by members of a group having a feeling of belonging, faith in the collective ability to meet the group's needs and a mutual commitment to be together (McMillan and Chavis 1986). ONSNs enable communities of trust via mechanisms such as strong separation of neighborhood-level sub-communities, rigorous identity verification and real-name policies (Vogel et al. 2020b). These communities of trust enhance the value of an otherwise traditional set of OSN features and, in addition, act as an enabler and amplifier for positive outcomes intended by other design goals of our artifact. Elderly individuals, who often refrain from open self-expression on public OSNs such as Facebook (Leist 2013), could be more willing to communicate as part of a trustful, closed community of neighbors on an ONSN. An ONSN should be able to establish a sense of community and trust amongst its users (**DG-05**). Social media users consider the privacy of their personal data an important issue (Acquisti et al. 2015). Elderly individuals, in particular, are often hesitant to use OSNs due to privacy concerns (Leist 2013). Yet, as per the privacy paradox, they seldomly act to protect their data or even give it away voluntarily (Gerber et al. 2018). Therefore, especially following the introduction of the General Data Protection Regulation (GDPR), any novel software artifact should follow the principles of Privacy by Design and Privacy by Default (Cavoukian et al. 2010) and thereby respect user privacy from the outset and throughout (**DG-06**). This is particularly important as an ONSN relies on sensitive personal data such as one's address or contact data to verify user identities.

Elderly citizens represent a rapidly growing group among the inhabitants of European cities (EU 2018). They are inherently vulnerable to social isolation and associated psychological and physiological health consequences (Shankar et al. 2011). Therefore, the elderly stand to benefit particularly well from an ONSN, which, as a precursor, has to be inclusive towards this group of users. The elderly represent but one group of actors on a multi-sided neighborhood platform that is to be interconnected via an ONSN, besides other neighbors, organizations or institutions. An ONSN must, therefore, be designed to accommodate the needs of all of these actors while at the same time being inclusive towards the elderly. Our intended design resembles the concept of the age-friendly city, which describes not a city exclusively for the elderly but a city for everyone, which is secure, accessible and inclusive towards the elderly (Buffel et al. 2012). Similarly, the ONSN should aim for an all-age audience while paying particular heed to the needs of elderly users (**DG-07**). However, elderly usage must be encouraged and enabled in a non-stigmatizing manner in order not to discourage users who may be of old age but not perceive themselves as elderly and without discouraging usage by non-elderly users, who are needed to achieve a healthy age-mix on the platform. Competence for technology usage, as well as access to digital devices, varies widely among the general population and also within the group of elderly technology users in Germany, manifesting a digital divide (Rockmann et al. 2018). Regarding potential access paths to an ONSN, 78 percent of Germans own a smartphone (Pew Research Center 2019), with operating systems split predominantly between Android and iOS (77%/21%) (Statista 2019). These devices exhibit varying display sizes, performance as well as operating system and software versions. Based on the evaluation of our first design cycle, stakeholders in our case neighborhoods strongly prefer being able to flexibly switch between desktop and mobile access and not being exclusively limited to one option. Besides functional capacity, the elderly need to possess a minimal level of knowledge regarding technology and social media use to enable the adoption of OSNs such as an ONSN (Leist 2013). Therefore, it is necessary to provide a system that is device, age and operating system agnostic (**DG-08**). Considering both the defined goals which aim at making the system both trust-invoking as well as effectively usable by a wide range of stakeholders, we define a fourth design principle:

DP-04: *Provide a system that establishes a community of trust and is usable by all neighborhood stakeholders.*

15.5 The MyNeighbors ONSN

We instantiate the design principles presented in the previous section by implementing the MyNeighbors ONSN based on eleven design features. On the web-based MyNeighbors platform, each user possesses an individual profile page where he or she can share profile information such as a profile picture, self-description and personal interests (**DF-01**). Interests are selected from and added to a central, neighborhood-wide repository and an interest browser allows users to identify neighbors with similar interests. Additionally, users are able to provide contact information, such as their email address or phone number. Verified neighbors are listed in a neighbor directory, which facilitates access to neighbor profiles.

Users can customize privacy settings to adjust the amount of personal information disclosed to their neighbors (**DF-10**). Per default, users are identified on the platform by their first name and the first letter of their last name. Similarly, the street name but not street number is visible per default. Using privacy settings, users can choose to disclose their full name and full address or no address at all. With these defaults, we aim to achieve a balance between assuring user privacy and creating a personal and trustful atmosphere on the platform. Users may further decide to show or hide their date of birth or contact data. A neighborhood calendar informs users regarding upcoming events in their neighborhood (**DF-02**; see Figure 3, right). Events can be submitted by neighbors, representatives of local organizations and neighborhood managers. Public and private groups are a means to create a further level of sub-communities on the MyNeighbors platform (**DF-03**). Example use-cases include interest-specific groups or building-level communities. Messages and posts are core features for enabling social interaction and information sharing on the MyNeighbors platform (**DF-04**). Messages are implemented via a direct messaging system that allows neighbors to communicate with each other, neighborhood managers and organizational representatives. Users can publish posts of different categories (announcement, question, request, offer and event) to a neighborhood-wide, searchable and filterable activity stream (see Figure 3, left). Users interact with each other's posts via likes, comments, sharing, subscribing to updates or by indicating planned attendance in case of events. Each post can reference a location that is displayed on an interactive map.

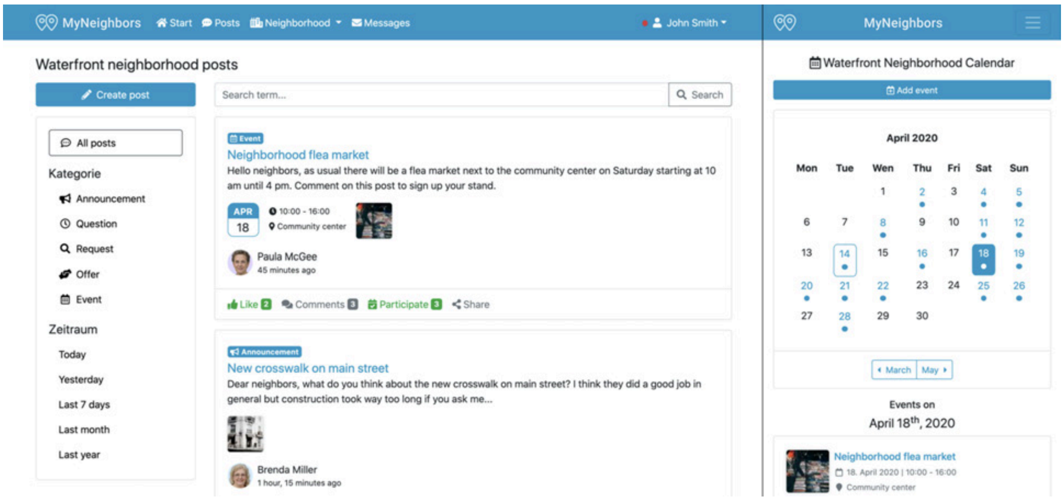

Figure 3. MyNeighbors desktop and mobile interface (sample content, translated)

The MyNeighbors platform supports neighbors in collaboratively ideating and implementing local community initiatives (**DF-05**). Via the initiative planner, neighbors can publish ideas for community initiatives and call on potential volunteers in their neighborhood. To attract potential volunteers, active initiatives are featured on the MyNeighbors landing page, while completed initiatives are accessible as read-only success stories. For the implementation of initiatives, the planner offers collaboration tools such as group messaging, decision-making via polls and meeting notes for formalizing results of offline meetups. Initiatives can be decomposed into individual achievable tasks that can be assigned to MyNeighbors users. At this time, the initiative planner remains in beta status and is not available to all platform users.

In both neighborhoods, a neighborhood management service and corresponding office are present. This service interconnects local businesses, citizen groups, institutions, clubs, political actors and other local stakeholders. By doing so, their activities and offerings become transparent, accessible and neighbors are empowered to participate in the continuous development and improvement of their local community. In the case of one neighborhood, this service is operated by a local housing collective and in case of the other by a housing provider specialized in elderly care. However, the neighborhood management service is open to all inhabitants of our case neighborhoods and not limited to customers or members of the respective service provider. Neighborhood management personifies the local footprint of our ONSN, acting as a facilitator and community manager online on MyNeighbors and offline alike. Their efforts regarding the coordination and orchestration of activities, actors and resources aimed at the betterment of their community are mirrored between MyNeighbors and the local real-world neighborhood. We support the efforts of neighborhood managers via a dedicated neighborhood management dashboard (**DF-06**). This dashboard provides functionality for management of users and identity verification, managing organizations as well as customizing neighborhood meta-data such as specifying responsible neighborhood managers and office locations. Neighborhood managers can compose interactive virtual showcases of text and images which are displayed to all users after login to promote selected platform content or for neighborhood-wide announcements. Neighborhood managers can further track statistics on neighbor activity and engagement and export this data for further analysis. The role of neighborhood managers is announced to platform users by badges that highlight their function and organizational affiliation.

Local organizations are present on the MyNeighbors platform via organizational profiles and offerings (**DF-07**). Organizational profiles are self-managed by representatives on the platform and offer information such as contact data, local representative and business hours and display the organization's address and location on an interactive map. Organizations can submit entries to a neighborhood-wide catalog of offerings that can be browsed by neighbors to identify local services and activities. By linking organizational profiles, offerings and events in the neighborhood calendar as well as by engaging with neighbors directly via messages and posts, organizations can establish a comprehensive and far-reaching presence throughout the platform. The MyNeighbors platform implements an identity verification system to ensure only real inhabitants of a neighborhood can join their respective MyNeighbors sub-community (**DF-09**). After providing registration data such as one's neighborhood, address and contact data, users are asked to verify their identity in one of two ways before being able to access the platform. First, a verification letter containing a unique verification code is semi-automatically sent to their mailing address by a neighborhood manager. Upon receiving this letter and entering the included code on the website, their verification is complete. As a second choice, users can verify their identity by visiting a local neighborhood management office and establishing their identity with a neighborhood manager in person.

MyNeighbors aims to provide an all-device, all-age user interface (**DF-11**). A responsive web interface and resource-conservative development enable usage on a wide range of mobile as well as stationary devices such as PCs, laptops, tablets and smartphones. Particular care was put on ensuring compatibility with older and low-performance devices. Our design is based on a simple, readable color scheme and a web-safe sans-serif font is used throughout the website to improve readability (Boll et al. 2017). We do not implement accessibility functionality such as font size adjustment or text-to-speech as this type of functionality is already provided by modern web browsers as well as desktop and mobile operating systems. However, we do ensure that our website interfaces correctly with this technology by implementing standard-compliant HTML syntax and HTML ARIA tags in crucial areas of the web application. Besides online tutorials and digital support channels, we engage the elderly by providing local support and smartphone classes (**DF-08**). In bi-weekly sessions with five to ten participants in both case neighborhoods, we offer training regarding general smartphone usage interspersed with hands-on MyNeighbors platform tutorials as well as question and answer sessions. Furthermore, we offer MyNeighbors platform manuals in print.

Beyond the functionality related to specific design features, the MyNeighbors platform implements support functionalities such as a notification system, user registration process and email newsletter, among others. Following DG-06, we retain full control over all data associated with the MyNeighbors platform. A university data center provides hosting and except for a top-level-domain provider and interactive maps by OpenStreetMap (openstreetmap.org), no external services are integrated. All website resources such as fonts, icons, images or scripts are hosted locally without coming into contact with third-party servers.

15.6 Evaluation

We analyze the **platform usage data** of the MyNeighbors ONSN during a roughly ten-month period, starting on June 4th, 2019 (calendar week 23) and ending on April 19th, 2020 (calendar week 16). Both the amount of user-generated content (based on comments, messages and posts) as well as platform activity (based on logins and visits[2]) follow a similar general pattern (see Figure 4). After the launch of the MyNeighbors platform and the onset of marketing activities performed by neighborhood managers in the third and fourth quarter of 2019, a rise in usage can be observed up until the turn of the year. A near-standstill of platform usage in the last week of December is followed by the steady return of usage beginning in early 2020. In total, 139 users registered for the MyNeighbors platform in our case neighborhoods, of which 131 (93%) verified their account. The average age of users was 52 (60 when excluding non-neighbors such as neighborhood managers, health consultants and organizational representatives) and with 39% being aged 65 and older, a significant share of platform users were elderly individuals. A total of 587 posts were submitted to the platform, complemented by 122 comments. Direct interaction between individual users took place via 383 direct messages and a total of 5489 email notifications were sent out.

Activity patterns on MyNeighbors resembled those of other OSNs, exhibiting a participation inequality where users can be segmented into a majority of lurkers, a group of intermittent contributors and a small group of heavy contributors, i.e., superusers

[2] A new visit is logged each time a user returns to the website more than 30 minutes after his last on-site action.

(Nielsen 2014). Segmenting the top 5% of MyNeighbors users as superusers, they contributed 54% of platform content (combined number of posts, comments and messages). Out of the six users in this group, three were neighborhood managers, one was a health consultant and two were neighbors. The following 15% of users (16 users), intermittent contributors, were responsible for 32% of platform content. Finally, the remaining 80% of users (119 users) were responsible for 14% of the content. This last group of lurkers also contains 46% of platform users (64 users), which did not contribute any content themselves but only consumed content.

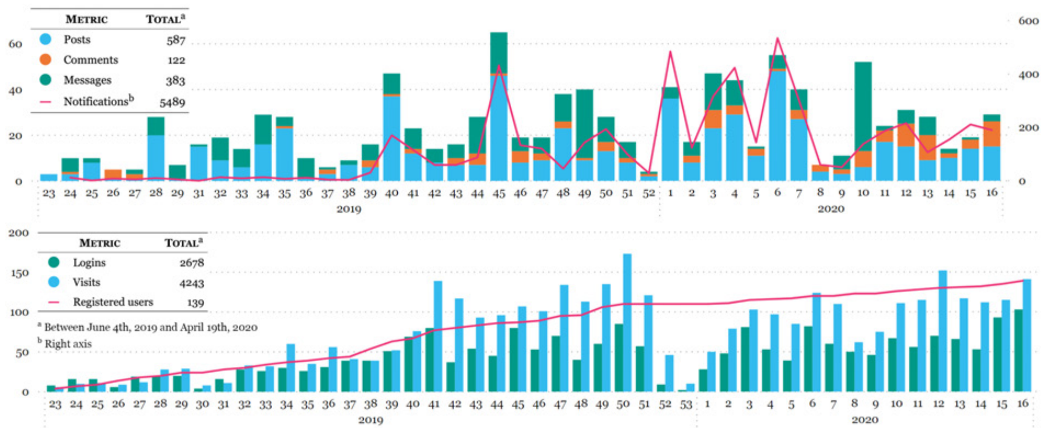

Figure 4. MyNeighbors platform content and activity per calendar week

Users addressed a variety of topics on the MyNeighbors platform. Of 587 posts, 79% were events, 16% announcements, 4% offerings, with the remaining percent split between requests and questions. Events were offered both by private actors (e.g., new year's celebration, board game afternoon, flea market), neighborhood managers (e.g., neighborhood consulting hours, neighborhood breakfast) and professional service providers (e.g., gymnastics lessons for elderly citizens, dancing lessons, health consulting hours). Announcements were a more ambiguous category, entailing, for example, posts where neighbors introduced themselves to their peers, pictures from neighborhood events or topics regarding neighborhood issues (e.g., regarding ongoing construction). Offerings and requests were made, for instance, regarding assistance with computer problems and increasingly, with the emergence of COVID-19 and the associated state of voluntary or mandated isolation, for assisting with daily necessities.

Our **online survey** was active from December 1st, 2019 until March 30th, 2020, and yielded additional insights into platform users' perception of MyNeighbors. A total of 28 users (21% percent of verified users at the time of survey closing) participated. Participants were 43% female and 54% male (one participant did not provide gender) and had an average age of 60. In the following, we present a selection of insights from this survey. Figure 5 depicts questions regarding social connectedness and participation (Q-01 to Q-07). For questions not included in Figure 5 and measured on a four-point rating scale, we show the distribution of responses in parentheses (agree/somewhat agree/somewhat disagree/ disagree). Neighbors report ambiguous results when it comes to deriving social connectedness from MyNeighbors. While they valued the communication with neighbors via the platform (Q-01), most did not report engaging more frequently with neighbors (Q-02) and less than half met new neighbors via MyNeighbors (Q-03). Regarding social participation, survey participants attest being informed about local events and offerings thanks to MyNeighbors (Q-04) and participating in those (Q-04) and being better informed regarding neighborhood life by using the platform (Q-05). Furthermore, they report being more participative in their neighborhood (Q-06) and feeling a stronger sense of community by cause of MyNeighbors (Q-07).

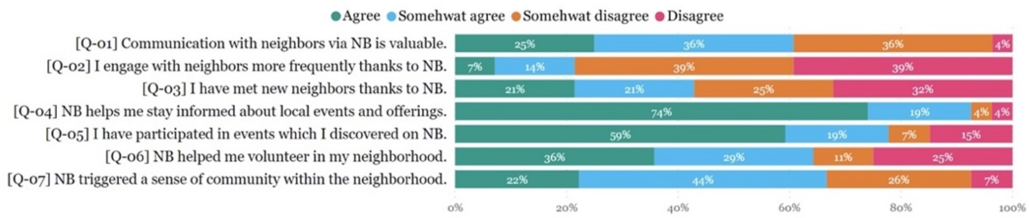

Figure 5. MyNeighbors survey selected insights relating to social connectedness and participation (n=28)

Regarding social support, neighbors report a readiness to provide support in daily life to neighbors if asked via MyNeighbors (10/15/2/0) and that they would use the platform to request help (9/11/6/1). However, most participants reported that the opportunity to help did not arise and that they did not request help via MyNeighbors (2/2/3/20). Contrasting MyNeighbors with other OSNs, participants feel that their data is secure with MyNeighbors (9/17/0/1) and that they trust MyNeighbors over commercial platforms when it comes to protecting their privacy (12/12/2/1). Furthermore, they report MyNeighbors as being more suited for their use compared to other OSNs (7/14/4/2) and being straightforward to use compared to other OSNs (6/16/4/1). Neighbors rate the neighborhood calendar as well as posts from neighborhood managers and neighbors as the most useful design features, with organizational offerings and private messages being rated as less impactful. Overall, most participants would recommend MyNeighbors (18/7/1/1).

Eight MyNeighbors users participated in our **qualitative interviews,** representing the final element of our ex-post evaluation. They had an average age of 68 years, were evenly split between male and female as well as our two case neighborhoods, lived in their respective neighborhood for an average of 14 years and signed up to for MyNeighbors two weeks to six months prior to being interviewed. In the following, we present some selected insights from our analysis of these interviews. Regarding social connectedness and participation, socializing with neighbors was recognized as a central capability of the platform. A participant stated that *"coming into contact […] I hope to communicate with people. And not sit at home alone doing nothing."* MyNeighbors was described as *"a platform for [the neighborhood] which provides neighbors a place to meet, to make contact, to exchange help, information, anything."* Interviewees saw MyNeighbors as a place to discover neighbors who would be interested in participating in local activities and events together, for example, by exchanging phone numbers. Regarding social support, attitudes resembled those expressed in our survey. Interviewees attested MyNeighbors the potential to connect those in need with volunteers and stated that they would readily respond requests for assistance. They described assistance in daily household tasks and assistance with technical problems as areas of interest. However, they were not in need of such assistance and mostly did not have the opportunity to help yet.

Interviewees describe the neighborhood calendar as the most useful design feature of the ONSN as it enables them to discover local events and offerings. According to one interviewee, the calendar's usefulness depends on events being up to date at all times and a stream of new content. One interviewee had organized their own events and publicized them via MyNeighbors. The need to stay updated regarding current events and neighborhood life was frequently expressed as a motivation for using MyNeighbors. One participant expressed: *"Now that I have a smartphone, I want to know what's going on. I'm curious, and I want to participate. […] You can always see which events are taking place."* Nearly all interviewees expressed that they trusted MyNeighbors over commercial platforms and that careful handling of personal data was a priority for them. They valued knowing that only verified neighbors could access the platform and that their data resided with the university data center and not a private company. Two neighbors conditioned their continued usage of MyNeighbors on the data remaining with the university and would otherwise consider quitting the platform. Although usability and ease of use were unanimously described as good, local smartphone classes were nevertheless frequently highlighted as a valuable element of the MyNeighbors ONSN. Neighbors identified a general lack of MyNeighbors publicity as the central obstacle to platform use.

15.7 Discussion

With the present research, we provide first design knowledge for an ONSN for fostering social connectedness and participation, validated via a long-term naturalistic evaluation. Our results constitute a situated implementation as well as nascent design theory (Gregor and Hevner 2013). Based on the DSR knowledge contribution types proposed by Gregor and Hevner (2013), we classify our research as an improvement type contribution as our ONSN for fostering social connectedness and participation among inhabitants of a local community represents a novel type of solution for a known problem space. Despite the increasing popularity of related privately operated ONSNs such as Nextdoor, there remains a lack of validated design knowledge on ONSNs as a suitable tool for addressing these issues in literature.

We introduce ONSNs as a novel type of artifact for fostering social connectedness and participation, validated via an extensive naturalistic evaluation. Evaluation participants confirm that information shared on the MyNeighbors ONSN (DP-01) led them to take part in local group activities, offerings and events, which in turn benefits their social connectedness and participation. The formation of novel social ties was described more ambiguously, with most neighbors describing MyNeighbors as a valuable form of communication but only around half deriving novel contacts via the platform (DP-01). Considering the high average age of platform users and evaluation participants, MyNeighbors was surprisingly successful in assisting the formation and maintenance of social ties. Regarding the establishment of a peer-support network (DP-02), we observe a general willingness of evaluation participants to provide support on MyNeighbors but not having the opportunity to do so due to a lack of requests for assistance. The number of organizational representatives active on the MyNeighbors platform as well as the extensive activity of neighborhood managers, suggests that integration with existing offline neighborhood resources and community structures did occur (DG-03). Similarly, across a variety of evaluation items relating to DP-04, such as the perceived ease of use, trust and privacy as well as a sense of community invoked by the platform, evaluation participants communicated a largely positive impression. Generally, the significant number of elderly users we attracted to the platform while still maintaining a healthy age-mix demonstrates the age-friendliness of the artifact, which balances elderly and non-elderly usage.

Considering the enactment of design goals and their interplay, we observe a permeability between our platform and the local communities it is active in, manifested via online actions with offline consequences and vice-versa. This permeability affects the enactment of design goals and their interdependence. For instance, evaluation data identifies the neighborhood calendar and events as among the most frequented and most useful design features of MyNeighbors. Discovering an event in the calendar may be considered a successful instance of information sharing, a goal that is enacted online on the platform. However, the actual offline participation in events discovered on MyNeighbors, which is confirmed by neighbors in our survey and interviews, may also be beneficial for one's social connectedness and participation. In this case, the design goal is enacted offline, temporally independent from and in the absence of the online platform. This permeability also represents an important design implication: as opposed to traditional OSNs, which aim to optimize for maximum online engagement of their users (Montag et al. 2019), the goal construct of ONSNs may be more complex, constituting a balancing act between online and offline engagement.

Throughout our research project, we retained control over the design parameters of our artifact by developing a custom software artifact as opposed to utilizing an existing OSN platform. This approach allowed us to flexibly respond to emerging requirements of local stakeholders. We follow the inherently iterative nature of DSR (Hevner et al. 2004). While the artifact iteration of our first design cycle resembled existing ONSNs, we were able to add novel, differentiating design features tailored to the problem space presented by our case neighborhoods in the second design cycle. These include, for instance, tool support for the ideation and collaborative implementation of community initiatives or the neighborhood management dashboard. Control of the design space allowed us to receive important decision-support (e.g., based on platform effects observed in usage data) and to act on this information by implementing adapted and novel design features. Designing a system in an ecosystem of local private and public stakeholders highlights the need to maintain productive relationships with all involved actors and to sensibly balance their at times incompatible requirements (Chatfield et al. 2019).

Our research highlights the nature of ONSNs as a socio-technical artifact, whose effectiveness depends on its embedding into its constantly evolving social and environmental context (Orlikowski and Iacono 2001). An ONSN cannot be bolted onto an existing local community and deliver beneficial outcomes. Likewise, its implementation is not simply a technical feat. The sensible integration with existing offline community structures, consideration of needs of local stakeholders, reactivity to their shifting needs as well as training and marketing play an important role in determining the platform's success. By doing so, we achieve a socio-technical embeddedness of our artifact with its context, the local community, but also with the institutions which are present there. Not only must the design of an ONSN be sound but also its interfaces with offline efforts, necessitating an effort spanning technological, institutional and human dimensions. If conditions such as specific target groups' ability to use the system are not satisfied, it may lose impact on those which stand to profit the most from improved connectedness and participation, e.g., the elderly.

Governments around the globe have reached a consensus that making cities inclusive, safe, resilient and sustainable represents a key building block of a sustainable future (United Nations 2018). ONSN platforms can render cities more inclusive by improving access to local resources and services to disadvantaged groups such as the elderly. They can improve resilience and safety by establishing a peer-support network among local actors such as citizens, organizations and institutions. Finally, they can contribute to social sustainability by improving the ability of members of a community to partake in society by assisting the enhancement of their social connectedness and participation. In this regard, our research holds valuable implications for practitioners from fields such as public administration, smart cities and communities and private and public housing development. These institutions are faced with societal challenges such as increasing urbanization, an aging society and associated negative outcomes, for instance, social isolation and social exclusion (United Nations 2018). We show that the increasing diffusion of personal information technology can be leveraged to improve the social connectedness and participation of inhabitants of local communities via ONSNs. Our developed design knowledge as well as artifact instantiation, serve as a blueprint for practitioners aiming to improve social connectedness and participation. ONSNs can serve as platforms for larger initiatives such as smart and connected cities or communities. We further offer insights for ONSN providers that aim to improve, expand or refocus the capabilities of their platforms based on our design principles and features as well as empirical insights derived from our evaluation.

15.8 Conclusion

Increasing urbanization and population aging, as well as associated adverse outcomes such as social isolation or social exclusion, threaten the well-being of local communities. In this research project, we propose an ONSN as a suitable means for improving the social connectedness and participation of inhabitants of local communities. Drawing on empirical data from two urban neighborhoods and extant research on ONSNs as well as technology-mediated social connectedness and participation, we define four design principles for such an ONSN. We instantiate the developed design knowledge into the MyNeighbors ONSN and conduct a long-term naturalistic evaluation. We determine that ONSNs harbor the potential to improve the social connectedness as well as social participation of neighbors. We further derive implications regarding the permeability of online and offline activities facilitated by an ONSN and their socio-technical embeddedness. Our validated design knowledge contributes to research on ONSNs as well as technology-mediated social connectedness and participation. The results of our research should be considered in light of some limitations. Both our design knowledge and instantiation are based on empirical data from two case neighborhoods, located in the same metropolitan area. Empirical data was collected from a limited sample of individuals and is prone to convenience sampling. Other neighborhoods may have resulted in diverging artifact requirements and, in turn, diverging design goals. Our research proceeds with the continued design and evaluation of the MyNeighbors ONSN as well as its expansion into novel case neighborhoods. Assessing the evolution of MyNeighbors in more neighborhoods may yield valuable implications for the development of the presented design knowledge, resulting from varying socio-demographic characteristics, organizational and institutional ecosystems and other differences.

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16 Older Adults' Use of Online Neighborhood Social Networks: Perceptions, Challenges and Effects

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Abstract

Online social networks (OSNs) have demonstrated potential for enabling older adults to remain socially connected and for counteracting social isolation and loneliness. With older adults preferring to age in place, their local community and neighborhood gain in importance. Online neighborhood social networks (ONSNs) are a novel type of OSN aimed at connecting local communities by facilitating social interaction, information sharing and peer support among neighbors. With a focus on trust and privacy, local relevance and integration with local organizations and institutions, they might be particularly well suited for the needs of older adults. We investigate the relationship between older adults and ONSNs by analyzing usage data, an online survey and interviews with users of an ONSN active in two urban neighborhoods in Germany. Our findings show that the case ONSN was successful in facilitating communication between neighbors and in promoting participation in community life for older adults.

Keywords: online neighborhood social networks, social media, older adults, age-friendly design, evaluation

16.1 Introduction

Improved longevity and declining fertility are causing a profound worldwide demographic change, with many countries' populations aging at an unprecedented pace. The United Nations estimate that in the year 2050, one in five people globally will be aged 60 years or older [1]. This development is expected to exert pressure on health care, social security and pension systems [2]. Due to the agglomeration of older adults in cities, urban areas are particularly affected by population aging [3]. Cities are responding by aiming to become age-friendly, increasingly catering to the specific needs of older adults regarding accessibility, security and participation [4]. With rising age, one's immediate surroundings, the neighborhood, gain in importance and become the preferred range of activities [5]. Older adults prefer to age in place and those aged 70 or older spend 80 percent of their time in their home or neighborhood [6]. Being able to interact with and access public and private actors, resources and infrastructure in their neighborhood, determines the experience of inclusion and exclusion for these individuals [7]. At the same time, rising age and the accompanying significant life events such as retirement, death of a spouse or loss of motor function put older adults at risk of suffering from social exclusion, social isolation and loneliness [8].

Digital technologies can play an important part in providing innovative solutions for alleviating the challenges associated with population aging [9]. Among these, online communities and online social networks (OSNs) have presented themselves as viable means for addressing some adverse outcomes of population aging, such as social isolation and loneliness, a lack of social support and a lack of social participation [10-12]. However, many older adults are met with obstacles when using OSNs, including a lack of functional capacity, relevant content or privacy concerns [12].

Online neighborhood social networks (ONSNs) are a novel type of online social network that focuses on improving the well-being of local communities by affording functionality such as information sharing, social interaction, peer support and access to offerings of local organizations and institutions [13]. By limiting access to neighbors inside a delineated geographic area, interactions on ONSNs take place in a community of trust [14]. In recent years, platforms such as Nextdoor (nextdoor.com) or nebenan (nebenan.de) have enjoyed rising popularity [15, 16] and are exhibiting promising effects such as increased neighborly communication [13, 17]. By emphasizing locally relevant information, neighbor-provided peer support and with a focus on trust and privacy, they may be particularly well suited for the preferences of older adults. While there are first studies presenting ONSN-like artifacts [17, 18], research investigating the relationship between older adults and ONSNs remains scarce, particularly regarding their long-term evaluation [13, 17].

To address this research gap, this paper investigates how older adults perceive ONSNs in comparison to other OSNs, how they are affected by ONSN use and what challenges they face regarding adoption and use. We analyze primary data collected from an ONSN called MyNeighbors, which is part of an ongoing research project conducted by the authors [19, 20]. For this purpose, we leverage platform activity data and conduct an online survey as well as semi-structured interviews with platform users. The findings show that the MyNeighbors ONSN enabled neighborly communication and fostered participation in local community activities for older adults. For the purpose of this research paper, we define older adults as individuals aged 65 years and older [1]. The remainder of this paper is structured as follows. In Section 2, we present related work on ONSNs as well as older adults' use of OSNs. Section 3 outlines our research approach and activities. We present the results of our data analysis in Section 4 and provide an interpretation and discussion of their implications in Section 5. We conclude with a summary, limitations and an outlook on future research.

16.2 Related Work

16.2.1 Older adults' usage of online social networks

Online social networks are commonly defined as "web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system" [21, p. 211]. Among older adults, the usage of OSNs is increasing steadily. In 2016, more than 67% of Americans aged 65 and older had broadband internet access and more than 40% used at least one social media site, up from 53% and 34% respectively in 2012 [22-24].

OSN adoption varies widely among older adults in the same age group, determined by factors such as education, income or employment status and history [25, 26]. The adoption of OSNs by older adults is hindered by age-related changes such as a decline in coordination skill, memory or declining vision [12, 27]. Further inhibiting factors for OSN use by older adults are negative attitudes towards OSNs due to critical media coverage, a lack of formal conduct on OSNs, a reluctance towards self-disclosure, complex user interfaces, a lack of content perceived as personally relevant and a lack of control of personal data [12].

For older adults, the online environment afforded by OSNs can serve as a source of social connectedness and a viable means of social interaction for individuals lacking face-to-face connections [28, 29]. Compared to young adults, older adults are more successful in deriving social connectedness from OSNs and less likely to experience negative effects of OSN use [12, 29, 30]. Furthermore, OSNs can serve as a complementary source of social support for older adults and can afford them a feeling of control and self-efficacy [10, 12]. By serving as an everyday context for cognitive stimulation and information processing, OSNs can positively impact the cognitive ability of older adults [31]. Previous research has demonstrated the potential and feasibility of leveraging OSNs in general and neighborhood-focused online communities in particular to improve the well-being of older adults [10, 13]. However, as of yet, research has not confirmed this potential via a long-term and naturalistic evaluation.

16.2.2 Online Neighborhood Social Networks

Beginning in the 1980s, community informatics projects such as the Blacksburg Electronic Village leveraged the diffusion of broadband internet technology to establish online communities aimed at the inhabitants of specific, geographically delimited areas [32, 33]. Segmentative network effects have led to the formation of similar online communities on OSNs such as Facebook in the form of groups [34]. In recent years, dedicated OSN platforms for local communities have experienced steep growth. These online neighborhood social networks can be defined as OSNs whose intended audience comprises the inhabitants of one or more spatially delimited neighborhoods and whose thematic and functional focus lies on issues related to these neighborhoods [14]. Examples of popular ONSNs include U.S.-based *Nextdoor* with more than 27 million monthly active users and 236,000 active neighborhoods globally, Germany platform *nebenan* with 1.6 million users across Europe or *Neighbourly* with 830,000 users in New Zealand [16, 35].

Core capabilities of ONSN platforms entail enabling information sharing, improving social connectedness and social participation, establishing a peer support network and integrating with local organizations and institutions [13]. Most ONSN platforms share a common set of functionality [14], including a neighborhood-wide activity stream for sharing local news, making announcements, asking questions or recommendations as well as requesting and providing peer-support. Furthermore, neighbors possess an individual profile and can communicate via chat or direct messaging. Other common features of ONSN platforms include neighborhood calendars, marketplaces, public and private groups, business profiles and other minor features.

ONSNs differ from traditional OSNs by separating users into isolated sub-communities based on their place of residence, usually enforced via identity and address verification mechanisms ranging from in-person ID checks to sharing one's device location. The term neighborhood is multi-faceted and notoriously hard to define, characterizations ranging from an area's socio-economic attributes to following geographic points of reference or municipal boundaries [36, 37]. Similarly, ONSNs take a variety of approaches to delimit their in-platform neighborhoods, including adhering to municipal boundaries, radius-based approaches, crowdsourced user-defined boundaries or algorithmically generated boundaries [14].

Recently, the peer support capabilities of ONSNs have found application during the COVID-19 pandemic [38], allowing local volunteers aiming to provide services such as household and shopping assistance to be matched to individuals in need in their neighborhood. Previous research on ONSNs has identified promising effects such as increased neighborly communication and activity, intergenerational communication and sense of community [13, 17, 18, 39] and a number of studies concerned with the design and evaluation of ONSN-like artifacts can be identified in the literature [10, 13, 17, 20, 40]. Studies explicitly investigating the relationship between older adults and ONSNs remain scarce [10, 13, 17].

16.3 Methodology

To investigate the relationship between older adults and ONSNs, we leverage empirical data collected in the context of the MyNeighbors ONSN. We utilize three sources of qualitative and quantitative data: platform usage data, an online user survey as well as semi-structured interviews. MyNeighbors is developed and evaluated by the authors as part of an ongoing design science research project in the field of healthy aging and connected communities [13, 20] allows for deep access and insights into platform activity and content.

16.3.1 The MyNeighbors ONSN

The MyNeighbors ONSN is being piloted in two case neighborhoods in a large German metropolitan area and has around 140 verified neighbors at the time of writing. The platform's features are similar to the common feature set described in Section 2.1. Neighbors verify their identity in person or by receiving a verification code via physical mail and are assigned a sub-community based on their address. They contribute to a neighborhood-wide activity stream by creating posts of different categories, communicate via direct messages, can access a neighborhood calendar of local events and are provided with a list of local organizations and their offerings. Each neighbor possesses an individual profile page where he or she can provide a profile image, contact information as well as a self-description and interests. MyNeighbors provides a variety of configuration options for specifying which personal data such as name, address and contact information are visible to other users.

A neighborhood directory provides an overview of all verified neighbors in one's neighborhood. Furthermore, MyNeighbors is integrated with a professional neighborhood management service which acts as online and offline community management, a health counseling service as well as smartphone training classes for senior citizens. Neighbors are notified of important events on the platform via configurable email notifications. From a technical perspective, MyNeighbors is a web-based platform developed using the Django web development framework (djangoproject.com) and provides a responsive user interface for desktop and mobile devices.

16.3.2 Data collection & analysis

We collect MyNeighbors **platform usage data** in the one-year timespan between June 15th, 2019 and June 15th, 2020. Data is collected using the Matomo open-source analytics software as well as the capabilities of the MyNeighbors platform itself. We analyze the collected data using the Microsoft Power BI data analysis software. Among the analyzed data are both user activity (e.g., logins, visits, used software features) and contributions (e.g., posts, private messages, number of registered users). We exclude usage data produced by the authors from our analysis.

The **online user survey** was active from December 2019 until the end of March 2020. 28 MyNeighbors users participated in the survey (21% of 131 verified users at the time of survey closing). The survey contained a total of 50 questions, structured based on the base capabilities of the MyNeighbors platform (i.e., social interaction, information sharing, peer support, and others) but also questions regarding perceptions of privacy, ease of use and usefulness as well as a set of demographic questions. The majority of questions were based on a four-point Likert scale (agree, somewhat agree, somewhat disagree, disagree), complemented by multiple-choice and open-ended questions. The survey was presented to verified MyNeighbors users directly via the ONSN platform upon login and distributed as part of an email newsletter. We perform eight **semi-structured interviews** with MyNeighbors users from both case neighborhoods in December and January 2020. Interviewees were approached via private message on the MyNeighbors platform or via local events in the case neighborhoods. Interviews took place in the subjects' homes, were documented using researcher field notes and refined using audio recordings. The semi-structured interviews followed a predefined interview guide containing open questions regarding general neighborhood life, MyNeighbors platform usage as well as demographic characteristics of participants. Direct quotes were carefully translated from German into English. By combining several data collection and analysis approaches (platform usage data, online survey and qualitative interviews), we balance the limitations of one evaluation element with the strengths of the others. Consequently, we can triangulate findings and can confirm usage patterns across multiple data sources.

16.4 Findings

16.4.1 Platform usage

16.4.1.1 Overview

At the end of our data collection period (June 15th, 2020), 136 users were registered and verified for the MyNeighbors ONSNs platform (146 including unverified users) in the two case neighborhoods. Three groups of users can be distinguished on MyNeighbors.

Neighborhood managers, representing the smallest group with six members, act as online community managers and facilitators for the other user groups. They possess certain administrative rights for curating platform content and user verification. *Professionals* represent the second largest group, with 38 users.

Table 1. MyNeighbors users age distribution

Age	N	P	Nm	Σ
18 - 34	11 (12%)	17 (45%)	2 (33%)	30 (22%)
35 - 44	11 (12%)	12 (32%)	1 (17%)	24 (18%)
45 - 54	12 (13%)	2 (5%)	1 (17%)	15 (11%)
55 - 64	22 (24%)	7 (18%)	2 (33%)	31 (23%)
65+	36 (39%)	-	-	36 (26%)
Σ	92	38	6	136
Ø age	58,6	37,5	45,8	52,2

N = neighbors; P = professionals; Nm = neighborhood managers

These include members of organizations and institutions which are active in the case neighborhoods, such as clubs, churches, nonprofits and health service providers. Finally, *neighbors* are private individuals using the MyNeighbors platform. As they are at the center of our research, the analysis in the following Sections 4.1.2. to 4.1.4. is limited to data of the neighbor user group (i.e., excluding professionals and neighborhood managers) unless otherwise stated. Table 1 provides an overview of the age distribution across these user groups.

16.4.1.2 User activity

We measure user activity on the MyNeighbors platform based on the number of logins and requests made by its users. Logins constitute visits to the website where the username and password are actively and successfully submitted. It must, however, be noted that not each visit to the MyNeighbors platform necessitates a new login as session information is stored across multiple visits. We evaluate HTTP GET requests to gain a more fine-grained measure of actions performed on the website subsequent to login. Figure 1 provides an overview of logins and requests made per user by age group.

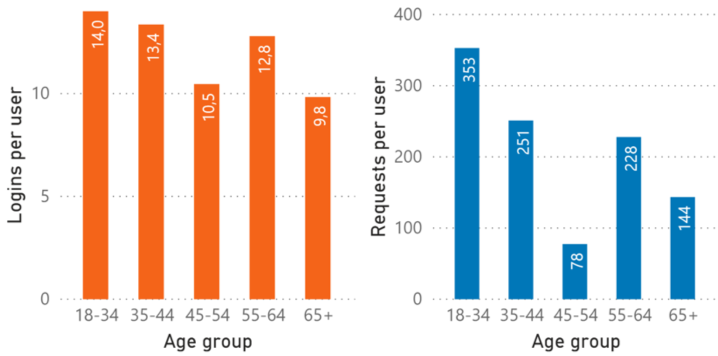

Figure 1. Logins and requests per user by age group

Across all age groups, the average number of logins per user was 12.1. Older adults logged in an average of 9.8 times, representing the group with the lowest number of logins, coming close only to the group of users 45 to 54 years of age with 10.5 logins. Regarding actions on the MyNeighbors platform, older adults ranked below the average of 210 requests across age groups, performing 144 requests per user on average. In contrast, the youngest group of users, aged 18 to 34 years, performed the highest number of actions on the platform with 353 requests per user.

16.4.1.3 User contributions

A total of 658 posts were published on the MyNeighbors platform during our data collection period. Of these posts, 282 were created by neighborhood managers, 188 by professionals and 188 by neighbors. The 188 posts created by neighbors included 141 events, 38 announcements, five offers, three requests and one question. Users of all user groups communicated with each other directly via 397 private messages (236 sent by neighbors), wrote 140 comments (83 published by neighbors) and received 6296 email notifications. Figure 2 provides an overview of the content generated per user on MyNeighbors by age group.

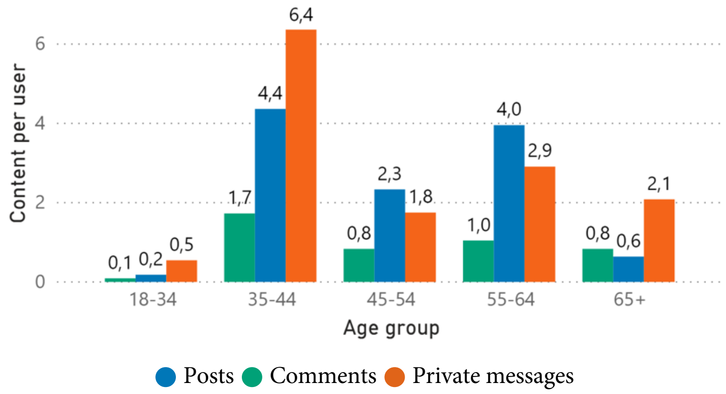

Figure 2. Generated content per user by age group

With an average of 0.6 posts per user, older adults created the second-lowest number of posts on the MyNeighbors activity stream out of all age groups. They created 2.1 private messages per user, being surpassed by the 35 to 44 and 55 to 65 year old users. Regarding comments made to posts, older adults rank identical to the 45 to 65 old users with 0.8 posts on average and are ahead of the 18 to 34 years user group.

16.4.1.4 Functionality usage

To illustrate functionality usage, we group the requests measured as described in 4.1.2. by the platform functionality they relate to. Requests not directly attributable to a platform functionality were excluded. With 39 requests per user, the neighbor directory as well as individual neighbor profiles were the most used functionality of MyNeighbors across age groups, followed by posts with 34 requests and the MyNeighbors calendar with 28 requests. Groups and the MyNeighbors offerings directory seem not to have attracted much attention from users, with only 3.4 and 3 requests per user respectively. Figure 3 provides a more detailed look at feature usage per user by age group based on requests made in the context of a specific functionality.

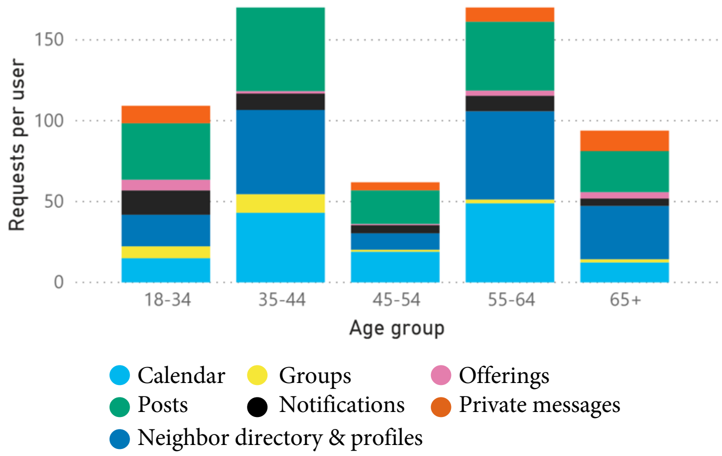

Figure 3. Functionality usage per user by age group

Generally, the majority of requests performed by older adults on MyNeighbors is associated with an above-average activity related to private messages as well as activity related to posts and the neighbor directory or profiles. While the previous Section 4.1.3. showed that older adults did generate few posts compared to other age groups, a considerable share of their on-platform actions were related to reading posts and visiting the post overview on the MyNeighbors activity stream. Despite not sending the most messages on MyNeighbors compared to other age groups as presented in Section 4.1.3., older adults performed more actions related to private messages than any other age group. Older adults, furthermore, did not perform many actions related to the MyNeighbors calendar compared to other age groups.

16.4.2 Online user survey

16.4.2.1 Overview

The 28 survey respondents had an average age of 60.2 years, ranging from 44 to 82 years. Participants were 43% female and 54% male, with an average household size of 1.7. Respondents estimated that they had used MyNeighbors for an average of 4.1 months prior to completing the survey. We included one partially completed survey in the following analysis.

16.4.2.2 Social connectedness, social participation and information sharing

The majority of respondents indicated that they valued communication and exchange with neighbors via the MyNeighbors platform (25% agree, 36% somewhat agree). In part, respondents were also successful in making new acquaintances via MyNeighbors (21% agree, 21% somewhat agree). However, respondents did not generally meet more frequently with neighbors since using MyNeighbors (7% agree, 14% somewhat agree) and only some were able to meet neighbors with matching interests (11% agree, 25% somewhat agree). However, based on responses, the platform was successful in driving neighbors to volunteer in their neighborhood (36% agree, 29% somewhat agree).

Respondents possessed a positive perception of information-sharing capabilities of MyNeighbors. Most reported that MyNeighbors had helped them to be better informed regarding events and offerings in the neighborhood (71% agree, 18% somewhat agree) and neighborhood life in general (50% agree, 39% somewhat agree).

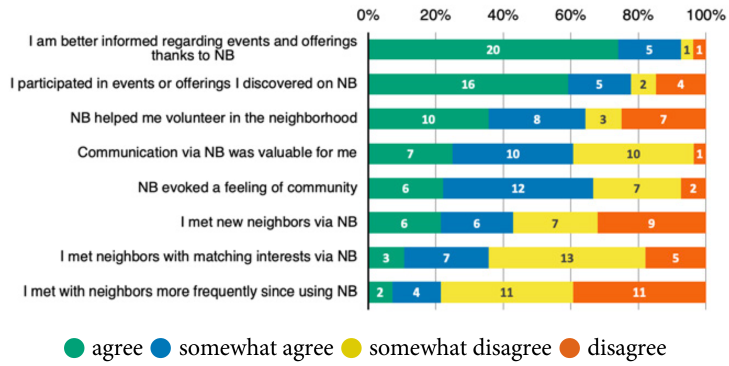

Figure 4. Social connectedness, social participation and information sharing

Respondents acted on the received information and participated in events and offerings discovered via MyNeighbors (57% agree, 18% somewhat agree). For some respondents, MyNeighbors was able to evoke a feeling of community (21% agree, 43% somewhat agree). Figure 4 provides a detailed overview of responses related to social connectedness, social participation and information sharing.

16.4.2.3 Peer support

Peer support presented itself as a multi-faceted issue based on survey responses. Respondents reported a strong willingness to provide assistance to others (35% agree, 53%

somewhat agree) and would also request assistance themselves, if in need (32% agree, 39% somewhat agree). However, based on responses, they did not request assistance via MyNeighbors as of yet (71% disagree, 11% somewhat disagree) and most respondents did not get the opportunity to assist others (25% agree, 11% somewhat agree, 61% did not have the opportunity).

16.4.2.4 Motivators and obstacles for platform use

Respondents indicated that their main motivation for using MyNeighbors lay in staying up-to-date with current neighborhood life, including local events and offerings. Furthermore, maintaining existing relationships with other neighbors represented a motivating factor while building new relationships played a minor role. According to respondents, the most motivating platform features were posts by neighborhood managers (considered motivating by 71%), followed by posts by other neighbors (57%), the neighborhood calendar (54%) and private messages between neighbors (18%).

A lack of new platform content and perceived activity on the platform, i.e., its liveliness, represent obstacles to MyNeighbors usage. However, responses suggest that technical issues or a lack of relevance of the available content are not significant obstacles. Obstacles mentioned via free-text response under "Others" include the lack of native mobile apps and a general lack of free time to commit towards using MyNeighbors. Table 2 presents an overview of motivators and obstacles for MyNeighbors use.

Table 2. Platform use: motivators & obstacles

Motivators	Information on local offerings	23	82%
	Information on local events	21	75%
	Staying up-to-date	19	68%
	Maintaining local social ties	11	39%
	Finding specific information	8	29%
	Forming new local social ties	4	14%
	Finding local organizations	4	14%
	Boredom/need for entertainment	2	7%
	Others	2	7%
Obstacles	Lack of participants	9	32%
	Others	9	32%
	Lack of activity	7	25%
	Forget to check for updates	7	25%
	Content not current	4	14%
	Content not relevant	1	4%
	Technical issues	1	4%

16.4.2.5 Ease of use and usefulness.

In comparison to other OSNs, respondents agreed (50%) or somewhat agreed (25%) that MyNeighbors was more suitable for their needs. Similarly, respondents agreed (21%) or somewhat agreed (57%) that NeigborBook was more clearly designed than other OSNs.

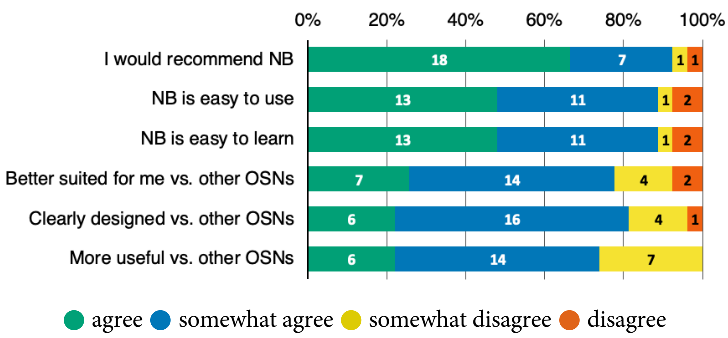

Figure 5. Ease of use and usefulness

Generally, the majority of users considered MyNeighbors as useful (21% agree, 50% somewhat agree) and described it as being easy to use and learn (46% agree, 39% somewhat agree). Overall, most users would recommend MyNeighbors (64% agree, 25% somewhat agree). Figure 5 provides a detailed overview of responses related to the platform's ease of use and usefulness.

16.4.2.6 Trust and privacy

Data privacy represented an important issue for respondents. Overall, they considered their data to be in good hands with MyNeighbors (32% agree, 61% somewhat agree). Furthermore, respondents indicated that they trusted MyNeighbors more with regards to data privacy than commercial social networks (43% agree, 43% somewhat agree). Regarding preferences for sharing one's name, address and profile image, opinions were split. 43% of participants preferred seeing the full names of other users on MyNeighbors (e.g., John Doe), while 54% preferred a partly anonymized version (e.g., John D.). Respondents were largely satisfied with knowing that other users live in the same neighborhood (50%), some preferring a more precise location based on the street name (29%) or street name and number (18%). Regarding profile images, a slight majority of respondents agreed or somewhat agreed that it was important to be able to see profile images of other users (21% agree, 36% somewhat agree).

16.4.3 Semi-structured interviews

16.4.3.1 Overview

The eight interviewees had an average age of 68, ranging from 47 to 84. They had lived in their neighborhood for an average of 14 years and were evenly split between male and female. Six out of eight interviewees were retired while two were employed part-time and lived in households of 1.25 on average. Six out of eight interviewees accessed MyNeighbors via both smartphone as well as desktop or laptop computer, the other two interviewees relying on only one of these devices. They had been members of MyNeighbors between 2 weeks and eight months prior to the interview taking place.

16.4.3.2 Social connectedness, social participation and information sharing

According to interviewees, the MyNeighbors platform was able to help them in staying up-to-date with current neighborhood life and a number of interviewees were able to identify and participate in local events via the MyNeighbors platform. Mentioned examples include cooking classes, gymnastics for seniors, meeting for coffee, smartphone training, health counseling or board game afternoons. One interviewee reported publishing her own events to the MyNeighbors calendar in order to attract participants. The MyNeighbors platform was characterized by one interviewee as follows:

> *For me it is a platform for the [case] neighborhood on which people who live here can meet, make contact and exchange help, information, anything really.*

Interviewees described the MyNeighbors platform as a complement but not a substitute for in-person interaction. However, many interviewees saw MyNeighbors as a valid means of initiating new social connections, which could then be further developed offline. Connections would not only arise via direct communication with other MyNeighbors users but also by meeting new neighbors in the context of events discovered via the platform's calendar.

16.4.3.3 Peer support

The topic of peer support was discussed animatedly by interviewees. Most considered establishing a platform-supported local peer support network as a feasible and commendable undertaking. Similarly, most interviewees would be ready to render assistance to neighbors if necessary, in some cases depending on how well the required assistance fits into their skillset or schedule. One interviewee considered peer support among the inhabitants of individual buildings as a promising scenario as trust among these proximate neighbors would likely be higher than between unknown neighbors in the neighborhood. Regarding using MyNeighbors to receive assistance with household tasks from neighbors one interviewee stated:

> *That is definitely a possibility, how well it works will depend on the actual human relationship. Such a platform is a starting-point I could hook into. […] Right now help comes via friends, not via neighbors. […] I wonder how reliable I could get what I need over certain periods of time [via MyNeighbors].*

However, interviewees unanimously reported not yet having requested assistance via the MyNeighbors platform and not having become aware of any requests for assistance they could have answered via the platform. Some interviewees also expressed doubts that those who could really benefit from local peer support would likely not possess an internet-connected device and, therefore, could not be reached effectively.

16.4.3.4 Motivators and obstacles for use

Interviewees expressed a variety of motivations for using the MyNeighbors platform. Curiosity towards the platform in general, as well as the potential of interacting with neighbors from the immediate neighborhood were mentioned frequently. Furthermore, being able to remain in the loop regarding local events via the MyNeighbors calendar represented an important motivator for interviewees, particularly when asked regarding motivators for continued and regular platform usage. Other motivators included wanting to counteract a feeling of social exclusion, being able to look up offerings of local organizations and gaining a novel use-case for smartphone usage. Almost all interviewees described the MyNeighbors platform as easy to use and quick to learn. Some reported that personal instruction during smartphone classes or by neighborhood managers helped them to get started using the platform. The main obstacle for use was described as a lack of diffusion of MyNeighbors in the case neighborhoods and a resulting lack of perceived platform activity or liveliness. Interviewees considered further marketing activity as necessary to increase platform usage.

16.4.3.5 Trust and privacy

Interviewees had a positive perception of trust and data privacy in relation to MyNeighbors. Several interviewees mentioned that the identity and address verification mandated by MyNeighbors increased their trust in the platform as these mechanisms ensured only real neighbors were present. Generally, data privacy was an important issue for interviewees and being able to trust the MyNeighbors platform was an important condition for using it. Interviewees expressed that trust in the MyNeighbors ONSN was strengthened by a university, perceived as a reputable public institution, acting as the platform provider due to malicious commercial interests being deemed unlikely. One interviewee expressed:

> *[MyNeighbors] seems to have a reputable background. The university takes care of it and it's checked personally if [users] are really in the neighborhood. I know there's a bunch of safety precautions to make sure that the pot's content fits the label.*

Regarding the use of profile pictures, interviewees largely considered them as valuable as they assisted in recognizing known neighbors, facilitated getting to know new neighbors and generally sparked interest in visiting user profiles.

16.5 Discussion

MyNeighbors was generally successful in attracting older adults, with individuals aged 65 and older constituting the largest age group among users. Assessing the platform usage of older adults requires differentiated consideration. The analyzed data shows that older adults did not contribute large amounts of publicly visible user-generated content such as posts to the platform, creating the smallest number of posts per user out of all age groups. They did, however, interact with the posts of other users via comments at a rate similar to other age groups. Regarding direct communication via private messages, older adults performed more platform actions on average than any other age group and created more messages than some younger age groups. Similarly, they performed more on-site actions based on requests than users aged 45 to 54 years and came close to the 18 to 34 demographic. For an age group typically hard to engage via online platforms [25], the data shows a surprising activity.

Consequently, while younger user groups acted as producers of public content, older adults leveraged MyNeighbors mainly for the consumption of this content and for private communication. The observed lack of public self-disclosure is in line with previous research showing that older adults are hesitant to openly communicate on OSNs and have less need for self-portrayal compared to younger user groups [12]. It can be speculated that the high activity related to private messages sent by older adults may in part be the result of a lower diffusion of messenger apps for direct communication such as WhatsApp among older adults compared to younger neighbors.

Access to locally relevant information, particularly regarding local events and general neighborhood life, presented itself as the main driver of platform usage cross usage data, online survey and interviews. Based on their combined on-site actions, posts and the MyNeighbors calendar represent the most used functionality. Survey responses and interviews indicated clearly that MyNeighbors helped them to stay up-to-date with current neighborhood life and that they actively participated in events discovered via

MyNeighbors. Partaking in these events and offerings can also be considered as positive regarding the social connectedness and participation of neighbors. Almost half of survey respondents reported meeting new neighbors via MyNeighbors, a considerable number especially considering the high age of respondents and their long residence in the case neighborhoods.

Based on our analyzed data, the MyNeighbors peer support network remained largely unutilized. Usage data shows that almost no posts of the category request were made. Similarly, survey respondents and interviewees indicated that they did not request any assistance via MyNeighbors. Conversely, a number of unsolicited offers for assistance could be observed in the usage data, in some cases related to the COVID-19 pandemic. It is unclear if these offers were accepted as communication to this end may have been conducted outside the MyNeighbors platform. Furthermore, survey respondents and interviewees exhibited a high readiness to support neighbors if the need for assistance ever arose but did not have the opportunity to act due to a lack of requests for help. Dissolving this causality dilemma may require external, non-neighbor stimulation, for instance via neighborhood managers publishing requests for assistance by proxy and thereby jump-starting the peer support network. Stimulation may also come via specific, novel functionality that provides structure to requests and nudges users to provide peer support.

Based on survey and interview analysis, platform users showed greater trust towards MyNeighbors concerning the handling of their personal data compared to other OSNs. The platform profited from its provider being a public institution, the address and identity verification mechanisms in place, privacy controls as well as real-name usage. Users described MyNeighbors as easy to use compared to other OSNs which may be explained by lower complexity due to a small feature set compared to other OSNs. Smartphone classes offered for older adults in the case neighborhoods also lowered the entry barrier to MyNeighbors and internet-connected devices in general for some users. Although, based on the limited data available, it cannot be determined with certainty if MyNeighbors is better-suited for older adults than other OSNs, the platform does show potential in addressing some obstacles faced by older adults when using OSNs, including complex user interfaces, lack of personally relevant content and concerns with data privacy [12]. The community of trust evoked by neighborhood sub-communities and the resulting smaller audience compared to other OSNs, may also have positively influenced adoption by older adults.

16.6 Conclusion and Outlook

In this study, we investigated the use of ONSNs by older adults based on empirical data collected from the NeigborBook ONSN platform. We analyze platform usage data, an online survey and interviews of platform users. Results show that the ONSN was generally successful in attracting and being utilized by a user base of older adults. We observe that the platform established itself as a useful information sharing medium in the case neighborhoods and served as a means of communication for older adults, who readily interacted with MyNeighbors. It was less successful in establishing a local peer support network among neighbors. Compared to other OSNs, users valued the ease of use as well as focus on trust and privacy of MyNeighbors but were in some cases deterred by a lack of perceived activity and liveliness.

This research furthers the understanding of digital technology use by older adults by providing a detailed perspective on their usage of OSNs and, in particular, ONSNs. We demonstrate the potential of ONSNs to positively impact the social connectedness and participation of older adults and provide insights for the future development of online communities aimed at improving the well-being of older adults in their neighborhood. Furthermore, we present ONSNs as one potential building block of initiatives aiming to create an urban environment that is age-friendly and enables older adults to age actively and in place.

This research is faced with some limitations. Data sample size is limited, collected from a relatively constricted geographic area and prone to selection bias. Therefore, the generalizability of the presented findings to a wider population and neighborhoods with different characteristics has to be considered as limited. The unique context of our case ONSN as part of a larger research project with neighborhood managers, health consultants and smartphone classes also hinders transferability to other settings. In the future, the MyNeighbors ONSN is expected to expand to further case neighborhoods in the same metropolitan area, enabling a comparison between neighborhoods with varying socio-demographic properties. In the long-term, an expansion into other cities, regions or countries could yield further impactful insights on ONSN use by older adults.

16.7 Acknowledgments

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17 Fostering Social Resilience via Online Neighborhood Social Networks During the COVID-19 Pandemic and Beyond: Status Quo, Design Dilemmas and Research Opportunities

Vogel, Pascal; Kurtz, Christian; Grotherr, Christian; Böhmann, Tilo

Abstract

Public health measures are curtailing the COVID-19 pandemic's spread but also impact individual and societal well-being. Altogether, they test the social resilience of communities, their collective ability to cope with crises. The pandemic highlights the significance of the immediate local community or neighborhood, be it for providing assistance to individuals in need, the sensible sharing of public spaces or a renewed conscience for supporting local businesses. We argue that online neighborhood social networks (ONSNs) represent a viable solution for improving social resilience as they enhance a community's resistance to disruptions, quicken recovery to a normal level of functioning and can become a platform for creative solutions to strengthening social resilience. We conduct a multiple case study to demonstrate how ONSNs foster social resilience in the focal crisis and beyond. Furthermore, we identify design dilemmas and highlight avenues for IS research with a high impact on local communities and their well-being.

Keywords: covid-19, social resilience, online neighborhood social networks, social media, case study

17.1 Introduction

The COVID-19 outbreak has rapidly evolved from a regional epidemic to being designated a pandemic by the World Health Organization (WHO) [1]. At the time of writing, the WHO reports a total of six million laboratory-confirmed cases and more than half a million deaths caused by the coronavirus disease 2019 (COVID-19) [2]. Governments around the world are responding with public health measures such as physical distancing, mandatory quarantines, stay-at-home orders and travel bans. While these measures show success in curtailing the spread of the COVID-19 pandemic [3], they impact our individual and societal well-being. Potential adverse outcomes can range from boredom and frustration to stress and depression [4]. Many types of businesses that rely on physical proximity, are affected, cascading into severe long-term effects for entire economies [5]. Yet, a selection of public health measures will likely have to remain in place for an extended period of time until an effective vaccine for COVID-19 is widely available, at least for some regions or population groups [6].

Hence, the COVID-19 pandemic tests the collective ability of communities to respond positively to and cope with a crisis, their social resilience [7]. These responses highlight the significance of our immediate surroundings, our community or neighborhood, which during the COVID-19 pandemic play a key role in ensuring social resilience [8]. Vulnerable groups such as the elderly, children or the poor rely on assistance from local institutions, organizations and individuals to sustain themselves during this crisis. Physical distancing has necessitated new usage patterns in public transportation and shared usage of public spaces in general. Disruptions in the supply chains of some goods, as well as business models challenged by public health measures, have raised a newfound awareness for supporting local businesses [9]. But communities pulling together during this pandemic must do so intelligently and without risking infection, lest they worsen the very crisis they are trying to surmount.

At the same time, the diffusion of broadband internet and digital technology allows us to sustain at least some facets of our personal and professional lives, whether it is for maintaining social relationships, education, work or entertainment. Online social networks (OSNs), in particular, can play an important role in mitigating the effects of crises [10], including the current COVID-19 pandemic [11, 12]. Online neighborhood social networks

(ONSNs) are a novel type of online social network (OSN) that affords their users functionality for social interaction and information sharing, peer support and integration of local service providers in a geographically delimited community of trustable neighbors [13]. These neighborhood platforms have gained in popularity over the last years, San-Francisco-based Nextdoor leading the charge with 27 million active monthly users and 236,000 active neighborhoods [14]. We argue that these capabilities make ONSNs a viable solution for fostering social resilience as they support a community's resistance to disruptions as well as recovery to a normal level of functioning. As they are already home to a like-minded community of neighbors and have reached a certain level of technological maturity and reliability, they are an instrument that is available for immediate application in the face of the current crisis. While there are first studies on the design and effects of ONSNs [15, 16] and they, among other OSNs, are finding application during the COVID-19 pandemic [11, 12, 17], their role in improving social resilience has not yet been investigated. Furthermore, there is a need for further research investigating how citizens leverage social media for self-coordination and self-help in times of crisis [18]. Taking into consideration both the current crisis of the COVID-19 pandemic as well as future crises, we define the following guiding research question:

How can online neighborhood social networks be leveraged to foster social resilience in local communities?

With this research question, we respond to the current calls for information system (IS) research on building resilience to pandemics and other crises [19, 20]. To answer our research question, we conduct a multiple case study of ONSNs and analyze their general capabilities for fostering social resilience as well as the means by which they adapt their capabilities to the COVID-19 pandemic. We combine an in-depth analysis of user-generated content of one specific ONSN based in a German metropolitan area with a high-level analysis of capabilities of a multitude of ONSN platforms available globally. Based on these findings, we highlight the conflicting role of "local" in the face of the COVID-19 pandemic, how ONSNs can contribute to the intelligent orchestration of neighborhood resources and how IS research can contribute to fostering social resilience in case of the COVID-19 pandemic as well as future crises.

This paper is structured as follows. The next section provides an overview of previous research on ONSNs and social resilience. The third section describes the applied case study research methodology, while the fourth section presents the results of our analysis. We discuss the implications of this study as well as opportunities for further research in the fifth section and conclude with a summary of its results, contributions and limitations.

17.2 Related work

17.2.1 Online neighborhood social networks

Neighborhood-centric information systems can be traced back to community computing initiatives such as the Blacksburg Electronic Village [21] or Netville [22], which provided neighbors with access to discussion boards, local news, email lists and business listings as early as the 1980s. With the rise of OSNs, cumulative and segmentative network effects led to the formation of neighborhood-focused sub-communities in the form of groups [23]. Online neighborhood social networks are a novel type of OSN whose functional and topical focus lies on neighborhood-related issues and that are aimed at the inhabitants of one or more spatially delimited neighborhoods [24]. Common functionality of ONSNs consists of a neighborhood-wide activity stream for sharing posts on topics such as local news, recommendations or requests for assistance in daily tasks, direct messaging between neighbors and neighbor profiles and directories [13]. While this set of features is similar to that of traditional OSNs such as Facebook, ONSNs differentiate themselves in a number of ways. A central design feature of ONSNs is the automated segmentation of users into isolated sub-communities based on their neighborhood of residence, determined via an address and identity verification mechanism ranging in rigorousness from sharing one's device location to in-person id checks. These mechanisms have been demonstrated to establish a community of trust amongst the members of some online neighborhoods [13, 25], increasing the value of ONSN content and features. For instance, trust in recommendations received, trades on a marketplace or willingness to request or provide assistance, which could technically also be found on traditional OSNs, could be of higher value in a community of trustful neighbors. Other frequently observed differences include a lack of user-to-user relationships such as friends lists or followers, a local offline footprint in form of representatives such as neighborhood managers and limited platform availability. Besides market leader Nextdoor, popular ONSNs include Berlin-based nebenan (German for *next door*) with 1.6 million users across several European countries [26] and Neighbourly with 830,000 users in New Zealand [27].

The term neighborhood can be defined from a multitude of perspectives [28] and ONSNs employ a variety of approaches to delineating the boundaries of neighborhoods. These range from crowdsourced delineation by users to radius-based approaches. While traditional OSNs such as Facebook aim to achieve maximum online engagement of users due to their business model [29], the goal construct of ONSNs is more ambiguous, positioning them more towards being facilitators of offline activity than online engagement. As a result, ONSN platform providers are required to develop novel business models that do not primarily rely on online advertising [13]. Studies analyzing the effects of ONSNs demonstrate their ability to increase neighborly communication and activities [16], to foster local engagement and intergenerational communication [15] and to improve social connectedness and participation among neighbors [30]. While ONSNs such as Nextdoor are also brought to bear alongside other OSNs during crises such as the COVID-19 pandemic [11], as yet, the focus in this regard has been generic communication and information sharing functionality as opposed to functionality targeted at improving social resilience.

17.2.2 Technology-mediated social resilience

Crises of natural and human origin as well as the accompanying disruption, challenge the resilience of communities. In this regard, social resilience describes "the capacity of social groups and communities to recover from, or respond positively to, crises" [7, p. 1]. Social resilience can be conceptualized based on the three properties of resistance, recovery and creativity [7, 31] (see Figure 1). Resistance describes the extent to which a community can withstand disruption without passing a point of no return, resulting in long-term negative consequences. Recovery can be understood as the time between a disruption and a community returning to its previous level of functioning. Finally, creativity describes how a community leverages experiences gained and adaptations made in the course of a disruption to achieve a permanently higher level of functioning compared to the pre-disruption base level. A community's social resilience is determined by a variety of attributes such as social and people-place networks, the knowledge and skills of its inhabitants, governance structures as well as infrastructure and economy [32].

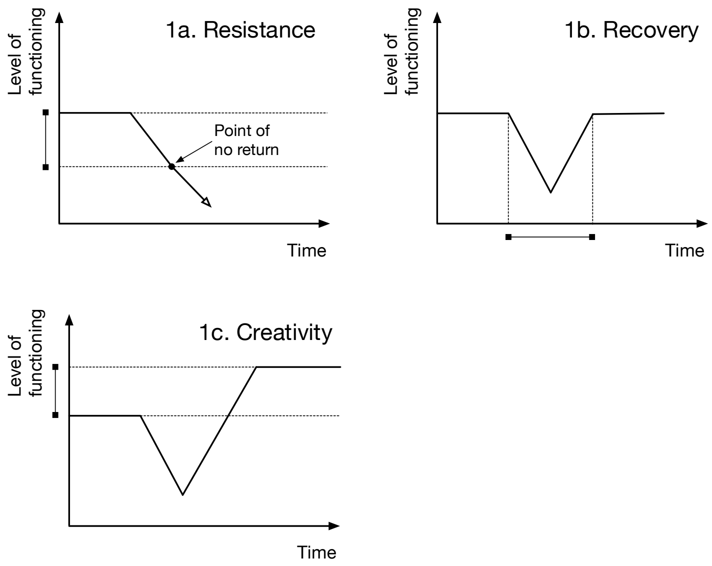

Figure 1. Properties of social resilience: resistance, recovery and creativity (adapted from Maguire and Hagan [7])

Digital technology can improve social resilience by facilitating access to education and health, enabling the monitoring of risks as well as by connecting and empowering communities. In particular, social media platforms can strengthen the social resilience of communities [11, 33, 34], for instance, by reducing risks for disaster through information distribution and education, assisting management and communication efforts during an active disaster or by developing communities of support amongst those affected by and responding to disasters and their aftereffects [35]. The cooperative use of social media by citizens and emergency services in times of crisis harbors the potential to foster social resilience, e.g., via emergent citizen groups and digital volunteering [33].

In case of the COVID-19 pandemic, social media is being leveraged to, among other capabilities, communicate health information, to build trustful relationships between citizens and public health institutions, to combat misinformation and to contribute to sense-making among the general population [17, 36]. The nature, scale and severity of the COVID-19 pandemic have led to a call for further research on technology-mediated social resilience and crisis responses [19, 20]. Cases, methods and tools for utilizing social media in communication between authorities and citizens have been extensively researched over the last decade [18]. However, there is a need for further research on the self-coordination and self-help practices employed by citizens on social media in times of crisis [18] and there is no research investigating the potential of ONSNs for supporting citizens in organizing self-help efforts.

17.3 Research methodology

We conduct a multiple case study [37] of ONSNs to investigate (1) how they foster social resilience during the COVID-19 pandemic and (2) how they are adapting their platform design features to face the challenges of the current crisis (see Figure 2). Our approach is T-shaped, performing both a deep analysis of user-generated data from one specific ONSN as well as a high-level analysis of platform design features from a broader selection of multiple additional ONSNs. We choose this approach because access to ONSNs is usually restricted to inhabitants of a specific neighborhood and this restriction is enforced via identity and address verification mechanisms, making it difficult to access user-generated content from an external perspective as opposed to public-facing OSNs such as Twitter. The MyNeighbors ONSN platform, which is being operated by the authors as part of an ongoing design science research project in the context of healthy and connected communities [24, 30, 38], offers a unique opportunity to gain comprehensive access to user-generated content on an ONSN.

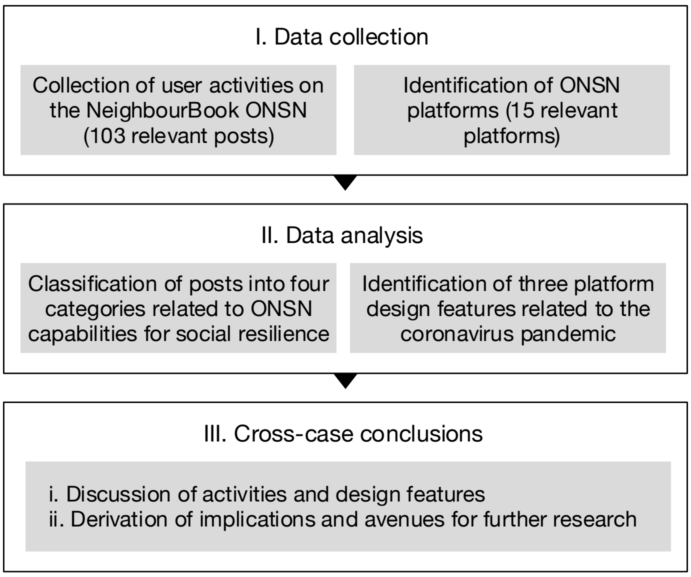

Figure 2. Research steps and activities

Choosing this approach, we are able to quickly develop first insights useful for coping with the COVID-19 pandemic while still drawing on a set of data that is both comprehensive and diverse. The final step of our research consists of the derivation of cross-case conclusions [37] by comparing the current state of usage and artifact design features of our set of ONSNs, determining commonalities and differences, and deriving implications for future research into leveraging ONSNs for fostering social resilience.

17.3.1 Analysis of user-generated content

To investigate how ONSNs foster social resilience during the COVID-19 pandemic, we collect user-generated content in the form of posts made to the MyNeighbors ONSN. The platform is being used by around 160 users in two case neighborhoods in a large German metropolitan area and possesses the common set of ONSN features described in Section 2.1. In addition, MyNeighbors is integrated with a professional neighborhood management service that takes the role of offline and online community management as well as several local organizations and institutions such as health service providers, clubs, citizen's initiatives and churches. Between March 1st and May 15th, 2020, 103 out of a total of 128 posts made on MyNeighbors were related to the COVID-19 pandemic.

Three researchers independently analyzed the collected data. Our coding scheme was developed based on the core functional capabilities of ONSNs: information sharing, social interaction, peer support and integration with local organizations and institutions [30]. During data analysis, coders first identify those platform posts that are related to the current crisis of the COVID-19 pandemic. Subsequently, the remaining posts are deductively coded by each researcher using the developed coding scheme. Intercoder agreement was measured at 88.976% based on average pairwise percent agreement and .838 based on Krippendorff's Alpha. In a final harmonization step, the three coders discussed deviations in their code assignments until intercoder agreement was reached. The results of this coding procedure are presented in Section 3.1.

17.3.2 Analysis of platform design features

To investigate how ONSNs are adapting their platform design features to face the challenges of the current crisis, we collect and analyze data from publicly available ONSN platforms on their websites, knowledge bases and company blogs. To identify ONSN platforms, we perform a criteria-based online search using the company databases crunchbase (crunchbase.com) and CB Insights (cbinsights.com), the iOS App Store and Google Play Store as well as the Google search engine. We utilize combinations of the search terms neighborhood, community, local, social media and social network. We exclude platforms that have a neighborhood focus but do not fit our definition of ONSNs (e.g., security-focused platforms such as Neighbors by Ring) and local social networks without a neighborhood focus (e.g., local shopping apps such as Wiva). Based on these criteria, we identify and analyze fifteen ONSNs (see Appendix A). As platform access restrictions prevent the gathering of user-generated content in case of these platforms, we instead collect data on the "specific artifact capabilities" [39, p. 814] or design features of these platforms developed or adapted in response to the COVID-19 pandemic. We complement this data with third-party, public sources such as news articles or blog posts that report information on the response of these ONSNs to the COVID-19 pandemic. Of the fifteen platforms, two (nebenan and Nextdoor) have implemented novel design features in light of the COVID-19 pandemic.

17.4 Results

In this section, we present our results regarding both the usage of ONSNs based on data collected from the MyNeighbors ONSN (Section 4.1) and adaptations made to platform design features of ONSNs in response to the COVID-19 pandemic (Section 4.2).

17.4.1 Community activity in response to the COVID-19 pandemic

OSNs can represent a viable source of social connectedness [40], with ONSNs being no exception. ONSNs afford their users a variety of means for **improving social connectedness and participation**, including communication via posts or messages and by promoting social online and offline activities and offerings. Local communities, such as those using MyNeighbors, seek ways to stay connected and retain a sense of community belonging despite the interruption of in-person events. The collected data shows several instances of neighborhood-specific offerings for social interaction being made. A local church organized a photo contest for creative family activities compatible with physical-distancing, with winners being announced during online church service. Neighborhood managers arranged an outdoor exhibition of neighbor-provided photographs, while neighbors themselves arranged to regularly provide collective applause to essential workers at an agreed-upon time every evening. The local church posted:

> *Who has the most creative ideas for good family time? Send us photos or descriptions of your common activities. […] We want to inspire each other and will award the most original ideas in the next family church service!*

Pandemic-induced public health measures such as physical distancing or stay-at-home orders have put a stop to many community activities, resulting in adverse outcomes such as social isolation and loneliness, particularly for vulnerable groups such as children or the elderly [41]. The analyzed data demonstrates how an ONSN supported the surveyed communities in maintaining existing social networks. This, in turn, may counteract social isolation and loneliness and strengthen the overall crisis resistance and ability to recover from disasters.

The ONSN capability of **sharing locally relevant information** was used in connection with the COVID-19 pandemic. Particularly at the pandemic's onset, information regarding public health measures on the national and state level, such as recommendations for personal hygiene or COVID-19 case numbers, was published. Furthermore, information regarding city-level measures and their implementation in the local neighborhood were shared. The collected data, furthermore, shows instances of neighborhood-level announcements regarding topics such as policies regulating the use of public spaces and restrictions for neighborhood events being made. A neighborhood manager declared:

> *Dear members and neighbors, the assembly ban remains in place and the neighborhood common rooms continue to be unavailable for events. Any necessary exceptions […] are only possible upon consultation and in accordance with appropriate safety measures.*

Providing citizens with timely access to relevant information is an essential element of responding effectively to crises, building crisis resistance, the ability to recover and for fostering social resilience [18]. On the MyNeighbors ONSN, organizational representatives, neighborhood managers and neighbors made available locally relevant and targeted information related to the ongoing crisis. In case of MyNeighbors, neighborhood managers possess the critical role of not only distributing information but also monitoring information provided by other actors.

Establishing a local peer support network represents an important capability of ONSNs. By segmenting the inhabitants of neighborhoods into separate online communities, ONSNs offer neighbors a direct channel for requesting and provisioning volunteer support not automatically available on other OSNs. During the COVID-19 pandemic, a peer support network can provide vital assistance to at-risk individuals such as members of a group of the particularly vulnerable, ease the burden of confinement and prevent the violation of stay-at-home orders. The MyNeighbors ONSN received a number of posts related to the topic of peer support. These include unsolicited offers for assistance as well as public appeals to support each other made by individual neighbors or local organizations and institutions. For instance, two neighbors took the initiative and offered to provide shopping assistance to anyone in need. One neighbor stated:

> *Dear neighbors, I am young, healthy, not part of a risk group, and have a lot of free time due to reduced working hours. If you need shopping assistance, feel free to contact me.*

In case of the COVID-19 pandemic, an effective peer support network can immediately strengthen a community's resistance and ability to recover from crises, allowing at-risk individuals to safely isolate while being provided for. In the long term, it could also offer a path towards recovery to a near pre-crisis level of functioning with at-risk individuals remaining in isolation and in the care of members of their community while others are able to return to their daily lives. As ONSNs are oftentimes home to a community of like-minded and proximate individuals, they are an ideal platform for establishing such a network.

Local organizations and institutions published further offers for assistance, often in relation to their field of expertise. For example, a local shop offered emergency deliveries for groceries and neighborhood managers acted as contact points for referring individuals in need to available volunteers. The MyNeighbors ONSN affords organizational users with organizational profiles, a directory of local service offerings and a communication channel with neighbors via the platform. Organizations leveraged these design features as a means of communicating adaptations to existing and the launch of novel service offerings in response to the COVID-19 pandemic. This included updates on availability, i.e., cancellation or postponement, or mode of delivery, shifting from in-person to virtual approaches. For example, a local church brought attention to their new online church service and a yoga teacher presented video instructions. Organizations made use of the integrated neighborhood calendar to reflect these changes.

17.4.2 ONSN adaptations in response to the COVID-19 pandemic

Among the analyzed ONSNs, we identify three platform features adapted in response to the COVID-19 pandemic. In March 2020, the ONSN platform nebenan received a novel design feature in the wake of the COVID-19 pandemic's increasing severity in Germany. The feature positions the ONSN as a **matching platform between local volunteers and individuals in need** as a result of the COVID-19 pandemic, strengthening its peer support capability. Requests for assistance are submitted by an individual in need via an automated phone hotline or online form without registering for the ONSN.

An interactive voice response system, in identical structure as the online form, collects a neighbor's name, postal code, contact information and type of required assistance. Proposed types include grocery shopping, household tasks or childcare. Alternatively, registered members can submit requests directly via the ONSN platform. Once submitted, requests for assistance are only visible to verified users in proximity to the requestor, i.e., in his or her neighborhood, which have undergone identity and address verification. Volunteer neighbors who accept a request for assistance are provided with the requestor's contact details and can mark a request as fulfilled upon completion.

Simultaneously, ONSN Nextdoor received a design feature called "Help Map" specifically targeted at mitigating the negative consequences of the COVID-19 pandemic. Using this feature, neighbors can announce their willingness to assist others by marking their location on an interactive map of their neighborhood and by specifying the types of assistance they are planning to provide. Individuals seeking assistance can use the same interactive map to identify helpful neighbors and contact them using Nextdoor's messaging system. Nextdoor describes grocery shopping or checking in on at-risk neighbors as potential services to be offered.

Both Nextdoor and nebenan aim to improve peer support but choose different approaches to achieve this goal. From the perspective of the individual in need, Nextdoor implements a "pull" approach where individuals in need pull a selection of available volunteers from the Help Map. This task needs to be actively repeated until a suitable volunteer is found.

Nebenan implements a "push" approach, notifying individuals in need as soon as a volunteer accepts their published request for assistance. Nextdoor requires both requestors and volunteers to sign up for an account while this is the case only for volunteers on nebenan. For some user groups such as the elderly, it could be speculated that a phone call or online form may be more approachable than signing up for and using a web or mobile application, which entails an address verification. As opposed to nebenan, Nextdoor displays the locations of volunteers, providing individuals in need with an understanding of how close volunteers are located, which may positively influence individuals' inclination to accept help.

Besides peer support functionality, nebenan also adapted existing design features aimed at **improving access to local service providers** by offering a combination of marketing support, business stimulus and charitable fund-raising. Local businesses can sign up for a free business account on the platform, providing them with enhanced visibility, an additional communication channel and the opportunity to advertise products and services to a local audience. Neighbors can purchase gift cards for local businesses via nebenan, which can be redeemed after crisis-related restrictions preventing a business from operating are lifted. With each purchased gift card, a donation of the same amount is made to the business by a pool of charitable partner organizations headed by nebenan. If a shop is not registered on nebenan, an employee will contact the owners and invite their participation in the initiative.

17.5 Discussion

In this section, we first discuss the implications of our results regarding the current state of using ONSNs for fostering social resilience (see Figure 3, [1]). Afterward, encountered dilemmas when designing for social resilience as well as future opportunities for IS research are highlighted (see Figure 3, [2]).

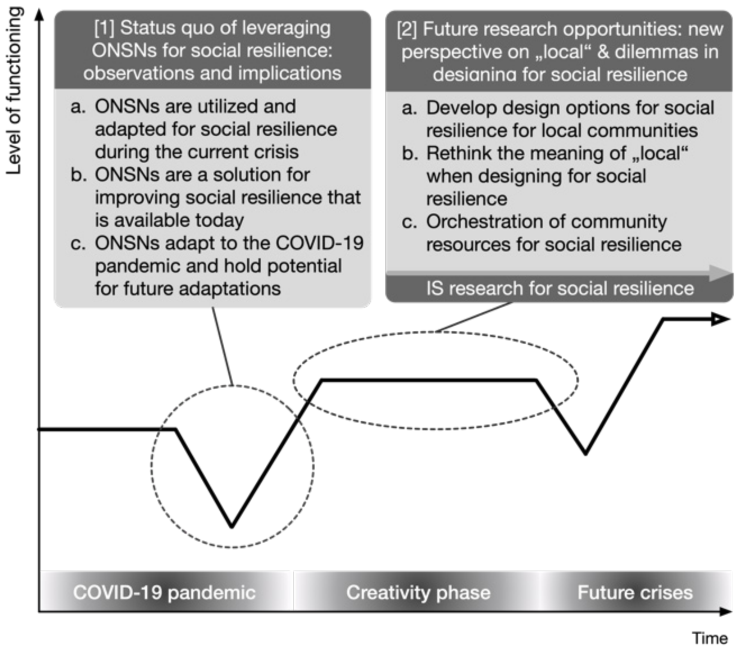

Figure 3. Overview of research results and implications for future IS research

17.5.1 Leveraging ONSNs to strengthen the social resilience of local communities

Our results show that ONSNs are being utilized to improve community resilience in the face of the COVID-19 pandemic, particularly by strengthening their resistance to and assisting their recovery from the crisis (see Figure 3, [1a]). They do so by maintaining social connections and a sense of belonging, via the distribution of locally relevant information, by establishing a peer support network and by improving access to local service providers. Strengthening the resilience of communities via ONSNs is not only valuable in case of the COVID-19 pandemic but can prove an investment in long-term preparedness for other crises and grand societal challenges such as population aging [42].

As ONSNs are readily available in many places and have reached a dependable technological and organizational maturity, they can provide immediate relief in the face of the COVID-19 pandemic. With the consequences of the pandemic expected to have a long-lasting impact on the well-being of communities and with a second wave of the pandemic as well as a repeated intensification of public health measures likely in many places [43], a timely establishment of measures for strengthening social resilience is imperative (see Figure 3, [1b]). As socio-technical artifacts, ONSNs can influence a community's practices and behaviors in the short term and shift norms, values and shared beliefs in the long term, ultimately contributing to the permanent institutionalization [44] of social resilience.

In light our results, we view ONSNs as a potential tool for improving social resilience by quickly adapting their design features to counteract negative consequences of the COVID-19 pandemic (see Figure 3, [1c]). We observe novel platform features aimed at enhancing peer support capabilities as well as for supporting local businesses. Furthermore, neighbors and local organizations exhibited novel patterns of usage, recognizing and utilizing MyNeighbors as a suitable platform for meeting the challenges of the COVID-19 pandemic.

These observations highlight the unique role of technology, in this case ONSNs, as a dimension of the social resilience of communities. In contrast to inflexible dimensions such as a community's local infrastructure or economy [32], ONSNs can be made available quickly, possess high adaptivity to the requirements of a specific crisis and are a platform for generating creative novel solutions for social resilience. In sum, technologies represent touchpoints for engaged actors such as citizens, local service providers and governmental institutions. The development of suitable interventions is essential to integrate and embed ONSNs into the natural environment of these actors [45]. By linking socio-technical artifacts designed to increase social resilience as well as empirically observable community behaviors on ONSNs, IS researchers can contribute evidence-based design knowledge for the last research mile in the triangle of rigor, relevance and design [46-49].

17.5.2 A new perspective on "local" in light of the COVID-19 pandemic: dilemmas in designing for social resilience

IS research is well-positioned to develop socio-technical patterns of social resilience [19] in the context of ONSNs through the creative usage and analysis of existing platforms as well as by developing design knowledge through the design and evaluation of novel ONSN artifacts and capabilities. While still adjusting to the initial impact of the COVID-19 pandemic, we consider it of high importance to enter the creativity phase of social resilience [7] and to develop actionable insights as well as design options for meeting the immediate challenges of the current crisis and to empower our communities for those to come (see Figure 3, [2a]).

Resilient communities pull together in the face of a crisis, bringing to bear their local resources such as social networks, people-place connections and community infrastructure [32]. But in this regard, the COVID-19 pandemic poses a dilemma: physical proximity represents a risk and must, in many cases, be avoided to contain the pandemic's spread. Where previously a community's tight interconnectedness was an asset for resilience, it must now be scrutinized and carefully managed. Similar to individual efforts to not be deprived of social connections and a sense of belonging when distancing physically, communities should not be forced to sacrifice their social connectedness together with their local connectedness (see Figure 3, [2b]). But as digital communication is often still an imperfect substitute for in-person interaction, the solution cannot be an absolute shift from a place-based social resilience to a purely digital approach to social resilience. Any efforts aimed at improving community resilience in the face of the COVID-19 pandemic must acknowledge and incorporate these constraints.

Under these circumstances, ONSNs are well-positioned to provide a form of hybrid social resilience, an intelligent orchestration of community resources that balances offline in-person interactions with online digital ones (see Figure 3, [2c]), for a number of reasons. Already, a pattern of ONSNs establishing themselves as platforms for peer support is evident in our results, with both Nextdoor and nebenan digitizing matchmaking and communication activities in order to enable the offline provisioning of volunteer services. But ONSNs have the potential to pursue this role even further, particularly in case of the COVID-19 pandemic. Their role as a platform interconnecting local actors and resources could be leveraged for the safe utilization of local shared spaces, e.g., community gathering places, parks or playgrounds, via mechanics such as booking or capacity management systems as well as by keeping a record of usage for contact tracing. This could serve to improve the resistance of communities by protecting at-risk individuals while at the same time, others can recover to a normal level of functioning.

Governments aim to improve the well-being of city inhabitants via digital technology [50], particularly in response to the COVID-19 pandemic [12]. These efforts should be expanded to not only aim at improving community well-being but also social resilience. Partnerships with public and private actors, e.g., providers in the housing, long-term care or technology sectors but also home delivery services, could complement volunteer-based peer support networks on ONSNs with professional service providers where necessary, more efficient or legally required.

17.6 Conclusion

In this study, we conduct a multiple case study of ONSNs and analyze their general capabilities for fostering social resilience as well as the means by which they adapt their capabilities to the COVID-19 pandemic. Our study has two main contributions. First, it demonstrates how ONSNs can support community resistance and recovery and, in turn, improve the social resilience of local communities during a crisis such as the COVID-19 pandemic. Furthermore, ONSNs are presented as a uniquely adaptive and flexible resource for fostering social resilience which can have a lasting positive effect on the level of functioning of a community beyond times of crisis. In the short-term, these results can offer guidance to local communities in coping with the coming months and years.

Second, we present future research opportunities in the context of ONSNs that build on the dilemma of "local" during the COVID-19 pandemic and leverage the unique position of ONSNs as intelligent orchestrators of community resources. We call for further IS research targeted at improving the long-term social resilience as well as disaster preparedness of local communities in order to develop creative solutions to meet the diverse challenges and adverse consequences arising in the course of crises such as the COVID-19 pandemic.

This research is subject to limitations. Our selection of ONSNs for analysis is biased as it is intentionally limited to the MyNeighbors ONSN as well as a set of English and German language platforms discovered via an internet search. We exclusively analyze user-generated content from the MyNeighbors ONSN, resulting in insights with limited generalisability due to the platform's limited availability and the small amount of data. However, we gain timely and comprehensive access and remain situated in the research context of our ongoing design science research project. We focus our comparison of other ONSNs on their externally visible platform design features. An in-depth analysis of user-generated content in cooperation with other ONSN platforms could yield additional insights regarding their contribution to social resilience, particularly during the COVID-19 pandemic.

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17.9 Appendix

Appendix A. List of analyzed ONSN platforms

Name	URL
fürenand.ch	https://fuerenand.ch/
FragNebenan	https://fragnebenan.com/
GoNeighbour.org	https://www.goneighbour.org/
JustMyNeighbors	https://justmyneighbors.com/
lokalportal	https://lokalportal.de/
Kiekmo	https://kiekmo.hamburg/
Meine Nachbarn	https://meinenachbarn.hamburg
Meet the Neighbors	http://meettheneighbors.org/
Nachbarschaft.net	https://nachbarschaft.net/
nebenan	https://nebenan.de/
Neighbourly	https://www.neighbourly.co.nz/
Nextdoor	https://nextdoor.com/
Scooploop	https://www.scooploop.com/
Remishueb	https://remishueb.stadt.sg.ch/
wirRauner	https://www.wir-rauner.de/

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19 Errata

In case of the publication Vogel et al. (2020c), Section 15 of this thesis, *Figure 5. MyNeighbors survey selected insights relating to social connectedness and participation (n=28)* should correctly read “Figure 23. MyNeighbors (MN) survey selected insights relating to social connectedness and participation (n=28)”. Furthermore, the figure contains the abbreviation “NB” which should correctly read “MN”.

In case of the publication Vogel et al. (2021b), Section 17 of this thesis, *Figure 2. Research steps and activities* contains the research activity “Collection of user activities on the NeighbourBook ONSN (103 relevant posts)” which should correctly read “Collection of user activities on the MyNeighbors ONSN (103 relevant posts)”.

20 Eidesstattliche Versicherung

Hiermit erkläre ich,

Pascal Vogel, geboren am 29. Mai 1992 in Karlsruhe,

an Eides statt, dass ich die vorliegende Dissertationsschrift mit dem Titel

„Designing Openness-Infusing Socio-Technical Artifacts“

selbst verfasst und keine anderen als die angegebenen Quellen und Hilfsmittel genutzt habe.

Ort, Datum	Unterschrift