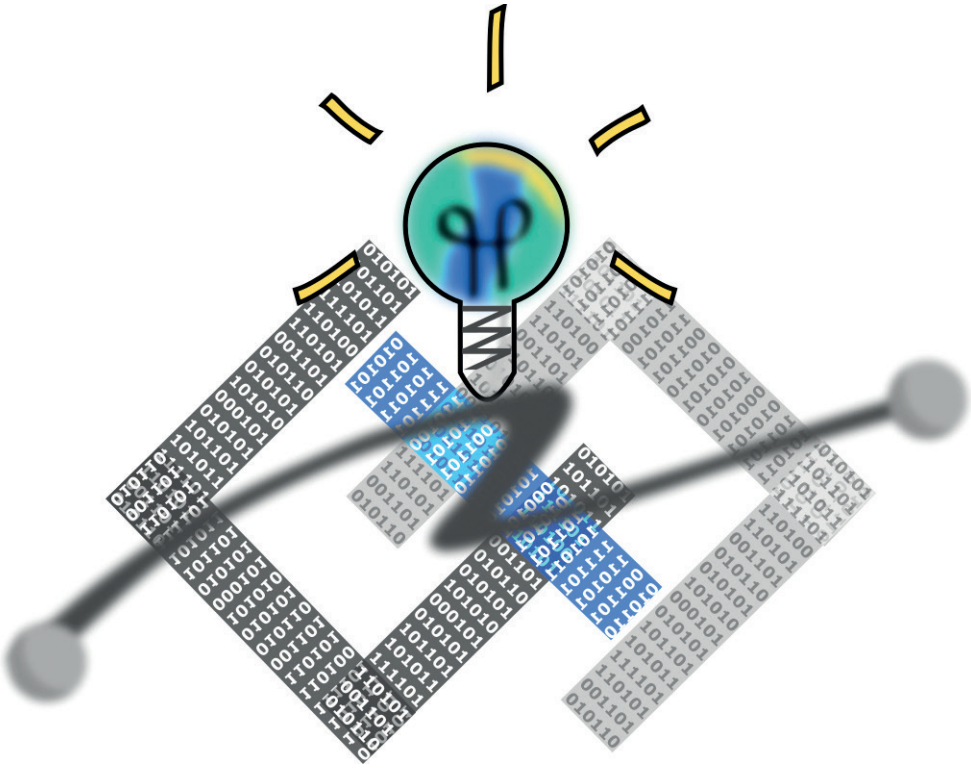
JYU DISSERTATIONS 527

Irawan Nurhas

Positive System Design for Intergenerational Innovation



UNIVERSITY OF JYVÄSKYLÄ
FACULTY OF INFORMATION TECHNOLOGY

JYU DISSERTATIONS 527

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Positive System Design for Intergenerational Innovation

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ABSTRACT

Nurhas, Irawan
Positive system design for intergenerational innovation
Jyväskylä: University of Jyväskylä, 2010, 84 p.
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Digital technology is increasingly becoming a part of life and culture in society, and it must be consciously designed for the long-term benefit of humanity. Today, information systems are designed to do more than fulfill human duties or complete tasks. A widely adopted approach is a system design that focuses on the positive aspects of human-technology interaction. Positive computing is a design paradigm gaining traction because it emphasizes the importance of well-being as a bold goal to be implemented in system design. In this dissertation, technology design is part of an intergenerational environment aiming to facilitate information sharing regarding global startup innovation.

Nevertheless, much of the research focuses on how technology can be used to facilitate intergenerational collaboration. On the other hand, very little is known about how technology can be "positively" designed to promote intergenerational innovation. Therefore, this dissertation applied Design Science Research (DSR) to inform and guide the creation of design principles through the lens of positive computing. The study results provide a holistic picture of the numerous barriers, well-being factors, competing concerns, and competencies that have been encountered in the context of intergenerational innovation and their implications. This dissertation is presented as a cumulative dissertation, answering three research questions divided into seven studies, consisting of nine articles.

Keywords: positive computing, intergenerational innovation, global startups

TIIVISTELMÄ (ABSTRACT IN FINNISH)

Nurhas, Irawan
Positiivinen järjestelmäsuunnittelu sukupolvien väliseen innovaatioon
Jyväskylä: University of Jyväskylä, 2010, 84 p.
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Digitaalisesta teknologiasta on tulossa yhä enemmän osa yhteiskunnan elämää ja kulttuuria, ja se on suunniteltava tietoisesti ihmiskunnan pitkän aikavälin hyödyksi. Tietojärjestelmät on nykyään suunniteltu tekemään muutakin kuin täyttämään ihmisten velvollisuuksia tai suorittamaan tehtäviä. Laajasti hyväksytty lähestymistapa on järjestelmäsuunnittelu, jossa keskitytään ihmisen ja teknologian vuorovaikutuksen myönteisiin puoliin. Positiivinen tietojenkäsittely on suunnitteluparadigma, joka on saamassa yhä enemmän kannatusta, koska siinä korostetaan hyvinvoinnin merkitystä rohkeana tavoitteena, joka on toteutettava järjestelmäsuunnittelussa. Tässä väitöskirjassa teknologian suunnittelu on osa sukupolvien välistä ympäristöä, jonka tavoitteena on helpottaa globaalia startup-innovaatiota koskevan tiedon jakamista.

Suuri osa tutkimuksesta keskittyy kuitenkin siihen, miten teknologiaa voidaan käyttää sukupolvien välisen yhteistyön helpottamiseksi. Toisaalta hyvin vähän tiedetään siitä, miten teknologia voidaan "positiivisesti" suunnitella edistämään sukupolvien välistä innovointia. Siksi tässä väitöskirjassa sovellettiin suunnittelutieteellistä tutkimusta suunnitteluperiaatteiden luomisen informoimiseksi ja ohjaamiseksi positiivisen tietojenkäsittelyn näkökulmasta. Tutkimuksen tulokset antavat kokonaisvaltaisen kuvan lukuisista esteistä, hyvinvointitekijöistä, kilpailevista huolenaiheista ja osaamisista, joita on kohdattu sukupolvien välisen innovoinnin yhteydessä, sekä niiden vaikutuksista. Tämä väitöskirja esitetään kumulatiivisena väitöskirjana, jossa vastataan kolmeen tutkimuskysymykseen, jotka jaettiin seitsemään tutkimukseen, jotka koostuvat yhdeksästä artikkelista.

Avainsanat: positiivinen tietojenkäsittely, sukupolvien välinen innovointi, globaalit startup-yritykset

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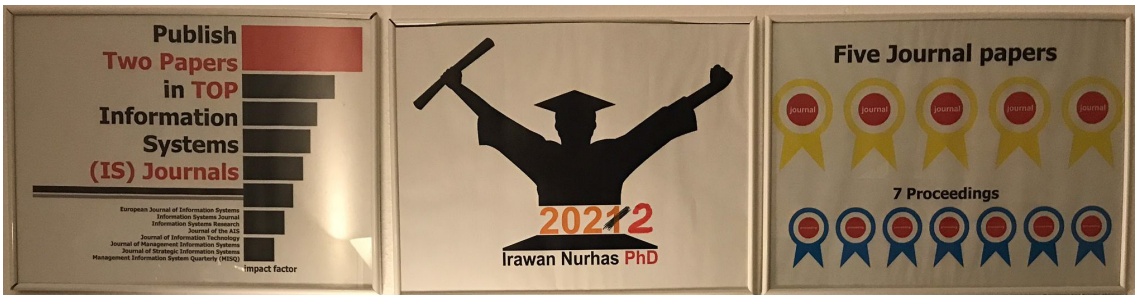

Three frames I set for myself in 2017 for my academic journey. Not everything goes according to plan, but that is one of the beautiful parts of this journey.

Never in my wildest dreams could I have imagined that my life's path would take me to two countries known for their excellence in education and technological innovation: Germany and Finland. As a doctoral student, I faced many challenges. I do not doubt that I made it to this stage thanks to the extraordinary support from my work/study environment and a helpful circle of people.

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Thank you, Prof. Pasi Tyrväinen, for the warm welcome and for making me feel part of the University of Jyväskylä (JYU) when we first met in 2018. Thank you for allowing me to participate in a Ph.D. program at the University of Jyväskylä and introducing me to Prof. Arto Ojala. Thank you, Prof Arto Ojala, for your guidance and support related to the research and educational process at JYU; I thank you for entrusting me with your dissertation book so that I could bring it with me to Germany and for being one of the guides for my dissertation. Thank you, JYU; I am proud to be a part of "Be Jyunited."

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Bottrop 12.04.2022
Irawan Nurhas

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I Nurhas, I., Geisler, S., Ojala, A., & Pawlowski, J. M. (2020). Towards a Wellbeing-driven System Design for Intergenerational Collaborative Innovation: A Literature Review. In *Proceedings of the Annual Hawaii International Conference on System Sciences*. University of Hawai'i at Manoa.

II Nurhas, I., Geisler, S., Ojala, A., & Pawlowski, J. M. (2021). Barriers and Wellbeing-oriented Enablers of Intergenerational Innovation in the Digital Age. *Universal Access in the Information Society*, (pp 1-17). Springer.

III Nurhas, I., Aditya, B. R., Geisler, S., Ojala, A., & Pawlowski, J. (2019). We are "not" too (young/old) to collaborate: Prominent Key Barriers to Intergenerational Innovation. In *Pacific Asia Conference on Information Systems.* AIS.

IV Nurhas, I., Pirkkalainen, H., Geisler, S., & Pawlowski, J. (2021). Examining Competing Entrepreneurial Concerns in a Social Question and Answer (SQA) Platform. In *International Conference on Knowledge Management and Information Systems*. (pp 145-152). SCITEPRESS.

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VI Nurhas, I., Geisler, S, & Pawlowski, J. (2022). An Intergenerational Competency Framework: Competencies for Knowledge Sustainability and Start-up Development in the Digital Age. (*As of May 11, 2022: Accepted at Sustainable Development*)

VII Nurhas, I., Geisler, S., & Pawlowski, J. M. (2019). Why Should the Q-Method be Integrated into the Design Science Research? A Systematic Mapping Study. In *Scandinavian Conference on Information Systems*. AIS.

VIII Nurhas, I., Jahanbin, P., Pawlowski, J. M., Wingreen, S., & Geisler, S. (2022). Chatbots for Intergenerational Collaborative Innovation. (*As of March 07, 2022: Minor revision at Human Behavior and Emerging Technologies*)

IX Nurhas, I., Mattick, X., Geisler, S., & Pawlowski, J.M. (2022). System Design Principles for Intergenerational Knowledge Sharing. (*As of April 8, 2022: Accepted for publication at the 17th International Conference on Design Science Research in Information Systems and Technology (DESRIST)*)

The author of this dissertation was the primary author of all of the publications listed above and was in charge of the research design, data gathering, data analysis, and findings, and drawing initial articles for each study regarding findings, implications, and research conclusions.

Other contributions of the author

In addition, the author has contributed to a variety of other scholarly works during his doctoral studies, both as a primary and supporting author. These contributions have been critical to the author's development as a doctoral student in a range of relevant fields and the application of the different methods and techniques described in this dissertation. The author's other work includes the following:

- **Nurhas, I**., Geisler, S., & Pawlowski, J. (2017). Positive Personas: Integrating wellbeing Determinants into Personas. *Mensch und Computer 2017-Tagungsband: Spielend einfach interagieren*, 17, 387.
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- **Nurhas, I.,** Pawlowski, J. M., & Geisler, S. (2019, April). Towards humane digitization: a wellbeing-driven process of personas creation. In *Proceedings of the 5th International ACM In-Cooperation HCI and UX Conference.* (pp. 24-31). ACM.
- Aditya, B. R., **Nurhas, I.,** & Pawlowski, J. (2019, April). Towards successful implementation of a virtual classroom for vocational higher education in Indonesia. In *International Workshop on Learning Technology for Education in Cloud* (pp. 151-161). Springer, Cham.
- **Nurhas, I.,** Aditya, B. R., Geisler, S., & Pawlowski, J. (2019). Why Does Cultural Diversity Foster Technology-enabled Intergenerational Collaboration?. *Procedia Computer Science*, 161, (pp. 15-22). Elsevier.
- Aditya, B. R., Permadi, A., **Nurhas, I.,** & Pawlowski, J. M. (2019, December). Design Features for Gender-specific Differences in Blended Learning within Higher Education in Indonesia. In *2019 IEEE International Conference on Engineering, Technology and Education*. (pp. 1-5). IEEE.
- **Nurhas, I.,** Boutouil, M., Geisler, S., & Pawlowski, J. (2020). Design Principles of Collaborative Learning Space Connecting Teachers and Refugee Children: A Design Science Research Study. In *EDULEARN Proceedings*. IATED Academy.
- **Nurhas, I.,** Aditya, B. R., Jacob, D. W., & Pawlowski, J. M. (2021). Understanding the challenges of rapid digital transformation: the case of COVID-19 pandemic in higher education. *Behaviour & Information Technology*. (pp 1-17).
- Detjen, H., **Nurhas, I.,** & Geisler, S. (2021, September). Attitudes Towards Autonomous Public Transportation. In *13th International Conference on Automotive User Interfaces and Interactive Vehicular Applications.* (pp. 62-66). ACM.

1 INTRODUCTION

> "Scalable startups require populations of over 100 million people to be viable. Only the US, China, Russia, Brazil, India, and Indonesia satisfy this requirement. Most nations lack the population to maintain startup growth on their own, so they must be global players from the start." (Steve Blank) [1]

Managing knowledge across generations in the development of business models has for many years been one of the keys to **sustainable innovation** (Kaplan et al., 2017; Perez-Encinas, Pablo, et al., 2021) to the continuation of a **family business** (Criaco et al., 2017; Gallo & Sveen, 1991; Karagouni, 2018; Pittino et al., 2020; H. X. Shi et al., 2019) and even to the **establishment** of companies and **startups** on a national and **global scale** (Debellis et al., 2021; Dou et al., 2021; Gallo & Sveen, 1991; Galvagno & Pisano, 2021; Pittino et al., 2020; H. X. Shi et al., 2019). Passing knowledge from one generation to another has always been a natural occurrence within society and organizations of different types, especially in a family environment (Debellis et al., 2021; Dou et al., 2021; Gallo & Sveen, 1991; Pittino et al., 2020). What differs from time to time is the knowledge as the **content** is passed on and the way or **channels** it is shared (Di Gangi et al., 2012; Holsapple & Joshi, 2000; Vătămănescu et al., 2020).

In the era of **globalization** and the **digital workplace**, innovation and learning in the context of **intergenerational collaboration** are taking place also outside family businesses and in organizations of all sizes (Becker et al., 2020; Gordon, 2018; Kaplan et al., 2017; Massingham & Chandrakumara, 2019). It faces diverse **barriers and challenges**, including various forms of barriers due to digital channels of work and learning space that are increasingly attracting the attention of researchers (Awang et al., 2014; Laudert, 2018; Loos, 2014; Lyashenko & Frolova, 2014; Strom & Strom, 2015; Taipale, 2019). However, some other areas remain unexplored, such as **what** content is relevant for the context (Avgerou, 2001; Holsapple & Joshi, 2000)? How to optimize the **design of channels** to maximize the best potential of each collaboration actor (Avital et al., 2006;

[1] Born Global or Die Local – Building a Regional Startup Playbook - https://steveb-lank.com/(last accessed 27. October 2021)

Convertino et al., 2007; Loos, 2014; Strom & Strom, 2015; Taipale, 2019)? Both **technical and social interventions** (Bostrom & Heinen, 1977; Gutierrez et al., 2019).

Moreover, **intergenerational collaboration** in promoting business sustainability and the **global process of startup innovation** will have significant implications for the **well-being** of all stakeholders and social inclusion in entrepreneurial activity (Jennings et al., 2013; Perez-Encinas, Bueno, et al., 2021; Santini et al., 2020; H. Shi, 2021). This makes intergenerational collaboration an immensely complex endeavor with positive and negative sides (Criaco et al., 2017; Jennings et al., 2013). In the last decade, the issue of well-being in entrepreneurial activities and **competency development** has attracted attention in entrepreneurship research (Schuck & Steiber, 2018; Shir et al., 2019) and information systems design studies (Anwar & Johanson, 2015). Consequently, a hybrid **well-being-based approach** to managing knowledge (Pawlowski, 2016; Pinho et al., 2012) is required, and a systematic process to **guide system design** (Avital et al., 2006; Pawlowski et al., 2015) that considers the dynamic **concerns** and factors that influence and **positively affect** the collaboration between two generations (Loos, 2014; Lyashenko & Frolova, 2014). Therefore, this study adopts a **positive computing** paradigm that places **human potential** and **well-being** at the center of technology development (Calvo & Peters, 2014; Pawlowski et al., 2015).

Based on the multidisciplinary field focusing on socio-technical system design. This dissertation delves into several research areas to better understand the issues that influence system design for intergenerational collaboration in the digital age. Figure 1 summarizes the main themes of the dissertation study in general. The themes include intergenerational collaboration and global innovation in a digital space. Positive computing is used to contextualize the themes, focusing on barriers, determinants of well-being, concerns, and competencies. The theoretical background for the corresponding themes is explained in the following sections.

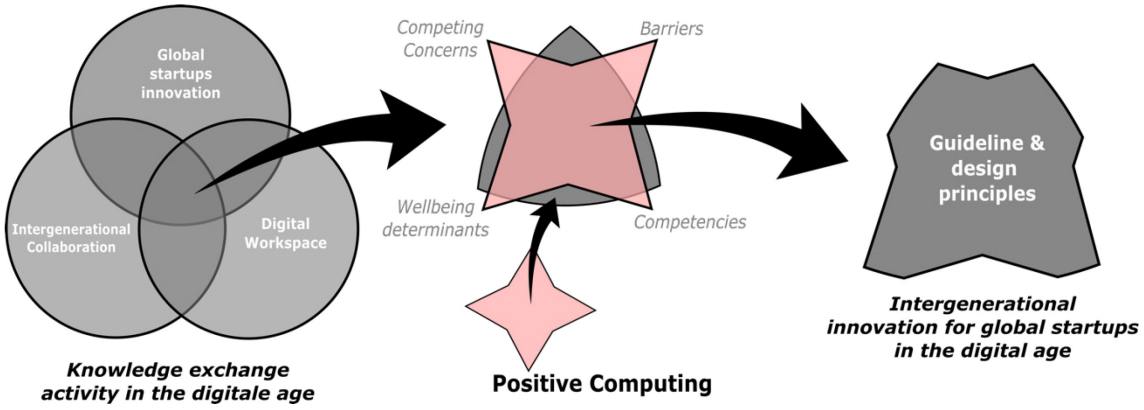

FIGURE 1 Conceptual overview

1.1 Intergenerational collaboration for global startup innovation

Studies show that entrepreneurship and innovation are inextricably linked (Drucker, 2014; Weiblen & Chesbrough, 2015). In fact, innovation is critical for both large and small companies and startups (Weiblen & Chesbrough, 2015). Innovation is both the discovery of new ideas or the improvement of the current status quo (Drucker, 2014; Li et al., 2008) and unlocking the potential inherent in those ideas for business, economic and societal progress (Drucker, 2014; Li et al., 2008). By managing knowledge about the existing or untapped potential at both the organizational and individual levels, it is possible to explore and exploit ideas so that they can become innovations (Andriopoulos & Lewis, 2009; Li et al., 2008). Studies in innovation management highlighted that the success of knowledge management is critical to innovation (Du Plessis, 2007), which is supported by advances in today's information and communications technology (Du Plessis, 2007; Gressgård et al., 2014). In addition, a collaboration between companies and individuals is also possible within an innovation ecosystem and on a global scale as comprehensive information technology has permeated the broader layers of society worldwide.

Companies can use global network ecosystems that exploit cultural, national, or country-of-origin differences to drive innovation through knowledge management and exchange (Engel & del-Palacio, 2009; Perks & Jeffery, 2006). Companies and organizations can also collaborate on concepts and bring products and services to untapped markets. In the last decade, the term "global startups" was introduced (Rasmussen & Tanev, 2015; Tanev, 2017), refers to companies that use the internet and digital technologies to build a global business model by exploiting differences such as access to different geographic markets in different countries (Rasmussen & Tanev, 2015; Tanev, 2017). There are two types of global startup innovations: companies that were founded with the explicit goal of expanding globally (Rasmussen & Tanev, 2015) and companies that started as local players but eventually expanded globally for various reasons (Rasmussen & Tanev, 2015), such as limited numbers of customer or buying power in the local market.

Moreover, the activities and processes associated with global innovation are also important (Jensen, 2017; Pawlowski, 2013; Rasmussen & Tanev, 2015) to understand priorities and preferences that can change. Different processes within innovation impact the conditions for success, both technically and socially. Innovation involves much more than just discovering something new or improved (Andriopoulos & Lewis, 2009; Li et al., 2008). In other words: Innovation is both an invention process and a commercialization process (Li et al., 2008). Previous research has provided an overview of the critical activities in the innovation process when global knowledge management is used (Pawlowski, 2013). This general overview of global knowledge management provides the basis for identifying the knowledge dynamics required for specific activities and topics. Since the focus is not on providing a detailed process, in this dissertation,

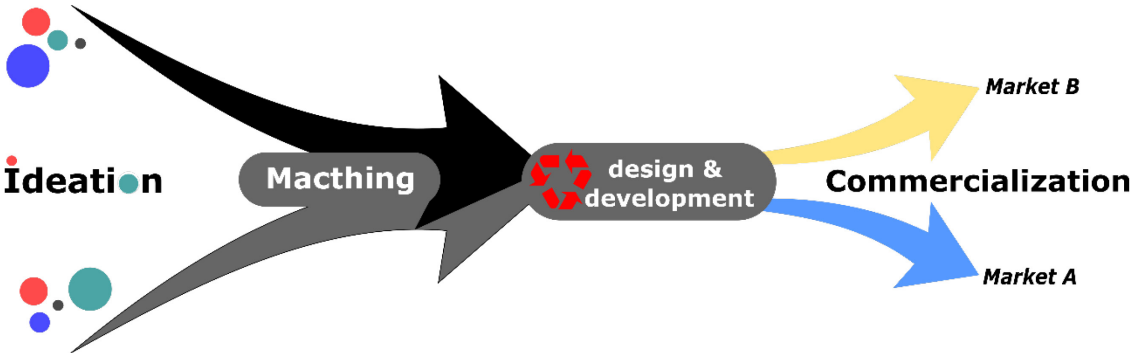

FIGURE 2 Simplified global innovation process

the global innovation process (Pawlowski, 2013; Tiwari et al., 2007) can be simplified into four phases:

1. Ideation process or activities to identify valuable products, services and business models that can be offered to the market.
2. Matching process or activities to find potential partners to develop the business idea in other countries.
3. Design and development or activities to specify the requirements, turn the ideas into reality, and localize the startup businesses.
4. Commercialization or activities to produce polished businesses and bring them to the end-users.

These phases are shown in Figure 2.

When developing a global business model, startup entrepreneurs typically use a causation or effectuation logic (Asemokha et al., 2021; Sarasvathy, 2001). The causation approach is motivated by specific goals that must be achieved (Sarasvathy, 2001), and various resources must be sought and deployed for the goal (Sarasvathy, 2001). In contrast, the effectuation approach is concerned with optimizing one's resources, networks, and means before specific goals are set (Sarasvathy, 2001) in the global innovation process. While both approaches are commonly used (Asemokha et al., 2021; Ciszewska-Mlinaric et al., 2016), the Effectuation strategy offers less time to launch a global business model (Prashantham et al., 2019), especially in the context of intergenerational collaboration in family businesses. Thus, intergenerational knowledge exchange is critical to a family business's success by utilizing available networks, knowledge, and resources (Chetty et al., 2015; Sarasvathy, 2001).

However, intergenerational knowledge exchange, which leverages the knowledge of predecessors as an effectuation strategy, has received little attention outside the context of family business combined with digital workspace (Reis et al., 2021). While the technology-driven, on the one hand, globalized ecosystem presents significant opportunities for startup entrepreneurs, the growing global population of older adults presents one of the geographic challenges worldwide to economic and social development (Bloom et al., 2010). On the other hand, this is an opportunity for startup entrepreneurs who want to

leverage intergenerational innovation or generational differences, experience, and knowledge to manage and develop innovation businesses or startups (Santini et al., 2020). In this study, the phrase "intergenerational innovation" will be used to refer to the process of promoting (startup) innovation through intergenerational collaboration. The startup setting was chosen to help ground the concept of increased innovation requirements in the uncertain environment in which startups operate. While the startup ecosystem enables the collaboration of initial ideas with external institutions, friends, and family, thereby incorporating the expertise of other generations (Perez-Encinas, Pablo, et al., 2021; Pittino et al., 2020; H. X. Shi et al., 2019; H. Shi, 2021), the failure rate of startup development is higher, particularly during the product/service development stage (Giardino et al., 2015; Wang et al., 2016).

Understanding intergenerational innovation is critical to developing global startups for four reasons:

1. demographic change,
2. the key to global (family) business expansion,
3. the higher failure rate of startups, and
4. technological progress.

Demographic trends in some countries indicate an aging workforce. As a result of the aging workforce, older workers will comprise a sizable proportion of group members (Convertino et al., 2007; Massingham & Chandrakumara, 2019). Thereby, intergenerational groups can be a valuable asset to organizational productivity, knowledge management, and well-being (Jennings et al., 2013; Santini et al., 2020). Historically, intergenerational collaboration has been key to the global expansion of family businesses (Galvagno & Pisano, 2021; H. X. Shi et al., 2019; H. Shi, 2021); understanding intergenerational innovation in the digital age will be beneficial to family businesses in managing innovation across generations as well as collaboration with businesses from diverse cultural backgrounds (Debellis et al., 2021; Galvagno & Pisano, 2021).

Entrepreneurs and small and medium-sized enterprises (SMEs) are critical economic drivers. Although they have a significant social and economic impact, most startups fail to develop into stable businesses and successfully grow their business models (Giardino et al., 2015). Intergenerational collaboration is one of the keys to solving the problem and developing sustainable business models based on the expertise and experience of senior adults (Kaplan et al., 2017; Perez-Encinas, Bueno, et al., 2021; Perez-Encinas, Pablo, et al., 2021). Technological improvements have made it easy to transform a locally-focused organization into one designed from the outset for a global market (Kowal & Paliwoda-Pękosz, 2017). However, an intergenerational collaboration facilitated by technology faces several issues and barriers that need to be contextualized.

These four factors drive research on intergenerational innovation and a better understanding of startup entrepreneurship within different generations. The importance of intergenerational collaboration outside of family relationships is becoming increasingly evident, especially with digital technologies and global startups. Therefore, this dissertation highlights both the negative and positive

sides of developing "channels" for knowledge sharing technologies (Convertino et al., 2007; Reis et al., 2021; Taipale, 2019). In addition, it is critical to consider the process of global innovation (Pawlowski, 2013) to understand better the dynamics of "content" change in intergenerational knowledge exchange. While the current literature on intergenerational innovation provides conceptual frameworks for studying the phenomena of entrepreneurship, global innovation, and intergenerational collaboration, there is an absence of explanation of how the design of digital technology as a channel facilitates knowledge sharing (Reis et al., 2021) or the positive impact of technology (Pinho et al., 2012) on intergenerational innovation, which opens up new research avenues for this dissertation study. The emphasis on well-being in technology development is also related to this issue, which provides the impetus for a shift in technology design from functionality to one that considers the importance of developing a technology for human potential. Overall, based on the presented research gaps presented in this section, the main research problem (MRP) of this study is:

MRP Lack of understanding of positive systems design to support knowledge exchange between different generations to develop global startups.

The following section presents a positive computing paradigm for promoting well-being in technology development. Positive computing guided the scoping process and research objectives to address the MRP.

1.2 Positive computing paradigm

The concept of "well-being" is the central notion behind the positive pathway to enhancing human potential and optimal human functioning (Calvo & Peters, 2014; Pawlowski et al., 2015). This issue has become a significant concern in the emergence of startups in academia (Wiklund et al., 2019), industry, and government at local to global levels. In the digital age, the importance of including factors of well-being in the development of startups is related to both the social elements of entrepreneurship (Uy et al., 2013; Wiklund et al., 2019) and technical aspects related to the use of digital technology in the development of business information systems (Pawlowski et al., 2015). In the context of knowledge management and information systems development (Avital et al., 2006; Pawlowski et al., 2015; Pawlowski, 2016; Pinho et al., 2012), the positivity approach was introduced in the study of positive psychology (Calvo & Peters, 2014; Gaggioli et al., 2017). A positive approach transformed into a design for well-being or "positive design" that is used for the development of general products (P. M. A. Desmet & Pohlmeyer, 2013) and subsequently was explicitly introduced for technology products, or as "positive technology" and "positive computing" are used as paradigms for the design of digital technology for well-being (Calvo & Peters, 2014; Gaggioli et al., 2017; Pawlowski et al., 2015; Riva et al., 2012).

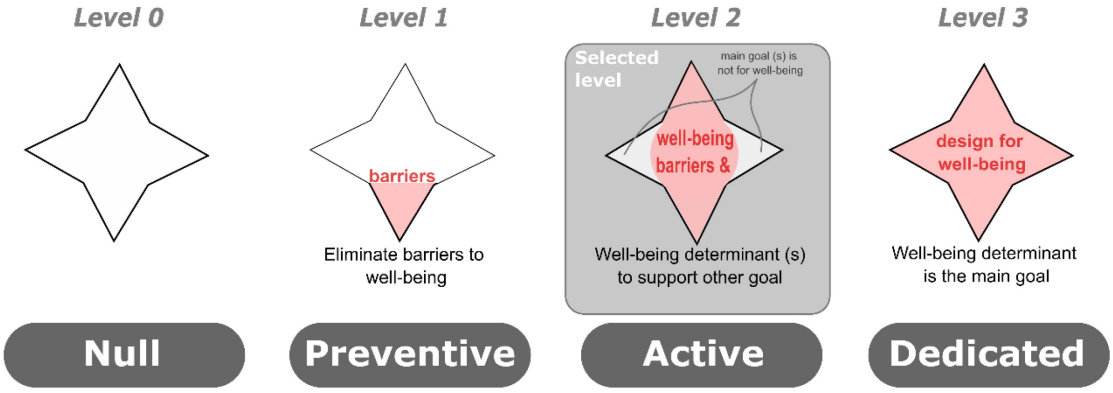

FIGURE 3 Level implementation of positive computing

Positive computing is a research paradigm. It is a technological development lens to promote aspects of well-being and support human potential in all stages of technology design, development, and evaluation (Calvo & Peters, 2014; Gaggioli et al., 2017; Pawlowski et al., 2015). Positive computing is intended that by using the proposed systematic viewpoints, the resulting technology will not only be functionally beneficial for the target users but will also give comprehensive benefits to human needs, promote innovation and long-term use (Calvo & Peters, 2014; P. M. A. Desmet & Pohlmeyer, 2013; Gaggioli et al., 2017), as well as mitigate the negative consequences of digital technology (Calvo & Peters, 2014). In terms of the collection of key concepts and theories, the positive computing approach is related to the enablers or determinants that can bring happiness to humans that interact with the developed technology (Gaggioli et al., 2017; Riva et al., 2012). According to Calvo & Peters (2014), the correlated well-being determinants to positive computing are divided into three categories: self or intrapersonal, social or interpersonal, and extra-personal or meaningful social acts. Fundamental theories for human needs for intrapersonal such as self-determination theory, consist of autonomy, competence, and relatedness (Calvo & Peters, 2014; Deci & Ryan, 2004).

Furthermore, the PERMA wellbeing model, which consists of positive emotion, engagement, positive relationships, and meaningful accomplishments/achievements (Seligman, 2012), are some theories that contribute to the positive computing paradigm. Calvo & Peters (2014) further classified implementation of those wellbeing determinants into four levels (shown in Figure 3): Level 0 or no-implementation. Level 1 or preventive, or identification of barriers to wellbeing determinants. Level 2 or active level implementation, or the use of wellbeing determinants to support the primary goal of technology development that is not directly related to wellbeing determinants. Lastly, level 3, or the higher level of implementation, is a technology development whose main aim is to improve wellbeing through the determinants (Calvo & Peters, 2014).

In developing socio-technical systems structured around various levels of positive computing implementation, it is critical to identify the barriers and determinants of well-being (Calvo & Peters, 2014) in the context of

intergenerational collaboration. The relevance of identifying barriers as an initial step for a research project and system design principles has been used in several studies (Pirkkalainen & Pawlowski, 2013; Silic & Lowry, 2020; Winkler et al., 2020). Identifying obstacles and problems is one of the first steps on the path to innovation and improvement of existing systems (Gregor & Hevner, 2013; A. R. Hevner et al., 2004; Peffers et al., 2007). However, the concept of positive computing is a general approach to different types of technology and the context of technology use. Identifying barriers and determining which well-being factors should be promoted in technology development is essential for the positive computing paradigm. These two aspects (barriers and wellbeing determinants) require contextualization and a more detailed selection of relevant issues, considering the context of intergenerational collaboration.

Positive computing offers many recommendations related to determinants of well-being. However, it is a challenge for system designers and developers to determine which determinants to focus on (Calvo & Peters, 2014). Moreover, in the global innovation process, where each consists of specific activities (Jensen, 2017; Pawlowski, 2013; Tiwari et al., 2007), it is essential to identify different opinions on important issues between generations, considering the main activities in the process. Thus, based on the aim of the study to design a system for intergenerational innovation and identify the sociotechnical problem for system development, the first research question (RQ) for this dissertation is:

RQ1 What issues should be prioritized in collaborative knowledge sharing for the different generations participating in the various stages of the global innovation process?

Based on positive computing, prioritizing specific **wellbeing determinants** and barriers should be the basis for system design. System design issues relate to problems between people, humans and systems, and systems and systems (Calvo & Peters, 2014; Liu et al., 2017). The problems arising from the interaction between systems are of great importance to the technological field of engineering and computer science. However, the scope of this study relates to the sociotechnical element of human-human interaction and human-system interaction (Bostrom & Heinen, 1977; Liu et al., 2017). Therefore, the issues can be categorized as **barriers** in terms of the context of intergenerational collaboration and the areas relevant to the development of startup entrepreneurship that focus more on the **concerns** of the personal and organizational environment; both the barriers and the concern includes issues relevant to both human-human and human-system interaction.

Barriers to intergenerational collaboration

Technology has long been used to foster intergenerational collaboration (Derboven et al., 2012). Several studies have used (digital) technology to support such collaboration (Derboven et al., 2012; Hausknecht et al., 2017; Lyashenko & Frolova, 2014). Prior research on the use of technology for intergenerational collaboration has focused primarily on designing and what features should be included (Derboven et al., 2012; Hausknecht et al., 2017; Loos, 2014). In addition,

discussions have been held about the obstacles encountered and those that technology design is intended to overcome (Lyashenko & Frolova, 2014). These barriers are discussed separately in the literature and generally do not provide a complete picture of barriers to intergenerational innovation.

A comprehensive overview of such barrier categories can help design systems and better understand what issues need to be addressed for both generations. Roving the barriers can improve the overall positive experience (Calvo & Peters, 2014). Several classifications can be used as a basis for initially grouping barriers, which can then be refined for the context of intergenerational innovation, including classifying barriers into perceptual, emotional, cultural, and intellectual blocks, as well as organizational, cultural, and technical blocks (Adams, 2019; Litz, 2010). However, in the context of intergenerational collaboration, there is still a need to identify and contextualize barriers to provide a comprehensive picture while highlighting priority barriers in the global innovation process for two different generations.

Concerns of startups entrepreneurs

Aside from intergenerational collaboration issues, it is also important to understand the topics of concern and how the polarization of concern in startups entrepreneurship (Jayaratne et al., 2019; Mason, 2011). Intergenerational discussions and knowledge sharing can positively improve well-being (Santini et al., 2020). Discussions can be triggered if the topics discussed are relevant, engaging, and current, as well as controversial (Mollon & Gentes, 2014; Zubiaga et al., 2011). The ongoing controversy will spark discussion, debate, and finally, opinions and knowledge about the topic can be exchanged (Ackerman et al., 2013; Sriratanaviriyakul & El-Den, 2016). The studies of startup motivation, concerns, and success factors provide an overview of the discussion's content. In the development of startups, topics such as marketing strategy, lean startups, site selection, and financing are discussed (Giardino et al., 2015). However, studies that are not limited to age, gender, or country are needed to overview startup concerns globally. Understanding the pattern of discussion on these topics to see which topics can trigger discussion and knowledge exchange is one challenge in developing content for the intergenerational exchange platform.

Determinants of well-being in intergenerational innovation

Intergenerational collaboration is a social activity that can fundamentally improve networking and professional relationships as a component of overall entrepreneurial well-being (Santini et al., 2020). One way to enhance the positive vibrancy of collaboration is to prioritize engaging activities and meaningful conversations (Derboven et al., 2012; Hausknecht et al., 2017; Liu et al., 2017; Loos, 2014). Engaging in activities and meaningful discussion can lead to human-system positive experiences (Calvo & Peters, 2014; Liu et al., 2017). Previous studies have identified game-based technological approaches to facilitating intergenerational collaboration to determine their importance for engagement in collaboration (Derboven et al., 2012; Hausknecht et al., 2017; Loos, 2014).

Studies suggest using various game elements or gamification strategies to promote intergenerational collaboration, which is also a prominent determinant of well-being-focused system design (Calvo & Peters, 2014; Gaggioli et al., 2017; Riva et al., 2012). However, the determinants of well-being for positive computing are not limited to system enjoyment; other well-being factors also have the potential to enhance intergenerational knowledge sharing. Therefore, capturing and mapping the correlated determinants of well-being for intergenerational innovation is important for developing a positive system design for the study context. Not only as a starting point for a design for well-being (Calvo & Peters, 2014) that facilitates intergenerational collaboration but also for further development of design principles and guidelines (A. R. Hevner et al., 2004; Offermann et al., 2010; Peffers et al., 2007) for intergenerational innovation.

In terms of facilitating meaningful discussion or knowledge sharing, Numerous studies have shown that one of the main barriers to startup development is a lack of knowledge or compatibility with the skills required for startup development (Giardino et al., 2015; Pittino et al., 2020; Shir et al., 2019; Uy et al., 2013). Understanding the required competencies benefits startups entrepreneurs in the marathon journey of startup development, and providing sharing knowledge and matching competencies can help startups to tackle the challenges (Santini et al., 2020; Schuck & Steiber, 2018; H. X. Shi et al., 2019; Shir et al., 2019; Uy et al., 2013). A discussion of competencies can both facilitate the development of awareness of required competencies, develop competency-based entrepreneurship programs but also facilitate the matching of startups and potential partners, especially in terms of access to international markets, and raise awareness of the competencies that should be mastered to optimize collaboration, especially with senior generations.

Moreover, it is also important to drive meaningful discussion by providing readiness self-assessment (Elenurm & Moisala, 2008; Slišāne et al., 2021) that can be used as a guiding tool for competency evaluation and assessment in the global innovation process, as well as to deliver immediate feedback, which is important for intergenerational collaboration (Coffin et al., 2012) and a central requirement to dive into the flow experience of knowledge exchange (Pee et al., 2010; Wiegand & Stieglitz, 2014). Furthermore, it is also necessary to understand the dynamics of these competency requirements within specific processes (Perez-Encinas, Pablo, et al., 2021), the global innovation process presented in Section 1.1. Therefore, the second research question in this dissertation is based on these aspects:

RQ2 How do the necessary competencies for startups in an intergenerational environment change dynamically relative to their importance in the global innovation process?

Competency for intergenerational innovation

Kirzner (2015) explains that an entrepreneur has the competitive competencies and behaviors that drive the market to create a new market and introduce

innovation into the current market and as a determinant of economic growth. According to entrepreneurship research, innovation and entrepreneurship are intertwined (Drucker, 2014; Weiblen & Chesbrough, 2015). Therefore, the competencies intersect in specific ways. On the one hand, in terms of innovation, managerial competence (Szczepańska-Woszczyna & Dacko-Pikiewicz, 2014), network, and technological competence (Ritter & Gemünden, 2004) show a significant positive impact on innovation. On the other hand, in terms of entrepreneurship, Beattie (2016) identified critical capabilities and competencies of entrepreneurs and divided the capabilities into curve phases (opportunity recognition, self-efficacy, tolerance of risk, and need for achievement).

Furthermore, Bacigalupo et al. (2016) provide a comprehensive entrepreneurial competence framework (three groups of competence, including ideas and opportunities, resources, and action) with expected learning outcomes and progression levels. Both innovation and entrepreneurial competencies can be used as valuable information to identify the experiential and instrumental outcomes of the system and matching process (Pawlowski, 2013) of collaborative knowledge development (Bogers, 2011) in the global innovation process. Previous studies on the competency framework for entrepreneurship and innovation can be an initial step towards understanding the dynamic competencies for intergenerational innovation (Perez-Encinas, Pablo, et al., 2021) of global startup entrepreneurs. Thus, this study will elaborate on digital and intergenerational collaboration to complement the overall intergenerational innovation competencies.

Intergenerational collaboration in a digital environment poses various challenges and necessitates acquiring specific digital skills (Lyashenko & Frolova, 2014). Positive Computing focuses on the possibility that users can achieve a state of well-being while interacting with proposed interventions to design sociotechnical interventions with a positive perspective (Avital et al., 2006; Pawlowski et al., 2015; Pinho et al., 2012; Riva et al., 2012) or in this study defined as **positive contextualization**. At first glance, this perspective appears to be opposed to traditional information systems design centered on problem-solving. The positive design emphasizes the importance of subjectivity (Avital et al., 2006; Calvo & Peters, 2014; P. Desmet & Hassenzahl, 2012; Riva et al., 2012) in identifying potentially beneficial elements in the user experience.

However, when considering the various levels of implementation of positive computing (Calvo & Peters, 2014), it is important to note that identifying relevant barriers is also a component of implementation, complemented by well-being determinants. Thus, the positive design systems establish a new paradigm for information systems design by fusing the positive lens, which emphasizes human well-being and potential, with the negative lens, which emphasizes problems and impediments (Avital et al., 2006; Calvo & Peters, 2014). As a result, adjustments are required in formulating research objectives related to social and technological factors and the research process itself, which incorporates multiple disciplines and user subjectivity and thus affects design requirements and principles. Nonetheless, contemporary research on intergenerational systems

provides a foundation for understanding the technical approach to intergenerational collaboration. Integrating various barriers, well-being factors, concerns, and competencies for intergenerational innovation must be done following user and expert preferences or subjectivity regarding proposed interventions. As a result, the third research question supporting the MRP is as follows:

RQ3 How should an intergenerational collaboration system be positively designed to support knowledge exchange in the internationalization of startups?

Tool for subjectivity-driven design

Subjectivity can be defined as a person's view or preferences of topics. Subjective and objective assessments are often used in designing and evaluating systems (Calvo & Peters, 2014). Even though assessments related to well-being can be both objective and subjective (Calvo & Peters, 2014; P. Desmet & Hassenzahl, 2012; Riva et al., 2012), the positive lens focuses more on discovering subjective opinions about well-being that influence design interventions (Avital et al., 2006; P. M. A. Desmet & Pohlmeyer, 2013). Users' subjective evaluation of problems and proposed interventions relies heavily on the experience and context of the evaluation to provide positive contextualization for success (Avital et al., 2006; Calvo & Peters, 2014; P. Desmet & Hassenzahl, 2012).

The ability to identify subjective patterns is critical for systems design focused on well-being (Calvo & Peters, 2014; P. M. A. Desmet & Pohlmeyer, 2013), where design proposals are formed not based on averages or the number of critical voices but on patterns of opinion that form specific groups that are then considered (Lundberg et al., 2020). A method that has already been used in information systems and education, which focuses on subjectivity is the Q-Method (Lundberg et al., 2020; Thomas & Watson, 2002). Although the method originated in human psychology studies, this approach has been applied to information systems. It shows a promising result in understanding users' preferred system design compared to other methods (Matzner et al., 2015). However, effective positive system design requires a comprehensive understanding of the application of the Q-Method as a tool to enable subjectivity-driven design for intergenerational innovation.

Design guidelines and principles for intergenerational innovation

Using a positive lens to guide technology design will impact the proposed design principles and guidelines (Avital et al., 2006; Pawlowski et al., 2015). As a result, the positive design system that places the human at the center of design should strive to create a set of design guidelines that apply to various technologies. Although the use of design principles and design guidelines is sometimes interoperable in some studies (Eggert & Edelbauer, 2020; Liu et al., 2017), for this dissertation, I understand design principles are a set of rules and characteristics that a generally described system must have, such as the connectivity, information transparency, and decentralized decision-making principles in the design principles for Industry 4.0 or the design principles of actionable and

interoperability of information, and information anonymity and protection for learning analytics in higher educations (Hermann et al., 2016). While design guidelines are specifications of design principles that serve as the foundation for more detailed design proposals, they also include context, actors, and behaviors performed information.

In terms of design principles, gamification, for example, is an approach that is gaining traction in information systems research (Liu et al., 2017). It is accomplished by incorporating game elements into the design of non-gaming systems and providing a set of principles (Liu et al., 2017); this description also corresponds to Level 2, or the active implementation of Positive Computing (Calvo & Peters, 2014). The inclusion of game elements encourages joyful experiences as part of the user's overall positive emotional state. Developing Positive Computing guidelines, on the other hand, allows for the development of different design principles that focus on aspects such as constraints, values, and long-term goals (Avital et al., 2006; Calvo & Peters, 2014; P. M. A. Desmet & Pohlmeyer, 2013; Riva et al., 2012) relevant to intergenerational collaboration.

Based on the identified well-being factors, tailored interventions are developed in this study to meet user preferences for intergenerational collaboration. Overall, the third research question should provide a set of application design principles and a tool that incorporates subjectivity to apply positive system design for intergenerational innovation.

1.3 Study objectives

As presented in Section 1.2, different studies by taking the positive computing paradigm (Calvo & Peters, 2014) provide a basic understanding of the study context and better understand previously unexplored areas of positive design of technology. However, taking the positive computing paradigm requires exploring well-being determinants, barriers, preferences, and prior socio-technological experiences of senior and younger adults for intergenerational collaboration.

Moreover, additional information regarding the global innovation process is required regarding the competencies and the competing concerns associated with innovation and entrepreneurship. Since the study covers a wide area of research, it is necessary to have boundaries and define the study context. As is common in information systems, there is a vast research area whereby several disciplines, such as physiology, engineering, and management, must be considered. Hence, the following boundaries should be established to ensure the study objective is met:

- A startup is defined as an organization. It is a newly founded company that is still in intensive product development and looking for sustainable business models with limited resources. Startup companies usually have no operational track record. High uncertainty of the final product with

limited time to market causes most startups to fail (Bajwa et al., 2017; Wang et al., 2016).
- A minimum of two different countries are involved in illustrating the global context.
- Intergeneration is defined as two groups of adults (younger and senior adults) with age differences minimum is 20 years (younger adults from 18 years old, senior adults from 55 years old, preferably > 60 years).

Moreover, based on the underlying study aim (MRP) and research questions (RQs) presented in the previous sections. The following five aspects will be the key issues to be explored in this dissertation regarding positive design contextualization for intergenerational innovation:

- Barriers and wellbeing determinants
- Competing concerns
- Dynamic competencies
- Subjectivity-driven design tool
- Design guidelines and principles

By defining the scope and focusing on specific topics, each study that addresses the research questions is intended to contribute to the themes addressed in this subsection. Nevertheless, the study is not strictly limited in scope; instead, there is an opportunity if required to expand on the key topics identified to gain a more comprehensive understanding of the content and context of the dissertation study. The following section presents how each article relates to the study's objectives.

1.4 Relationship of the included studies to research objectives

This dissertation contains seven studies with nine articles. The studies focus on five key issues for positive contextualization that are presented as research objectives to answer specific research questions. The list of studies with correspondence articles is as follows:

- Study 1: Articles I and II
- Study 2: Article III
- Study 3: Article IV
- Study 4: Articles V and VI
- Study 5: Article VII
- Study 6: Article VIII
- Study 7: Article IX

The list of studies shows how the key issues presented in Section 1.3 were organized and divided among several articles. Each study contributes to answering the main research question. The relationships between the studies to

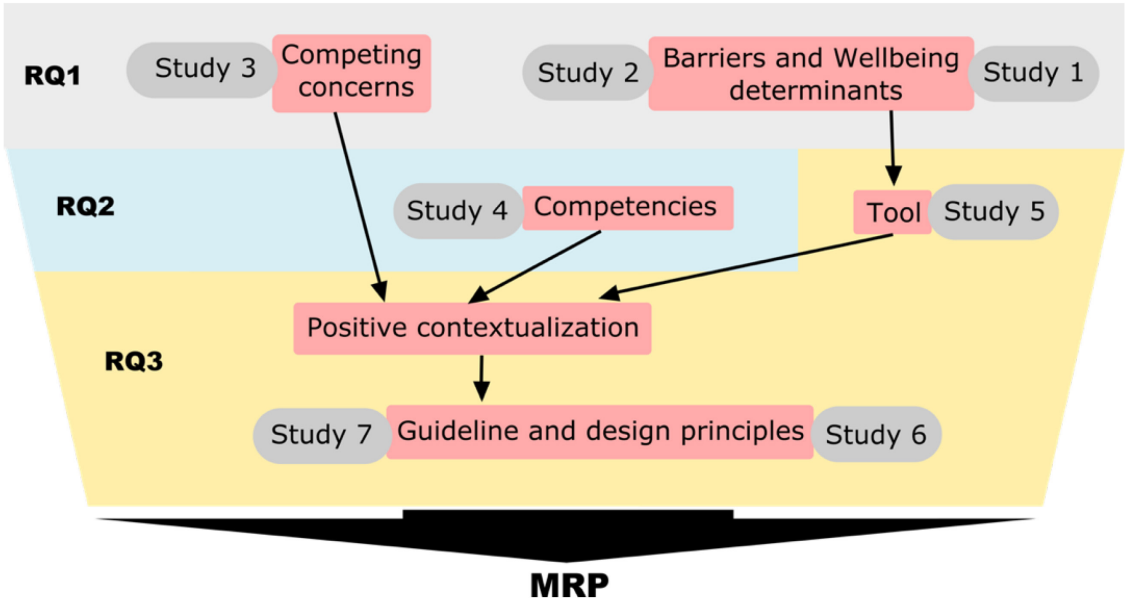

FIGURE 4 Overview of the research objectives and the studies conducted

answer RQ1, RQ2, and RQ3, as well as the structure of this dissertation, are shown in Figure 4.

To answer RQ1, Study 1 presents the barriers and associated determinants of well-being to intergenerational innovation in the digital age. Study 2 validated the identified barriers to the global innovation process and mapped between different generations. Study 3 presents the competing concerns of startup entrepreneurs and complements the important issues raised in RQ1. For RQ2, Study 4 highlights various competencies of intergenerational innovation. By answering RQ1 and RQ2, the results provide a rigorous foundation for positive contextualization that can be used for Studies 5, 6 and 7 to answer RQ3.

Based on Study 1, further findings also suggest using a particular tool presented in Study 4 to promote subjectivity in shaping well-being in the study context. In comparison, Study 5 presents a framework to adapt the subjectivity-based tool for system design. Studies 5, 6, and 7 combine all the findings to present the contextualization of design principles in design and the use cases of design technology to support intergenerational innovation.

2 RESEARCH METHODOLOGY

Research in information systems is a collection of activities to study social and technological aspects to create value-added artifacts (March & Storey, 2008). In information systems, artifacts are defined as artificial works that contain socio-technological components such as models, frameworks, systems, equations, software, and applications (Offermann et al., 2010). The value-added artifact does not always require creating something new but can also improve the status quo (Gregor & Hevner, 2013; A. R. Hevner et al., 2004; Offermann et al., 2010). To create value-added artifacts that meet research objectives, research activities must be conducted systematically with a set of consistent assumptions (Saunders et al., 2009) and follow a logical reasoning process that can be clearly described and documented to ensure rigor, credibility, and (when possible) replicability. Saunders et al. (2009) provide a framework for better understanding the logical flow of reasoning when selecting specific methods versus alternative methods chosen in this research study. Although the framework was developed for a study in business administration, the proposed framework can be applied in other fields, including information systems, an interdisciplinary field that deals with the use of information technology for society, businesses, and organizations. Therefore, the framework provides a logical flow of reasoning and justification for the chosen approaches.

On the one hand, answering the research questions outlined in the previous chapter required a comprehensive and diverse approach to data collection for each question. On the other hand, it is also important to choose a method that integrates different approaches in a single process that solves the main research problem. To better understand the rationale for the choice of research process and methods, this dissertation employs the research onion framework proposed by Saunders et al. (2009).

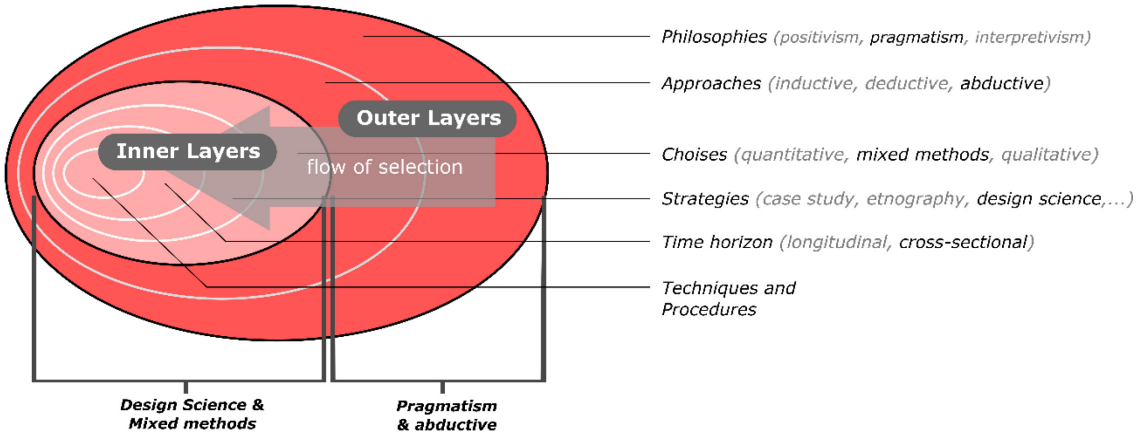

FIGURE 5 The methodological overview

Figure 5 shows the overview of the research methodology as an "onion layer," following Saunders et al. (2009) holistic approach to setting up a research methodology. The framework consists of six layers, which can be divided into outer and inner layers. The logical narrative of the framework progresses from the outer levels to the inner levels. The layers are interconnected and provide a logical overview of the approaches chosen to achieve the study objectives. Based on the framework, this chapter is divided into two sections. The first section covers the outer layer of the research onion or the rationale for methodological foundations and approach. The second section discusses Design Science Research (DSR) (A. R. Hevner et al., 2004; Peffers et al., 2007) as the inner layer and the primary research process for investigating the MRP with the presentation of various data collection methods within the DSR process.

2.1 Research foundations

The outer layers of Saunders' framework deal with the philosophical stance toward knowledge development (Saunders et al., 2009). The outer layer is concerned with the worldviews or system beliefs of the researcher as an actor in the research activity, as well as their assumptions that shape and influence the process of interpretation and analysis in the study. In terms of philosophical perspectives for the outer level, there are three philosophical lenses discussed in information systems research: positivism, interpretivism, and pragmatism (Goldkuhl, 2008, 2012; Orlikowski & Baroudi, 1991). While positivism gives researchers more control over knowledge discovery and lies in objective observation, it is opposed to interpretivism, where knowledge is based on subjective values and interpretation due to interaction between researcher and study participants. Pragmatism lies between positivism and interpretivism, or the balance between control and interpretation by the researcher (Goldkuhl, 2008, 2012; Orlikowski & Baroudi, 1991). To determine which philosophical lens is

more apropos for this research, three aspects, including ontology, epistemology, and axiology, can be used to guide the justification of the chosen philosophical lens (Saunders et al., 2009).

Ontology means knowledge about the reality of what exists. It is perceived by individuals or the specification of conceptualization defined in an information system domain (Hassan et al., 2018). Ontology articulates the different levels of abstraction to describe different perceptions of knowledge, whether based purely on reality and an objective evaluation or a subjective evaluation based on personal preferences (Goldkuhl, 2008, 2012; Hassan et al., 2018). Much research has been done on intergenerational collaboration, particularly in the social sciences (La Hera et al., 2017).

In addition, studies on entrepreneurship and global innovation have been conducted in the research communities for decades, providing facts and objective evidence about existing knowledge about the context in some parts of the overall research context. However, the integration of technological aspects in the field of information systems is indeed limited when it comes to creating solutions by paying attention to combined aspects of individuals, organizations, and technologies, in particular, by combining multidisciplinary perspectives (Avital et al., 2006; Calvo & Peters, 2014). Considering well-being factors develops the characteristics of knowledge associated with collaboration between such generations, including each generation's (emotional) incentives to collaborate (which in this study focus on subjective well-being). This required information reflects the subjective preferences of the different generations. As a result of the ontological analysis of what knowledge exists and what properties it possesses, the revealed knowledge will be both objective and subjective. The choice is pragmatism (Goldkuhl, 2008), which combines the best approaches of positivism and interpretivism, using both objective knowledge and subjective knowledge as long as it can solve the given problem.

In terms of epistemology, epistemology aims to address how knowledge can be understood and claimed as knowledge, what is proper knowledge, what is accurate information, and what legitimate knowledge (Hassan et al., 2018; Saunders et al., 2009). Based on the research objectives, which aim to provide a comprehensive understanding of how to shape intergenerational innovation, knowledge will be highly dynamic and contextual. On the one hand, inquiry through RQ1 and RQ2 requires authors to understand themes based on previous studies and individual perspectives based on documented content. On the other hand, using positive computing to contextualize study findings (RQ3) positively requires researchers to validate proposed design guidelines through actions and worked examples. In other words, based on epistemological analysis, knowledge of design guidelines for intergenerational innovation requires validated knowledge through action and doing, which facilitates comprehensive understanding rather than explaining specific relationships or causalities (Goldkuhl, 2008). These criteria also support the choice of pragmatism, where change is the underlying objective and is therefore highly context-dependent.

Concerning the axiology or value theory aspect, based on the usefulness of newly acquired knowledge or the usefulness and utility of existing knowledge (Hassan et al., 2018; Saunders et al., 2009), the main objective is to achieve an improvement in the status quo about the lack of understanding of the positive design of intergenerational innovation, that is, not to try to validate truth, but to create valuable information that is proposed as valid in a given context. Thus, based on axiology, this study will emphasize pragmatism by focusing on value-laden or presuppositional knowledge of design principles and guidelines based on validated issues and competencies relevant to entrepreneurial well-being.

Overall, the analysis of ontology, epistemology, and axiology is based on the analysis of the objectives and scope of the study. Therefore, this study adopts pragmatism or a mixture of positivism and interpretivism (humanistic qualitative method) based on the previous section. As for interpretivism, the study articulates the perceptions and subjectivity of collaboration in innovation activities with different generations of entrepreneurs and academics in terms of what motivates them to share information with others, what challenges they face, and what skills are essential for starting a business so that the design principles for intergenerational collaboration are in place. However, quantitative assessment is also important and is used to examine how the meaning and value of the relationship changes and how these competencies change depending on the context. Pragmatism seems appropriate as a philosophical foundation for this study, combining different approaches to developing understanding and knowledge that can benefit research communities and entrepreneurs.

Pragmatism as a philosophical layer provides a first step in choosing the research strategy and method(s). Based on the outer layer of the Saunders et al. (2009) framework, the next step is to choose the methodological approach. There are three methodological approaches or logical inferences that can be used in the research process (Hassan et al., 2018): first, deductive reasoning or the use of data to test knowledge. Second, inductive reasoning or using data to build knowledge. Moreover, third, abductive reasoning or the extension of knowledge through inferences based on valid and credible assertions (Hassan et al., 2018). Based on the philosophical approach presented, abductive reasoning was used in this dissertation in most parts of the research process, although in some places, especially in RQ3, inductive reasoning might be appropriate for building knowledge or deductive reasoning for RQ1 and RQ2 to validate the existence of problems and competencies for the study context.

On the other hand, the reason for using abductive reasoning is that the knowledge about the context of intergenerational collaboration and the content related to global startup entrepreneurship are both already mature research in order to provide a comprehensive understanding of this study, which combines different fields but also expands the knowledge of dynamic changes in issues and competencies. Abductive reasoning is well suited for this reason. By following abductive reasoning, the best possible explanation will be built based on previous knowledge and fact that can be gathered from different mature study

fields and expert opinions. Thus, in the end, it will help in the knowledge development to address the MRP and RQs.

This section presents the philosophical approach and data handling to build a logical reasoning flow. However, to integrate different studies to answer the RQs, it is important to present the research activities or have a systematic process for combining different results of the RQs and finally solve the MRP. Based on the research onion, the selection of research activities is part of the inner layer discussed next. In this study, DSR was selected as a research strategy through a systematic process consisting of mixed data collection and evaluation.

2.2 Mixed-method within design science research process

The outer layer explains the philosophical underpinnings of method selection and how knowledge is developed to fit the selected method (Saunders et al., 2009). On the other hand, the inner layer of the Saunders et al. (2009) framework focuses on method selection and the research strategy and activities. The steps, processes, forms, and duration of data collection are carried out to build knowledge. The first component of the inner layer is the strategy selection process, which is guided by the chosen research objectives and philosophical foundations (Saunders et al., 2009). Many research strategies are available, including action research, ethnographic research, experiments, survey research, case studies, grounded theory (Saunders et al., 2009), and design science (Gable, 2020). According to the research objectives, which are divided into three main questions, the DSR methodology (A. R. Hevner et al., 2004; Peffers et al., 2007), was chosen as the most appropriate research strategy to integrate all the research questions in one process and fill the primary research gap.

In recent decades, DSR has begun to be widely used in the information systems field (Gregor & Hevner, 2013; Peffers et al., 2007). Various information systems journals have published and discussed the application of design science research to social, managerial, and technological issues. This methodology is considered to bridge the gap between the need to produce science and knowledge (A. R. Hevner et al., 2004; March & Storey, 2008; Offermann et al., 2010), which is the main goal of the research, especially in the field of nature, and, on the other hand, to produce applicable technology or forms of social interventions that can be used in management practice and social science (A. R. Hevner et al., 2004; Peffers et al., 2007).

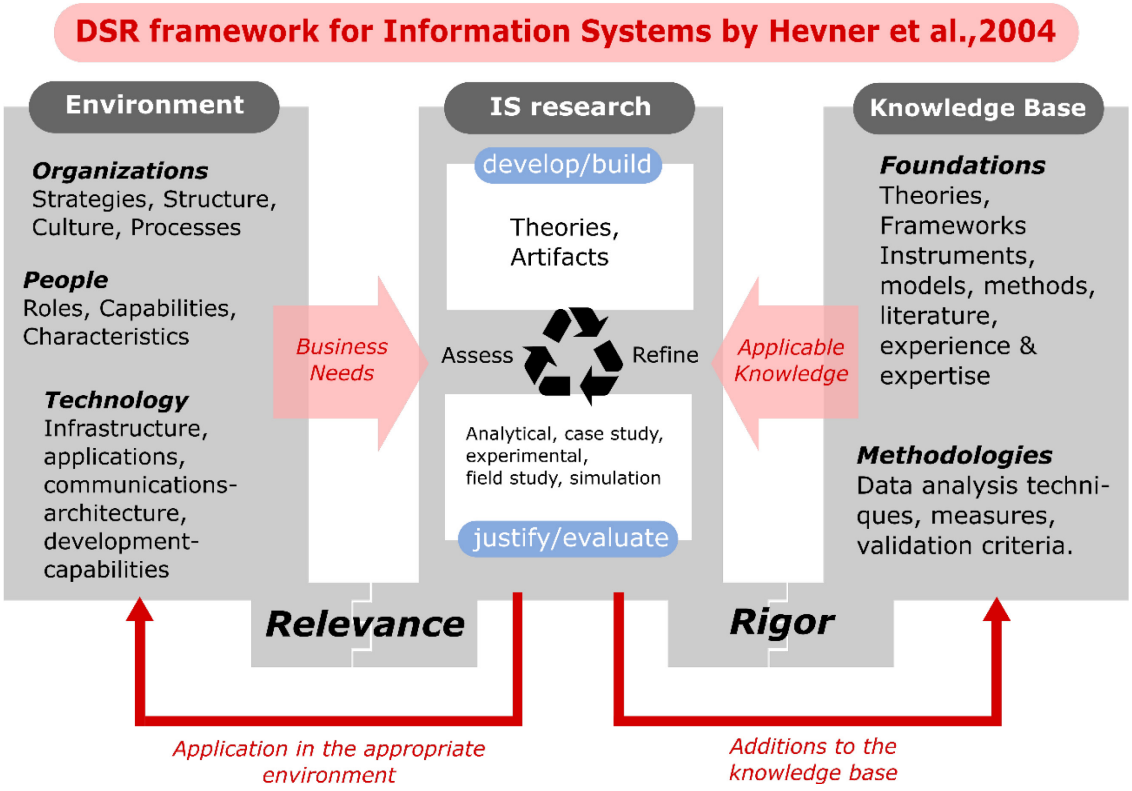

FIGURE 6 DSR-framework for Information Systems

The research method of design science, based on an analysis of research objectives, the philosophical foundations, and the framework of design science in information systems presented in Figure 6, is considered appropriate to fill the research gap in this study. The considerations are based on several points, including:

Pragmatism Knowledge development through demonstrative solution(s). The research method of design science focuses on producing artifacts or proposed solutions (A. R. Hevner, 2007). One of the most important phases in design science is the demonstration and evaluation based on design and development (A. R. Hevner et al., 2004; Peffers et al., 2007), in which the study results were produced. This phase follows important pragmatism as the philosophical basis chosen in this study.

Relevance DSR in information systems focuses on developing artifacts, including design guidelines and design principles following the research objectives. In addition, design science research is consistent with the scope of research that consists of individual, organizational and technological aspects (A. R. Hevner et al., 2004). These three elements are the main balanced issues discussed in this study, addressing issues of well-being in terms of determinants, barriers, and competencies at the individual level, the collaboration between senior adults and young entrepreneurs in the development of global startups at the organizational level, and knowledge collaboration in the digital world as part of the technology environment to be designed.

Rigor The study should play an important role to the advancement of science. DSR is a research strategy that involves the development of knowledge-based on a solid scientific foundation or has already been disseminated and validated in the research community (A. R. Hevner et al., 2004). The proposed intervention in design science does not always have to be something completely new from scratch. However, the main goal is to improve the status quo. Improvement is one of the contributions that research can make through design science, with research findings derived from examining what has been achieved to date and improving what already exists. These principles correspond to the research foundations for abductive reasoning. They are part of the areas of study that are already mature in the study context of intergenerational collaboration and entrepreneurship.

Iterative design DSR involves repetitions. The evaluation and communication processes' outcomes can be reused as a reflection process to determine the most appropriate explanation for the process's disparate outcomes (A. R. Hevner et al., 2004; Peffers et al., 2007). This can aid in the abductive reasoning process used to develop the theoretical framework, resulting in a better understanding of how positive design can foster intergenerational innovation. This iterative process will assist in determining what has previously been discovered in the literature, which adaptations, evaluations, and communications strategies work and do not work in answering the research questions, and which adaptations are necessary (A. R. Hevner et al., 2004; Peffers et al., 2007).

Multiple entry points The iterative nature of DSR allows researchers to participate in specific design science processes. If the research problem is valid, the research process can begin directly with the search for alternative solutions; alternatively, the research process can begin directly with the evaluation process once the solution has been conceptualized. Since all processes are reflexive, it is possible to return to an earlier state (A. R. Hevner et al., 2004; Peffers et al., 2007). This allows for greater flexibility in this dissertation by dividing the research process into small research study projects according to the RQs and objectives. In addition, dividing the research into different research projects based on the RQ allows for greater flexibility in collaborating with other researchers on specific research projects who have the expertise or can assist with certain aspects of the research process.

Series of validations A pragmatist philosophical perspective allows more room for selecting multiple methods. Thus, pragmatism and abductive reasoning complement DSR by allowing the use of multiple data collection methods and validation of results to achieve a complete understanding of the study content and context. Iterative DSR for multiple activities provides flexibility for validating the results of a particular process in design science activities. Therefore, it can be used to investigate responses to RQs in various Design Science activities. Multiple evaluation episodes ensure the validity of knowledge in design science (Larsen et al., 2020; Venable et al., 2016). According to the various concepts of validity in DSR (Larsen et al., 2020), the validity of the problem space in problem

definition is determined by the availability of the current study in context and expert opinion. Validity in terms of theory validity, construct validity, criterion validity, and representative validity are critical for problem definition in this study. In the solution space, internal design validity, i.e., consistency, transparency, and explainability of the proposed solution, is examined. In addition, during the primary DSR evaluation process, knowledge of defensible design principles is gained by developing a prototype for requirements validity and relative improvement validity based on the research questions and objectives (Larsen et al., 2020). The final step in communicating the results to stakeholders and scientific communities is to openly discuss and disseminate the validity of the results (Peffers et al., 2007).

In light of these considerations, this study uses DSR as a research strategy. Additionally, to integrate the three research questions into DSR, this study is based on process-oriented DSR (Peffers et al., 2007). This DSR approach can supplement the rationale for considering design science as the appropriate research strategy for addressing MRP and answering all RQs via a series of processes within DSR. The established DSR process (Peffers et al., 2007) includes problem identification, solution definitions, design and development, demonstration, evaluation, and communication. The following describes each process and its relationship to the studies conducted in each process to address the research question:

Identification of problems

Problems, research questions, or research motivation were identified (Peffers et al., 2007) and further validated. The research gaps and research questions presented in the first chapter are used to motivate various study projects. Studies 1, 2, and 3 were conducted in problem formulation and validation for the study context using a systematic literature review, a quantitative survey, and topic modeling and sentiment analysis to answer RQ1. This process listed and prioritized barriers related to the study context, identified the pattern of problems and concerns, and validated the existence of problems.

Defining the solutions

In this phase, frameworks are created for the positive design of intergenerational innovation. A framework consisting of barriers and determinants of well-being related to context and competing concerns and competencies related to the content of intergenerational innovation is formulated based on several methods. At this stage, all studies, except for Study 6 (Article VIII), were conducted using this method. Each study uses a different approach. Moreover, the abductive reasoning approach was used to formulate the best conclusions regarding the solution in a framework based on an analysis of the collected facts. Studies 1, 2, and 3 were used to formulate and validate the problem and issue framework to answer RQ1. Study 4 (Articles V and VI) was used to develop solutions related to the competency framework to answer RQ2. Studies 5, 6, and 7 were used to develop solutions using tools to integrate within the DSR process, user type identification, and design principles to answer RQ3.

Design and development

In this stage, all studies produce artifacts such as a conceptual framework, prototype, metrics, and design principles (Offermann et al., 2010). However, studies 5, 6, and 7 containing provable prototypes, metrics, and design principles continue into the demonstration phase to be evaluated and disseminated according to the research phase of design science. Several techniques are used in this phase, including using a conceptual matrix in conjunction with a literature review, evaluation matrices, and developing a working prototype in the form of a website application.

Demonstration

During the demonstration stage, following pragmatist philosophy, which emphasizes action and doing (Goldkuhl, 2008), In this approach, Study 5 (Article VII) develops a competency-based framework with a readiness self-assessment tool; Study 6 (Article VIII) is a case study for the framework developed in Studies 1, 2, 3, and 4 on intergenerational innovation chatbot design. Furthermore, research Study 7 (Article IX) synthesizes the findings of prior studies to create a prototype knowledge exchange platform for intergenerational innovation.

(Series of) evaluation

This stage is about the procedures for validating and/or reflecting on the demonstrated results. This step can be a repeatable process depending on the approach used to answer the research question in each study. For example, the relevance of the barrier and competency issues and frameworks presented in Studies 2 and 4 is determined using an online Likert scale survey in Study 2 (Article III). A Delphi panel, also using a Likert scale, may be repeated in Study 4 (Articles V and VI) if consensus is not reached. In addition, qualitative and quantitative data were used to assess whether the use cases created for technology development accurately reflected the needs of two different generations presented in Studies 6 and 7. Study 7 (Article IX) was presented as a DSR paper that utilizes group preferences of an expert panel and a quantitative Likert scale to evaluate the prototype.

(Series of) dissemination activities

Dissemination is a means of publicly communicating the results of individual studies. Communication can take the form of presenting study results at workshops and events, particularly in the case of projects conducted by the Institute of Positive Computing at the Ruhr West University of Applied Sciences, which funded the research. Moreover, other important channels of communication in the forum of the scientific community are conference proceedings and communication in journals. The selection of proceedings and journals is based on the recommendations of the Finnish publication forum (referred to as JUFO in Finland) as a scoring system.

The DSR process includes numerous validation/evaluation and dissemination rounds for each study conducted in this dissertation. Therefore,

consistent with the pragmatic philosophy, a mix of data collection and evaluation methods were used to identify appropriate evaluation phases for a given study.

The following briefly explain the different data collection methods used within DSR.

Systematic literature review

A systematic literature review (SLR) is a methodical process of reviewing a body of selected literature on a particular topic using predetermined questions. This organized approach is necessary to document each stage and provide the basis for selecting an article as part of the literature reviewed and attributing metadata and concepts discovered in the literature. This method was chosen to identify gaps, challenges, barriers, and existing expertise in several already mature research areas related to intergenerational collaboration, entrepreneurship in startups, and digital collaboration. This dissertation followed the SLR guidelines (Kitchenham et al., 2009; Webster & Watson, 2002) as a baseline process and literature mapping (Petersen et al., 2008) of concepts found in the literature.

Moreover, abductive reasoning is an integral aspect of the conceptualization process of the iterative concept classification framework, where different findings are presented in a concept matrix. Studies 1 and 5 used a systematic literature review as the main method. Study 1 (Article**s** I and II) examined the barriers and well-being factors for answering RQ1. Study 5 (Article VII) provides an overview of the application of the Q-Method to the study of information systems and its incorporation into design research. In addition, the systematic literature review approach is a preliminary investigation combined with the Delphi method in Study 4 (Articles V and VI).

Topic modeling and sentiment analysis

Two research techniques, topic modeling and sentiment analysis (Saura et al., 2019), were used in Study 3 (Article IV). Both methods were used to examine a series of questions about entrepreneurship on the social media platform Social-media Questions and Answers (SQA). SQA has become a popular platform for startup entrepreneurs and anyone interested in growing startups to ask questions, share expertise, and network globally without regard to country, gender, or age boundaries. To capture the patterns of competing concerns based on given text data, topic modeling and sentiment analysis are prudent tools (Saura et al., 2019). Combining these methods can create a comprehensive picture of the critical concerns associated with startup development, which can be used as a conversation starter for information sharing among the different generations interested in entrepreneurship.

In addition, identifying the attitudes and sentiments associated with each issue can help determine which issues tend to be negative and cause problems and which issues tend to be positive and motivating. By identifying the pattern, the result can lead to a better understanding of how a topic can be used to initiate discussions in knowledge sharing.

Quantitative survey

The quantitative survey in this dissertation is devoted to empirically validating the relevance, significance, and applicability of concepts or frameworks to the dissertation's context and content. The vast majority of quantitative data for Studies 2 (Article III), 4 (Articles V and VI), and 7 (Article IX) was gathered online. To assess the relevance and significance of the barriers identified in Study 2, an online survey using a Likert scale (Joshi et al., 2015) was conducted (1: strongly disagree to 5: strongly agree).

Moreover, statistical analysis, the mean, and correlation between the barrier and a particular generation were calculated. Study 4 gathered data using a Likert scale to ascertain the relevance and significance of entrepreneurial competencies cited in literature studies on generational collaboration in startup internationalization. All participants' average value assigned to competency was calculated for statistical analysis. In Study 7, quantitative data was gathered through an online Likert scale based on the System Usability Scale (Brooke, 1996). This was done as part of a set evaluation to validate the applicability of design principles and the prototypes' usability.

Delphi study and open-ended questions

A Delphi study is an iterative process in which the ranking of a topic is determined based on expert opinion and consensus (Skulmoski et al., 2007). Experts are presented with a set of topics on specific issues. After several iterations, a consensus is reached in which the experts express their opinion on the importance of the topic (Skulmoski et al., 2007). The iteration process was repeated until agreement or consensus was reached on the final ranking of the issues. The Delphi survey was used in Study 4. The topics covered correspond to the competencies identified through the literature review. In addition, experts were asked open-ended questions if they wanted to suggest new competencies, combine competencies, or elaborate on specific competencies. The Delphi method and open-ended questions were asked online to a panel of twenty experts from developed and less developed countries, most of whom were from Germany.

In addition, four of the twenty experts in the study were senior experts from the German Association of Senior Experts with expertise in startup entrepreneurship development.

Q-methodology

To differentiate with overall DSR, the selected methodology will be written as Q-method. The Q-Method is a tool in social science studies that uses factor analysis to group subjectivity concerning specific topics (Lundberg et al., 2020; Thomas & Watson, 2002; Watts & Stenner, 2005). It is a mixed method that originated in psychology and applied to various fields, including information systems (Thomas & Watson, 2002).

In this study, the perceptions and preferences of all participants are first collected from various sources, such as interviews, observations, and literature. These perceptions are then presented as statements in the text, images, or video.

Participants in the study then sort the statements according to specific criteria such as relevance and importance. Participants sort using a Q-Sort procedure, which compares all statements during the sorting process. In Studies 6 (Article VIII) and 7 (Article IX), the Q-Method was used. This method was used in Study 6 to derive personalized system requirements for chatbots for intergenerational innovation based on the statements derived from Study 1 (Articles I and II) and 2 (Article III). Study 7 (Article IX) evaluated the system prototype using the Q-Method in a group discussion with experts.

Overall, this study's research process followed the process-oriented DSR proposed by (Peffers et al., 2007). Peffers et al. have introduced a minimum process for conducting DSR in information systems. The proposed DSR process fits our research goal because it provides a systematic process that can help us construct solutions to the MRP and RQs, provide new and profound insight for positive design for intergeneration innovation and support the development of an applicable conceptual framework, also for the entrepreneurial study (A. Hevner & Gregor, 2020).

Figure 7 illustrates the use of an overview of the DSR in conjunction with mixed methods in responding to the RQs for this dissertation. The next chapter will explain each study, including using a particular data collection method presented in this chapter.

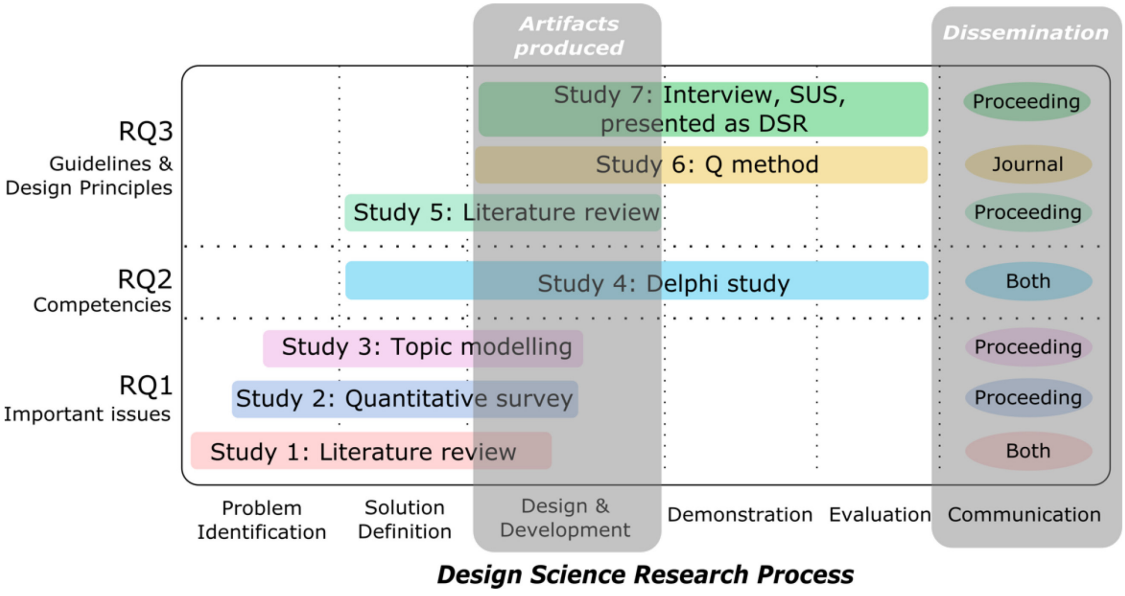

FIGURE 7 Mixed methods within the DSR process

3 OVERVIEW OF THE INCLUDED ARTICLES

This chapter summarizes the corresponding dissertation study articles, which outline the objectives, methods, and results and the role of the article in the overall study.

3.1 Articles I and II: Barriers and Wellbeing-oriented Enablers of Intergenerational Innovation in the Digital Age

I Nurhas, I., Geisler, S., Ojala, A., & Pawlowski, J. M. (2020). Towards a Wellbeing-driven System Design for Intergenerational Collaborative Innovation: A Literature Review. In *Proceedings of the Annual Hawaii International Conference on System Sciences*. University of Hawai'i at Manoa.

II Nurhas, I., Geisler, S., Ojala, A., & Pawlowski, J. M. (2021). Barriers and Wellbeing-oriented Enablers of Intergenerational Innovation in the Digital Age. *Universal Access in the Information Society*, (pp 1-17). Springer.

The results of Study 1 have been published in these articles. Article II is an expanded version of Article I.

Aims and methods

Numerous studies have demonstrated the critical role of intergenerational innovation in managing an aging workforce and the success of startups. Therefore, this initial work reviewed studies on intergenerational collaboration in innovation activities to determine what factors of well-being and what barriers influence the design of the system to support intergenerational innovation. In addition, definition of intergenerational innovation was introduced based on various literature sources in this study. The study's main objective is to build on previous research to identify a (class of) barrier and well-being factors that can influence system design and are critical to intergenerational collaboration in creative processes, especially in global startup innovation.

Therefore, Study 1 (Articles I and II) conceptualized a well-being-focused system design for cross-generational innovation using a positive computing approach. In addition, potential research plans are presented to address the research gaps identified in the literature review. To provide the best possible explanation for a conceptual model that incorporates barriers, well-being factors, and potential technological interventions to support intergenerational innovation, Study 1 (Articles I and II) used a two-step systematic review of the literature as recommended by (Webster & Watson, 2002), a metadata analysis, and abductive reasoning for conceptualizing the proposed framework.

Findings

A conceptual framework for IGC system design technology was developed. The article identifies important thematic contexts and a popular topic in the study context. The study also presents findings related to the growing attention to the topic worldwide and in various industries. The conceptual framework provides a holistic view of intergenerational collaborative systems in the innovation process by defining five barrier dimensions and employing six well-being factors as IGC catalysts. The barrier dimension consists of perceptual, emotional, technological, operational, cultural, and institutional barriers.

The study introduces several technological approaches, such as social robots to facilitate collaboration, gamification, and hybrid environments to support different generation preferences and previous experiences. In addition, this article provides a set of well-being factors that can serve as a starting point for applying the positive computing approach to intergenerational innovation. Review articles present positive emotions, including joy and playfulness, pride and achieving collective goals, competence-based satisfaction, motivation, and engagement with a specific approach to building intergenerational relationships. This paper also discusses future research directions for IGC systems.

Role in the dissertation

The findings of this first study served as a solid basis for other articles within this dissertation. These findings are consistent with the DSRM approach and provide insight into the types of problems that may arise during the development of a system for fostering intergenerational innovation. Additionally, this study provides a starting point for selecting technological interventions and approaches related to wellbeing that must be considered when developing wellbeing-driven system designs to foster intergenerational collaboration.

To summarize, this study contributes to the dissertation in terms of RQ, research artifacts generated, and the DSR process:

- Study 1 (Articles I and II) answers research questions RQ1 and RQ3 by 1) elucidating critical barriers to intergenerational innovation and 2) identifying common methods and sociotechnical interventions to facilitate global innovations that prioritize human well-being throughout the design, development, and evaluation process of technology development.
- Study 1 (Articles I and II) provides research artifacts in the form of guidelines as a conceptual framework for wellbeing-driven system design,

a list of feasible technology interventions, and an outline of research gaps for future research in the context of intergenerational innovation.

- Study 1 (Articles I and II) assisted in identifying problems and formulation of solutions for the DSR process. The study identifies intergenerational innovation-associated barriers and the well-being determinants incorporated into system design to facilitate intergenerational innovation.

3.2 Article III: We are "not" too (young/old) to collaborate: Prominent Key Barriers to Intergenerational Innovation

Nurhas, I., Aditya, B. R., Geisler, S., Ojala, A., & Pawlowski, J. (2019). We are "not" too (young/old) to collaborate: Prominent Key Barriers to Intergenerational Innovation. In *Pacific Asia Conference on Information Systems*. Association for Information Systems.

Aims and methods

Building on a previous literature review on barriers to intergenerational innovation, this study empirically tests barriers for two different generational groups. Drawing on the positive computing approach, in which the positive experiences of human activities can change depending on the context of the activities, it is important to identify the dynamic changes in the meaning of barriers in the innovation process. Therefore, Article III aims to answer the related questions: What are the most important barriers for individuals in the intergenerational innovation process through technology brokering? To address this research gap, this study conducted a quantitative online survey using the Likert scale (Joshi et al., 2015) of individuals aged 18 to over 65 to assess the relevance and importance of each barrier identified in the literature in various global innovation activities. The younger participants were students or academics under the age of 40 who were involved in the usability research, while the older adults over the age of 50 were recruited and approached through an online crowdsourcing platform. All participants were exposed to different scenarios of the co-creation in the innovation process, such as ideation, matching, design and development, and the commercialization process.

Findings

Study 2 (Article III) complements previous research on intergenerational barriers, particularly differences in mindset, interest, and technology. Working with older and younger people also presents unique challenges. A system could be designed to prioritize the most important barriers in both groups to avoid biases in the system design that would affect the use of the system by a different user group.

Study 2 shows the dynamic change of barrier dimensions in each of the main activities of the global innovation process: more barriers related to the perception dimension appear in the idea generation phase, the perception, technical, and cultural barriers dimension in the adaptation process. The

technical barriers dimension predominates in the design and development phase. In contrast, the dimension of the emotional barrier is low in the commercialization phase. In contrast to other studies in which older adults focus on intergenerational collaboration, in this study, the younger generation is perceived as having more barriers than older adults.

Role in the dissertation

This study validates the list of barriers identified in the literature review. This study supports the study's progress by identifying prominent barriers for system designers in the particular targeted activity of the innovation process. During the implementation phase, it can spark a discussion for each generation to accept, reject, or provide other preferences about the importance of the barriers based on their circumstances.

In summary, Study 2 (Article III) contributes to the dissertation in terms of RQ, research artifacts generated, and the DSR process:

- Study 2 answers the research question of RQ1 to validate the important competing barriers between different generations in intergenerational innovation.
- Study 2 provides a validated pattern as the research artifact regarding barriers between two different generations in the context of intergenerational innovation. In addition, the study provides initial personas for the study context.
- Study 2 helped define problems for the DSR process by validating the proposed barrier framework relevant to both generations in intergenerational collaboration.

3.3 Article IV: Examining Competing Entrepreneurial Concerns in a Social Question and Answer (SQA) Platform

Nurhas, I., Pirkkalainen, H., Geisler, S., & Pawlowski, J. (2021). Examining Competing Entrepreneurial Concerns in a Social Question and Answer (SQA) Platform. In *International Conference on Knowledge Management and Information Systems.* (pp 145-152). SCITEPRESS

Aims and methods

Study 3 (Article IV) aims to uncover the competing concerns of startup entrepreneurs. To achieve the study objective, this study explored the issues faced by entrepreneurs (or those who want to start their own business) through the sentiment analysis and topic modeling of social media queries (Saura et al., 2019), which is becoming increasingly popular in the startup community for learning and knowledge sharing. Study 3 sheds light on further details of many issues involved in the startup debate without limiting the discussion to a specific country, gender, or age group. Therefore, Study 3 analyzes online question-and-answer communities on social media. The topic of conversation and sentiment of

each query are identified using Latent-Dirichlet Allocation, topic modeling, and sentiment analysis (Saura et al., 2019).

Findings

In Study 3 (Article IV), thirty topics relevant to entrepreneurship in the startup phase are identified and investigated. In addition, the results of Study 3 show that the topics are classified as a list of words, with each word having a coefficient value indicating how important the word is to the topic. Study 3 highlights a new classification of topics related to discussing the place and emerging market for internationalization of startups and inspiring companies and founding figures.

Overall, 48.9 percent of all inquiries had a positive sentiment. In comparison, only 10.1 percent had a negative sentiment, and the rest were neutral. Topics such as pitching, reputable information sources, disruptive innovation, concept creation, and marketing advice were remarkably positive. Study 3 includes information on the popularity of the identified topics and how they have changed over time.

Role in the dissertation

The findings of Study 3 present a comprehensive overview of the fascinating issues facing startup founders and those interested in entrepreneurship. The issues include the keys to a successful business and the best locations for startups, internationalization, lean startups, and break-event points. The results of Study 3 contribute to the dissertation by providing a list of critical issues and the pattern of the issues for discussion on startup entrepreneurship, especially internationalization. In addition, the study provides a database of questions that can elicit emotional interaction within the discussion topic through sentiment analysis.

To sum up, Study 3 (Article IV) contributes to the dissertation's RQ, research artifacts, and DSR process in the following ways:

- Study 3 addresses RQ1's research question by identifying the pattern of startup entrepreneurs' concerns in an international context without focusing exclusively on specific regions or age groups.
- Study 3 provides research artifacts in the form of thirty themes of concern. The identified themes reveal dynamic patterns of important concerns that may arise from startup entrepreneurs in the digital age through an SQA platform. This could be important for researchers, educators, and system developers when developing a system for intergenerational knowledge sharing for global startup development.
- Study 3 was conducted in the DSR processes of problem identification. Study 3 clarifies several previously identified issues in the literature. It establishes a pattern of required issues for eliciting benefits and drawbacks in the knowledge-sharing process.

3.4 Articles V and VI: An Intergenerational Competency Framework: Competencies for Knowledge Sustainability and Start-up Development in the Digital Age [2]

V Nurhas, I., Geisler, S, & Pawlowski, J. (2021). Developing a Competency Framework for Intergenerational Startup Innovation in a Digital Collaboration Setting. In *International Conference on Knowledge Management and Information Systems*. (pp 110-118). SCITEPRESS.

VI Nurhas, I., Geisler, S, & Pawlowski, J. (2022). An Intergenerational Competency Framework: Competencies for Knowledge Sustainability and Start-up Development in the Digital Age.

The results of Study 4 have been published in these articles. Article VI is an expanded version of Article V.

Aims and methods

Study 4 (Articles V and VI) aims to explore the competencies that startup entrepreneurs, both individuals, and startup institutions, necessitate during the internationalization process through intergenerational collaboration. Intergenerational collaboration has become a strategy that supports family businesses long term and during their internationalization process. Therefore, it is crucial to understand the competencies required for intergenerational collaboration in global innovation processes. While numerous studies have been conducted on entrepreneurial competencies, there are few studies on intergenerational competencies, especially outside the context of family firms. Yet, the existing studies fail to provide an overview of the dynamic changes in competencies during the global innovation process.

To answer the research question, Study 4 (Articles V and VI) conducts a systematic literature review (Kitchenham et al., 2009; Webster & Watson, 2002) and Delphi study (Skulmoski et al., 2007) with experts from academia, industry, and senior adults. In this way, a range of relevant disciplines and different ages was represented to identify and prioritize relevant competencies for use in the global innovation process.. In addition, an online readiness self-assessment was developed, and applicability was validated using two use cases.

Findings

Study 4 established and classified 27 competencies into eight categories: growth virtues, technical expertise, values-based organization, cultural awareness, effective creativity, responsive teamwork, sustainable networking, and advocacy for intergenerational safety. Based on a Delphi analysis, this study highlights the importance of top intergenerational competencies for startup internationalization in the digital age, such as clarity of vision, intergenerational adaptability, commitment, and dedication to intergenerational collaboration.

[2] The journal version is an extended version of the proceedings paper.

Additionally, Study 4 demonstrates how competency dynamics alter across the global innovation process, implying that startup entrepreneurship may prioritize skills within a particular global innovation process. While not all of these competencies must be acquired concurrently, some must be prioritized and shared between generations, which is highly dependent on the global innovation activities that startup entrepreneurs are currently engaging in.

Role in the dissertation

Study 4 (Articles V and VI) contributes significantly to the dissertation in two ways. To begin, the study gives a list of competencies and sets of capabilities that can be used as a starting point for self-reflection on one's current preparation for intergenerational collaboration in the global innovation process. The proposed list of competencies can also serve as a springboard for conversation and knowledge sharing in intergenerational collaboration. It is a starting point for recalling specific experiences and expertise in global startup innovation. Second, the paper presents an early prototype of a self-assessment instrument that has been validated via the DSR process. Study 4 developed and implemented two important artifacts for the DSR process: a competency framework and a prototype rubric verified through expert panels and case studies.

In short, Study 4 adds to the dissertation's RQ, research artifacts, and DSR processes in the following ways:

- Study 4 addresses the research question (RQ2) by validating key competencies and competency groups and determining their relative importance to the specific process of global startup innovation in an intergenerational setting.
- The research artifact of Study 4 is a metric to assess the readiness of startup entrepreneurs. The study develops a competency-based conceptual framework and an online rubric for assessing startup entrepreneur readiness.
- Study 4 focuses on the prototype development and assessment activities associated with the DSR process. The competency framework and prototype self-assessment tool were evaluated with the participation of experts and two use cases.

3.5 Article VII: Why Should the Q-method be Integrated Into the Design Science Research? A Systematic Mapping Study

Nurhas, I., Geisler, S., & Pawlowski, J. M. (2019). Why Should the Q-Method be Integrated into the Design Science Research? A Systematic Mapping Study. In *Scandinavian Conference on Information Systems*. Association for Information Systems.

Aims and methods

Study 5 (Article VII) explored the use of the Q-method as a promising strategy for understanding patterns of subjectivity and addressing socio-technical challenges in systems design. Study 5 aims to bridge the gap between tools for well-being-oriented system design and complementary techniques to support primary processes in the DSR process.

To achieve the research objective, Study 5 (Article VII) used a systematic mapping research method (Petersen et al., 2008) to capture DSR-related processes of Q-method implementation, opportunities for Q-Method contributions to IS research, and potential benefits of Q-Method implementation the Q-Method to the IS community. The systematic mapping was conducted across 45 pieces of literature that use the Q-Method as a primary or supporting method to solve their research problem. Journals were selected by searching for keywords and applying various criteria for inclusion to journals classified as a "Basket of Eight" or journals listed in the Association for Information Systems (AIS) database.

Findings

Study 5 exhibits two significant findings: first, it demonstrates how the Q-Method is typically used in conjunction with other methodologies in information systems research, such as case studies, grounded theory, or literature reviews. While the Q-Method is exceptionally adaptable in data collection methods, it makes limited use of big data, social media, or non-literature-based data when creating statements or concourse. If integrated into the DSR process, this represents a future application opportunity, more precisely, the analysis and design of information systems.

Secondly, Study 5 establishes a framework for incorporating the Q-Method into DSR. The Q-Method can develop well-being-driven personas that focus on subjectivity patterns, thus developing more personalized system requirements. Existing assertions can be validated and ranked according to their priority within the identified group. Not only can they identify consensus within a particular group, but they can also show the prioritization of the group on the presented statements. The Q-Method shows the potential to aid in the critical DSR activities of a (class of) problem or solution identification and the DSR evaluation process. Therefore, it may serve as the primary instrument for assisting the whole process of DSR. The study participants for the Q-Method will sort a set of statements that consist of barriers or problem domains, well-being factors, and sociotechnical designs.

Role in the dissertation

Study 5 (Article VII) contributes to the dissertation by proposing a well-established method for DSR that can then be adapted and used to determine design requirements based on a more subjective sense of well-being. The DSR process outlines several steps that researchers/authors should follow when solving problems through sociotechnical interventions. However, there is a dearth of research on applying the well-being approach to design selection in the DSR process based on subjective preferences.

Study 5 (Article VII) exemplifies how this can be accomplished within the framework of the Q-Method for DSR. Based on this study, the Q-Method can be used to identify primary and secondary personas for intergenerational innovation, prioritize design preferences based on different personas, and evaluate proposed interventions in more depth. The process is to present senior and younger adults with a set of statements about intergenerational barriers to innovation and a set of socio-technical interventions to support knowledge sharing for global startup innovation.

In summary, Study 5 (Article VII) contributes to the dissertation's RQ, research artifacts, and DSR process in the following ways:

- Study 5 addresses RQ3's research question by introducing the Q-Method as a potential tool for designing subjective-driven systems in general and, more specifically, well-being-focused systems.
- Study 5 presents a method as a research artifact that explains how to incorporate the Q-Method for subjectivity into the DSR process and outlines a set of activities for integrating a well-being-based system design.
- Study 5 supported the DSR process's solution definition and design and development phase. The proposed tool could be used to develop a well-being-centered technology design for intergenerational innovation.

3.6 Article VIII: Chatbots for Intergenerational Collaborative Innovation

Nurhas, I., Jahanbin, P., Pawlowski, J. M., Wingreen S., & Geisler, S. (2022). Chatbots for Intergenerational Collaborative Innovation.

Aims and methods

A chatbot is a computer-based conversational system or social robot that uses speech or text to persuade users to adopt new services and technologies. Chatbots can act as virtual tutors, coworkers, and creative collaborators in an intergenerational setting. As a result, this study examines various types of collaborators in Study 6 (Article VIII) and the potential for chatbots to foster intergenerational innovation. Despite the benefits of chatbots for intergenerational collaboration as teammates with human-like competencies and an emphasis on human-like response, age is subjectively perceived in an intergenerational work environment, affecting attribute control and motivation.

However, little research has been conducted on different generations' subjective perspectives on the sociotechnical requirements for chatbots. Study 6 employed the Q-Method (Watts & Stenner, 2005) to close this gap to characterize chatbots' subjective preferences for intergenerational innovation across two age groups. The participants in the study completed a Q-sorting activity that included a scenario involving the use of a chatbot to assist with innovation activities and a collection of statements combining technical and social aspects of

chatbots. Study 6 (Article VIII) aimed to understand better the various priorities, consensus, and preferences for chatbot requirements, thereby filling a knowledge gap regarding technological design interventions that can foster intergenerational innovation through the definition of various types of collaborators or personas.

Findings

Study 6 (Article VIII) reveals four types of collaborators four distinct patterns regarding preferences for using chatbots to support intergenerational innovation, which is influenced by barriers, wellbeing determinants, and the socio-technical design requirements of chatbots: 1) Enthusiastic Senior-Collaborators who share their perspectives on the value of intergenerational collaboration and the use of chatbots to facilitate digital collaboration. This group would appreciate it if chatbots could provide adequate emotional indicators and ask polite questions. 2) Considerate, empathic collaborators that consist of both generations. This group expected the chatbot to facilitate cross-generational collaboration around shared goals. Additionally, chatbots can help eliminate disparaging remarks directed at a particular generation while simultaneously assisting all generations in developing collaborative behaviors. 3) Goal-oriented younger collaborators place a premium on the chatbot's expressiveness than other utterances. 4) Technologically savvy younger collaborators interested in the technical aspects of chatbots and believe that chatbots should promote collaboration by emphasizing immediate responses, providing user awareness, and displaying empathy. Based on the finding and the percentage, the study shows the potential of chatbots to serve intergenerational innovation (type 2 of collaborators)

Role in the dissertation

By applying the Q-Method and following the logic of abductive reasoning as a critical approach to knowledge discovery, Study 6 is the first step toward a more solid understanding of chatbot design based on systematic observation of subjective preferences in the intergenerational context. In this sense, the study significantly contributed to society's knowledge by expanding our understanding with a set of chatbots of specialized design concepts for intergenerational collaboration considering technological and social dimensions. Moreover, the typology of each collaborator consists of different barriers, goals, and priorities, which can be used in a problem-oriented design and lean software development strategy. The Study 6's findings demonstrate that chatbots can support intergenerational innovation by focusing on chatbot interactions that facilitate shared goals between generations.

In a similar vein, Study 6 (Article VIII) contributes to the dissertation's RQ, research artifacts, and DSR processes in the following ways:

- The research question (RQ3) is addressed in Study 6 by proposing a set of design principles for chatbots as one potential intervention to facilitate intergenerational innovation.
- Study 6 provides research artifacts on the technology's design requirements, identifies various types of collaborators when using

chatbots, and demonstrates how to use the Q-Method to support the development of well-being-focused systems.
- Study 6 identifies and demonstrates the application of the Q-Method to the development of intergenerational innovation technology. Study 6 confirmed the existence of multigenerational groups using chatbots to facilitate intergenerational collaboration.

3.7 Article IX: System Design Principles for Intergenerational Knowledge Sharing

Nurhas, I., Matic, X., Geisler, S., Pawlowski, J., (2022). System Design Principles for Intergenerational Knowledge Sharing.

Aims and methods

With the rapid development of digital technology and an aging population, intergenerational collaboration in the digital workplace has become increasingly common. Although technology offers many benefits and features that may facilitate intergenerational collaboration in the digital world, it can also harm people from the outset. The problem is not the technology but how it is intentionally designed. A technological design that focuses solely on features or technological advances that perform or support human tasks is profoundly problematic in the long term, so several methods of technological design are being developed that focus on people and the environment. One of these is a positive approach that focuses on happiness and human potential. Although an emerging and timely approach considers the importance of well-being to global society, there are no concrete blueprints or design guidelines for using positive lenses to stimulate intergenerational innovation. The entire research process is presented in a DSR study. Study 7 (Article IX) uses a literature-based method as a foundation for developing design principles to address these challenges. Proposals based on the principles are presented in a prototype demonstrated, evaluated by a panel of experts, and by two different generations of adults, older and younger.

Findings

Meta-artifacts combining requirements and design interventions were identified in Study 7. These meta-artifacts include barrier dimension aspects and well-being factors critical to intergenerational collaboration, such as connectedness, playfulness, and engagement. Accordingly, design guidelines for meaningful collaboration are proposed, including focus, immersion, social interaction, knowledge sharing and enhancement, consensus, and prioritization of issues. Guidelines on technical aspects such as a hybrid physical and digital environment, user interface customization, goal narrative, language selection, leaderboards, synchronous and asynchronous collaboration, and digital rewards support aspects of well-being and meaningful collaboration. These initial

requirements and design interventions will be prototyped and tested for applicability and relevance by implementing various design proposals derived from the literature.

Based on the iterative evaluation of the initial requirements and design interventions, five design principles for intergenerational innovation are proposed:

- Positive personalization,
- Progressive design ecosystem,
- Effectual system design,
- Iterative goal reflection,
- Coopetitive intergenerational tasks.

In general, the results of the mixed-methods evaluation in Study 7 (Article IX) show that the design prototype is a promising approach to facilitate intergenerational knowledge sharing in the context of the startup internationalization process. Some design principles should be prioritized; the results of the usability evaluation using the usability score system indicate that the value achieved is not yet optimal; there is a need to improve the design of the user interface, the narrative content of the questions, and also the selection of a more user-friendly hybrid technology.

Role in the dissertation

In Study 7 (Article IX), a new strategy for addressing the issue of well-being in technology design for intergenerational innovation has been developed. As a first use case of the experimental web technology features (by using WebNFC) as part of the proposed design principles, a hybrid technology environment combined with real-time consensus and adversarial discussions is proposed.

To summarize, Study 7 contributes to the dissertation in terms of RQ, research artifacts generated, and the DSR process:

- Study 7 answers the dissertation research question (RQ3) regarding the contextual applicability and relevance of design principles to the content of global startup innovation.
- Study 7 provides research artifacts in the form of design guidelines and principles.
- Study 7 helped to demonstrate and evaluate the proposed design principles through the DSR process. Moreover, design principles were refined based on the iterative design and evaluation process.

4 DISCUSSION

This chapter highlights the contributions of the dissertation's research. First, it describes how the research questions in the previous section are addressed, contextualized, and further developed. Second, the theoretical implications of the study artifacts yielded throughout this study's DSR process are discussed. This is followed by an analysis of the study's practical implications. Finally, the study's limitations are discussed to improve it and identify areas for future research. The following subsection depicts the role of studies in answering specific research questions (RQs), how they connect to the DSR process, and the artifacts (Offermann et al., 2010) created as study contributions.

4.1 Addressing the research questions

The preceding chapter briefly explained how each study relates to the research questions posed in this dissertation. This chapter explains in more detail and from a holistic perspective the answer to each research question. How do individual study articles relate to each other to answer RQs? How do the answers to RQs indicate the achievement of the research objectives presented in this dissertation?

4.1.1 Answers to RQ1

RQ1 What issues should be prioritized in collaborative knowledge sharing for the different generations participating in the various stages of the global innovation process?

Studies 1 (Articles I and II), 2 (Article III), and 3 (Article IV) addressed the RQ1. To begin, Study 1 was conducted using the literature review method, as a collaboration between generations is not new and has been discussed in numerous studies (Gutierrez et al., 2019; Perez-Encinas, Pablo, et al., 2021; Santini et al., 2020; Schuck & Steiber, 2018; H. X. Shi et al., 2019), though it still needs to

be combined with other related topics to the process of startup innovation and development in digital collaboration (Reis et al., 2021). Thus, the first step in Study 1 is to draw on prior research, compile various related articles, and review various research fields about the barriers encountered during cross-generational collaboration on creativity and innovation. The **conceptualization of barriers** is developed in this first article through 38 lists of barriers classified into five major categories. **Perceptual barriers, emotional barriers, technical** and **operational barriers, cultural barriers, and institutional barriers** are the five categories. These five categories expand on the dimensions of creative collaboration barriers (Adams, 2019) that can be partially found in the intergenerational workspace (Rupčić, 2018; Tang & Martins, 2021), adding groupings for aspects of an innovation collaboration with technological intermediaries.

Study 1 (Articles I and II) provides an exhaustive list of existing barriers and examples of how previous research has used concepts related to wellbeing determinants to address these issues. However, Study 1 merely summarized the barriers and the correlated well-being determinants; the study does not attempt to validate or contextualize the global innovation process. Study 2 (Article III) validated the **list of barriers** against **two distinct age groups** in a startup collaboration narrative scenario.

Study 2 integrated list **barriers into global innovation processes**, specifically ideation, matching, design and development, and commercialization. In Study 2, RQ1 is addressed more specifically concerning the innovation process, what barriers are essential for different generations in each process, and which barriers are generally preferred differently by each generation. For **senior adults**, the barriers include a lack of collaborative time, technological complexity, a lack of shared resources, and a supportive social environment. **Concerning the younger generation,** such as a greater capacity for comprehension than previous generations, a lack of motivation and access to technology, and a lack of a supportive social environment,

The barriers group, which focuses on the ideation process, is concerned with perceptual barriers. Specific barriers that become major impediments **include divergent mindsets, divergent interests, divergent educational levels,** and a **lack of awareness of generational differences.** Perceptual and technical barriers become more prevalent during the matching process than other barriers. The **technical barriers group** is dominant during the design and development process. The costs of technology investment, the complexity of the technology used, a lack of technical training, and diverse technological backgrounds all act as barriers to this activity. Meanwhile, **emotional barriers are less visible** in commercialization activities than other barriers.

Study 3 (Article IV) identified **competing concerns** to focusing exclusively on startup entrepreneurship. Study 3 conducted the research using data gathered from social media. The findings of Study 3 indicate topics related to startup entrepreneurship that are both challenging and interesting to discuss when developing a business. Some perceived **negative concerns** include founder figures, secrets to success, and a startup's location. Furthermore, other concerns were scored **positively**, mainly when it came to pitching, identifying reliable

sources, disruptive innovation, idea-generating, and commercialization assistance. Studies 1, 2, and 3 together provide an **overview of the relevant yet provoking issue to intergenerational** and **startups innovation**. Being the first step in system development, it is concerned with the topic of problems affecting the system's design. This subject generates discussion and knowledge exchange between generations. Study 1 (Articles I and II) was conducted using the literature review method because intergenerational collaboration is not a new concept, and numerous studies have addressed this subject.

However, it still needs to be combined with other related topics to fit with aspects of startups' global innovation, digital collaboration, and development process. Thus, the objective of Study 1 was to draw on prior research, compile various related articles, and provide a review of various areas of research that address the barriers to intergenerational innovation.

Overall, Studies 1 (Articles I and II), 2 (Article III), and 3 (Article IV) together provide an overview of the critical issues to intergenerational innovation for global startup development. Compared to other studies to understand barriers and challenges to intergenerational collaboration that focus on social interaction for knowledge exchange (Rupčić, 2018; Tang & Martins, 2021), the results of studies 1, 2, and 3 provide a deep understanding of **barriers dimension** on a general level, adding barrier dimensions of technical and institutional to previous studies, providing but greater detail of each barrier dimension (Adams, 2019; Rupčić, 2018; Tang & Martins, 2021), and at the same time distinguishing the barriers for both generations and **contextualize** the **intergenerational barriers** in term **global innovation process**. Listing the barriers and competing concerns is the first step in system development for positive system design, identifying the issues that impact the system's design and serving as a discussion point for intergenerational knowledge sharing.

4.1.2 Answers to RQ2

RQ2 How do the necessary competencies for startups in an intergenerational environment change dynamically relative to their importance in the global innovation process?

To answer RQ2, which is addressed in Study 4 (Articles V and VI), a Delphi study was conducted and combined with a systematic literature review. The barriers identified for RQ1 serve as an impetus for Study 4 to find solutions, especially those related to lack of knowledge, different educational levels, and awareness of generational differences (Reis et al., 2021; Rupčić, 2018; Schuck & Steiber, 2018; Tang & Martins, 2021). Cooperation between generations of young entrepreneurs in the internationalization process requires a wide range of competencies, and experts' preferences can reveal this. For this reason, the Delphi method was used in conjunction with a systematic literature review. A set of competencies appropriate for the study environment was identified based on the findings in Study 4.

Twenty-seven competencies were identified and divided into **eight groups**. In Article VI of Study 4, the twenty-seven competencies include visioning, intergenerational flexibility, grit or passion for achieving a long-term purpose(s), intergenerational orientation, financial negotiation, self-determination, conscientiousness, foresight skill, personal resource allocation, effective communication, business storytelling, transparency, intergenerational reflection, resilience, quality orientation, decisiveness, influence, digital information literacy, intergenerational leadership, conflict resolution, and global design.

The list of competencies encompasses and extends previous research on institutional entrepreneurship and innovation management that emphasized or downplayed (social) competence and knowledge at the expense of values and attitudes. Study 4 (Articles V and VI) shows **conceptualization of the competencies** at a higher level of abstraction to cover a broader range of competencies, such as business storytelling, mentioned in expert panels. The eight competency categories examined in this study are intergenerational safety, cultural awareness, growth virtues, effectual creativity, technical expertise, responsible teamwork, values-based organization, and sustainable network development.

Furthermore, Study 4 (Articles V and VI) emphasizes that to succeed as a startup entrepreneur in the global innovation ecosystem, growth virtues are required as the foundation for all primary activities of the global innovation process. While previous research has not emphasized that the importance of various stages of internationalization and business growth necessitate the acquisition of specific competencies at specific points in time (Santini et al., 2020), existing research demonstrates the critical impact of a specific process for the required competencies in intergenerational settings (Perez-Encinas, Pablo, et al., 2021) without taking digital collaboration into the development.

The findings of Study 4 emphasize the **dynamic importance of competency groups** concerning the four global innovation processes. As shown in the findings of Study 4, different sets of competencies are required at various stages of the innovation process, implying that not all skills must be present simultaneously. Allow startups to concentrate on specific competencies based on the current innovation process of the company. Startup entrepreneurs can concentrate on specific categories and determine which competency within the competency group needs improvement to meet its minimum requirement for their specific innovation activities. The complex shifts in skills and competencies required for global innovation can be minimized.

Furthermore, the findings of Study 4 show that responsive teamwork and a long-term employee network are more important in the ideation process but less critical in the coordination process. The design phase of creativity necessitates establishing a safe environment conducive to intergenerational collaboration.

4.1.3 Answers to RQ3

RQ3 How should an intergenerational collaboration system be positively designed to support knowledge exchange in the internationalization of startups?

RQ3 was addressed and demonstrated in Studies 5, 6, and 7. Study 7 (Article IX) summarizes the initial guidance provided in Study 1, integrates barriers and competencies to develop design principles and stimulate intergenerational dialogue through gamified knowledge sharing and employs the Q-Method. Based on the review in Study 1, Study 7 (Article IX) elaborates in more detail on which determinants to include in technology design is the first step to putting the positive computing paradigm into action (Avital et al., 2006) for intergenerational innovation. Based on the results of Study 7 (Article IX), the following are some of the well-being determinants that can guide the system development in intergenerational innovation:

- Knowledge sharing between generations should be fun and playful. Hybrid technologies that connect the physical and digital worlds, persuasive technologies, and location-based games are examples of interventions that contribute to enjoyment.
- Positive emotions include exploration and interest in a problem-based learning scenario. These emotions or expressions result from emotional curiosity in intergenerational collaborative learning. Skill development programs such as hackathons and blended learning have been introduced to foster the interests of IGC employees. Assistive systems or robots can also be used for technological guidance, hub agent integration, and gamification. On the other hand, metadata visualization has shown that it can gamify tasks supported by digital technology in intergenerational settings.
- Satisfaction with group achievement. These emotions are associated with achieving specific goals, such as checking off tasks on a to-do list. The use of persuasion technology and the digitization of social presence are discussed in the literature.
- Satisfaction and self-perception based on competence. The use of interactive storytelling, IGC evaluation and assessment programs, and intergenerational competency sharing and development is supported in the literature.
- Social bonds (empathy, compassion, altruism) or relatedness for intergenerational training. This determinant is about helping others, and helping others is facilitated by its social and self-actualization aspects. Intergenerational determinants that strengthen interpersonal and professional bonds between young and older adults include a skill development workshop, place-based play, hybrid/mixed learning, and interaction.

The Q-method is presented in Study 5 (Article VII) as a tool for subjectively driven system design that can integrate well-being factors into the design process, particularly to elicit system requirements based on personas. Study 5 shows how **personas-based design requirements** statistically can be created for use in product or service development processes such as design thinking or human-centered design (Cooper et al., 2014). Study 5 shows the Q-Method as a possible complementary tool to the critical process in DSR. The Q-method applies to all processes within DSR. However, the integration of the Q-Method depends on the importance of human involvement in the design of IS artifacts. The Q-Method can help identify multiple hypotheses for a given study and focus on one before testing a hypothesis.

Moreover, the Q-Method can support all processes in the DSR methodology, from selecting focal problems and categorizing user types based on propositions to selecting the applicable artifact by user type and assessing user preferences that influence usability and system acceptance. Furthermore, the **Q-Method can be used to obtain stakeholder views** on the utility of the artifact generated by the DSR study. For example, the benefits of technological interventions on user well-being can currently drive the information systems development process. However, the Q-Method can be used to solve problems and reflect on design proposals based on stakeholder opinions.

As shown in Study 5 (Article VII), the design of the Q-Method is informed by two complementary primary sources, namely literature-based statements and non-literary statements. In the problem identification process, a statement can be a problem statement; in the solution definition process, design principles or suggestions; and in the evaluation process, benefits in psychological, economic, or organizational advantages. Digital data collection in the form of Big Data sets, newspapers, or expert opinion can also supplement literature-based statements for discourse. Developing technologies and Big Data analytics can collect social media statements for Q-sorting. Using the Q-Method, DSR researchers can categorize the list of participants and identify various pros and cons for stakeholders. Moreover, both DSR and Q-Methods can be integrated by focusing on activity levels. Episodic DSR includes the activities of search, ex-ante assessment, construction, and ex-post assessment.

In addition, the Q-Method can bridge the gap between quantitative and qualitative methodological debates. Moreover, the Q-Method performs better than rating, ranking, and various maximum scaling methods in measuring technology preference (Matzner et al., 2015). While Study 5 (Article VII) presents the process for integrating the **Q-Method into DSR**, Study 6 (Article VIII) presents an example of using the Q-Method to identify chatbot requirements for intergenerational innovation. Study 7 (Article IX) summarizes the design principles, **integrates barriers** and **competencies to develop design principles,** stimulates intergenerational dialogue through gamified knowledge sharing, and employs the Q-Method.

Study 7 research developing and testing a prototype based on the proposed design principles. Some of the proposed design features and requirements that

were incorporated into a prototype of a real-time knowledge exchange platform are relatedness, playfulness, engagement, concentration, immersion, social interaction, knowledge sharing & improvement, consensus, and issue prioritization for discussion, hybrid-physical and digital environment, interface customization, goal narrative, language selection, leaderboards, synchronous and asynchronous collaboration, and digital rewarding. The following subsection will discuss the theoretical contributions of the study to the DSR process.

4.2 Theoretical contributions

This research focuses on the barriers, competencies, and well-being determinants as the foundation for creating a support system in intergenerational knowledge exchange for global startups innovation. With the DSR process as a methodological strategy, it is critical to discuss the theoretical contributions of research done through the lens of a DSR-based perspective (Baskerville et al., 2018; Iivari, 2020). Therefore, this dissertation discusses some literature that considers the theoretical merit of DSR study results (Baskerville et al., 2018; Gregor, 2006; Gregor & Hevner, 2013; Venable, 2006). Some literature is (Gregor & Hevner, 2013; Iivari, 2003) in combination with Gregor (2006) and Iivari (2020) to understand the classification of theoretical contribution of DSR study. Positioning statements of DSR study contribution based on particular research objective (Baskerville et al., 2018), presenting the meta-artifact that consist of meta-requirements and meta-design (Iivari, 2003, 2020; Venable, 2006), and the importance of activity within DSR in Design Research Activity Framework (DRA) by Maedche et al. (2021) was also considered to understand activities behind the knowledge development.

There are many interpretations of theorizing or argumentative statements in design science (Iivari, 2020). Iivari (2020) divides the competing concerns of IS scholars regarding design theory or theorizing in DSR into four different categories. However, all discuss the three primary elements of meta-artifacts (Iivari, 2003, 2020), namely the kernel theory element or theories used as a foundation, **meta-requirements**, which are a class of goals of design research activities, and **meta-design** as design solutions in the form of information technology (IT) artifacts to achieve the meta-requirements (Iivari, 2020). The proposed categories of design theory differ in terms of the nature of the kernel theories, as well as the effectiveness and relationship of the three meta-artifact elements (Iivari, 2020).

Although there are various interpretations of design theory, the outcome of design activities is generally divided into a **"design product"** in the form of an IT artifact and a **"design process"** in the form of the method by which the "design product" is produced (Walls et al., 1992). Both outcomes must be communicated via an argumentative statement or design theory. Baskerville et al. (2018) provide **guidelines** for communicating DSR outcomes that can be applied regardless of

the communication objective, whether it is artifact design, the development of technology and science, the implications of DSR, or the process of conducting DSR. However, when communicating the design theory of DSR, it should be noted that its contribution can be recognized as sufficient if the novelty and usefulness of the **design theory can be demonstrated** (Baskerville et al., 2018).

DSR studies produce four types of knowledge contributions according to (Gregor & Hevner, 2013): **Design routines** or artifacts of DSR studies that are known solutions to known problems. **Invention** or creation of new solutions to new problems, where the solutions' scope and maturity are limited. **Improvement** or solutions to known problems with high coverage but low solution maturity. **Exaptation** of the process of implementing a known solution for a new problem when the scope is young, and the solution is mature. These four classifications help DSR researchers categorize research contributions, whether the knowledge contributions are categorized as routine design, extension, discovery, or innovative knowledge contribution. Moreover, according to Gregor (2006), the nature of theory in information systems research is divided into **theory for analyzing, explaining, predicting,** and **theory for design** and **action**. These five categories can classify the theoretical contribution presented in this section.

In addition to using the DSR knowledge contribution developed by Gregor & Hevner (2013), the contribution of design science can also be represented using the framework developed by Maedche et al. (2021). Maedche's framework is distinct from the preceding one. It emphasizes the researcher's work activity (observation vs. creation) and the scientific contributions made to an artifact (prescriptive vs. descriptive). According to Maedche et al. (2021), design research contributes to knowledge in the following ways:

- Constructs or researchers employ their creativity to create an artifact and get prescriptive knowledge from direct experience.
- Deployment: the researcher acquires prescriptive knowledge by seeing and analyzing existing artifacts in environments other than those in which they were developed.
- Manipulation: The researcher exhibits some inventiveness in developing investigations that incorporate artifacts of descriptive knowledge.
- Explanation: Through observation and analysis of existing artifacts and their use, the researcher gets descriptive knowledge about design elements that can be modified.

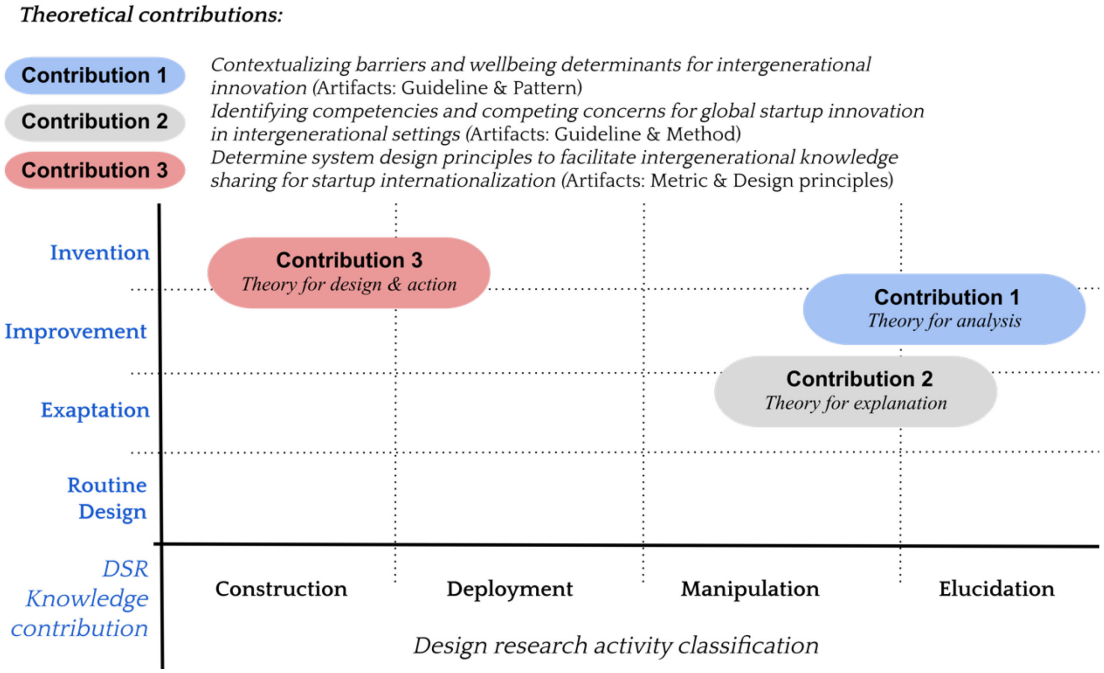

FIGURE 8 Mapping the knowledge contributions

As shown in Figure 8, the study of this dissertation's knowledge contributions may be split into three broad areas. Figure 8 gives an overview of the theoretical contributions underlying the DSR-based frameworks, followed by detailed explanations of each contribution based on the research objectives and included articles.

4.2.1 Contextualizing barriers and wellbeing determinants for intergenerational innovation

This research's first knowledge contribution is

Contribution 1. To contextualize critical issues concerning barriers, competing interests, and well-being factors required for intergenerational innovation.

Contextualization is critical in information systems research because the development of systems to solve specific problems takes place within an organization, not just in a laboratory (Avgerou, 2001). In an organizational setting, factors relating to the interaction of technology and people influence system design, particularly when it comes to behavioral characteristics that influence or impede technology adoption and change. In other words, technological change is the "content" of information systems design and the research being conducted. In contrast, the socio-organizational aspect is the "context" in which the "content" changes (Avgerou, 2001). As a result, a more comprehensive understanding of the context aids in determining the technology's content (Venable, 2006).

While previous research has identified barriers and challenges to intergenerational collaboration (Rupčić, 2018; Santini et al., 2020; Schuck & Steiber, 2018; Tang & Martins, 2021), the studies, however, did not provide a comprehensive overview that includes the aspect of technology, barriers to

wellbeing, and wellbeing determinants which currently prevalent in the digital age (Calvo & Peters, 2014) and entrepreneurship (Wiklund et al., 2019), compared to the use of positive computing as a basis for conducting the study.

Also, despite significant studies conducted on the use of technology to facilitate intergenerational collaboration, many of these studies have concentrated on collaboration between young children and parents (Reis et al., 2021), rather than younger and senior adults, outside the scope of the family, and have omitted startup innovation activities. Due to this study, the context becomes more specific to intergenerational innovation outside the family circle. It **complements** previously **established general dimensions of barriers** to creative collaboration (Adams, 2019). The DSR process is used in this study to understand better and create a system for intergenerational innovation. Studies 1 and 2 describe the context of the intergenerational innovation system. Both studies provide information on barriers and well-being determinants in the form of guidelines and patterns, barriers and well-being that exist, and what well-being-related technological interventions and behavioral differences between young adults and older adults can be utilized when using technology for intergenerational collaboration in the innovation process.

Contribution 1 gives a **detailed pattern** and a **comprehensive list of barriers**. However, the barriers are not formulated as a prescriptive meta-requirement. As a result, Contribution 1 adheres to Venable (2006) design theory, which focuses on theoretical effects that can be used to support the development of meta-artifacts and identify relevant (features of) technologies (Venable, 2006). Moreover, based on the DRA framework, the overall activities in Studies 1 (Articles I and II) and 2 (Article III) are **centered on observation**, and the type of knowledge contributed is **descriptive knowledge (what-is?)**. According to these two criteria, Contribution 1 of this dissertation is primarily classified as elucidation using the DRA model. The artifacts can be evaluated by including the generated descriptive statements in a case study or survey, as demonstrated in Study 2 (Article III) . The dissertation's studies 1 and 2 established a classification of socio-organizational factors affecting intergenerational collaboration in the age of digitization, backed up by issues that must be discussed during the startup development process. While the "context" of implementing artifacts in intergenerational collaboration is relatively mature, with a large body of research on startup entrepreneurship and intergenerational collaboration, solving the problems through the positive computing approach that begins with identifying dynamic changes of barriers and (active and dedicated-) wellbeing determinants to support this collaboration in the development of global startups is novel.

Thus, the first and second studies present an approach to system design that incorporates the well-being factor by providing a well-being-focused framework as a basis for setting design priorities and selecting technological interventions. Following the Gregor & Hevner (2013) framework, the category of **"improvement"** was chosen for the knowledge contribution based on this explanation. Moreover, the positive contextualization of intergenerational innovation describes different barriers and well-being determinants related to

the global innovation process. Thus based on Gregor (2006), the first theoretical contribution to the information systems field is providing a **theory for analysis** (Gregor, 2006). In other words, the first contribution of this study is to improve the current understanding of designing support systems for intergenerational innovation. Knowledge complements current understanding by contextualizing well-being-focused design guidelines and barriers to intergenerational innovation. Study 1 (Articles I and II) and Study 2 (Article III) also elucidate the improvement of knowledge related to the "context" (Avgerou, 2001) for intergenerational collaboration.

4.2.2 Identifying competencies and competing concerns for global startup innovation in intergenerational settings

The second theoretical contribution of this study is

Contribution 2. To identify, understand the dynamic pattern and validate a set of competencies and competing concerns for the study context.

Previous studies have produced an exhaustive list of entrepreneurial competencies (Bacigalupo et al., 2016; Beattie, 2016). These competencies are critical considering that entrepreneurship is a significant economic and social force. As multiple variables affect a person's predisposition to entrepreneurship, previous studies have focused on elements of entrepreneurial motivation, with culture, environment, competence, and attitude all being important factors in intergenerational entrepreneurial motivation (Criaco et al., 2017; Kaplan et al., 2017; Perez-Encinas, Pablo, et al., 2021; H. X. Shi et al., 2019).

Studies 3 (Article IV) and 4 (Articles V and VI) compare the **motives, preferences,** and **competencies** critical to **intergenerational innovation**, particularly for global entrepreneurs. Study 3 provides an overview of competing concerns for startup entrepreneurship. Study 3 complements previous studies on entrepreneurial concerns that focus on discussing difficulties (Giardino et al., 2015) or success factors (Beattie, 2016; Dou et al., 2021), Enabling a broader overview of timelessly relevant content for discussion. Study 4 begins with a thorough literature review involving observational research activities. However, the conclusions drawn from this observation are only the beginning of the process of gathering data and description on the competencies needed by global startup entrepreneurs working in intergenerational collaborative contexts.

Compared with Jensen (2017), which describes a framework of competencies and critical factors for global innovation, Study 4 complements the framework by providing categories relevant to digital collaboration. Study 4 also complements other entrepreneurship studies (Bacigalupo et al., 2016; Beattie, 2016; Ritter & Gemünden, 2004; Slišāne et al., 2021) competency categories related to wellbeing (intergenerational safety facilitation) and intergenerational settings. Concurrently, the importance of integrating dynamic changes in competencies into intergenerational entrepreneurship training has also been identified (Perez-Encinas, Pablo, et al., 2021), which is consistent with the finding of Study 4 (Articles V and VI) in demonstrating different levels of competencies

required for specific processes in innovation. However, since Positive Computing was applied, considering both social and technological aspects, Study 5 (Article VII) complements the technological aspect.

Following the expert panel assessment, an abduction process is used to understand required competencies and the **category of competencies.** The competency attribution in the innovation process is a process that emphasizes the creative activities of the researchers, with the created competency statement serving as descriptive knowledge and the overall competency outcome serving as prescriptive knowledge about how to be an ideal startup entrepreneur in intergenerational collaboration. Study 4 discusses competencies, and Study 3 (Article IV) regarding competing concerns are classified as "manipulation" articles. In contrast, some sections from Studies 3 and 4 articles that discuss pattern observations and literature reviews are classified as "elucidation" articles.

Therefore, Contribution 2 is much more precisely defined as "manipulation," which refers to creative and ingenuity acts in research (Maedche et al., 2021), and involves adapting artifacts associated with competencies from previous studies to the setting of intergenerational collaboration. Likewise, Contribution 2 includes more advanced competency categories for globally oriented young entrepreneurs who work with senior adults. The design theory is centered on generalizing meta-requirements (Baskerville & Pries-Heje, 2010) of competencies applicable to various stages of the global innovation process. Thus, the framework's generalization can be applied to general and various sociotechnical intervention scenarios (Baskerville & Pries-Heje, 2010), ranging from online self-assessment tools to "content development" for training and matching programs facilitate knowledge sharing between generations.

While Contribution 1 is concerned with "context," Contribution 2 emphasizes the "content" of knowledge to share between generations. Contribution 2 elaborates a **competency-based** study approach commonly used in social and educational research to address the growing challenges of intergenerational collaboration in the digital age, focusing on knowledge sharing during startup internationalization. Additionally, Study 3 also identifies concerns that spark discussion about the relative relevance of these challenges in the global innovation process of startups. In conclusion, Contribution 2 contains key components for self-reflection and issues on the current readiness of global startup entrepreneurs, both as individuals and as organizations, for intergenerational contexts. Contribution 2 can be classified as a **theory for an explanation** based on Gregor (2006) since Contribution 2 **explains what competencies are required, when** and **how many particular competencies are required** in the innovation process. Also, Study 3 explains what, when, how the competing concerns for startup entrepreneurship evolve. Therefore, according to Gregor & Hevner (2013) classification, Contribution 2 can be categorized as "exaptation," or the application of existing solutions to novel situations that combine discussion on the content for understanding competencies and startup entrepreneurship for the global innovation process and intergenerational collaboration outside family settings.

4.2.3 Determine positive system design and design principles for intergenerational innovation

The third contribution of the dissertation is

Contribution 3. To provide a positive system design and a set of design principles to facilitate intergenerational knowledge sharing for startup internationalization.

Contribution 3 draws on the results of Studies 5 (Article VII), 6 (Article VIII), and 7 (Article IX). As presented in Study 5, this research contributes to understanding how the Q-Method can be used as an alternative method in designing a system that focuses on the subjectivity of a group formed based on similar preference patterns. Study 5 includes activities that focus on observing existing literature to provide prescriptive insights on how the Q-Method can be used in design research to support design focuses on subjective well-being. Previous studies have proposed the application of the Q-Method in information systems research (Matzner et al., 2015; Thomas & Watson, 2002) or in the design of systems focusing on human-computer interaction (O'Leary et al., 2013) by providing examples of the application of the Q-Method in the study area.

Study 5 enriches both studies by offering knowledge of how the approach has been utilized by information systems researchers, a set of the rationale for using the Q-Method, and an initial understanding of the method's use as part of a supporting tool for process-oriented DSR. The usefulness of the Q-Method for identifying preference categories may be one of the missing tools for information systems and human-computer interaction designers who want to provide design for personalization and inclusivity (Olbrich et al., 2015). The results of Study 5 follow up on a previous study that demonstrated the use of card-based design tools for studies in intergenerational research (Fraga Viera et al., 2020). This dissertation proposes using the Q-Method in the Design Science process, which combines card-based Q sorting (on the problem with well-being-determinants and solution spaces to address the problem and support the well-being determinants) with Q factor analysis minimize researcher bias in persona formation.

In addition, with the goal of Industry 5.0, which is **moving from mass production** (e.g., designing the system based on the highest number of preferences or the mean value of particular features that has been used for a long time in determining design decisions), **to more inclusiveness** and **mass customization**, which focuses on personalization and individualization in technology design (Nahavandi, 2019).

Next, Study 6 (Article VIII) presents an example of **implementing the proposed method** from the fourth study to identify chatbot technology requirements for intergenerational innovation. The use of the Q-Method and positive approach that combine barriers and well-being determinants focuses on the research activities in Study 6 (Article VIII). This includes identifying propositions relevant to chatbot design, applying the Q-Method to create chatbot personas for intergenerational collaboration, and creating narratives about

chatbot use based on the study context. The resulting artifact is **prescriptive knowledge** about how to **design chatbots** based on the preferences of different personas. The results of Study 6 provide the identification of design principles for intergenerational innovation that focus on the well-being approach, following level-1 of the implementation of the positive computing approach, i.e., not only removing barriers but also using well-being factors to support the main activities of human interaction with the system. While the previous study used the Q-Method to develop a set of chatbot design affordances in the workplace (Stoeckli et al., 2020), Study 6 developed intergenerational personas that combine social and technical aspects of chatbots.

Study 7 (Article IX) proposes the principles of system design for intergenerational innovation. The seventh study is a collection of meta-requirements resulting from the study of barriers, well-being factors, and competencies. Study 7, presented as a DSR study, focuses on design activities in which prototypes are developed, demonstrated, and evaluated by a panel of experts based on the identified requirements. The Q-method (Watts & Stenner, 2005) and the "System Usability Scale" (Brooke, 1996) are also used to evaluate the requirements and meta-design. Reflecting on the results of Studies 5, 6, and 7 in Table 1 shows the proposed research framework for positive design science.

TABLE 1 Positive system design

Process-oriented DSR	Problem(s) identification	Solution definitions	Design & Development; Demonstration; Evaluation; Communication
Adjustment	**Yes**	**yes**	no
Positive system design	Inquirie(s) identification	Personas-based solution definitions	
Proposed adjustments based on study reflections	Determine the inquiries that comprise the problem and the possibility space. In addition to identifying the problem, inquire about the importance of promoting well-being (ask the counterpart of the problem to the people and the organization what activities lead to well-being, happiness, or potential human enhancement in the study context).	By applying the Q-Method to identify personalized and rigorous sociotechnical solutions based on literature and other sources (e.g., expert opinions, big data analysis, or user observations)	

Based on Studies 5, 6, and 7, this dissertation study also proposes a positive approach to DSR (as shown in Table 1). In this dissertation, a novel understanding of the motivation of DSR is created based on the study of the inquiry relevance (problem space and the possibility space to improve people's well-being and happiness). The Q-Method can be used to improve inclusiveness and mass individualization, especially in solution definition, which combines various possible design solutions to both solve problems and promote people's well-being. The inclusion of well-being determinants in the early stages of DSR is also pertinent, as DSR begins with both problem identification and opportunity-based theory building (Baskerville et al., 2018).

The results of Study 7 contribute to the provision of prescriptive knowledge based on the creative activity of the research. The creation activity is done by design requirements based on a positive computing lens. As a result of these requirements, a new approach has emerged that addresses the well-being issue to support system design for intergenerational innovation. The context of collaboration between specific generations for specific content in the global process of innovation creation and implementing a hybrid environment using web NFC leads to applying new solutions to new problems (Gregor & Hevner, 2013).

To sum up, Studies 6 (Article VIII) and 7 (Article IX) for Contribution 3 present **prescriptive meta-artifacts** based on Contributions 1 and 2 and a meta-design of chatbots and a web-based knowledge-sharing platform. Contribution 3 shows how to instantiate the proposed barriers, well-being determinants, and competencies. Even though the validation and evaluation of the proposed instances still need to be improved. However, developing IT artifacts in DSR or provable design theory instancess exceedingly challenging to validate in practice due to technology's rapid evolution, complexity, and frequently short life cycle (Iivari, 2003). As a result of the demonstration in various use cases, Contribution 3, this DSR dissertation study can be recognized as a **sufficient contribution** (Baskerville et al., 2018). In addition, the dissertation's reflection on well-being-driven system design, which suggests **improving the DSR process**, also qualifies as a research contribution (Baskerville et al., 2018).

According to Gregor & Hevner (2013) definition, Contribution 3 gives rise to knowledge designated as a knowledge **invention** (concerning **intergenerational innovation**). This contribution is expected to include design recommendations in the form of system requirements for developing systems for intergenerational innovation. This resulted from critical factors and targeted interventions to rejuvenate philosophical conundrums about intergenerational innovation. As a result, the findings establish a novel foundation for future empirical research, the development of metrics and systems for intergenerational innovation that is currently lacking. The dissertation takes a mixed approach from a pragmatic standpoint, incorporating different techniques, most notably the Q-methodology, into the DSR process to establish solid research groundwork rather than relying on researcher bias when developing personas and system

requirements for human-centric development. The systematic steps involved to arrive at theoretical contributions were examined and evaluated.

Overall, based on Gregor (2006), Contribution 3 of this study can be classified as a theory for design and action. The study results for Contribution 3 provide a prescription about how to design a system for intergenerational innovation and positive system design for personalization and inclusiveness. The following section discusses the practical implications of the dissertation for future work.

4.3 Practical contributions

This dissertation contains a series of research papers that focus on producing scientific contributions and the implementation of these contributions in practice. From the seven studies conducted as part of this dissertation, three practical implications can be summarized in the form of use cases:

4.3.1 *Use case 1:* Q-method-based system development

The first practical application of the dissertation is the use of Q-Method in the DSR, which is based on a positive computing approach. System design emphasizing well-being is a potential technique for information system designers and researchers. However, the proven tools and resources necessary to implement this strategy continue to be scarce. While tools have been developed specifically to aid in adopting this strategy (Klapperich et al., 2018), validation and use in several scenarios are still required to ensure the tools' rigidity. The need for such a tool was identified in this dissertation through the proposed research gaps presented in Study 1, which were also supported by other studies (Klapperich et al., 2018). Then a systematic review of the literature was initiated in Study 5 (Article VII) to conceptualize how the Q-Method can be integrated into design and research activities, serving as the foundation for user experience studies. Finally, in Study 6 (Article VIII), the Q-Method was used to develop the design requirements for a chatbot.

Study 6 (Article VIII) employs the well-being approach to denote the personalization of chatbot design based on personas for intergenerational innovation. This study explains how to utilize Q factor analysis to cluster personas using the Q-Method. Study 6 highlights how the Q-Method's propositions embrace a well-being perspective through barriers, well-being determinants, and socio-technical requirements for chatbots. The clusters form a narrative that displays unique perceptual categories based on linkage concepts with additional information regarding demographic variables. These narrative clusters are analogous to personas (Cooper et al., 2014), narrative representations of potential system users (Cooper et al., 2014). Personas are a frequently used tool in human-centered design (Cooper et al., 2014). By utilizing the Q-Method, personas can be created without a large number of respondents, which is critical

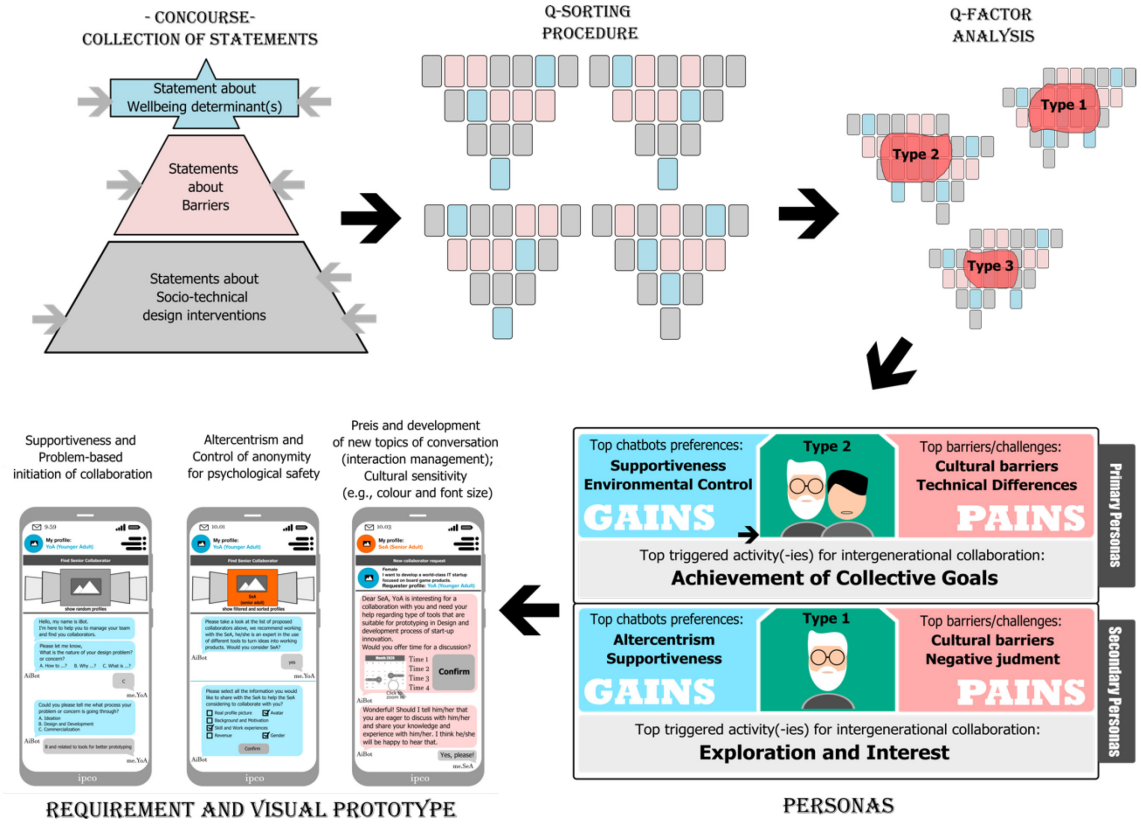

FIGURE 9 Personalized prototyping based on the Q-Method study on a chatbot for intergenerational innovation

for industrial projects (Klapperich et al., 2018), while still maintaining the clustering of the created personas based on statistical processing analysis, which minimizes researcher bias when creating personas.

Use case 1 addresses the **lack of tools** necessary to assist in **developing well-bing-focused systems** (Klapperich et al., 2018). The research artifact was produced by developing a framework and using a mature tool that has been tested and deployed while also emphasizing subjectivity, which is critical for the well-being component. Future research can use the Q-method by including well-being implementation characteristics into the concourse of the Q-Method, such as statements about barriers, well-being determinants, and requirements for specific technologies, all within the Q-sets for sorting procedure. Figure 9 shows the practical use of positive system design to develop chatbots for intergenerational innovation.

4.3.2 *Use case 2:* Rubric for intergenerational innovation

The second practical implication of the dissertation is the inclusion of an intergenerational innovation competency framework in the design of a rubric or an online readiness self-assessment tool. A rubric is a form of assessment used to track an individual's progress in acquiring a competency (Seemiller, 2016). A rubric is an effective tool for developing competencies and can be used for self-assessment and peer assessment (Seemiller, 2016). Study 4 (Articles V and VI) is

FIGURE 10 Visual representation of the prototype self-assessment tool for the competency-based framework for intergenerational innovation.

divided into two articles: Article V addresses the conceptualization of competencies through a systematic literature review; Article VI focuses on validating and fine-tuning the competencies with a panel of experts and identifying the minimum level required for each competency in any global innovation process.

Article VI of Study 4 extends the contribution of the current study on intergenerational innovation competency (Perez-Encinas, Pablo, et al., 2021) by developing a prototype rubric based on the expert panel's preferences for rating the importance of competency using a Likert scale. The rating was converted into a specific value indicating whether the competency was required for a particular process and compared to self-assessment scores of startup entrepreneurs. The original version of the tool was an offline version that was assessed and refined before being made available online. This tool can be used **to identify potential startup partners** and **assess entrepreneurs' readiness** for global and intergenerational innovation. Figure 10 presents the interface of the online rubric,

and the result of the self-assessment of the rubric, The online version of the Study 4 (Articles V and VI) Rubric was created as an open-source tool[3]. In addition to creating rubrics, competency sets for intergenerational innovation can be used to develop **competency-based** entrepreneurship **curricula**.

4.3.3 *Use case 3:* Knowledge exchange platform for intergenerational innovation of global startups

The third practical implication deals with the **proposed design principles** used by system designers and user experience researchers as starting points for developing supporting systems for knowledge exchange in intergenerational settings. As described in Study 6 (Article VIII), most of the study artifacts directly impacted the requirements analysis and prototype implementation phases of the DSR process. The study's domain-specific knowledge gained and demonstrated was shared with the scientific community and with startup entrepreneurs and students. The intergenerational barrier framework (Study I) guided the requirements analysis for the dissertation project. It was extended beyond the scope of this study to the "Nucleus" project of the Institute for Positive Computing at Hochschule Ruhr West University of Applied Sciences. The barrier framework and contextualization method contribute to creating a knowledge-sharing platform in an intergenerational setting with global startup innovation as the platform's content. As DSR points out, effective research should consider what constitutes a good design (A. R. Hevner et al., 2004). This study demonstrated applicable design principles for the study setting in Study 7 (Article IX).

Because the focus of this work is on integrating well-being into system design, which is strongly related to socio-behavioral research of information systems, technical design considerations were generally described in Study 7. The requirements elicitation process used in the Nucleus project at the institute of positive computing was not discussed in detail in Study 7 but has been used in several research projects described in the list of publications not part of this dissertation. In addition, the Q-method study was conducted to validate the identified needs revealed critical requirements for intergenerational innovation environments. This led to an effective design by focusing on specific criteria relevant to a particular type of persona or user group.

However, this dissertation shows that overcoming critical intergenerational barriers to innovation, competencies, and well-being cannot be addressed only at the technical level; institutional and cultural barriers must also be addressed to support a better ecosystem for intergenerational innovation.

[3] https://inurhas.github.io/iGOAL-rubric/dashboard (last accessed: October 2021)

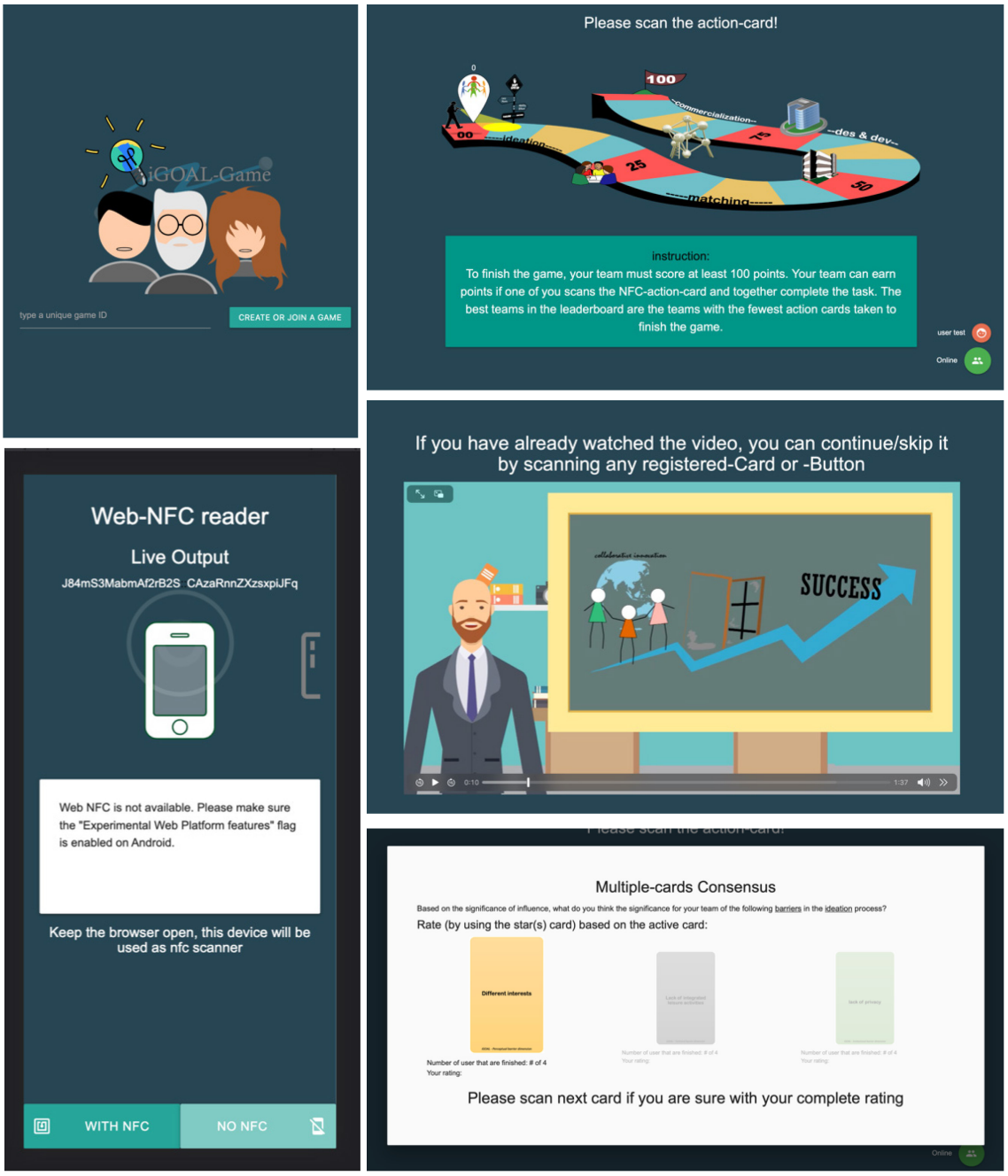

FIGURE 11 Visual representation of knowledge sharing prototype for intergenerational innovation of global startups

The overview of the prototype is shown in Figure 11. Through the DSR process, several concepts impacting the system design were translated into functional prototypes that received a wide range of positive and negative feedback during the evaluation in Study 7 (Article IX). The prototype applies a range of requirements, including synchronous collaboration in the form of video chat, a hybrid environment through the use of web NFC to simulate a card-based board game, game elements to support a gamified environment, topic maps related to barriers, competencies, and competing concerns for specific global

innovation activities that should be discussed to achieve consensus within the group.

Overall, the interest and engagement in using the platform to facilitate discussions on relevant topics for the global innovation process within a group of different generations demonstrate the relevance of the contextualized framework for intergenerational collaboration based on the positive computing approach and prove that the dissertation has produced innovative solutions for **managing knowledge sharing** for intergenerational innovation.

4.4 Limitations and Recommendations

The preceding sections described the dissertation's theoretical and practical contributions and how each article linked to the dissertation's research questions. Research limits and restrictions must be noted due to the study's broad scope, especially in **generalizing** the findings due to wellbeing's complicated nature, which is based on **subjective individual preferences**. Presenting the study's limitations, on the other hand, can help to open up new avenues for future research.

First, this study distinguishes **between content** and **context**, both of which have a degree of influence on the DSR process. The content of this study is focused on global startup innovation, while the context is established through intergenerational collaboration. As a result, the design and evaluation processes were not exhaustive. The content related to global startup innovation competencies is evaluated by experts with experience and knowledge in global startup innovation and entrepreneurship. The knowledge exchange platform assessment, on the other hand, is geared toward intergenerational collaboration and does not require all participants to have prior experience with startups. Compared to prototype assessments that must be conducted synchronously or collaboratively at a specific time, the time and location flexibility offered by the online Q-Method or asynchronous online-based assessment encourages expert participation in studies. As a result, when implementing the requirements in the future, special consideration should be given to how the assessment process is conducted in light of the intended assessment participants. These are experts, senior or younger adults, and startup entrepreneurs with limited time in this case. Likewise, this roadblock was mentioned in Studies 1 and 2.

The second limitation is the **small sample size** and **diversity of respondents** to the prototype evaluation study, both for the prototype rubric in Study 4 (Articles V and VI) and the intergenerational knowledge-sharing platform in Study 7 (Article IX), and the low proportion of female respondents in the competency framework evaluation. This imposes a constraint on the number of participants and their representation of inclusion and diversity in the study. This also provides an opportunity for future studies to emphasize diversity and the number of participants. In this sense, the succeeding study has the potential to investigate the impact of this diversity on variables such as barriers,

competencies, and well-being factors associated with the design of intergenerational systems.

The third point is to **evaluate** the **meta-design** proposed by integrating the Q-Method, which is in the current study restricted to a chatbot use case and imposes constraints on the implementation of various proposed requirements in the prototype. For example, web NFC technology is not yet mature. There are numerous development resources available for implementing a hybrid environment. In addition, there is **room for improvement** in selecting game elements that are more suitable for intergenerational innovation. Further research can be conducted to identify game elements conducive to intergenerational innovation. Another possibility is to use the Q-method to select the most appropriate game elements and a more specific use case for implementing the Q-method to support intergenerational innovation through gamification.

In summary, promising studies on the phenomenon of intergenerational innovation in the digital sphere remain necessary and open. The positive computing paradigm provides a novel approach to design interventions for intergenerational innovation. Further research can shed light on the phenomena by using the artifacts generated in this study as a springboard for scholarly inquiry in collaboration with practitioners involved in the DSR process. New research likely has greater potential to blend the "content" of global startup innovation with the "context" of intergenerational collaboration across the DSR process.

YHTEENVETO (SUMMARY IN FINNISH)

Tämän tutkimuksen tarkoituksena on tunnistaa sosio-teknisiä tekijöitä, jotka voivat estää tai helpottaa sukupolvien välistä oppimista startup-yritysten kansainvälistymisessä digitaaliaikana.

Tausta ja motivaatio

Tässä väitöskirjassa korostettiin useita taustalla olevia syitä sukupolvien välisen innovaatiotutkimuksen kriittiselle luonteelle. Teknologiset edistysaskeleet, jotka mahdollistavat työhön liittyvän yhteistyön digitaalisen muutoksen, kuten COVID-19-pandemian esimerkki, demografiset muutokset, jotka tuovat haasteita mutta myös mahdollisuuksia sukupolvien moninaisuudelle työpaikoilla innovaation lähteenä, ja startup-yritysten suuri epäonnistumisprosentti kestävien liiketoimintamallien kehittämisessä, erityi-sesti globaalien startup-yritysten kohdalla, ovat vain muutamia syitä, joiden vuoksi sukupolvien välistä startup-innovaatioita koskevia tutkimuksia tarvitaan. Sukupolvien välinen innovointi määritellään tässä tutkimuksessa nuoremman yrittäjäsukupolven ja kokeneiden vanhempien aikuisten väliseksi yhteistyöksi, jossa on merkittäviä ikäeroja globaalien startup-yritysten kehittämisprosessissa. Merkittävät ikäerot, joita tässä tutkimuksessa tarkasteltiin vähintään 20 vuoden ikäeroina, johtivat merkittäviin eroihin taidoissa ja kokemuksessa, erityisesti di-gi-taaliteknologian käytön osalta. Sukupolvien välistä tiedonvaihtoa helpottavan digitaaliteknologian kehittäminen on ratkaisevan tärkeää sukupolvien välisen innovoinnin helpottamiseksi. Tässä tutkimuksessa, jossa käytetään positiivista laskentatoimen lähestymistapaa, tarkastellaan, miten hyvinvointi voidaan sisällyttää sukupolvien välisten innovaatiojärjestelmien suunnitteluun. Parempaa hyvinvointia edistävät esteet ja tekijät on tunnistettava täytäntöönpanopro-sessin aikana positiivisen laskentatoimen lähestymistavan mukaisesti. Tässä tutkimuksessa keskitytään sukupolvien välisen yhteistyön esteiden tunnistamiseen ja mielekkään sisällöllisen tiedonvaihdon kehittämiseen globaalien startup-osaamisten ja -kysymysten ympärille.

Menetelmät

Tässä tutkimuksessa käytetään pragmaattista lähestymistapaa sukupolvien välisen innovaation tutkimiseen Ruhr West -ammattikorkeakoulun kulttuuri- ja tiedeministeriön rahoittamassa ydinhankkeessa Nordrhein-Westfalenissa. Positiiviseen laskentaparadigmaan perustuvan monimenetelmällisen tiedonkeruumenetelmän vuoksi suunnittelutieteellinen tutkimusprosessi (DSR) on ihanteellinen menetelmä järjestelmän suunnitteluvaatimusten määrittämiseksi ongelmiin/esteisiin perustuvan positiivisen laskentaparadigman mukaisesti. Lisäksi DSR-prosessi alkaa ongelman tunnistamisesta ja etenee ratkaisun määrittelyn, suunnittelun ja kehittämisen, demonstroinnin ja arvioinnin sekä lopuksi tutkimustulosten julksitamisen kautta. Kussakin DSR-prosessissa käytetään sekamenetelmää, joka alkaa esteiden ja hyvinvointitekijöiden laadullisista tutkimuksista, jotka tehdään systemaattisen kirjallisuuskatsauksen ja sisällönanalyysin avulla, ja sen jälkeen

tehdään empiirisiä tutkimuksia, joissa käytetään kyselylomakkeita, jotka annetaan kahdelle nuorten ja vanhusten ryh-mälle. Lisäksi käytetään Delphi-menetelmää asiantuntijapaneelin kanssa yhdessä systemaattisen kirjallisuuskatsauksen kanssa, jossa käsitellään osaamista objektiivisessa ratkaisuprosessissa, joka liittyy globaalin innovaation sisältöön. Prototyyppi luodaan, ja vaatimuksia kartoitetaan kyselylomakkeen ja Q-menetelmän avulla suunnittelu- ja kehitysvaiheessa. Haastattelut startup-yrityksen perustajien ja asiantuntijapaneelin kanssa sekä järjestelmän ja vaatimusten esittely ja arviointi Q-menetelmää käyttäen.

Tulokset

Panokset ja löydökset Tutkimuksessa syntyi lukuisia tutkimustuloksia, jotka tiivistettiin seitsemään artikkeliin. Kussakin artikkelissa käsitellään tiettyjen artefaktien levittämistä konferenssien tai lehtien kautta. Lukuisat artikkelit on julkaistu ja asetettu vapaasti saataville verkossa, ja useat artikkelit ovat saatavilla myös käsikirjoituksina, sekä valmiina käsikirjoituksina että tarkistettavina käsikirjoituksina. Kukin artikkeli antaa seuraavan panoksen:

- *Tutkimus I:* Määritellään esteet ja hyvinvointiin vaikuttavat tekijät, jotka on otettava huomioon suunniteltaessa järjestelmiä sukupolvien välisen yhteistyön helpottamiseksi digitaaliaikana.
- *Tutkimus II:* Osoittaa esteiden paikkansapitävyyden sekä niiden merkityksen dynaamiset muutokset tietyissä globaaleissa innovaatioprosesseissa.
- *Tutkimus III:* Selvittää kilpailevien startup-yrittäjien huolenaiheita sosiaalisen median kysymysten ja vastausten avulla.
- *Tutkimus IV:* Määritellään sukupolvien välistä innovaatiokompetenssia ja kehitetään itsearviointiprototyyppi kompetenssikehyksen avulla.
- *Tutkimus V:* Kuvaa Q-menetelmää positiivisen laskennan sisällyttämiseksi muotoilutieteelliseen tutkimukseen.
- *Tutkimus VI:* Antaa suosituksia sukupolvien välisen innovaation chatbottien suunnittelua varten.
- *Tutkimus VII:* Antaa suunnittelusuosituksia sukupolvien välisen tiedon jakamisen alustalle.

Rajoitukset ja suositukset

Tämä tutkimus toimii ponnahduslautana tulevalle tutkimukselle liittyen sukupolvien välisen. Mitä tulee sukupolvien välisen innovoinnin suunnitteluvaatimuksiin, esimerkiksi sisällyttämällä pelielementtejä, jotka edistävät myönteisiä tunteita iloisen kokemuksen kautta tiedon jakamisesta. Käytännön toimijoiden osallistuminen osaamisperusteisen sukupolvien välisen innovoinnin jatkuvaan kehittämiseen ja arviointiin eri maissa ja eri täytäntöönpanomenetelmillä.

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ORIGINAL PAPERS

I

TOWARDS A WELLBEING-DRIVEN SYSTEM DESIGN FOR INTERGENERATIONAL COLLABORATIVE INNOVATION: A LITERATURE REVIEW

by

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Towards a Wellbeing-driven System Design for Intergenerational Collaborative Innovation: A Literature Review

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Abstract

Researchers have previously utilized the advantages of a design driven by well-being and intergenerational collaboration (IGC) for successful innovation. Unfortunately, scant information exists regarding barrier dimensions and correlated design solutions in the information systems (IS) domain, which can serve as a starting point for a design oriented toward well-being in an IGC system. Therefore, in this study, we applied the positive computing approach to guide our analysis in a systematic literature review and developed a framework oriented toward well-being for a system with a multi-generational team. Our study contributes to the IS community by providing five dimensions of barriers to IGC and the corresponding well-being determinants for positive system design. In addition, we propose further research directions to close the research gap based on the review outcomes.

1. Introduction

The importance of the global issue of well-being among the aging workforce for intergenerational innovation has been highlighted in several studies [21, 37, 39]. For instance, Forbes [20] noted that addressing intergenerational issues in diversity management is one of the key factors of successful global organizations and start-up innovation. In fact, cross-generational issues have become one of the key concerns of today's workforce, where employees of a single company might span up to four generations [20]. This study defines intergenerational innovation as a group of adults of more than one generation working together in the creative process to explore and apply valuable business ideas [4, 47]. The main goal of this paper is to understand the barriers and effects of intergenerational collaboration, particularly with regard to collaboration for global startups.

Although several studies in information systems (IS) propose the integration of well-being to improve IS design and support collaborative innovation processes [13, 44, 49], a lack of in-depth understanding of barriers and how to embed well-being into the IS design of intergenerational collaboration (IGC) remains [47]. Furthermore, we found no publications providing information on dimension barriers to IGC or a framework that integrates well-being into IGC system design. Using the keyword "intergenerational" produced only 44 publications in the Association for Information Systems (AIS) digital library (based on an inquiry run on March 15, 2019). From those 44 publications, two papers related to well-being focused only on providing IS design for senior adults [13, 17], not for several generations in an IGC context.

Therefore, we aim to provide an overview and basis for a problem-based approach to system design, an analysis of barriers to ICG, and the correlated well-being determinants of intergenerational innovation. Based on the study objectives, we have conducted a two-stage literature review [27, 58] leading to a conceptual model for designing support systems in the context of intergenerational innovation. Systematically reviewing the literature [27, 58] on the barriers to IGC helped us to understand different types of barriers and design strategies correlated with technology-related well-being determinants in intergenerational innovation. For this purpose, we utilized the positive computing (PoCo) approach to the upcoming trends in the fields of human-computer interaction and IS design [11, 49].

The paper is structured in five additional sections: the theoretical foundation; the methodological section, comprising data collection and analysis; the results section, comprising barrier dimensions and the targeted well-being determinants; discussion; and finally, the conclusions of the study.

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2. Foundation for the literature review

2.1. Intergenerational innovation

As the knowledge-based society has grown, the ability to collaborate across continents and cultures has become an essential prerequisite for international companies. A global economy and demographic changes are also creating new opportunities to attract young talent from different countries to collaborate and improve global innovation processes. In addition, more experienced innovators can benefit from young trainees and actively participate in the global innovation process while improving their own well-being and social connectedness [63]. In terms of innovation processes, IGC can strengthen exploitation and commercialization processes by creating new opportunities [26].

We adopted the definition of generations based on Hilman [23]; the generational age difference is at least 20 years, which can be calculated from the difference in the median age of generations within one period of classification (e.g., the median age of Generation Y less the median age of Generation X). Therefore, we define younger adults as adults aged 18–30 years and senior adults as 50 years and older.

The concept of intergenerational innovation is an intergenerational knowledge collaboration within the innovation process in which older and younger adults can exchange experience and knowledge related to the innovation process or to processes derived from ideation, design, or development. These exchanges are related to the commercialization of valuable ideas [13, 47]. On the one hand, senior adults are potential resources of innovation training and counseling for younger adults in a global environment. Conversely, barriers to intergenerational collaboration in digital learning seem to hamper collaboration [18]. We begin with three main processes of innovation to review the existing determinants of well-being to overcome the barriers to intergenerational collaboration in the innovation process.

2.2. Barrier dimensions of collaboration

The perception of IGC depends on age differences [55], but studies show that when conflicts do occur, they are due to differences in system interaction and operational styles rather than age differences [32]. If a system is designed for the younger generation, the developers may lose the older audience and vice versa. Age is not a factor in the success of interaction and learning [32], but is instead a demotivating element for both generations in using technology [33]. Barriers to intergenerational settings can demotivate the collaboration process. Several important barriers have already been studied by Edge [16] and Nurhas et al. [47], including, for instance, generational trust, lack of supportive environment, and different generational attributes.

We chose a classification of barrier dimensions from Adams [1] and Litz [36] because they cover a wide range of barriers to the creative collaboration process [1, 47]. The first dimension is the intellectual dimension, which is related to barriers caused by information, the beliefs of experts, and style. The second dimension is the perception dimension, which is caused by stereotyping. For example, perceptions of others based on gender, culture and physical characteristics. The third is the emotional dimension, which arises mainly from embarrassment, discomfort, or fear of failure. Last is the cultural and environmental dimension, which includes outside support and how to address a situation [1]. These barrier classifications can be used as a starting point to classify the dimension of the barriers to IGC in innovation process.

Therefore, based on the dimension of the barriers to creative collaboration [1], this literature review addresses the first guideline research question, “What barriers (and dimensions) exist in intergenerational collaboration?”

2.3. Positive computing approach

As technology provides new opportunities to mediate IGC, researchers have begun to study age differences in digital environments, with a focus on IGC in innovation processes [10, 23, 28, 47]. Focusing on the use of digital technology by the senior adults in IGC, Amaro et al. [2] found that senior adults are not technophobic and that they innovatively use IGC to maintain meaningful relations across borders [46].

Calvo and Peters [11] introduced the concept of PoCo, which promotes well-being determinants and enhances human potential through digital interaction. In this study, we used the PoCo approach as the basis of a design for a collaborative learning system between younger and older adults in the personal dimension. We used the PoCo approach because we believe that this approach will help us motivate older people to participate by giving them a meaningful task (for instance: sharing experiences, life wisdom or marketing strategies for specific target markets) and helping younger users by considering using the relatedness determinant to its full potential and thus becoming more successful. The PoCo process also requires the identification and consideration of barriers and challenges during technology design. Moreover, the provided well-being determinants of the PoCo approach

focus on the personal level rather than on the organizational level. Those advantages of PoCo fit our research objective.

The PoCo approach is not limited to the user interface, but also covers the overall process to design of the IS [49]. PoCo can affect the entire process of system design, from initialization and user study to development and evaluation [49]. Calvo and Peters [11] introduced three classifications of determinants that can be used to improve well-being and can simultaneously be converted to technological design interventions. The groups of determinants consist of three groups of determinants [11]:

The first group of determinants is related to the self or the intrapersonal. This group primarily focuses on design features that support the personal interaction of the user with the system, including *joyfulness, interest in exploring and learning, pride in achievements, self-views, love or feeling safe, and close relationships), self-awareness, engagement, mindfulness, and resilience*. The well-being driven technological interventions cover displeasing activities overlain with enjoyable interaction experiences.

The second group of determinants is related to the social or interpersonal. The determinants in this category provide interventions that support social connectedness among users and different social roles in the system. Determinants in this category include *gratitude* and *empathy*. The interventions include features to support expressions of appreciation; communication features aim to facilitate an expression of emotion using the narratives and graphics.

The last group of well-being determinants relates to the transcendent or extra-personal. This category emphasizes intervention for virtue or focusing on performing meaningful social actions. Calvo and Peters [11] categorized *compassion* and *altruism* in this group. Different types of technological interventions include a design for group empathy, technological features to minimize blame and judgment, and system development for inspiration that supports the ability to transform empathy into action.

Integrating well-being into a system's design process can occur on four levels of implementation [11]: The first level is no integration of well-being. The second level is preventive implementation (addressing barriers). The third level is an active approach (using well-being determinants for IS design), and last is the design of a system in which the overall goal is to foster targeted technology-oriented determinants of well-being and human potential. This study mainly focuses on the second and third levels.

Therefore, based on the PoCo approach, the well-being determinants can be used as keywords for content analysis. Hence, the second question for our review is "Which well-being determinants are employed to foster IGC in innovation processes?"

3. Methodology

Our literature review follows the systematic process [27, 58], that described a method of reviewing relevant articles based on clearly formulated research questions, topics, or phenomena. An initial search resulted in 601 publications, and 57 publications were selected for analysis based on the study scope [7] and the inclusion and exclusion criteria. The overall structured process of the review is summarized in Figure 1.

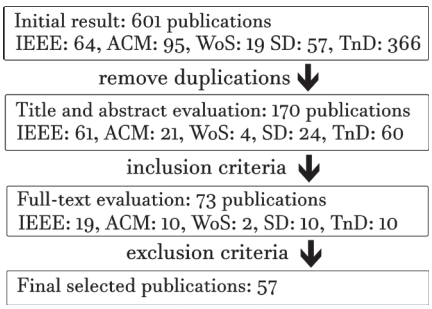

Figure 1. Selection process of publications

3.1. Data selection

3.1.1. Keywords and Database. We employed a web-based automated search through digital libraries [27, 64]. for IGC-based studies published in scientific databases. The selection of the database was based on a proposed list of the top databases for software and technology engineering [64]. The selected databases were IEEE Xplore (IEEE), ACM Digital Library (ACM), Science Direct (SD), Taylor and Francis Online (TnD), and ISI Web of Sciences (WoS). The proposed databases included all reliable publications in a wide area of research from strong technically-oriented journals to more socio-technical fields such as IS journals and proceedings from the Association for Information Systems (AIS) Electronic Library. We believe that adding more databases would only provide duplicate results and increase the difficulty of validating the quality of publication processes.

We utilized a trusted database for the scholarly publication channel without limiting our scope to specific journals or proceedings because the topic is discussed in multidisciplinary research areas. To find correlated publications in selected databases, we applied two different groups of keywords; we applied a set of keywords on February 26, 2018, without limiting the time interval. The first group of keywords was for technology-specific databases. In the first category we

found minimal sources if we specified the keywords; therefore, we introduced a more general search, related only to barriers to intergenerational collaboration and not specifically related to technology.

The keywords for our IEEE and ACM searches were *("intergenerational") OR ("intergenerational" AND ["barrier" OR "collaboration"]) OR ("intergenerational" AND ["barrier" OR "problem" OR "challenge" OR "GAP" OR "obstacle"]).* Moreover, for non-technology focused databases, we detailed the keywords for designing a digital technology to support IGC in the workspace *("intergenerational" AND ["digital" OR "computer" OR "technology"] AND ["gap" OR "barrier"] AND ["workspace" OR "workplace"]).*

3.1.2. Inclusion and exclusion criteria. A publication was selected as a source for the analytical process if the proposed inclusion criteria were met; a publication was removed from the reference list if it met the predefined exclusion criteria. Adhering to the research questions and guidelines for reviewing papers and scoping the study on IGC [7], the applied inclusion and exclusion criteria are presented in Table 1. For our study, we also excluded publications that focus only on collaboration between senior adults and children (age below 18 years) without clarifying the barriers and the potential research benefits for younger adults and senior adults.

Table 1. Criteria for inclusion and exclusion

Inclusion	Exclusion
• Peer-reviewed paper (journal or conference proceeding) • Explicit mention of intergenerational-related terms in the abstract, title, or keywords • Collaboration between generations related to the innovation process	• Not written in English • No explicitly stated barriers to IGC • Paper incomplete or research in progress.

3.2. Data analysis

To provide a design framework for IGC oriented toward well-being, we used the concept matrix [58] to create a matrix of barriers to IGC. We then synthesized the content of each selected publication, recorded the barriers, and combined the redundant barriers based on their associated verb and object. We first categorized the barriers into four barrier dimensions following the classification by Adams [1]. Any barrier that did not match one of the predefined classifications remained uncategorized.

We redefined the previous dimensions based on the barriers that corresponded to each; we described the perceptual dimension as thinking or opinion that focuses on the image of the other and renamed it an empathic dimension. We described the emotional dimension as a feeling that focuses on self-image. Both are related to the concept of self vs. other. We expanded the intellectual barriers to include technical and operational barriers since the identified barriers are correlated with knowledge regarding technological use and operational management.

In addition, some barriers in this dimension are also highly correlated with the new definition of the other two dimensions (point of view). Finally, the cultural-environmental dimension was divided according to the rules and requirements, regardless of whether the barriers were organizational (officially written rules and requirements) or cultural (unofficially written). Furthermore, we recategorized the uncategorized barriers that corresponded to the newly defined dimensions. Possible disagreements regarding the categorization were resolved through discussions with the co-authors.

Although the barriers do not appear to be mutually exclusive, precise characteristics and definitions can be used to differentiate them and identify a tendency toward group-specific barriers. The proposed barrier dimensions occur in the interactions among user, system, and environment. Perceptual and emotional characteristics focus on the user's internal dimension, which is more intangible; the environmental or intangible external dimension of the user is cultural and institutional; and the system barrier is related to the technological and operational dimension or external tangible.

In the second stage of the analysis and review of the well-being determinants, we first determined the type of collaboration activity involved, such as ideation, design, and development or commercialization [4, 35]. Publications were grouped into collaborative and non-collaborative innovation activities. Of the collaborative innovation activities, we analyzed 23 (ideation: two publications; design and development: 12 publications; exploration: eight publications; and commercialization: one publication) to identify the well-being determinants of the PoCo approach to collaborative innovation activity. Five papers were removed because they did not mention well-being or correlate to the determinants of the PoCo approach, leaving only 18 publications.

We analyzed the remaining 18 publications looking for three main activities in the innovation process, using manual content analysis to find the determinants. We used the keywords based on the well-being determinants

of PoCo approach and carefully read the selected papers to identify the corresponding determinants. Similarly, we can identify the correlated well-being determinants of collaborative innovation processes [4, 35].

4. Findings

Extracting the data based on year of publication of the reviewed papers (Figure 2, top) shows that researchers' interest in the IGC correspondent barriers has increased in the last five years. In 2016 and 2017, studies conducted on this topic more than doubled compared with the three previous years. Based on study origins, the global movement of the study of IGC includes every continent except Africa (Asia: 10%; South America: 6%; Australia/Oceania: 10% Europe: 27%; North America: 42%; collaboration between North America and Europe: 5%). The results of the analysis of the study origins parallel the growing number of individuals in the aging population on both continents [62].

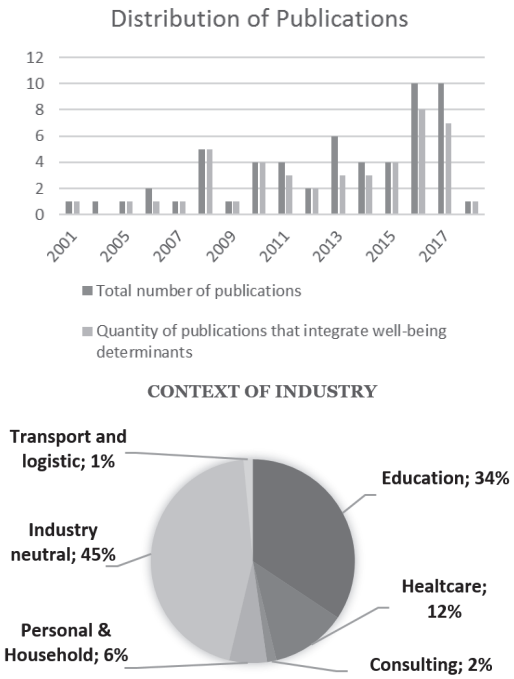

Figure 2. Mapping the Publications

Regarding the industry context within which the study was conducted (see figure 2, bottom), the study of IGC-related barriers usually focuses on neutral industries (or can be implemented across industries). However, education and healthcare are the two dominant industries in which barriers to IGC are commonly found. Interestingly, few studies focused on banking, retail, hospitality, or government.

4.1. Barrier dimensions to intergenerational collaborative innovation

The conceptual classification of the barrier dimensions for intergenerational innovation comprises five dimensions.

4.1.1. Emphatic/Perceptual dimension. We defined the empathic dimension as the negative viewpoint of a generation toward different generations. This strong negative viewpoint hinders IGC because of someone's experience in the past. Barriers related to perceptions of others include age discrimination [3, 34, 53], a different mindset [16, 53] and interests [8, 24], and generational resistance [3, 18, 53]. Moreover, a lack of understanding of IGC [5, 32], a lack of awareness of differences between generations [16, 18, 50], a lack of empathy [10, 53], building interpersonal trust [15, 16] and a lack of respect [10, 53] are challenges to cross-generational collaboration.

4.1.2. Cultural dimension. The cultural dimension represents external environment-related barriers that concern informal codes and norms. One of the main issues of global collaboration is the substantial differences in cultural traditions compared with other generations [8, 12]. Barriers also arise in this category because people are unaware that they can work with someone who is culturally different [43, 46]. Furthermore, other barriers in this dimension that can hinder IGC are a lack of social support [8, 12, 16] and a lack of sensitivity to technological design that interferes with the cultural background of a particular generation [6, 46].

4.1.3. Emotional dimension. The emotional dimension is a collection of barriers associated with feelings and a negative self-view or egocentricity. These barriers are related to how one generation conceives of working with another generation. Barriers in this category are feeling underappreciated or unappreciated [6, 8, 16, 53] and feeling that others are slow to understand [10, 42]. Fear of technology [5, 8, 9], functional limitations [3, 5, 46], lack of motivation [5, 6] and feeling isolated [3] are barriers related to the emotional dimension.

4.1.4. Technological and operational dimension. The technological and operational dimension covers barriers related to knowledge and resources regarding technology and operational use. Barriers in this category include lack of independence [2, 28, 29], the high cost of technology investment [3, 8, 15], the complexity of virtual presence management [9, 15], and generational differences in technological backgrounds [6, 8, 10, 12, 15]. Other barriers are lack of joyful activities [8, 41]

that can be integrated into real-life collaboration [3] the lack of technical training for digital collaboration [15], insufficient technological access [15] without a supportive technological environment [31, 57], and the complexity of technology [9, 15, 22]. In some cases, collaboration between the two generations could also be challenging because there is no right time for an appointment [6, 16, 51, 60] and the differences in routine patterns are unclear [36, 45].

4.1.5. Institutional dimension. The institutional dimension is defined as administrative barriers that focus on organized rules and requirements, including barriers to shared resources [45, 46, 57], geographical distance [6, 45] between cooperation partners and high market uncertainty in product markets [43] for innovation partnerships. Issues of data protection [15] and differences in educational levels [3, 8, 15] can complicate technology-mediated intergenerational collaborative innovation.

4.2. Well-being determinants of IGC systems

The collected publications did not explicitly mention the type of collaborative innovation activity within the context of IGC. Some publications addressed overall collaborative innovation activities [24, 36, 43], including exploration (ideation + design and development) and commercialization or market exploitation [35, 47]. Although IGC can strengthen innovation, we found only one publication [43] on IGC-related barriers that supported collaboration in commercial activities. The correlated well-being determinants and associated collaborative innovation activities, with their sources, are presented in the following subsections.

4.2.1. Positive emotions of joy and playfulness in intergenerational knowledge exchanges. These positive emotions are feelings or expressions related to the emotional experience of pleasure that is integrated into IGC. One should feel joyful when using an IGC system. This determinant was identified in design and development [12, 52, 54, 56, 59] and exploration [28, 36, 38]. The types of interventions related to joyfulness are the use of hybrid technology by combining the real and digital worlds in a collaborative activity [12, 54], the use of persuasive technology, and location-based gamification [28, 37, 38, 54, 56].

4.2.2. Positive emotions of interest in and exploration of a problem-based learning scenario. These feelings or expressions are related to the emotional experience of curiosity in the learning process that is integrated into IGC. These feelings often occur in unpredictable scenarios. Twelve papers indicated the user's interest in and exploration of system design. The determinant was identified in the following collaborative innovation activities: ideation [25, 30], design and development [2, 12, 19, 29, 54, 56, 59], and exploration [28, 36, 38]. Competence development programs using blended learning for IGC were integrated [12, 36] to support the interests of collaborators. Instructional guidance for technological use, integrating hub actors, and gamification through assistive systems or robots are also utilized [25, 54].

4.2.3. Positive emotions of pride and achievement of collective goals. These are feelings or expressions related to the emotional experience of achieving meaningful goals, such as accomplishing a list. These emotions are found in exploration [28, 36, 38]. The types of interventions found in the literature are the digitalization of social presence, the use of persuasive technology [28, 38] and competence-based assessment [36].

4.2.4. Positive emotion of competence-based contentment and self-views. These emotions are feelings or expressions related to the emotional experience of high certainty and low effort based on self-evaluation. They are found in the collaborative innovation activities of ideation [25] and exploration [28, 40]. The types of interventions in the literature are features to support competence exchange and competence building for IGC [25], the use of interactive storytelling, and scheduled IGC evaluation and assessment programs [28, 40]

4.2.5. Motivation and Engagement (ME). Motivation and engagement for the IGC community are a flow of experiences or the momentary condition that balances challenges and competence, stimulating eagerness, ownership, and possession. ME was found in 10 of 18 papers in the following collaborative innovation activities: ideation [30], design and development [2, 12, 19, 29, 52, 54, 56, 59, 61], and exploration/commercialization [28]. Gamification [54, 56], persuasive technology [28], self-assessment and evaluation instruments [29], competence acquisition through role-playing, and intergenerational community building [61] apply to this determinant.

4.2.6. Apprenticeship-based social relatedness (empathy, compassion, altruism). This determinant concerns the act of helping others. It provides functionality that can support social interaction and actualization to help others. Mentorship and companionship are examples of relatedness found in the

collaborative innovation activity of exploration [24]. Some publications related the well-being determinant of "relatedness" to ME in the areas of ideation [30] and exploration [10, 38]. IGC aims to improve relatedness between younger adults and senior adults through persuasive technology for the co-creation of innovative products [24], hybrid/blended learning [30], and location-based game [30], Workshop for competence development [30], digitize social presence and interaction [10].

5. Discussion

Determining barriers and correlated well-being determinants help to develop a conceptual framework for the positive design of IGC within the context of innovation activities. Within the preventative approach of PoCo [11], which minimizes factors that hinder IGC while interacting with technology, we identified five dimensional barriers. Those barrier dimensions apply generally to collaboration in a global context because the barriers were collected from various continents and include the cultural dimension.

Compared with previous dimensions [1, 36], in terms of IGC, our barrier dimensions support the current study on barriers to intergenerational innovation that contain specific dimensions for technological and operational knowledge [47]. These barrier dimensions also represent the nature of technology-mediated collaboration and the problem faced by different generations when interacting with technology. Moreover, we defined the empathic dimension as a barrier concerning interpersonal and extra-personal issues.

Regarding barriers in the PoCo framework, Calvo and Peters [11] proposed that gratitude and empathy may help connect interpersonal aspects and technology features. We found empathy, compassion, and altruism (ECA) within the context of collaborative innovation activities but not gratitude. ECA is associated with relatedness or social connectedness [11]. Therefore, we propose relatedness as the well-being goal of IGC or as the dedicated approach to IGC design oriented toward well-being. Barrier dimensions in IGC related to the empathic and the perceptual can be addressed through the use of robots, chatbots, or digital mediators that can mediate and reduce difficulties in communication and understanding one another [25, 54].

It seems that gratitude, as one of the strongest predictors of well-being [61], can be used as an alternative determinant of well-being in a dedicated approach to designing IGC systems. Supporting relatedness can be used in synchronous and asynchronous communication channels within the context of IGC learning [12, 38, 59]. Moreover, IGC can be designed to support coping abilities to transform empathy into action that can address judgment and blame [11]. A role play between generations in a local activity [28, 37, 38, 54, 56] could increase connections and empathy among collaborators and address cultural, perceptual, and empathetic barrier dimensions.

We also found that compared with other well-being determinants, motivation and engagement are a primary focus in IGC publications (occurring in more than 55% of selected papers). System designers should therefore consider interventions related to the determinant motivation and engagement to support IGC design. Moreover, it is essential to provide a common meaningful goal, empower creativity, and elicit appropriate feedback through virtual goods that can motivate [14] both the senior and younger adults.

We did not find any papers that mentioned "positive emotion." Instead, we noted that joy and interest were mentioned in 66% of IGC publications regarding innovation activities. Therefore, we included joy and interest as determinants that can be used to support IGC and proposed the positive emotions as a focus determinant of well-being in the active approach of PoCo. Moreover, the flow of experience can be integrated into positive emotions to cover pleasant activities such as serious games or gamification [36, 38, 54, 56].

Apparently, cultural, institutional, technical, and operational barriers are common in the design of IS [48, 58] and also appear in the IGC system. We included pride and contentment among the alternative determinants of an active approach to well-being [11]. Despite being two elements of positive emotion, they were rarely mentioned. Nevertheless, pride or achievement can be used in the exploration process. For instance, a system designer can use a progress bar, fixed action rewards, a leaderboard, and badges to facilitate both contentment and pride [14].

Related to institutional barriers, using the determinant of pride or achievement, the IGC system designer can integrate the competence-based self-assessment system into the matching process of the IGC system. IGC collaborators can assess their skills and achievements [29], which may overcome barriers, particularly in the institutional dimension. The self-assessment system can automatically match collaborators or help identify the right person with whom to collaborate. A hybrid technology [30] that combines tangible and intangible technologies can also lead to the delivery of a system that can be adapted according to users' physical and cognitive capabilities and preferences.

6. Conclusions

Following the analysis, we built a conceptual model (figure 3) of an IGC system designed to address the barrier dimensions to IGC in the innovation process. We achieved this by integrating determinants that are classified into dedicated and active approaches of the PoCo framework.

Our findings reveal motivation, engagement, and positive emotion (interest and joy) and can be found in all three collaborative innovation activities. This finding indicates that these determinants play an essential role in IGC. Concerning motivation and engagement, tasks within innovation activities require specific competencies, e.g., problem-solving and creative thinking. The system can provide a flow of experiences to motivate both the senior and younger adults by providing a meaningful common goal for both generations, and the tasks in the IGC system must be suitable for the users' physical states as well as their physiological and cognitive abilities to avoid techno-stress.

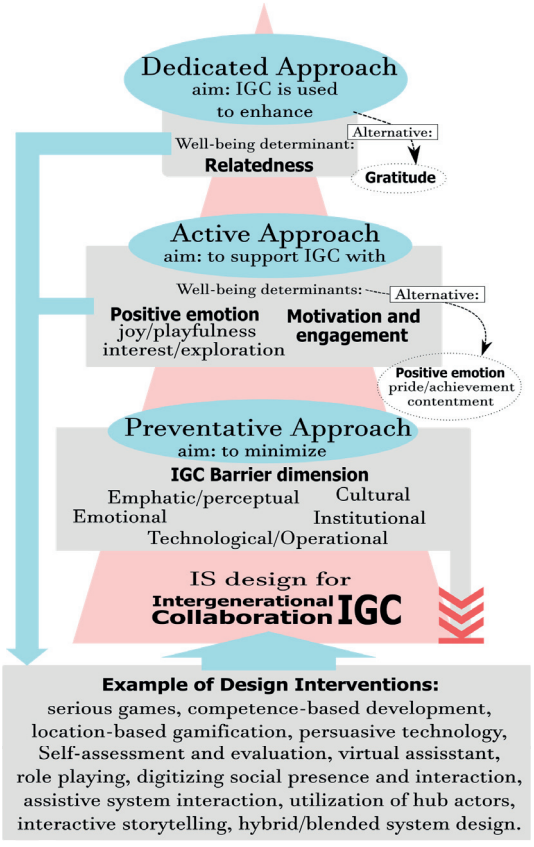

Figure 3. Wellbeing-oriented IS design for IGC

Interspersing the tasks with joyful experiences can help users overcome barriers (primarily in the empathic and emotional barriers dimension) and provide a flow of experience in technology-mediated IGC. We found that IGC is not only a global issue but is also attracting increasing attention from researchers across continents that can be useful in many industries, especially in the training and education industries.

Based on our review, we created a conceptual model that integrates the findings into a system design of innovation activities for IGC driven by well-being. Figure 3 depicts the conceptual model of a system design for intergenerational collaborative innovation that is oriented toward well-being. We hope that further studies on technology-mediated IGC will open up new possibilities to observe and develop the proposed framework.

The results of our review will also be used to develop further research questions that can be utilized to support IS research on a system design for intergenerational innovation oriented toward well-being (Table 2). The questions can be used as a baseline to address the gaps in recent IGC studies, and researchers can modify these questions to better fit their specific research problems. Moreover, a need remains to analyze the barriers based on geographic distribution and further attributes; such information can be used to design a global IGC system.

Table 2: Proposed research questions

Topic	Proposed questions
Barrier	How does the barrier framework affect the choice of technology and approaches in intergenerational system design? How do both generations perceive the level of barriers to collaborative innovation? Which barriers do both generations believe will have the most significant impact on each of the more specific collaborative innovation processes?
Well-being factors	Which well-being determinants of PoCo can promote IGC in the commercialization process? How and what type of human potential in the global innovation process can be supported by the dedicated design approach of IGC?
Method	How can a well-being-oriented design approach to an IGC system be evaluated?

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II

BARRIERS AND WELLBEING-ORIENTED ENABLERS OF INTERGENERATIONAL INNOVATION IN THE DIGITAL AGE

by

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REVIEW PAPER

Barriers and wellbeing-oriented enablers of intergenerational innovation in the digital age

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Abstract
So far, researchers have used a wellbeing-centered approach to catalyze successful intergenerational collaboration (IGC) in innovative activities. However, due to the subject's multidisciplinary nature, there is still a dearth of comprehensive research devoted to constructing the IGC system. Thus, the purpose of this study is to fill a research void by providing a conceptual framework for information technology (IT) system designers to use as a jumping-off point for designing an IGC system with a wellbeing-oriented design. A systematic literature study was conducted to identify relevant terms and develop a conceptual framework based on a review of 75 selected scientific papers. The result consists of prominent thematic linkages and a conceptual framework related to design technology for IGC systems. The conceptual framework provides a comprehensive overview of IGC systems in the innovation process by identifying five barrier dimensions and using six wellbeing determinants as IGC catalysts. Moreover, this study discusses future directions for research on IGC systems. This study offers a novel contribution by shifting the technology design process from an age-based design approach to wellbeing-driven IGC systems. Additional avenues for investigation were revealed through the analysis of the study's findings.

Keywords Intergenerational collaboration · Intergenerational innovation · Barriers and challenges · Digital collaboration · Startups innovation

1 Introduction

The prominence of the global issue concerning the aging workforce's wellbeing for intergenerational innovation has been stressed in several studies [1–4]. For instance, studies [5–8] noted that addressing intergenerational diversity management issues is critical to successful global organizations' startup innovation. Indeed, intergenerational issues have become one of the main concerns of today's workforce [8, 9], where the employees of a single organization can encompass up to four generations [4, 5]. We refer to intergenerational innovation as a group of adults from more than one generation collaborating in the creative process to explore and exploit valuable business ideas [7, 10]). The main objective of this paper seeks to understand the barriers, implications, and drivers of intergenerational innovation, especially concerning collaboration for global startups.

Although studies on the intergenerational context are still being debated [11, 12], the challenges are real [1, 6, 7, 13], notably how to shape positive interventions [14, 15] for the IGC [11]. While several studies on the Information Technology (IT) domain propose the incorporation of wellbeing as the driver to better IT design and to support collaborative innovation processes [15–17], a profound understanding of the barriers and how wellbeing can be embedded in intergenerational collaboration (IGC) systems design continues to be lacking [7]. Accordingly, the importance of a shift from age-based system design to a design that encompasses a broader range of ageless stereotypes has been highlighted in several studies [11, 12]. Therefore, we aim to address this study's underlying main research question: how to design a wellbeing-driven IGC system that supports the innovation process?

By examining the barriers to IGC and intergenerational innovation's associated wellbeing drivers, this study seeks to

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provide an overview and a foundation for a problem-based approach to system design. We conducted a thorough systematic literature review (SLR) [18, 19] and metadata analysis based on the study goals, which led to a conceptual model for designing intervention systems in the context of intergenerational innovation. The metadata and content analysis of SLR [18, 19] on IGC barriers enabled us to understand relevant sub-topics, different types of barriers, and strategies associated with technology-related wellbeing determinants in intergenerational innovation. To this end, we used the Positive Computing (PoCo) approach to emerging trends in human–computer interaction and IT design [14, 15].

As a reminder, the paper is structured as follows: the theoretical background; the methodological section, which covers data collection and analysis; the findings section, comprising barrier dimensions and the proposed determinants as the enabler of wellbeing for IGC; discussion; and finally, the conclusions and recommendations drawn from the research gaps.

2 Theoretical background

2.1 Intergenerational innovation

As the knowledge society grows, collaborating across continents and cultures becomes an essential requirement for international companies. A global economy and demographic shifts are also creating new ways to attract young talent from different countries to engage in collaboration and improve global innovation processes. Besides, senior innovators can benefit from young apprentices and actively participate in the global innovation process while improving personal wellbeing and social cohesion [7, 8, 23]. Regarding innovation processes, the IGC can strengthen exploitation and commercialization processes by creating new opportunities [24].

The grouping of generations in the workplace tends to be subjective [25]. However, based on Table 1, we started with the classification of generations based on age. It can help us determine which correlated differences, problems, and enablers were discussed in the literature together with generational differences. Following Loos et al. [26] and based on Table 1, we defined intergeneration in the digital age as: "interaction between different generations facilitated through digital media that has a greater likelihood of having disparate digital backgrounds and competencies due to (at least) 20 years age gaps." The number of age-year gaps is derived from the median age of the generations within a classification period (e.g., the median age of generation Y minus the median age of generation X). Therefore, as an entry point, we define younger adults as adults aged 18–30 years and senior adults as adults aged 50 years and older.

Table 1 Classification of Generations in IGC

Sources	Proposed Age-based Classification of Generation	Significance for this study
[20]	(a) Traditionalists: born between 1922 and 1946; (b) Baby Boomers: born between 1946 and 1964; (c) Generation X: born between 1964 and 1980; and (d) Generation Y: born between 1980 and 2000. This classification is mainly derived based on work–value differences for a given generation born within a given period	The paper presents an overview of age-based generational classification, which may be used to establish the number of years between generations with significantly different background experiences
[21]	(a) The modernists: before 2003 and (b) the postmodernists: born between 2003 and the present. This classification is based on the mindset of human power and authority	The study allows us to understand how differences in cultural environment can lead to differences in skills, competencies, and thinking patterns that shape particular generations
[22]	(a) Digital natives: educated digitally; (b) digital immigrants: born before the digital age and had to adapt; and (c) pre-digital immigrants: educated with a language other than digital and have often had to adapt to Information and Communication Technology (ICT) subsequently. The various main criteria for the classification of generations are related to digital literacy and digital experience	The study enables us to link generational differences in workplace behavior to divergent digital operational capabilities, technological design preferences, and preferred digital work platforms

Intergenerational innovation describes an intergenerational knowledge collaboration within the innovation process, where senior and younger adults can mutually share experiences and knowledge related to the innovation process or processes emerging from the conceptualization, design, or development, and commercialization. Such mutual knowledge exchange occurs in the exploitation of valuable ideas [7, 16]. On the one side, senior adults offer valuable resources for innovation training and mentoring for younger adults in a global environment. Conversely, barriers to intergenerational collaboration in digital learning seem to hamper collaboration [27, 28]. At this point, we begin with three main innovation processes to review the existing determinants of wellbeing and overcome the barriers to intergenerational collaboration in the innovation process.

2.2 Barrier dimensions of collaboration

Awareness of the IGC depends on age differences. Still, studies show that when conflicts occur, they are more likely to be due to differences in system interaction and operational styles as opposed to age differences [9, 29, 30]. Designing a system for the younger generation may cause the developers to lose the senior audience and vice versa. Age may not be a factor in the success of interaction and learning [9, 29], but rather a demotivating element in the use of technology for both generations [31]. For this study, we understand barriers as problems, challenges, gaps, or obstacles that can impede the achievement of a particular goal. Barriers in the intergenerational environment can demotivate the collaboration process. Several significant barriers have already been examined in other studies [7, 27, 28, 32, 33], including generational trust, lack of a supportive environment, lack of intergenerational collaboration competencies, and different generational characteristics.

For this study, we considered a classification of the barrier dimensions of Adams [34] and Litz [35] because they cover a wide range of barriers to the creative collaboration process [7, 34]. The first dimension relates to the intellectual dimension, which refers to barriers caused by information, expert beliefs, and style. The second dimension is the perceptual dimension caused by stereotyping—for example, the viewpoint toward others based on culture, gender, or physical characteristics. The third dimension is the emotional dimension, which arises mainly from embarrassment, discomfort, or fear of failure. The last is the cultural and environmental dimension, including external support and how to deal with a situation [34]. These classifications of barriers serve as a fundamental dimension for the IGC in the innovation process.

Based on the preliminary review in this section, it is crucial to understand the common barriers to IGC to develop IGC system requirements. Therefore, this study deals with the first guiding question of our research: "Which barriers (and dimensions) are involved in intergenerational collaboration?" The dimension of barriers to creative collaboration will be used as an initial classification that can be refined, extended, and modified based on the finding and the context of this study.

2.3 Positive computing approach

Calvo and Peters [14] introduced the concept of Positive Computing (PoCo). This concept promotes the determinants of wellbeing and boosts human potential through digital interaction. We employed the PoCo approach as we consider that the PoCo approach enables us to motivate senior adults to participate by entrusting them with meaningful activities (e.g., sharing experiences, wisdom, and appropriate marketing strategies). Secondly, to support younger users by exploring the potential to take full advantage of the wellbeing determinants and thus become more successful. The PoCo approach also requires the identification and consideration of barriers and challenges in technology design.

Furthermore, The PoCo approach goes beyond the user interface and encompasses the entire process of shaping the information society [15]. PoCo can influence the entire process of system design, from initialization and user study to development and evaluation [15]. Calvo and Peters [14] established three categories of determinants that can be used to promote wellbeing and, at the same time, can be translated into technological design interventions [14]:

- The first group of determinants is the self or the intrapersonal. In this group, the focus is primarily on design attributes that support the user's interaction with the system, including joy, interest in exploration and learning, pride in achievement, self-esteem, love, or the feeling of safety and close relationships. In this first group, the wellbeing-oriented technological interventions comprise uncomfortable activities that intersect with enjoyable interaction experiences;
- The second group of determinants pertains to the social or interpersonal designed to support users' social connectedness and the different social roles in the system. The determinants in this category include gratitude and empathy. Interventions include features that promote expressions of appreciation; communication features are designed to enable the expression of emotions through narratives and graphics;
- The last group of wellbeing determinants refers to the transcendental or extra-personal. It emphasizes the intervention for virtue or the focus on carrying out meaningful social actions. Calvo and Peters [14] classified compassion and altruism into this category. The variety of technological interventions available involves a design

for group empathy, technological features to mitigate guilt and judgment, and system development for inspiration that promotes the ability to translate empathy into action.

The integration of wellbeing into the design process of a system can be accomplished on four levels of implementation [14]: The first level is no integration of wellbeing. The second level is preventive implementation (removal of barriers). A third level is an active approach (use of wellbeing determinants as a driver for IT design). Finally, the design of a system aims to promote targeted technology-oriented determinants of wellbeing and human potential. This study concentrates principally on the second and third levels.

Overall, based on the PoCo approach, we postulate the second question for our review is: "Which wellbeing determinants are used to facilitate IGC in innovation processes?".

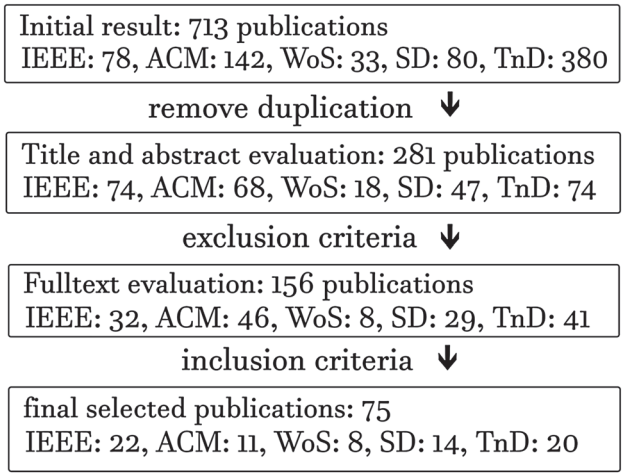

Fig. 1 The selection process of publications

3 Methods

In this study, the positive computing approach has guided our research process of a systematic literature review or SLR [18, 19]. SLR was chosen as the main method for conceptualization to develop a concept based on a solid scientific basis [19].

3.1 Literature review and data collection

We performed a web-based automated search in digital libraries [18, 36] for IGC-based studies published in proposed scientific databases [36], including ACM Digital Library (ACM), IEEE Xplore (IEEE), Taylor and Francis Online (TnD), Science Direct (SD), and ISI Web of Sciences (WoS). The preliminary search for the deletion of duplicates revealed 281 out of 713 publications, and 75 publications were selected for analysis based on the SLR process and scope of the study [37]. The overview of the whole structured review process is outlined in Fig. 1.

We applied a set of keywords on 3 April 2020 to selected databases for articles published from the year 2000 and March-2020. The keywords for technology-specific databases (IEEE/ACM) searches were ("intergenerational") OR ("intergenerational" AND ["collaboration" OR "barrier"]) OR ("intergenerational" AND ["challenge" OR "problem" OR "GAP" OR "barrier" OR "obstacle"]). Moreover, for non-technology focused databases, we detailed the keywords for designing a digital technology to support IGC in the workspace ("intergenerational" AND ["digital" OR "computer" OR "technology"] AND ["gap" OR "barrier"] AND ["workspace" OR "workplace"]).

A publication was included as a source for the analytical review process if the proposed inclusion criteria were fulfilled [37]; likewise, a publication was removed from the reference list if the pre-defined exclusion criteria were found to be met. The inclusion and exclusion criteria are set out in Table 2. In selecting keywords, the term "intergenerational" already limited the number of articles. By including the term "Wellbeing" into the keywords selection, the results will be returned no selected articles. Therefore, in this phase, the term "Wellbeing" was not used but will be included in the second stage of analysis by combining different aspects of wellbeing determinants.

3.2 Bibliometric analysis

Once a relevant literature set was identified for inclusion in the review, a bibliometric analysis was conducted based on the corpus of abstracts. The abstracts of the articles provide an overview of the research presented in the study and can therefore serve as a basis for identifying relevant terms and concepts that are commonly used for the study context beyond the keywords presented. Bibliometric analysis is a quantitative analysis tool to generate information about statistical metadata information to uncover emergence topics within a particular research area [38, 39]. One possible outcome of the bibliometric analysis is to list various terms and indicate the number of occurrences of each term (also with other terms to build the network between terms) in the collected data [39–41]. The correlation of the term with other terms can be determined to create a network visualization between the terms [40, 41]. Bibliometric analysis can be used to identify correlated terms based on the abstract to understand how research related to barriers to intergenerational innovation uses different terms in the knowledge corpus of this study context. Vosviewers software was used to conduct the bibliometric analysis, automatically provide cluster and weighting value of each term, and visualize the

Table 2 Criteria for inclusion and exclusion

Inclusion	Exclusion
Peer-reviewed journal or proceedings	Not written in English
Explicit citing of intergenerational terms in the abstract, title, or keywords	No explicitly stated barriers to IGC
Intergenerational collaboration in the context of the innovation process	No implications for younger and senior adults collaboration or in the global context

knowledge network [40, 41] based on the abstract of the included literature.

3.3 Literature analysis

The development of the conceptual model followed abductive thinking. Therefore, the best explanations for a particular concept were developed based on the selected articles' available observations. A single researcher conducted the coding procedure for content analysis to develop an initial conceptual model from the literature, following the epistemological approach of qualitative inquiry [42] and since a single researcher was used for the coding procedure in this study. Consequently, it is not necessary to perform inter-rater reliability for content classification validity in this study [43]. However, to achieve a robust result, a consensus approach was used. The initial conceptual model was presented and discussed with three other researchers with expertise in the study areas. All discrepancies in the initial conceptual model were reviewed and resolved until no further comments were received for significant changes to reach consensus among the researchers.

To provide a wellbeing-oriented design framework for the IGC, we used the concept matrix approach for literature review [19]. We synthesized the content of selected publications carefully, listed the identified barriers, and merged the redundant barriers based on their respective verbs and objects. Initially, we classified the barriers into four barrier dimensions based on the classification of Adams [34]. Those barriers that did not fit one of the defined classifications remained uncategorized. We coded and identified the similarity between uncategorized barriers until all the barriers were grouped based on the similarity of topics, objects, or verbs. The process was iterative until all barriers were carefully fit into one of the categories to the developed matrix of concepts (See Appendix Table 6).

The second stage of the analysis and review of the wellbeing factors led us to determine the type of collaboration activities, such as ideation, design, and development, or commercialization [10, 44]. Publications were grouped into collaborative and non-collaborative innovation activities. We analyzed 40 publications looking for three main activities in the innovation process (ideation, design and development, commercialization) of the collaborative innovation activities, using manual content analysis to find the determinants. We drew on keywords based on the wellbeing determinants of the PoCo approach and thoroughly read the selected papers to identify the relevant determinants. Accordingly, we identified the correlated wellbeing determinants of collaborative innovation processes [10, 44].

4 Result

4.1 Network visualization of relevant terms based on the abstract corpus

The bibliometric analysis results provide 59 terms clustered into six categories and provide visualization of the networking terms (Fig. 2). The first cluster has 22 terms or 37,28% of the identified notions, including [words (number of occurrences)]: benefit (7), characteristic (7), conflict (9), engineer (13), evidence (9), generation (55), generational difference (17), idea (10), knowledge (12), leadership (5), member (8), older worker (49), organization (9) outcome (10), problem (17), process (28), resource (5), solution (7), usefulness (5), work (9), worker (7), workplace (7). The first cluster shows the dominance of identified literature on the study context regarding intergenerational collaboration (for the terms: generational differences and generation) and collaborative innovation (for the terms: leadership, member, idea, knowledge, process, organization, workplace). Moreover, it also has relevancy regarding the term of problem and solution.

The second cluster consists of eighteen terms (30,51%) that can be described as technological experiences that mediate intergenerational collaboration; the terms included in this cluster are computer (7), experience (18), factor (14), family member (15), game (14), internet (12) medium (12), older person (8) past (5), population (11), project (15), service (16), sns (5), social interaction (6), social medium (5), system (17), use (16), and user (15). The third cluster consists of seven terms that focus on how to understand the technology accessibility of different roles: access (5), case study (5), family (27), programming (6), range (5), role (9), understanding (10).

The fourth cluster describes terms related to the teachers' types and forms: analysis (15), form (9), place (5), teacher (18), type (7), way (7). Moreover, the fifth clusters consist of five relevant to wellbeing and the background: mental health (6), migrant worker (8), the new generation (7), old

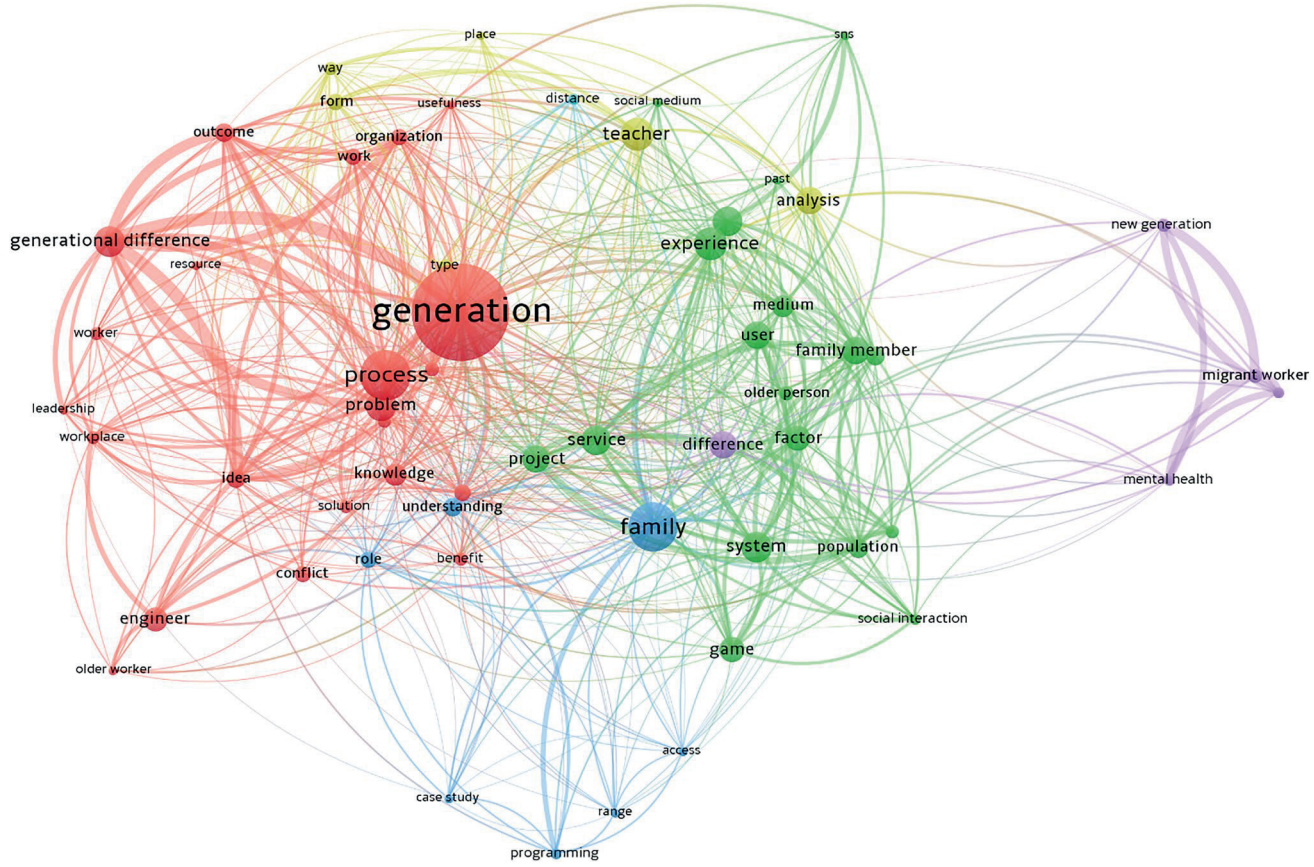

Fig. 2 Visualization network between identified terms in the study of intergenerational collaborations

generation (6). The last cluster has only the term "distance (6)".

4.2 Wellbeing-driven Framework for Intergenerational Innovation

The descriptive statistics of the collected papers (Fig. 3, right) show that researchers' interest in the correspondence barriers of the IGC has increased over the last five years. Given the origins of the studies, the global movement of the IGC study covers all continents except Africa (Asia: 13.7%; South America: 4.4%; Australia/Oceania: 8.6% Europe: 28.7%; North America: 38.4%; a collaboration between North America and Europe: 6.2%). The analysis of the study origins parallels the growing number of individuals in the aging population in both Europe and North America [45].

In terms of the sector in which the study was conducted (Fig. 3, left), the analysis of IGC-related barriers usually focuses on neutral industries (or can be conducted across industries). However, education and health care are the two dominant sectors where barriers to IGCs are prevalent. Interestingly, few studies seem to focus on banking, retail, hospitality, or government.

4.2.1 Barriers dimensions of intergenerational innovation

The conceptual mapping of barrier dimensions for intergenerational innovation comprises five dimensions. They include personal views (perceptual and emotional) and environmental views (cultural, institutional, technological dimension). Based on the conceptual matrix of Appendix Table 6, we present in Table 3 the five barrier dimensions of intergenerational innovation.

As a first step toward implementing a positive IT design for IGC, we identified five barrier dimensions covering a wide range of common challenges and difficulties faced dynamically by senior and younger adults in innovation activities [7, 33]. The barrier dimensions represent an important element in the implementation of the deductive approach of positive computing.

Emphatic/Perceptual barrier dimension. We defined the empathic dimension as the negative viewpoint of a generation toward different generations. This strong negative viewpoint hinders IGC because of someone's experience in the past. Barriers related to perceptions of others include age discrimination [46, 57, 58], a different mindset [32, 58] and interests [59, 60], and generational resistance [27, 46, 58].

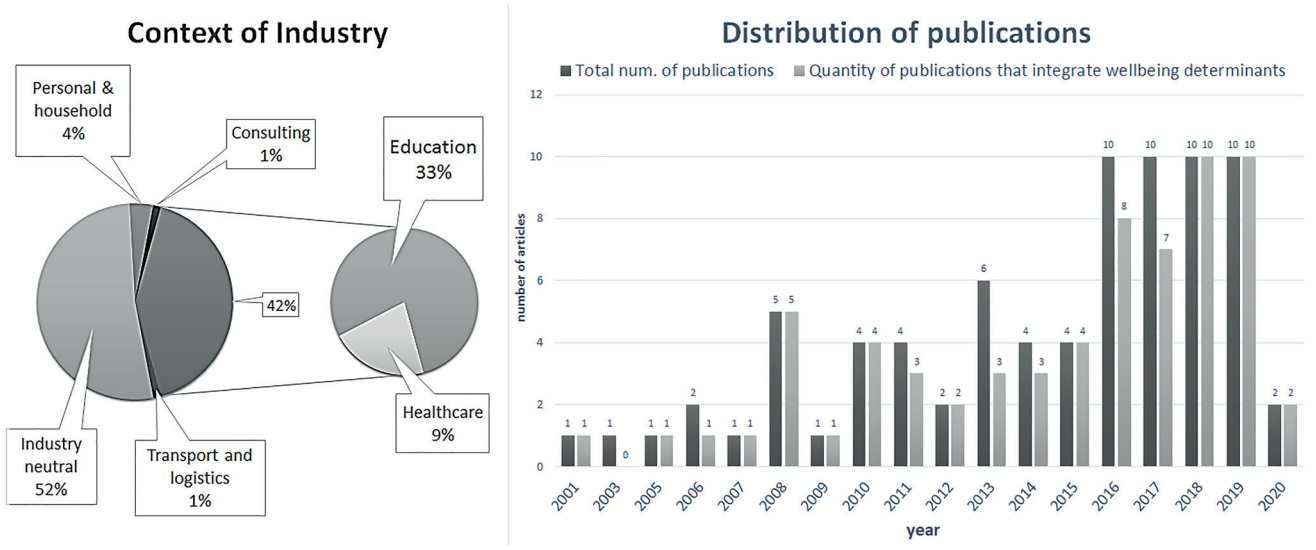

Fig. 3 Mapping the IGC publications

Table 3 Barrier dimensions of intergenerational innovation

Dimension	Explanation	Example of references
Perceptual barriers	Barrier dimension concerning the way someone perceives others. Negative viewpoints of a generation toward different generations	[32, 46–49]
Emotional barriers	Associated with a negative self-view or egocentricity. These barriers are related to how people understand themselves	[6, 50, 51]
Cultural barriers	Denotes external environmental barriers that focus on informal codes and standards	[9, 48, 52]
Institutional barriers	Imposing barriers from the external that elaborate organized or formal rules and requirements	[9, 51, 53]
Technological and Operational barriers	Barriers associated with technology and operational use	[54–56]

Moreover, a lack of understanding of IGC [29, 61], a lack of awareness of differences between generations [27, 32, 62], a lack of empathy [47, 58], building interpersonal trust [32, 63] and a lack of respect [47, 58] are challenging to cross-generational collaboration.

Emotional barrier dimension. The emotional dimension is a collection of barriers associated with feelings and a negative self-view or egocentricity. These barriers are related to how one generation conceives of working with another generation. Barriers in this category are feeling underappreciated or unappreciated [32, 58, 59] and lack of self-confidence, and the feeling of reacting too slowly [47, 64]. Fear of technology [59, 61, 65], functional limitations [46, 61, 66], lack of motivation [61] and feeling isolated [46] are barriers related to the emotional dimension.

Cultural barrier dimension. The cultural dimension represents external environment-related barriers that concern informal codes and norms. One of the main issues of global collaboration is the substantial differences in cultural traditions compared to other generations [59, 67]. Barriers also arise in this category because people are unaware that they can work with culturally different people [66, 68]. Furthermore, other barriers in this dimension that can hinder IGC are a lack of social support [32, 59, 67] and a lack of sensitivity to technological design that interferes with the cultural background of a particular generation [13, 66].

Institutional barrier dimension. The institutional dimension is defined as administrative barriers that focus on organized rules and requirements, including barriers to shared resources [13, 66, 78], geographical distance [78] between cooperation partners, and high market uncertainty in product markets [8, 56, 68] for innovation partnerships. Data protection issues [63] and differences in educational levels [46, 59, 63] can complicate technology-mediated intergenerational collaborative innovation.

Technological and operational barrier dimension. The technological and operational dimension covers barriers related to knowledge and resources regarding technology and operational use. Barriers in this category include lack of independence [54, 72, 79], the high cost of technology

investment [46, 59, 63], the complexity of virtual presence management [63, 65], and generational differences in technological backgrounds [47, 52, 59, 63, 67, 69]. Other barriers are lack of joyful activities [54, 59, 69, 80] that can be integrated into real-life collaboration [46, 50], the lack of technical training for digital collaboration [63], insufficient technological access [52, 63, 69] without a supportive technological environment [52, 55, 56, 69, 81], and the complexity of technology [56, 65, 82]. In some cases, the collaboration between the two generations could also be challenging because there is no right time for an appointment [21, 32, 83]. The differences in routine patterns are unclear [13, 35, 78].

4.2.2 Wellbeing determinants of intergenerational innovation

The selected publications may not have explicitly mentioned the type of collaborative IGC innovation activities. Some publications dealt with more general collaborative innovation activities [8, 13, 35, 60, 68], including exploration (ideation and design and development) and commercialization or market exploitation [13, 44, 56, 84]. Even though the IGC potentially boosts innovation, we identified only three publications [8, 56, 68] highlighting IGC-related barriers that promote collaboration in commercial activities. Table 4 shows the wellbeing determinants as enablers of IGC identified from the literature.

Positive emotions of joy and playfulness in intergenerational knowledge exchanges. These positive emotions are feelings or forms of expression linked to the emotional experience of joy incorporated into the IGC. The experience of joy should be perceived when using an IGC system. The determinant has been identified in the design and development, and exploration. The types of interventions involved in enjoyment are the use of hybrid technology by combining the physical and digital spheres in a collaborative activity, the use of persuasive technology, and location-based gamification [52, 56, 69, 70].

Positive emotions of interest in and exploration of a problem-based learning scenario. Such feelings or expressions are related to the emotional curiosity acquired in learning integrated into the IGC. These feelings frequently emerge in unforeseeable scenarios. Twenty contributions pointed to the user's interest and exploration of the IGC system design. The determinant has been identified within the following IGC activities: ideation, design and development, and exploration. Competence development programs through hackathons [73] or using blended learning for IGC were integrated to foster the interests of the collaborators of IGC. Guidance on technological use, integration of hub agents, and gamification via assisting systems or robots can also be employed [33, 50, 51, 71].

Positive emotions of pride and achievement of collective goals. Such feelings or expressions are associated with the emotional experience of accomplishing purposeful goals, such as achieving a list. These types of emotions do exist in the exploration. The types of interventions encountered in the literature are social presence digitalization and implementation of persuasion technology [33, 35, 72–74].

The positive emotion of competence-based contentment and self-views. It is an emotion or expression associated with the experiencing of high certainty and minimal effort based on self-reflection. These emotions can be found in the IGC innovation activities of idea generation and exploration. The types of interventions in the literature are attributes that support the exchange and building of competencies for the IGC, the use of interactive storytelling, and scheduled IGC evaluation and assessment programs [8, 9, 30, 33, 69, 75];

Motivation and Engagement (ME). Motivation and engagement for the IGC community represent a flow of personal experience or the momentary state of affairs that

Table 4 Wellbeing determinants as an enabler for intergenerational innovation

Determinants	Explanation	Example of references
Joy and playfulness	Positive emotions (joy/playfulness) are feelings or expressions related to the emotional experience of pleasure that is integrated into IGC	[52, 56, 69, 70]
Interest and exploration	Positive emotions (interest/explore) are feelings or expressions related to the emotional experience of curiosity that is integrated into IGC	[50, 51, 71]
Pride and achievement	Positive emotions (pride/achievements) are feelings or expressions related to the emotional experience of achieving meaningful goals	[35, 72–74]
Competency-based contentment and self-views	Positive emotions (contentment/self-views) are feelings or expressions related to the emotional experience of high certainty and low effort based on self-evaluation on competency development	[8, 9, 30, 69, 75]
Motivation and engagement	Motivation and engagement are the flow of experiences or the momentary condition that balance between task and competence	[55, 69, 70, 76]
Apprenticeship-based social relatedness	Apprenticeship is "concerns the act of 'helping others." It provides functionality that can support social interaction and actualization to help others	[50, 51, 69, 71, 75, 77]

creates a balance between challenges and competence as well as stimulating eagerness, self-responsibility, and ownership. ME was found the following ICG innovation activities: ideation, design and development, and exploration/commercialization. Gamification, persuasive technology, self-assessment and evaluation instruments, competence acquisition through role-playing, and intergenerational community building can be applied to support ME [33, 55, 69, 70, 76].

Apprenticeship-based social relatedness (empathy, compassion, altruism). The determinant deals with the act of helping others. It presents functionality to support social interaction and self-actualization to assist in helping others. Mentorship and camaraderie are good examples of the relatedness found in the IGC innovation activity of exploration. Some publications related the wellbeing determinant of "relatedness" to ME in ideation and exploration. The purpose of the determinants for the IGC is to strengthen the interpersonal and professional ties between younger and senior adults through persuasive technologies for the co-development of innovative products, hybrid/blended learning, and location-based game, a workshop for competence development, digitize social presence, and interaction [33, 50, 51, 69, 71, 75, 77]

5 Discussion

In this study, through the process of SLR, we combined bibliometric analysis with a two-step literature analysis. Correlation between different terms related to intergenerational collaboration was identified. Detailed barriers and wellbeing-based solutions were presented. Based on the bibliometric analysis, we discussed several correlated important terms that were found from the selected literature. First, our study shows that problems in intergenerational collaboration are complex and multifaced. To support the previous study [9], the problems in intergenerational collaboration can occur in the workplace, and organizational context, but also in the family context regarding different experiences of technological used [37, 59, 85]. There is also relevance to take attention to the leadership skill for intergenerational collaboration, different accessibility, and importance to discuss what are the expected outcomes of intergenerational collaborations. The filtered visualization of the network of problems can be seen in Fig. 4.

Second, when filtering the visualization network by the term "solution" (presented in Fig. 5), the study results show that the number of occurrences is smaller than that of the term "problem," which means that it is important to investigate the problems before exploring relevant solutions for intergenerational collaboration. Some terms that correlated directly with the terms "problem" also correlated directly with the "solution," such as leadership, workplace, process, work, outcome, and terms related to the second cluster or technological experiences (user, factor, and computer). In the visual networking of terms, the terms "games" were also mentioned, showing the potential for gamification of tasks supported by digital technology within innovations in intergenerational settings. Furthermore, there is no direct link from "solution" to the term "mental health," which is known to be negatively associated with wellbeing [14]. However, in this study, a two-step literature review was conducted to gain a deeper understanding beyond numbers and bibliographic analysis of competing concerns and the role of wellbeing determinants that have been used but little recognized.

The mapping of barriers and correlated wellbeing determinants contributes to developing a conceptual framework for the positive design of the IGC in the context of innovation activities as part of the preventive approach of PoCo (Calvo and Peters 2014). To mitigate the factors that are hampering the IGC's interaction with technology, we identified five-dimensional barriers. These barrier dimensions may generally be applied to collaboration in a global context, as the barriers were identified from different continents and cover the cultural dimension.

As for the theoretical contributions of the study, compared to previous dimensions [34, 35]regarding the IGC, the barrier dimensions underpin the current study on barriers to intergenerational innovation, which includes specific dimensions for technological and operational skills [7, 13]. Such barrier dimensions also embody the nature of technology-mediated IGC and the challenges faced by generations regarding technological interaction.

Regarding barriers in the PoCo framework, Calvo and Peters [14] suggested that gratitude and empathy could help to combine interpersonal aspects and technological attributes. We found empathy, compassion, and altruism (ECA) associated with collaborative innovation activities as opposed to gratitude. ECA is commonly linked with relatedness or social connectedness [14]. Therefore, we propose relatedness as the wellbeing goal of IGC (as the dedicated approach to IGC design oriented toward wellbeing). Barrier dimensions of the IGC relating to empathy and perception can be addressed through the use of robots, chatbots, or digital mediators, which can facilitate collaboration and potentially alleviate negative sentiments and difficulties in communication and mutual understanding [86, 87]. Apparently, as one of the strongest predictors of wellbeing, gratitude [88] appears to be missing from the literature. It can be an alternative determinant of wellbeing in a dedicated approach to designing IGC systems. The supportive relationship can be used in synchronous and asynchronous IGC communication channels in the context of mutual learning [67, 74, 85].

Furthermore, the IGC design can be shaped to support coping skills to transform empathy into actions that can deal with judgment and guilt [14]. Role-playing between

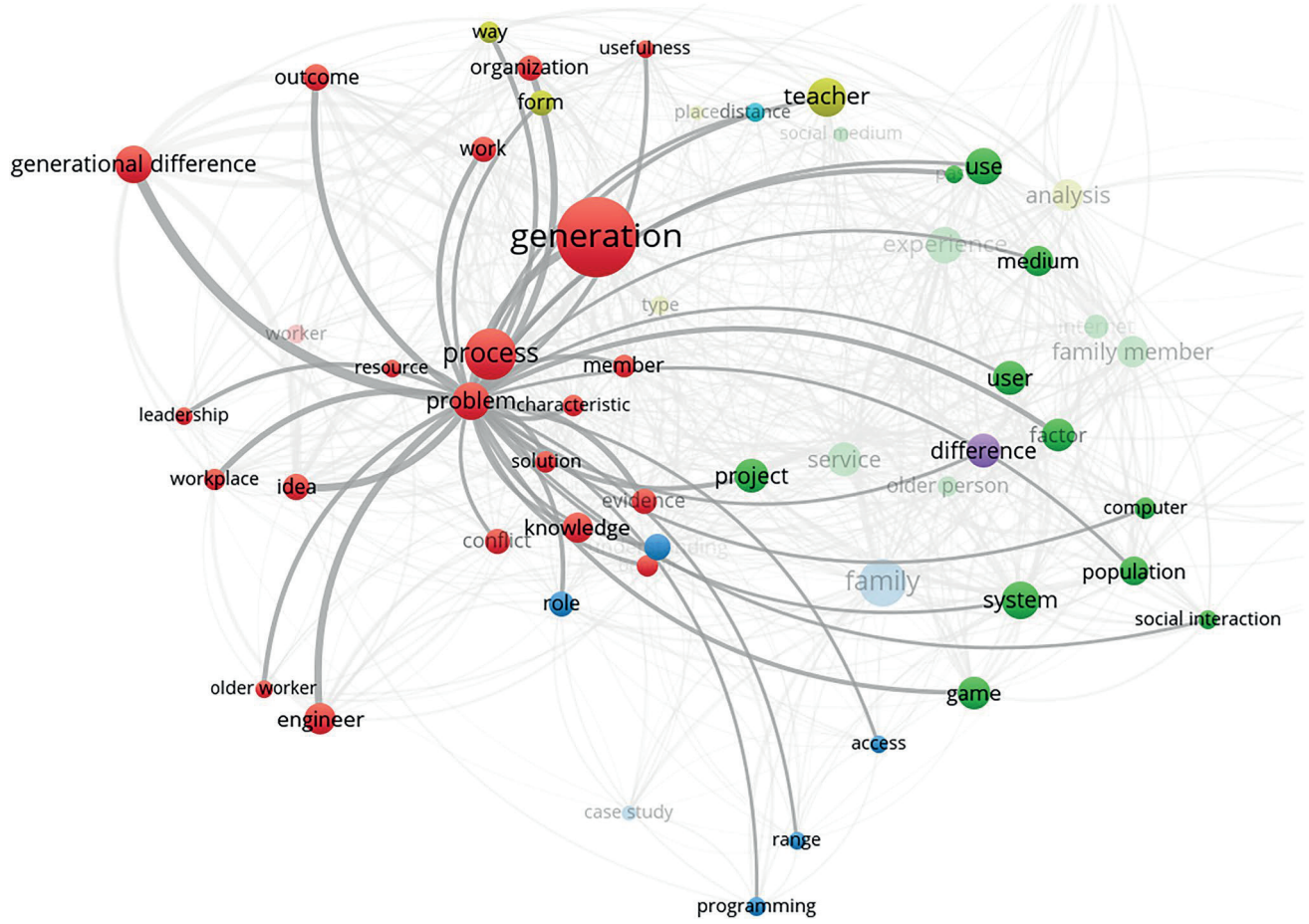

Fig. 4 Network visualization of the term "problem" in the literature on intergenerational collaboration

generations in localized community-based activities [2, 72, 74, 87, 89] could strengthen the emotional bonds and empathy among collaborators and tackle the dimensions of cultural and perceptual barriers.

We also found that compared to other wellbeing determinants without including the positive emotion that consists of three sub-categories, motivation and engagement focus on IGC publications (occurring in 20.3% of selected papers, based on Appendix Table 6. Therefore, system designers of IGCs should be aware of interventions that address motivation and engagement. Moreover, setting a common meaningful goal, empowering creativity, and eliciting appropriate feedback through virtual goods to motivate [90] both the senior and younger adults is important.

We were not able to identify any papers in which "positive emotion" was explicitly mentioned. Instead, we noticed that joy and interest were referred to in 16.2%, interest and exploration: 27%, pride, and achievement: 4% selected publications as enablers for IGC. Therefore, we considered joy, interest, and exploration as determinants of wellbeing to support the IGC design and recommended positive emotions as a critical factor of wellbeing in the active approach of the PoCo. Additionally, the experience flow may be combined with positive emotions to accommodate fun and enjoyable activities such as serious games or gamification [35, 74, 87, 89].

Obviously, cultural, institutional, technical, and operational barriers to the system design are common [7, 19, 91] and emerge in the IGC system. We consider pride and contentment to be one of the alternative determinants of an active approach to wellbeing-driven system design [14]. Although these are two elements of positive emotions, they were rarely discussed. Nevertheless, pride or achievement might serve in the exploration process. For instance, system designers could use a progress bar to set action rewards, a ranking, and badges to promote satisfaction and pride [90].

Concerning institutional barriers, the IGC system designer can use the determinant pride or accomplishment to integrate the competency-based self-assessment system into the matching process of the IGC system. IGC collaborators can evaluate and self-reflect their skills development and performance [79], which may overcome barriers,

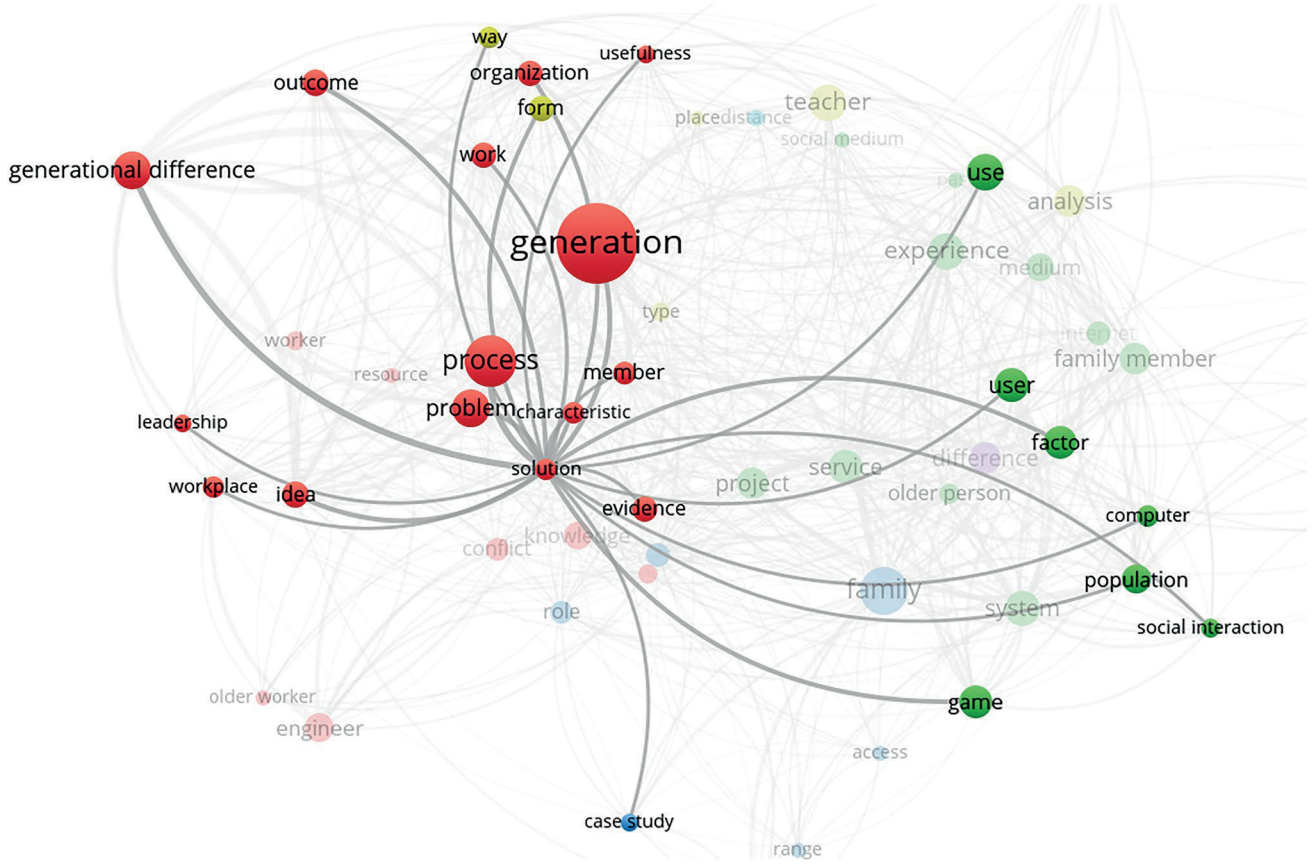

Fig. 5 Network visualization of the term "solution" in the literature on intergenerational collaboration

particularly in the institutional dimension. The self-assessment system can automatically match collaborators or help identify the right person with whom to collaborate. A hybrid technology [52, 53, 92] combining tangible and intangible technologies also leads to developing a system that can be customized according to the user's physical and cognitive abilities and preferences.

Overall, in terms of knowledge contribution, the outcome of this study, by providing targeted determinants of wellbeing, confirmed the previous study in focusing on activities, roles, goals, or motivation to promote intergenerational collaboration [93], rather than focusing on age stereotypes [12].

For practical contributions, the proposed conceptual framework can be used as a basis for the development of IGC system requirements, as a reference for system designers or developers in the development and prioritization of system design principles. The proposed barriers and enablers of an IGC system can also be used as an assessment tool or to evaluate an existing system that is to be used to support intergenerational collaboration.

Moreover, system designers can use the framework to identify the appropriate design principles by targeting specific wellbeing determinants for the IGC context. Also, system designers can prioritize particular barriers and enablers to design technology for the IGC setting. For IT designers with a strong background in developing applicable interventions based on the Design Science Research Methodology, the barriers can be used as an entry point for the research design process of problem identification or research entry points for objective solutions [94]) for positive design interventions [15]. Also, for IT designers who focus on human-centered design [91], the dimensions of the barriers, as well as the wellbeing determinants, can be used to develop user personas [91] and set the proposed wellbeing determinants as part of the goal or motivation for the IGC personas [7].

6 Conclusion, limitations, and recommendations

In conclusion, subsequent to the analysis conducted to address the primary research question, we elaborated an overview (Fig. 6) on designing a wellbeing-driven IGC system. The overview emphasizes the positive design of

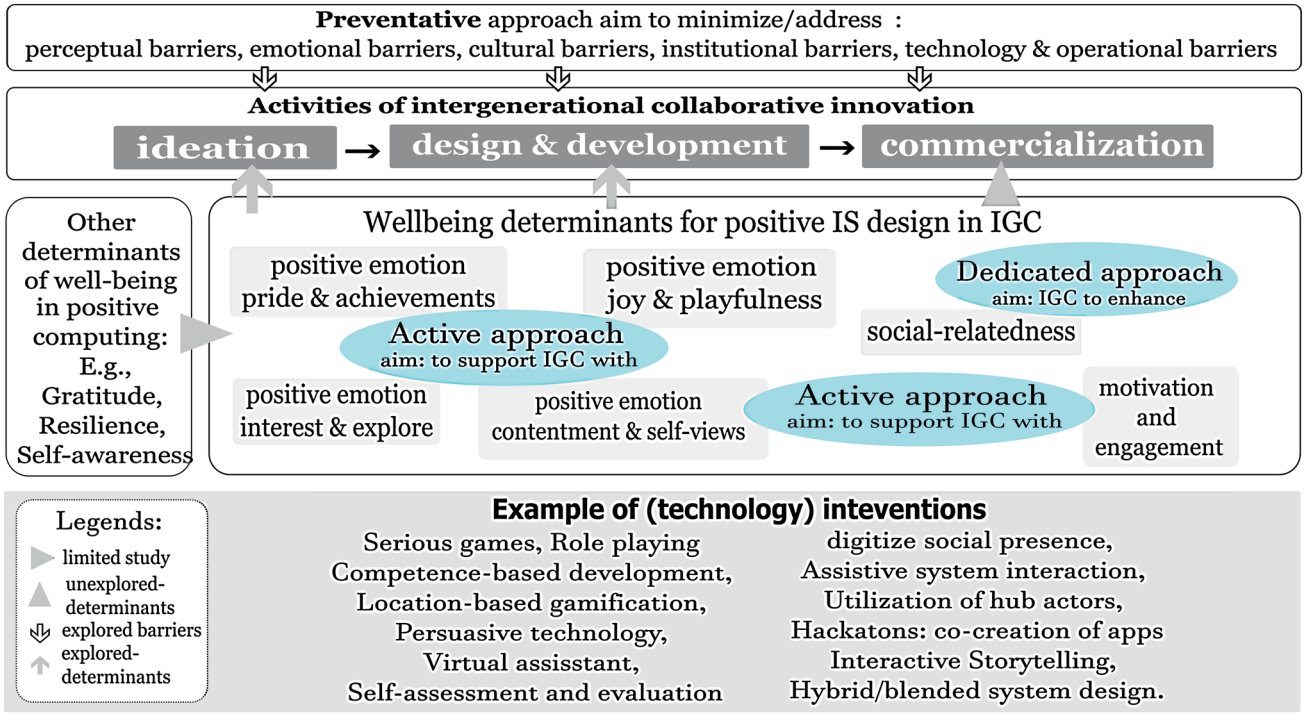

Fig. 6 Wellbeing-oriented IT design for IGC

IGC in innovation activities by incorporating various types of technological interventions.

To promote a wellbeing-driven system for IGC, the system can be initiated by integrating five dimensions of barriers, the correlated wellbeing determinants, and implementing preventive (to remove the barriers), dedicated (to improve social relatedness between generations), or active approaches (to support innovation activities with design for positive emotions including achievements, contentments, self-views, interest and exploration; and design for motivation and engagement) according to the PoCo level of implementation. To achieve the positive design for the IGC system, system designers can utilize, for instance, the gamification approach, competency-based collaboration in hybrid digital environments.

Moreover, several limitations are also presented in this study for further analysis 1) Different keywords were applied; however, subjective opinion is nature in the search effort, particularly selecting the keywords. Keyword selection can affect search results. It is essential to determine whether keywords produced the best results. Some associated keywords may be missing;

2) We only performed web-based automatic literature searches. Databases selected may contain important journals that were not included in the selected literature. However, we have carefully conducted the selection process. A manual search was also performed, and relevant where recommended IGC journals from IGC scholars and experts could be included;

3) Lack of thorough location-based barrier analysis to identify barriers relevant to specific continents could be used to design a global IGC system. Therefore, our study's limitations also represent an opportunity for further research to support the IGC innovation process.

The findings suggest that motivation, engagement, and positive emotions (interest and pleasure) play an integral role in the IGC. As far as motivation and engagement are concerned, specific competencies are required for assignments within the innovation activities, e.g., problem-solving and creative thinking. We noted that the IGC is a global issue and increasingly attracts researchers interest in all continents, which can be useful in many areas, particularly in the education and training industry. We expect that further studies on the technology-mediated IGC will open up new opportunities to assess and elaborate on the proposed framework. Therefore, in Table 5, we provide a set of questions that need to be addressed to close the gaps in recent IGC studies, allowing researchers to modify these questions to better suit particular research problems.

Table 5 Proposed research questions for further studies

Proposed questions	
Topic related to IGC Barriers	How does the barrier framework affect the choice of technology and approaches in intergenerational system design?How do both generations perceive the level of barriers to collaborative innovation? What barriers do both generations believe will have the greatest impact on each of the more specific collaborative innovation processes? How do the dimensions of the barriers change dynamically in the innovation process? Which barriers should be given priority in the development of specific technologies for the IGC? How can age differences be incorporated into the system, which focuses on the barrier dimension of the IGC?How does the dimension of the barriers of the IGG manifest itself in different industrial sectors, especially in public institutions?
Topic related to Method	How can a well-being-oriented design approach to an IGC system be evaluated? How can we better design a social inclusion system that takes into account the preferences of both younger and senior adults? How can the participation of both generations in designing a support system for the IGC on global innovation be facilitated?
Topic related to Wellbeing determinants as IGC enablers	Which wellbeing determinants of PoCo can promote IGC in the commercialization process? How and what type of competencies (human potential) in the global innovation process can be supported by the dedicated design approach of IGC? Why are particular wellbeing factors superiors compared to other determinants to support the IGC? Which personal, social, and organizational factors contribute to the better impact of the wellbeing determinants? How can the determinants of wellbeing be integrated into more detailed innovation activities?Which design principles based on the wellbeing determinants are suitable for the IGC?How can technology be designed to promote gratitude in the IGC?

Appendix

See Table 6**Table 6** Concept matrix of IGC studies

Reference	Barriers					Wellbeing determinants					
	PB	EB	CB	IB	TB	JP	IE	PA	CS	ME	AR
[95]			x		x						
[52]			x		x	x	x			x	
[46]	x	x			x						
[61]	x	x			x						
[96]					x						
[69]					x	x	x		X	x	x
[97]	x	x		x							
[98]	x			x							
[50]		x		x	x	x	x				x
[59]	x	x	x	x	x						
[65]	x	x			x						
[99]	x		x								
[47]	x	x			x		x			x	
[100]				x							
[67]			x	x	x	x	x			x	
[48]	x	x	x	x					X		
[53]		x	x	x		x			X	x	
[63]	x			x	x						
[32]	x	x	x		x						
[101]	x		x								

Reference	Barriers					Wellbeing determinants					
	PB	EB	CB	IB	TB	JP	IE	PA	CS	ME	AR
[55]	x			x	x				X	x	
[51]	x	x	x	x			x				x
[71]					x		x		X		x
[102]	x										
[49]	x				x		x				
[82]			x								
[6]	x	x			x					x	x
[20]	x						x				
[60]	x						x				x
[103]					x						
[86]					x		x		X		
[104]		x		x	x						
[105]			x	x	x						
[72]	x					x		x	X	x	
[79]		x				x	x			x	
[56]	x		x		x						
[73]	x	x			x		x	x			
[106]	x	x	x		x		x				
[92]				x	x		x			x	
[81]				x							
[29]	x				x						
[31]		x			x						
[57]	x	x			x						
[107]					x						
[35]					x	x	x	x			
[108]	x		x								

Reference	Barriers					Wellbeing determinants					
	PB	EB	CB	IB	TB	JP	IE	PA	CS	ME	AR
[74]	x					x		x		x	x
[23]			x		x				X		
[80]	x	x			x						
[64]		x			x						
[68]			x	x							
[78]				x	x						
[66]		x	x	x							
[13]	x	x	x	x	x		x				
[75]	x			x	x				X		x
[62]	x										
[109]		x	x	x	x						
[9]	x	x	x	x					X		
[83]					x						
[30]			x	x					X		
[77]	x		x						X		x
[70]	x					x				x	
[110]			x	x							
[58]	x	x			x						
[8]			x	x					X		x
[87]	x		x			x	x			x	
[111]	x										
[112]			x		x						
[113]	x		x								
[114]				x	x						
[76]	x		x	x							
[89]				x		x	x			x	
[115]	x				x						
[85]					x		x			x	
[21]	x				x						

PB Perceptual barriers dimension, *EB* Emotional barriers dimension, *CB* Cultural barriers dimension, *IB* Institutional barriers dimension, *TB* Technological and Operational barriers dimension, *JP* Joy and playfullness, *IE* Interest and exploration, *PA* Pride and Achievement, *CS* Competency-based contentment, *ME* Motivation & Engagement, *AR* Apprentincehsip-based Social relatedness.

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Declarations

Conflict of interest The author declare that they have no conflict of interest.

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III

WE ARE "NOT" TOO (YOUNG/OLD) TO COLLABORATE: PROMINENT KEY BARRIERS TO INTERGENERATIONAL INNOVATION

by

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Abstract

In this study, we analyzed the barriers to technology-supported intergenerational innovation to understand better how young and old can collaborate towards global innovations. Researchers in different disciplines have already identified various barriers to intergenerational collaboration. However, barriers are changing depending on the context of collaboration, and difficulties still exist to support intergenerational innovation in global settings. Therefore, we investigated the barriers that emerge when people work with someone decades older or younger. The results of our study have shown what barriers are influenced by age, what barriers exist only for senior and younger adults. The study theoretically contributes to deepening the Information Systems (IS) community's understanding of the barriers to intergenerational innovation that need to be considered when developing systems for global innovation.

Keywords: challenges, problems, cross-generational cooperation, intergenerational teamwork, global innovation

Introduction and Motivation

Demographic change is a challenge and an opportunity for companies in the industrial age 4.0 or the connected industry (Gordon 2018; Wolf et al. 2018). The collaboration between senior and younger adults can take place in different contexts. Studies show that intergenerational collaboration flourishes within the context of family social relationships (Miller et al. 2003), as well as organizational contexts

such as business development (Litz and Kleysen 2001), educational and teaching industry (Edge 2014; Talmage et al. 2016) and healthcare industry (Mestheneos and Withnall 2016). Besides, recent trends in the digital workforce also try to bring back the senior adult to support startup development (Edelman et al. 2016; Gordon 2018; Wolf et al. 2018). The demand to design a system that supports intergenerational collaboration is not only because the member of an organization can consist of four different generations (Forbes 2011; Gordon 2018). Various studies show how the positive effects of intergenerational collaboration affect the increase in the innovation of an organization (Forbes 2011; Miller et al. 2003), the increase in individual well-being of younger and older generations (Amaro et al. 2016; Levitt et al. 1992) and fostering the experience and knowledge transfer between the team member (Harvey 2012; Hillman 2014).

Furthermore, innovation is one of the essential keys to global business (Pawlowski 2013; Rönkkö et al. 2013) moreover, intergenerational innovation is common knowledge in the sustainable success of kinship- or family-based company (Litz and Kleysen 2001; Miller et al. 2003). Given the various advantages of intergenerational collaboration for businesses, particularly in the context of innovation, there are still considerable obstacles to the design of information systems that underpin intergenerational collaboration. On a broader level, the focus of user study in human-centered system design (Cooper et al. 2014) and value-based product innovation (Osterwalder et al. 2014) shows the essential role in the investigation of barriers as entry points for system developers (Cooper et al. 2014; Nurhas et al. 2017) and the design for inclusion and human well-being (Calvo and Peters 2014). To our knowledge, however, such distinct key barriers are not yet available for user modeling in an intergenerational context.

The use of technology in combination with intergenerational collaboration is one of the critical keys to tackle the barriers of demographic change and transforming them into opportunities for innovation (Forbes 2011; Gordon 2018). These barriers are increasingly being experienced in different countries and organizations (Gordon 2018; United Nations 2017) and are still difficult to overcome in the design of a system that supports intergenerational collaboration of two people or groups from very different age ranges who go through different phases of their lives (Edge 2014; Forbes 2011; Gordon 2018). This age gap is related to work expectations and the use of technology or other age-related challenges (Edge 2014; Forbes 2011). Also, if the differences are not adequately addressed, it will lead to severe misunderstandings (Forbes 2011) in collaborators capability (Kurniawan 2008), cultural background (Charles and Charles 2016) and technological experience (Cresci et al. 2010) that can hinder the collaboration (Forbes 2011; Gordon 2018). Therefore, in this study, we aim to answer the related questions on why intergenerational collaboration in the innovation process tends to be difficult and which are the prominent barriers for the individual in intergenerational collaboration through technology intermediaries?

Advancements in technology and science can trigger demographic change by improving the quality of life in a country that improves the average lifespan of its population. In some countries, the greying the population is on the rise, it describes an increase in the number of senior adults, which is often not accompanied by an increase in the number of young adults due to social, lifestyle or work-related factors (Boling 2008; United Nations 2017). Besides, the improvement of life quality in one country attracts young citizens from other countries, whether for educational reason, for business, or because of the effects of wars or ongoing conflicts in their community, all reasons aimed at improving the quality of life for the better future (Nesterko et al. 2013; United Nations 2017). The growing number of greying population and the recent arrival of young people from different cultural backgrounds encourage companies to integrate these differences into their business process activities and innovation (Forbes 2011; Gordon 2018; Nesterko et al. 2013).

Although some publications have mentioned various limitations related to collaboration (Boulton-Lewis et al. 2007; Charles and Charles 2016; Muñoz et al. 2015; Nurhas et al. 2018; Stoffregen et al. 2015) that can be addressed through the design of information technology (Kow et al. 2012; Muñoz et al. 2015; Nedelcu 2017), the prominent barriers have not been identified in the global innovation process where the collaboration between different generation must be carried out without close family or cultural relation. To address this research gap, we conducted a quantitative study (Wright 2005) among people aged 18 to over 65 to highlight the critical barriers posed by the various issues identified in the

literature and to map these barriers by the global innovation process. The result of this study provides insight into intergenerational collaboration in a global context and the process-based innovation barriers. We also discussed the practical contribution of the study in order to give the system designer a first impression of how barriers are perceived differently.

In the following section, we initiate a literature review highlighting the barriers identified from different literature and the primary process in the context of global collaboration. Next, the method is briefly outlined. We then analyze the results of our study and discuss the contribution of our research. Finally, we present the limitations of the study, recommendations, and conclusions from our research.

Theoretical Background and Formulation Hypotheses

In this section, we describe the barrier model underlying our study concerning the global innovation process, as the basis for determining how these barriers evolve according to the innovation process.

Global Innovation Process

Innovation is the heart of the business movement, and it is one of the timeless vital ingredients for the success of business or organization. The term of innovation to some extent is interchangeable with the word "invention" or "improvement" that is because innovation is very closely related to the identification of value added (Brozen 1951) which is also part of an invention and improvement. More than that, the value offered in innovation is an economic value or business reliable. Therefore, in our study, we follow the definition of innovation from (Li et al. 2008) and understand that “innovation” is an “invention” that must be accompanied by “exploring” the potential to social, business and financial gain for the inventor. An “invention” cannot be an “innovation” when it is only valuable for solving a problem but cannot exploit what the business and social benefit for the inventor, so it is just an invention. However, no matter how small a process improvement is, as long as it can be useful for business and society, it can be categorized as an innovation.

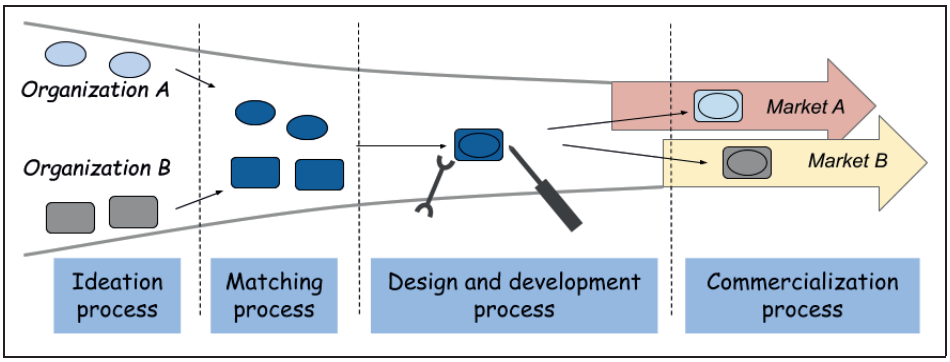

Figure 1. Global Innovation Process Modified From (Pawlowski 2013)

In this study, we elaborate the term of intergeneration collaboration with the innovation as intergenerational innovation. The concept of intergenerational innovation is an intergenerational knowledge collaboration within the innovation process, in which different generation support each other through the sharing of knowledge, experience, and wisdom as an accumulation of interaction with the innovation process (Gordon 2018; Icenogle 2001). Since innovation is the process of invention and exploitation (Andriopoulos and Lewis 2009), it means finding not only the "valuable things" for the target group but also exploiting the market and how to deliver the "offered value." (Andriopoulos and Lewis 2009). In this study, we identify “exploitation” as the commercialization process (Li et al. 2008). The process of collaborative innovation including the defining goals, idea generation, idea evaluation, planning, prototyping, implementation, and reflection (Joiko et al. 2018) is a critical process to support intergenerational innovation.

Moreover, in term of global innovation (Pawlowski 2013) highlighted the importance of matching process as the critical part to find a collaborator for a different market. Therefore, for our study purpose, we simplified the collaborative innovation process (Joiko et al. 2018; Pawlowski 2013) into four main

phases as illustrates in Figure 1. First, the ideation process as the first process to invent a proposed business value, the matching process as the requirement for global collaboration; the design and development process as the process to actualize the invention based on the target market. Finally, the commercialization process as the process to disseminate the invention aiming to gain financial and business profit. These four main processes of global innovation are our starting point for identifying dynamic changes of barriers to the intergenerational collaboration in the specific innovation process.

Each process in innovation has different characteristics, required different competencies and therefore the barriers will be different in each process. In relation with system design, the barriers come from a different dimension (Chesbrough 2010; Nurhas et al. 2018) seem to hinder the volunteering in digital knowledge collaboration (Nurhas et al. 2018). Therefore, in the next subsection, we present the most prominent barriers based on the literature.

Barriers to intergenerational collaboration

For the literature review on barriers, we provide an overview of a barrier framework to intergenerational innovation. The barrier framework or model has different meanings, including problems that someone faces (Fee et al. 2004), challenges in a business process, or some constraints that occur at a particular goal (Chesbrough 2010). In this study, we follow the understanding of a barrier framework as a collection of constraints, challenges, obstacles or problems perceived by individuals or organizations in a particular context (Stoffregen et al. 2015). About the context of this research, which focuses on intergenerational innovation, we will follow the classification of barriers, which is more general and can be implemented in field knowledge management and innovation (Pirkkalainen and Pawlowski 2014; Stoffregen et al. 2015) and combined with the classification of barriers, which focuses on intergenerational collaboration (Litz 2010). Based on this classification, sets of barriers dimension exist that are emotional barriers, perceptual barriers, technological barriers, institutional barriers, and cultural barriers. Table 1 is a description of the barrier dimension, accompanied by all the correlated barriers from literature.

Table 1: Barriers Code and the Barriers Dimension

Code	Barriers	Code	Barriers
Perceptual Barriers Relate to the barrier dimension in terms of what someone thinks when looking at other people, which can happen because of someone's experience of similar things in the past.			
BR2	Age discrimination (Anca et al. 2013; Sellers et al. 2010)	BR9	Do not know how to work with the other generation (Kurniawan 2008)
BR5	Different mindset (Edge 2014; Sellers et al. 2010)	BR24	Lack of empathy (Brücknerová and Novotný 2017; Sellers et al. 2010)
BR7	Different interests (Boulton-Lewis et al. 2007; Icenogle 2001)	BR25	Lack of respect (Brücknerová and Novotný 2017; Sellers et al. 2010)
BR15	The other generation's resistance (Anca et al. 2013; Fernández-de-Álava et al. 2017; Sellers et al. 2010)	BR37	Lack of (interpersonal) trust (Cresci et al. 2010; Edge 2014)
		BR17	Lack of awareness of differences with other generation (Paolacci et al. 2010)
Technical and Operational Barriers barriers associated with technology and operational use			
BR1	Different technological background (Binda et al. 2017; Boulton-Lewis et al. 2007; Brücknerová and Novotný 2017; Charles and Charles 2016; Cresci et al. 2010)	BR21	The investment cost for technology(Anca et al. 2013; Boulton-Lewis et al. 2007; Cresci et al. 2010)
		BR19	Lack of independence (Amaro et al. 2016)
BR3	Lack of time for collaborating (Binda et al. 2017; Edge 2014)	BR28	Lack of technical training for digital collaboration (Cresci et al. 2010)

BR4	Different routine pattern (Litz 2010; Muñoz et al. 2015)	BR18	Technological complexity (Cresci et al. 2010)
BR11	Lack of supportive technological environment (Kow et al. 2012; Walsh et al. 2012)	BR16	Lack of integrated leisure activities (Boulton-Lewis et al. 2007; Mestheneos and Withnall 2016)
BR12	Lack of technology access (Cresci et al. 2010)	BR31	The difficulty to manage virtual presence (Nedelcu 2017)
Emotional Barriers A collection of barriers related to feeling - self-centered barriers. These barriers are related to how people see themselves working with someone			
BR6	Functional (physical and psychological capabilities) limitations (Anca et al. 2013; Nedelcu 2017),	BR35	feel underappreciated (Binda et al. 2017; Boulton-Lewis et al. 2007; Edge 2014; Sellers et al. 2010)
BR8	Lack of motivation (Binda et al. 2017)	BR14	Feel isolated (Anca et al. 2013)
BR26	Fear of technology (Boulton-Lewis et al. 2007)	BR33	Lack of confidence in the use of technology (Boulton-Lewis et al. 2007)
BR30	Quicker understanding than other generations (Brücknerová and Novotný 2017)	BR36	Feel unappreciated (Binda et al. 2017; Boulton-Lewis et al. 2007; Edge 2014; Sellers et al. 2010)
Cultural Barriers represent external environmental barriers that focus on unorganized codes and norms			
BR10	lack of a supportive social environment (Boulton-Lewis et al. 2007; Charles and Charles 2016; Edge 2014)	BR29	the design of the system harms the cultural background (Binda et al. 2017; Nedelcu 2017)
BR23	Do not know how to work with a different cultural background (Miller et al. 2003; Nedelcu 2017)	BR34	strong differences in cultural traditions compared to other generation (Boulton-Lewis et al. 2007; Charles and Charles 2016)
BR22	the cultural differences (Boulton-Lewis et al. 2007; Charles and Charles 2016)		
Institutional Barriers environmental barriers that focus on organized rules and requirements			
BR13	different educational levels (Anca et al. 2013; Boulton-Lewis et al. 2007; Cresci et al. 2010)	BR20	geographical distance (Binda et al. 2017; Muñoz et al. 2015)
		BR32	Higher market uncertainty of the product (Miller et al. 2003)
BR27	lack of privacy (Cresci et al. 2010)	BR38	lack of shared resources (Nedelcu 2017; Walsh et al. 2012)

As we move towards global collaboration, we consider the use of English as a liaison between collaborators and therefore our study, not including the language barrier (DeLone et al. 2005) that can be addressed through the use of an international language (Sharifian 2017) as essential requirements for global collaboration.

Although the dimension of the barrier provides a general description of what could hinder intergenerational collaboration, so far it has not focused on barriers in the innovation process mediated by information systems technology. Therefore, based on the proposed list of barriers (See Table 1), in Figure 2 shows the overview of study-objectives. We aim to find out why intergenerational innovation in the advancement of digital technology is still difficult to establish. Since the barriers in Table 1 are the barriers to intergenerational collaboration; therefore, in this study, the hypothesis is:

H0: both groups of employees in the intergenerational innovation perceived the barriers at the same level (PoB).

To evaluate the H0, first, we determine what barriers in each dimension correlate with age and the influence of each barrier (IoB) dimension compare to another dimension (marked with "?") as well as the percentage of influence of barriers for both age groups.

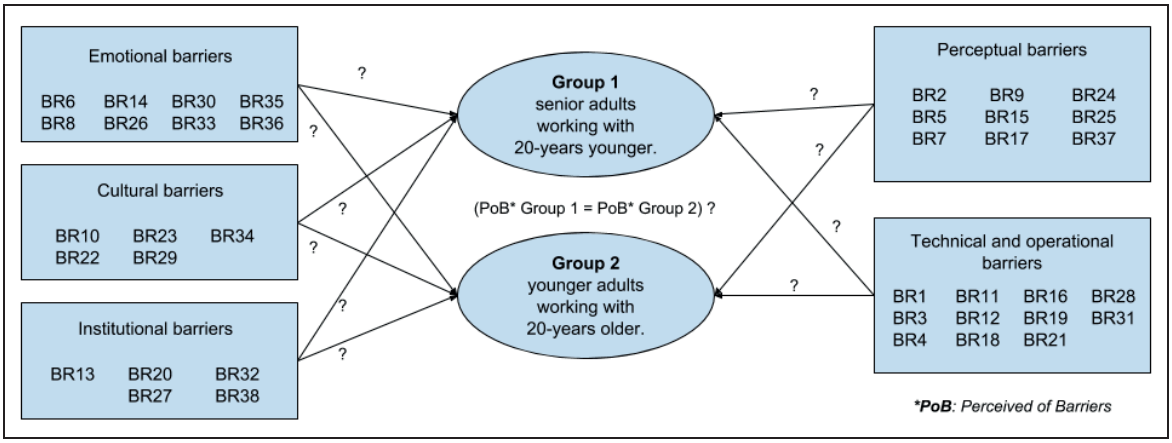

Figure 2. Overview of the Study aim on Barriers to Intergenerational Collaboration

Research Methodology

In this section, we briefly describe the way we conducted our study. We use a quantitative research methodology approach (Wright 2005) to determine which of these barriers are affecting intergenerational collaboration in the innovation process and the method is in line with the purpose of our study to examine our hypothesis. We will start by providing information about our survey concept, and then briefly explain the data collection and statistical analysis we have conducted.

Survey design

For the survey research, we structured our questions into four parts. The first part is linked to factors that influence barriers such as age, experience with digital technologies and differences in cultural background. In the second section examines issues related to barriers of intergenerational collaboration, the Likert scale with narratives of barriers in technology-supported collaboration with someone older / younger than 20 years old (Hillman 2014). The Likert scale is on a scale of 1-5 with 1: strongly disagree - 5: strongly agree (Boone and Boone 2012). Also, an open question was included to identify whether there are new barriers that are not included in the list of questions.

In the third part, a narrative is informed about collaboration in the innovation process. The participants were asked in which innovation processes each barrier would be dominantly perceived. The respondent of the participant for each barrier was used as the data for the Frequency of Mentions (FoM) of a barrier in a particular process. The respondents could choose that a barrier occured in all process of global innovation, in one or more innovation processes or not in every process of global innovation. A list of questions related to barriers was compiled in English and reviewed by an English linguist who also researched topics in the field of information systems but did not participate in the co-authoring process of this paper.

Data Collection and Analysis

We used Amazon Mturk and created our online questionnaire so it could be accessed globally. The online survey system automatically adapted the question to the age of the respondents. For respondents below the age of 40, the questions referred to working with people who were => 20 years older. For respondents who were 40 years or older, the questions referred to working with people who were > 20 years younger. Researchers for conducting a study on the global scale utilized Amazon Mturk (Nurhas et al. 2018; Paolacci et al. 2010). Therefore, we then distributed the questionnaire via Amazon Mturk using various selection criteria (including 100% positive track record for doing task from Amazon Mturk, language proficiency, experience in intergenerational collaboration using digital technology as

well as targeted respondents with a certain age group) to filter participants who would like to participate in our online questionnaire. We conducted data collection from July 2018 to December 2018, after five months of collecting appropriate respondents via Amazon Mturk, there were only 77 respondents who fit for our study objective. The respondents consisted of 35.1% Female and 64.9% Male. With cultural background coming from (Africa = 5.2%; Asia = 29.9%; Europe = 36.4%; North America = 24.7%; South America = 3.9%; Australia/Oceania = 0.1 %) And for the age of respondents (18-22 years = 3.9%; 23-29 years = 41.6%; 30-35 years = 11.7%; 36-39 years = 5.2%; 40-45 years = 2.6%; 46-50 years = 7.8%; 51-55 years = 15.6%; 56-60 years = 6.5%; 61-65 years = 1.3%; > 65 years = 3.9%). Based on the year of experience in technology-supported intergenerational collaboration (No experience = 6.5%; 1-3 years = 31.2%; 4-7 years = 16.9%; 8-10 years = 11.7%; > 10 years = 33.8%). Five data participants were removed from the final selection due to inconsistencies related to years of experience in intergenerational digital collaboration. Therefore, only 72 were processed for analysis.

Several statistical methods were used for data analysis: we converted the Likert scale to relative weight value for all respondents. For the selection of top barriers in each process of the global innovation, we calculated the third quartile value based on the FoM in each process as criteria to categorize a barrier as the top 25% in that process. Moreover, regarding the correlation with age factor. An independent chi-square test (Mantel 1963) was employed to check whether there is a correlation between each barrier with age factor. The group was classified into group 1 (age of respondents > 39 years old) and group 2 (18-39 Years old). 44 respondents for group 2 and 28 respondents for group 1 indicating the reasonable minimum number (+-30) for sample size (Johanson and Brooks 2010).

Furthermore, the reliability test using Cronbach alpha calculation showed the score = 0.96, indicating the data reliability in the excellent category. The chi-square method was chosen because it was very suitable for comparative tests with nonparametric data where the data types of the two variables were nominal (Mantel 1963). The results for calculating the chi-square provided information on what barriers were associated with the age group and which were no correlation (*barriers are perceived the same for both groups*)? After determining which barriers were correlated with the age differences, we calculated the weighted value for each group. Then, a t-test was performed to find out the differences between group 1 with group 2. We used, as shown in Figure 1 (PoB Group 1 = PoB Group 2?), as the hypothesis of H0. Next, to get the influence of each barriers dimension to both groups (IoB), we first calculated the mean of Relative Weighted Value (RWV) of each barrier in one barrier dimension and compared the result as a percentage with all barrier dimensions.

Results

There were three main results presented in this section. First, concerning the barriers in the global innovation process. Secondly, in the context of the influence of age on the barriers (C-Val* in Table 2). Third, the ranking of barriers based on the classification of the age group of collaborators (RW1* and RW2 in Table 2).

Table 2. Assessment of Barriers in the Context of Global Innovation and Intergenerational Collaboration

Code	RWB*	FoM in Innovation Process				**C-Val***	RW1*	RW2*
		Ideation	Matching	D&D*	Com*			
BR1	73,06	11	20	23	19	3,94	No correlation*	
BR2	69,44	9	18	13	17	6,76	No correlation*	
BR3	69,44	6	11	20	15	9,60	64,83	70,00
BR4	68,61	8	15	26	15	7,63	No correlation*	
BR5	76,94	21	11	24	22	8,80		
BR6	62,78	5	16	24	17	6,02		
BR7	73,89	19	19	17	17	1,08		
BR8	64,44	10	12	13	14	15,61	47,59	70,83
BR9	58,61	7	17	19	15	16,08	42,76	65,83
BR10	65,83	8	15	20	20	9,65	53,10	69,58
BR11	60,28	7	21	28	18	19,75	46,21	67,08

BR12	61,11	8	14	19	24	26,52	41,38	70,42
BR13	65,28	15	17	20	18	11,00	57,93	65,83
BR14	58,60	8	13	9	18	26,15	37,93	67,50
BR15	67,50	13	13	20	20	5,46	No correlation*	
BR16	62,22	2	15	20	13	20,04	48,28	67,92
BR17	62,50	14	15	20	20	18,64	48,28	68,33
BR18	64,44	9	14	29	25	12,52	57,93	65,42
BR19	56,39	4	11	15	16	15,30	41,38	62,50
BR20	60,28	6	12	19	15	23,04	44,14	67,50
BR21	63,89	3	13	30	25	3,01	No correlation*	
BR22	62,78	14	17	18	15	14,04	50,34	67,50
BR23	56,94	10	13	17	17	13,93	43,45	62,08
BR24	53,33	10	15	10	12	20,43	36,55	60,42
BR25	57,50	9	10	20	12	9,68	44,83	62,08
BR26	53,89	4	11	19	16	19,07	37,93	60,83
BR27	56,67	7	8	20	14	11,75	44,83	61,67
BR28	63,06	9	16	28	18	16,19	51,03	67,08
BR29	52,78	7	7	17	19	26,12	31,72	63,33
BR30	66,67	9	11	18	19	16,46	51,72	73,33
BR31	60,28	6	15	23	18	11,54	50,34	63,75
BR32	62,22	3	14	14	37	6,03	No correlation*	
BR33	59,72	12	8	26	17	8,32		
BR34	58,89	13	16	13	16	5,68		
BR35	62,50	11	8	20	13	9,13		
BR36	62,22	12	14	10	16	9,21		
BR37	60,83	7	10	19	18	4,18		
BR38	63,33	7	14	29	20	12,80	53,10	66,25
3rd Quartile		11	15,75	23	19	Mean	46,98	66,13
H0 is accepted if (value of t-stat) > (value of t critical two-tail)						t-stat = -11,279 P(T<=t) two-tail = 1,10E-12 t critical two-tail = 2,0369		

*D&D: Design and Development
*Com: Commercialization
*C-Val: Chi-square value
*RW1: Relative Weight for Group 1
*RW2: Relative Weight for Group 2
*RWB: Relative Weight Both Group
*No correlation with age, because C-Val < 9,49 (Chi-square Table with α=5%, and df = 4)

Based on Table 2, in the ideation process, the barriers that occured were more dominant to the dimension of the Perceptual barrier; those barriers were the difference in mindset and interest. In the matching process, the barrier to the technical barriers dimension (total 102 FoM) competed with perceptual barriers dimension (total 84 FoM). In the process of design and development, the barriers are different, with technical barriers dimension dominants overall another dimension with 187 of total FoM (compare to second place with the only a total of 50 FoM).

Furthermore, in the context of commercialization, BR37 was mentioned 37 times. Besides, specific barriers showed a substantial impact on both age groups, such as BR5, BR7, BR1, BR4, these barriers were generally considered as the top issues for both groups. The dynamical changes of barriers dimension for the innovation process can be drawn based on the number of total FoM in each innovation process.

Next, from Table 2, we could redraw Figure 2 by highlighting the correlated barriers including the IoB for both groups and provide the answer to the H0 hypothesis. The statistical calculation of the t-stat showed that H0 is rejected (t-stat = -11.279 < t-critical two-tail), which meant that there was a significant difference in the perception of the barriers for both groups regarding collaboration in the intergenerational innovation process. The complete redraw of the study result is presented in Figure 3.

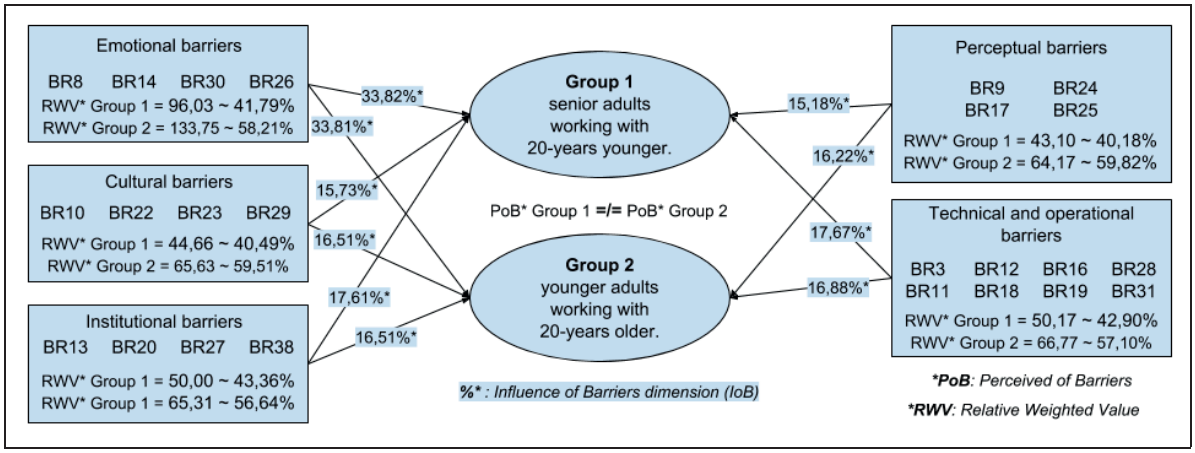

Figure 3. Influence Percentage of Barriers Dimension to Intergenerational Collaboration

In correlation with the results of the open question, 94% of respondents mentioned no additional barriers for the list (Comments on additional barriers were only expressed by Group 1), as follows:

"None, all were covered," "Pretty much covered it all," "I think they are covered.", "Different approaches perhaps, but I think it is in there," "I do not like working in groups period even with people of my age," "Communication gap," "I do not always understand their jargon," "Lack of respect for older person's knowledge and experiences."

Discussion

Based on the results of the quantitative data processing and the analysis of the individual barriers. In this section, we would like to discuss three of our research contribution to information systems society. Two contributions related to the theoretical and one contribution related to the practical.

Dynamics of Intergenerational Barriers in the Innovation Process

Secondly, still concerning the theoretical contribution, the finding of our study extends the knowledge to the previous study on barriers to intergenerational context (Boulton-Lewis et al. 2007; Icenogle 2001; Litz 2010). In this study, we provided a better insight into the dynamic changes of barriers in the global innovation process (see Figure 4). While other studies concentrated on generating barriers model to intergenerational collaboration (Litz 2010) or barriers framework to global innovation (Nurhas et al. 2018; Pirkkalainen and Pawlowski 2014), our barriers analysis ware process-based barriers that enable a more detailed overview of barriers. We also argued that the study results of process-based barriers could better support the IS community in designing IS requirements (Leymann and Roller 1997) for intergenerational innovation.

The result of our study outlines how the dimension of perceptual barriers dominated the top 25% barriers in the ideation process, and then the percentage was almost as high as the technical dimension in the matching process. The perceptual dimension in the design and development process changed drastically. In the design process, the dimension of the technical barrier took a dominant percentage compared to other dimensions, the result on the dominance of technical barriers in the design and development process supports the previous study on the majority of barriers to co-creation of knowledge (Nurhas et al. 2018).

Besides, the dynamical changes of barriers dimension are supported to the definition of a barrier that depended on the context (Chesbrough 2010; Fee et al. 2004; Long and Fahey 2000), the more specific the context, the more specific the barriers are. Therefore, this study contributes to creating workflow process-based intergenerational barriers in the context of global innovation.

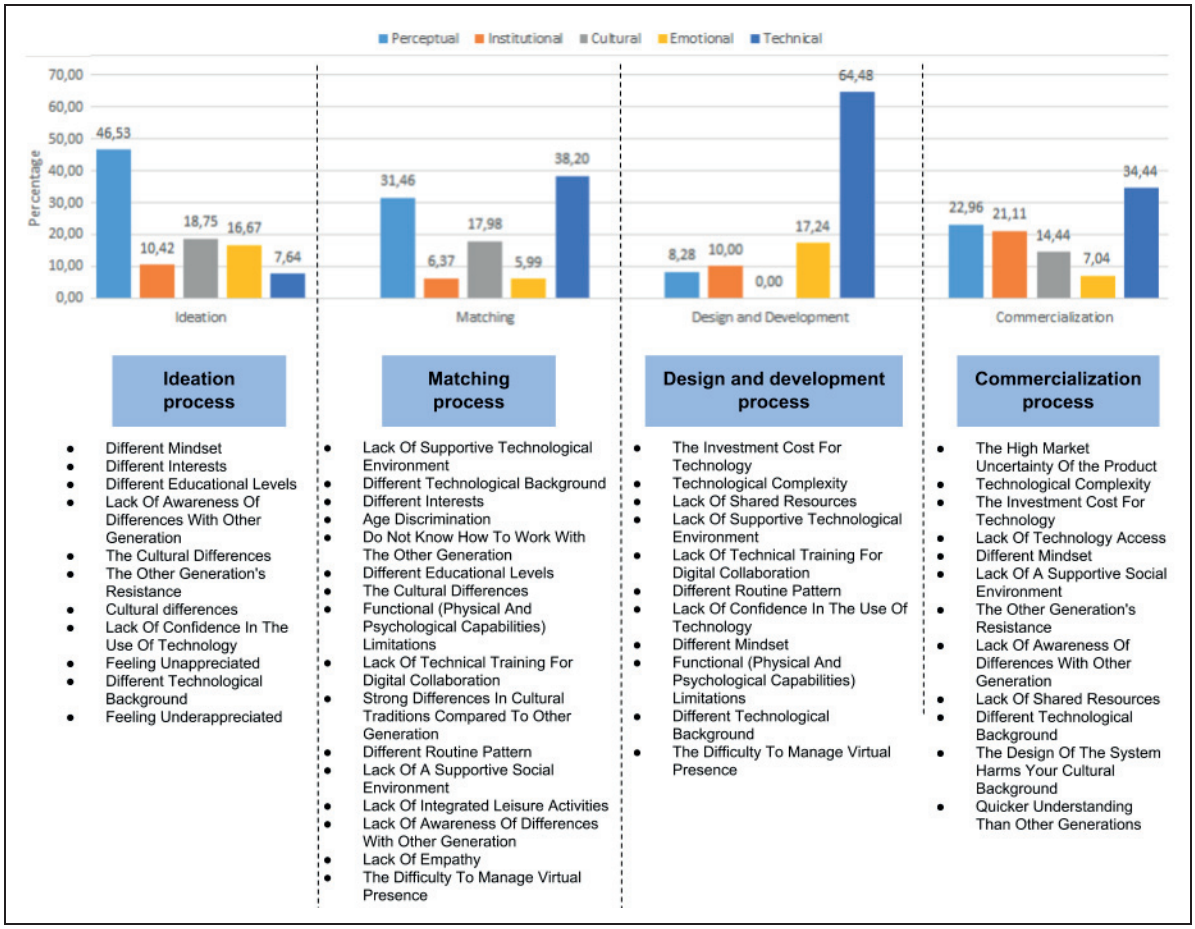

Figure 4. Top Third-Quartile of Intergenerational Barriers to Innovation Process

Prominent Barriers to Intergenerational Innovation

This study supports prior research on the barriers perceived by both groups of employees equally in the intergenerational context, namely the differences in mindset (Edge 2014), interest and technological background (Boulton-Lewis et al. 2007; Kurniawan 2008). More importantly, we highlight how barriers are perceived differently when someone works with older or younger people. Age differences undoubtedly do not affect all barriers equally, as shown in Table 2, only 63% of barriers in all dimensions that are differently influenced by age. The differences in the ranking of barriers based on the value of relative weight (e.g., in Table 3) between the two groups could be used to design the system by prioritizing significant barriers in both groups to eliminate distortions in system design that would affect the use of the system by another user group (Amaro et al. 2016; Kurniawan 2008). The calculation of the IoB could be used as an entry point to understanding that both groups had influenced twice (about 33%) the emotional barrier dimension compared to other barrier dimensions (mean of the other four dimensions except the emotional barrier: 16%). The result offers knowledge for the system designer the possibility that in addition to the dynamical change of barrier dimension in every process of global innovation, the IS designer could support intergenerational collaboration through positive emotional-driven design (Kow et al. 2012; Kurniawan 2008; Litz 2010; Muñoz et al. 2015).

Furthermore, the mean value of RW for senior adults was 46.98 compared to 66.13 for younger adults. Shows contrast with other studies that the majority of subjects focus on older adults (Cresci et al. 2010; Edge 2014; Sellers et al. 2010) because the barriers of younger adults were more perceptible than those of older adults in intergenerational collaboration. Therefore, we should strive to reduce the barriers to intergenerational collaboration among younger adults rather than senior adults, for example through technology design or the integration within the curriculum for intergenerational collaboration.

Table 3. Top Barriers Based on Value of Relative Weight (RW) 1 and RW2

Top Five Barriers for Senior Adults	RW	Top Five Barriers for Younger Adults	RW
Lack of time for collaborating	64,83	Quicker understanding than other generations	73,33
Technological complexity	57,93	Lack of motivation	70,83
Different educational levels	57,93	Lack of technology access	70,42
lack of shared resources	53,10	Lack of time for collaborating	70,00
Lack of a supportive social environment	53,10	Lack of a supportive social environment	69,58

Barriers Profile for Personas in Intergenerational Innovation

The contribution of our study to practice is to outline barriers for user modeling in personas (Cooper et al. 2014) as the initial model for human-centered system design. The barriers profile could be used to help developers by providing visual representations of barriers perceived by the user of a system to be used in the innovation process. In order to visualize the percentage of barriers, we could get the total percentage of barriers dimension for a specific group by summing the percentage of RWV with IoB (e.g., see information from Figure 2 for Group 1. Without specific for the matching process the perceptual barriers = (40,18%+15,18%) = 55,36% and by focusing on the matching process = (40,18%+((15,18%+31,46%)/2)) = 63,50%). The total percentage of each barrier dimension can be converted into a spider or radar diagram. Profiling in the form of personas can later be used by system development to determine the system requirements as well as the design of the user experience (Cooper et al. 2014). Figure 5 shows the integration of barriers profile into personas (Nurhas et al. 2017) by focusing on senior adults for collaborating in the matching process.

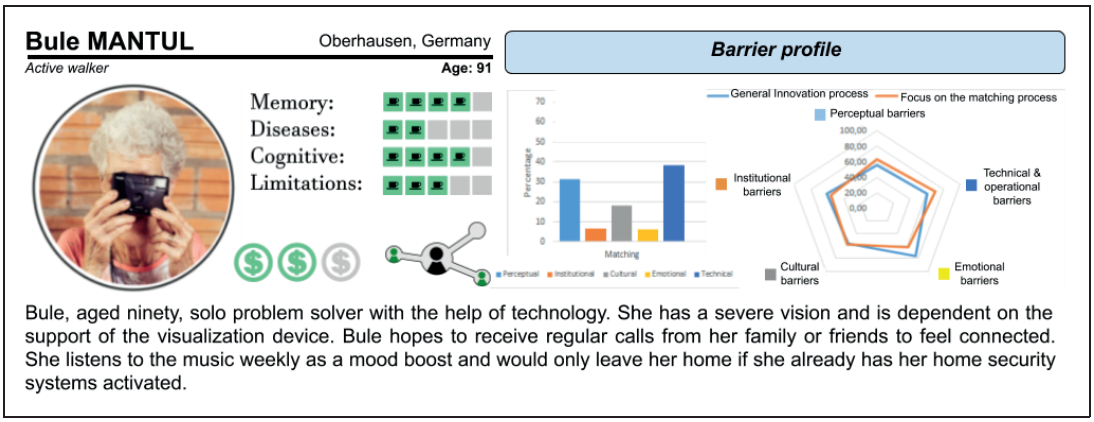

Figure 5. Personas for the Matching Process of Intergenerational Innovation

Limitations and Recommendations

In this study, the limitations we faced were the difficulty of finding participants over 60 years old who were still actively working with digital technology and were familiar with the online questionnaire. Therefore, in the future, the evaluation and identification of barriers can also be done with offline-based questionnaires to reach participants over 60 years of age. Another limitation is that the information generated by the open-ended questions is not significant enough to improve the list of barriers encountered. The majority (94,44 % of all participants) responded by stating that all barriers were included in the list. Therefore, in the future research could use mixed method through Q-method (Sostrin 2008) to find a consensus about prominent barriers and to compare the research results in this study.

Furthermore, as a practical contribution of our paper, we propose in the context of User Profiling to integrate the barrier profile into a single unit that can be used in user experience design. One of which is the integration of the positive computing approach (Pawlowski et al. 2015) or the wellbeing-driven

system design (Calvo and Peters 2014) in the form of positive personas (Nurhas et al. 2017). The integration of positive computing approach can support the positive emotion to overcome most of the influence of intergenerational barriers of emotional dimension. Problem-based research not only for IS design research (Peffers et al. 2007), by profiling the barriers to well-being is also one of the critical points in the positive computing approach (Calvo and Peters 2014), which can affect the "reengineering" and evaluation of IS design (Pawlowski et al. 2015).

Conclusion Remarks

As a conclusion, this study outlines the barriers to intergenerational collaboration in the global innovation process. We mapped the dynamics of changes of age-based collaborative barriers mentioned in the literature to the global innovation process and provided workflow process-based barriers to the study context. We also showed which barriers were prominent for younger and senior adult to collaborate. Interestingly, senior adults not only had much experience, but they were also very open to working collaboratively with younger people (compared to younger ones). In the discussion, we explained the contribution of our paper, the obstacles, and recommendations for future research related to the integration of positive computing. By looking at the dynamics of the barriers that exist in the process of global innovation in an intergenerational context, the questions arise whether the IS community will pay attention to the proposed specific barriers in the global innovation that requires interconnected generation? Moreover, whether the barriers remain exist despite the advancement of technology in the era of connected industry.

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IV

EXAMINING COMPETING ENTREPRENEURIAL CONCERNS IN A SOCIAL QUESTION AND ANSWER (SQA) PLATFORM

by

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Examining Competing Entrepreneurial Concerns in a Social Question and Answer (SQA) Platform

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Keywords: Entrepreneurial Concerns, Challenges to Startups, Topic Modeling, Entrepreneurship, Sentiment Analysis.

Abstract: This study aims to determine the competing concerns of people interested in startup development and entrepreneurship by using topic modeling and sentiment analysis on a social question-and-answer (SQA) website. Understanding the underlying concerns of startup entrepreneurs is critical to society and economic growth. Therefore, greater scientific support for entrepreneurship remains necessary, including data mining from virtual social communities. In this study, an SQA platform was used to identify the sentiment of thirty concerns of people interested in startup entrepreneurship. Based on topic modeling and sentiment analysis of 18819 inquiries in various forums on an SQA, we identified additional questions about founder figures, keys to success, and the location of a startup. In addition, we found that general questions were rated more positively, especially when it came to pitching, finding good sources, disruptive innovation, idea generation, and marketing advice. On average, the identified concerns were considered 48.9 percent positive, 41 percent neutral, and 10.1 percent negative. This research establishes a critical foundation for future research and development of digital startups by outlining a variety of different concerns associated with startup development in the digital age.

1 INTRODUCTION

This study provides a comprehensive insight into people's concerns interested in entrepreneurship and startup entrepreneurs (SEs). Entrepreneurship is a powerful economic and social force (Harb & Shang, 2021; Schöning, 2013; van Stel et al., 2005). As a result, several initiatives have been launched to encourage SEs to establish their enterprises or business models (Ratinho et al., 2020).

Meanwhile, in the knowledge economy and age of virtual communities, the Social Question-and-Answer (SQA) platform is rapidly moving information-seeking behavior toward a more collaborative and personalized question-and-answer experience based on expertise (Choi et al., 2014). Thus, SQA provides access to business networking and open knowledge- and experience-based business and entrepreneurial solutions to SEs with minimal resources (Shneor & Flåten, 2015).

Although numerous studies on SEs have been conducted (Chandra et al., 2016; Puhakka & Ojala, 2021; Saura et al., 2019), it is important to determine the concerns of the discussed topic on a large scale to capture better the different and more detailed aspects (Saura et al., 2019). Therefore, topic modeling (Chandra et al., 2016; Onan et al., 2016; Rehurek & Sojka, 2010) and sentiment analysis (Gao et al., 2013; Hutto & Gilbert, 2014; Onan et al., 2016) methods were applied to the questions collected from an SQA.

By investigating the substance of the issues in an SQA, we set out to identify which competing concerns are most salient and how these concerns are perceived and evolve over time in the face of digitalization. This study contributes twofold: First,

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we identify thirty areas of concern that emphasize the most disputed issues involving positive and negative emotions, thus paving the groundwork for future scholarly investigation. Second, this study expands the body of knowledge based on previous research by emphasizing the use of SQA as a valuable element for researching entrepreneurship and confirming the identified SEs' dilemmas through the lens of SQA, spanning a broader range of SE development topics that are not limited by cultural, country-specific, gender, or age boundaries.

As a reminder, the research presentation should adhere to the following structure. In the next section, we present studies on entrepreneurial challenges for startups and the use of data mining techniques to identify entrepreneurial insights. Subsequently, we describe how we conducted our research using topic modeling and sentiment analysis. We then highlight the competing concerns of SEs in our findings section. Next, we address the study's findings, limitations, and recommendations for future research in the following discussion section-and; finally, we provide an overview of the study report.

2 RELATED WORKS

SEs face a variety of challenges in the early stages or throughout their entrepreneurial journey (Giardino et al., 2015; Nurhas et al., 2020; Saura et al., 2019; Wang et al., 2016), including issues related to product and team development, lean process, business model design, and financing, scaling, partnerships, sales, and product and market alignment (Giardino et al., 2015; Wang et al., 2016). These challenges motivate SEs to freely discuss, share, and communicate attached with emotion in order to highlight the elements of success, concerns, or motivations (Saura et al., 2019) that spread across the Internet, the social media community, including SQA (Chandra et al., 2016; Puhakka & Ojala, 2021; Shneor & Flåten, 2015).

Giardino et al. (2015) highlighted that in addition to the team and product-related challenges, technology uncertainties and acquiring the first customer are prominent challenges for software startups that are also relevant to developing a technology-based startup in the digital age. However, in the study based on the analysis of entrepreneurial posts on social media, these issues were not mentioned as essential concerns for success factors for SEs (Saura et al., 2019).

The potential of identifying the topic of concerns of SEs has already been investigated in a study of shared thoughts on Twitter[1], where topics were categorized into business angels, business plans, methodology, tools, projects, jobs, and founders (Saura et al., 2019). Topic modeling and sentiment analysis are two well-known tools (Gao et al., 2013; Onan et al., 2016) for revealing the categories of concern and emotions behind shared thoughts and have also been used to study entrepreneurship and startup based on a large amount of data collected (Chandra et al., 2016; Harb & Shang, 2021; Puhakka & Ojala, 2021; Saura et al., 2019). The methods have already been used in various fields and SQA (Jiang et al., 2018; Kumar et al., 2018).

Uncovering topics and sentiments from SQA is important to identify motivations, areas of interest, and expectations that will raise community awareness of specific issues (Choi et al., 2014). Furthermore, sentiment analysis has been demonstrated to reveal feelings and perspectives that can influence decision-making on particular concerns (Chen et al., 2018; Choi et al., 2014; Johnson, 1990). Consequently, it is critical for triggering discussion, directing, and promoting the selection of policies, strategies, and approaches to entrepreneurial development (Blanchflower & Oswald, 1998; Gifford, 1992; Nurhas et al., 2020; O'Shea et al., 2017).

3 METHODS

Two commonly accepted strategies for doing SQA research are user-based and content-based research (Choi et al., 2014). This research involved the use of a content-based SQA method that focuses on content patterns rather than user characteristics (Choi et al., 2014). The Selenium Python package was used to extract snapshot data at the beginning of the process (Huber et al., 2011). The data was compiled from the text of questions posted in the SQA Quora[2] forums dedicated to startups and entrepreneurship.

We chose Quora as our study platform because it appears to be a promising source for investigating various social phenomena in other studies (Jiang et al., 2018; Wang et al., 2013). Quora is an online community founded in 2009 and headquartered in California, United States of America. Quora focuses on an online open-knowledge that is based on user-generated content. Quora's primary content is a question posed by a user to which other users respond. Users of Quora are expected to use their real

[1] https://www.twitter.com/

[2] https://www.quora.com/

names, though they can choose to remain anonymous. Quora is ranked #356 globally by AlexaPage Rank (as of June 15, 2021) and is available in many countries. Even though Quora's content is open, the company does not offer an official API for retrieving data from its websites.

In the following instance, data collection was done by taking all the data in Quoran SQA on September 21, 2018, removing duplicate questions (N_initial:24802 questions to N_final: 18819 questions), cleaning the data by removing punctuations and stop words, developing labels for different topics as concerns, and identifying the sentiment of each topic to identify competing concerns. The Latent Dirichlet Allocation (LDA) algorithm of Gensim was used as a Python package for clustering topics because it is considered to outperform other known topic models (Harb & Shang, 2021).

The LDA class of statistical language models is used in generative probability computing, which is a subset of statistical computing. LDA makes Topics using word clusters instead of text clusters to understand data better (specifically, in this study, the SQA's questions). In LDA, each topic is a model of a mixture of words. Each word is represented by a Dirichlet distribution coefficient. The model in each topic has the capability to forecast significantly related topics in a document (Blei et al., 2003). For LDA, a predictive likelihood-based approach was utilized to pick out the most optimal number of topics (Chang et al., 2009). Then, the concern was labeled based on the given keywords and the coefficient of each identified topic from the Gensim LDA model. Three to ten relevant keywords of word clusters were used to designate each topic.

Following the identification of each cluster's pertinent topics, the next step is to ascertain the sentiment for each question posed within each cluster. The Vader algorithm (Hutto & Gilbert, 2014) was used to identify sentiment for each issue, which shows not only sentiments and viewpoints from written language but also emojis or spoken emotions (Hutto & Gilbert, 2014; Onan et al., 2016) that are relevant and frequently contained in a text (Gao et al., 2013). All queries that have the same identified topic were grouped individually. The Vader algorithm determines each question's negative, positive, and neutral trends on the same topic. The percentage of sentiments for each issue was derived by comparing the three tendencies to the total number of questions on a specific topic of concern.

Following that, each topic's popularity ratio was determined and organized in descending order (1 to 30, where 30 is the most popular topic in a given year; and 0 for topics not found in a given year, this may happen, for example, if a topic appears after 2010). The popularity ratio value is the percentage of questions asked about a specific topic in a given year compared to the total number of inquiries from all topics. It is compared to the percentage of each topic to detect dynamic changes in topic popularity.

4 RESULT

Based on the log-likelihood value of various learning decay scenarios (0.5, 0.7, & 0.9). Thirty topics with a consistent value amongst diverse scenarios of concern were taken into account. As shown in Figure 1, thirty topics were chosen as the number that can yield the greatest number of topics for the dataset. The selection is based on the maximum feasible log-likelihood value under specific conditions before the log-likelihood value for a larger number of topics drops significantly.

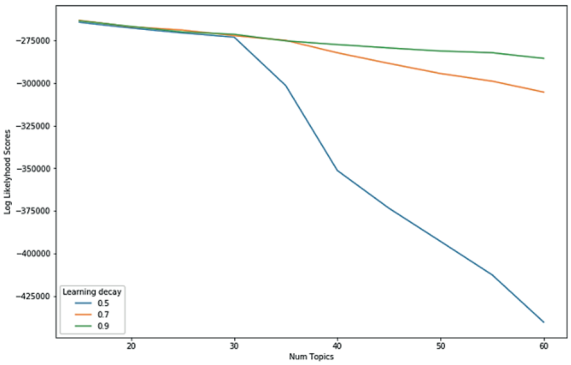

Figure 1: log-likelihood value for a different number of topics.

Table 1 presents the thirty labeled concerns as a result of defining the cluster from LDA. This includes, for example, lean startup, the entrepreneurial process, pitching the idea, scaling the business, and managing company resources, such as founders and co-founders, investments, and location, partnerships, and emerging trends (Giardino et al., 2015; Ratinho et al., 2020; Shneor & Flåten, 2015; Wang et al., 2016).

Overall, sentiment for each concern was positive, with an average percentage of 48.9 percent. All competing concerns for positive and negative were outlined in gray in Table 1. For example, concerns about Pitching and finding good sources with 66% and concern about success keys (64.8%) were

Table 1: List of concerns of SE and the identified sentiment.

Label of concern	Top 3 words and the coefficient	*N*	Percentage of sentiment (%)		
			(-)	*(n)*	*(+)*
Lean startup	0.34*"startup"+ 0.18*"lean"+ 0.05*"book"	751	7.1	53.5	39.4
Inspiring Company	0.11*"company"+ 0.12*"grow"+ 0.06*"learn"	743	10.2	42.8	47.0
Founder figure	0.17*"elon_musk"+ 0.05*"time"+0.04*"tesla"	895	24.4	40.2	35.4
Find co-founder	0.18*"startup"+ 0.11*"founder"+0.05*"hire"	756	10.7	44.3	45.0
Success keys	0.19*"entrepreneur"+ 0.15*"successful"+ 0.03*"key"	881	10.4	24.7	64.8
User-centric app	0.12*"build"+ 0.08*"app"+0.06*"user"'	658	5.6	43.6	50.8
A year of remote work	0.18*"work"+ 0.07*"year"+0.06*"job"	701	17.1	43.5	39.4
Payment service	0.13*"service" + 0.06*"pay"+0.05*"problem"	672	16.4	32.9	50.7
Pitching	0.12*"innovative"+ 0.09*"idea"+0.06*"sell"	653	6.9	27.1	66.0
Investment capital	0.27*"start"+ 0.11*"business"+ 0.07*"investment"	623	10.1	49.9	40.0
Scaling the business	0.21*"small"+ 0.19*"business"+ 0.06*"scale"	521	8.3	49.7	42.0
Breakeven point	0.25*"make"+ 0.14*"people"+ 0.11*"money"	716	15.6	42.0	42.3
Small business owner	0.22*"business"+ 0.18*"small"+ 0.08*"owner"	540	11.7	45.4	43.0
Disruptive innovation	0.18*"innovation"+ 0.04*"change"+ 0.03*"life"	787	8.8	30.9	60.4
Important items	0.09*"thing"+ 0.07*"important" + 0.06*"open"	647	7.4	41.7	50.9
Find good sources	0.28*"good"+ 0.14*"find"+ 0.07*"software"	447	5.8	28.2	66.0
Funding	0.20*"startup"+ 0.06*"investor"+ 0.05*"invest"	608	9.7	46.4	43.9
Startup location	0.32*"startup"+ 0.32*"tech"+ 0.02*"silicon_valley"	836	8.4	45.2	46.4
Product launch	0.25*"product"+ 0.11*"market"+ 0.08*"launch"	672	8.2	38.5	53.3
Initate new business	0.36*"business"+ 0.08*"run" + 0.08*"start"	513	5.3	35.5	59.3
Risk management	0.27*"strategy"+ 0.04*"fail"+ 0.03*"corporate"	684	13.0	45.2	41.8
Business plan	0.40*"business"+ 0.15*"plan"+ 0.12*"good"	486	5.8	50.6	43.6
Business model	0.12*"business" + 0.10*"model"+ 0.08*"strategic"	591	6.4	50.3	43.3
Marketing advise	0.08*"marketing"+ 0.07*"give"+ 0.07*"website"	531	7.3	32.4	60.3
Validating idea	0.12*"customer"+ 0.08*"development" + 0.05*"idea"	497	10.1	40.2	49.7
Digital business	0.31*"business"+ 0.25*"start"+ 0.10*"online"	431	7.7	45.0	47.3
Emerging markets	0.16*"start"+ 0.13*"business"+ 0.10*"india"	496	9.3	56.7	34.1
Partnership	0.37*"company"+ 0.04*"partner"+ 0.03*" competitive_advantage"	447	13.9	36.7	49.4
Technology trends	0.11*"technology"+ 0.09*"big"+ 0.08*"industry"	509	9.4	41.3	49.3
Idea invention	0.15*"idea"+ 0.11*"invention"+ 0.10*"good"	527	12.0	24.7	63.4

N: total questions; (-): negative sentiment; (+): positive sentiment; (n): neutral sentiment;

positively perceived. Conversely, some issues are perceived as challenges to SEs development, with concerns about founder figure (24.4%), remote work (17.1%), payment services, and break events (at around 16% each) being perceived as more negative. Based on Table 1 and in light of previous literature on the dimensions of startup challenges, including product, financial, team, and market (Giardino et al., 2015; Ratinho et al., 2020; Shneor & Flåten, 2015; Wang et al., 2016), we identified the following as additional concerns of SEs that need to be considered.

As illustrated in Table 2, international startups and role models are two additional dimensions of

challenges that have been overlooked previously and may arise due to Quora's global nature. As a result, people from various countries use the platform to inquire about opportunities, challenges, and success factors associated with developing startups in other locations and require an example of successful development.

The "role models" category is an example of how digital technology can help small and medium-sized enterprises (SMEs) find inspiring stories of role models who are either individuals or organizations to gain insights into how startups in situations similar to their own are evolving.

Table 2: Further concern dimension for SEs.

(Challenge category): definition	Label of concern	Example question from Quora
(international startup): lack of knowledge regarding place developing international startup	Startup location	*"Why has Sub-Saharan Africa failed to produce tech giants like Twitter, Facebook, Apple, Google, Arm (acquired by SoftBank), etc.?"* *"Is Silicon Valley really the best tech startup location?"*
	Emerging market	*"What are the ways to start a tech startup in India while being located in the USA? "*
(Role model): lack of inspiring role model	Founder Figure	*"What Elon Musk Gets Wrong About Leadership?"* *"Why did Steve Jobs push technology forward, even risking his company to fail?"* *"Why are there relatively few female tech startup founders?"*
	Inspiring company	*"I'm 16, and I want to start my own software company like Apple and Microsoft. How and where should I start with?"* *"What do you learn in a small company that you can't learn in a big one?"*

SQA provides a place for direct engagement with other successful SEs when it comes to using SQA to look for role models. They may have a comparable background and can serve as inspiring role models.

As seen in Figure 2, the number of queries for all topics climbed dramatically year after year. Based on the percentage of the ratio value of each year's calculation. We discovered some intriguing patterns of concerns that can help us better grasp how the popularity of a specific issue competes in the SQA.

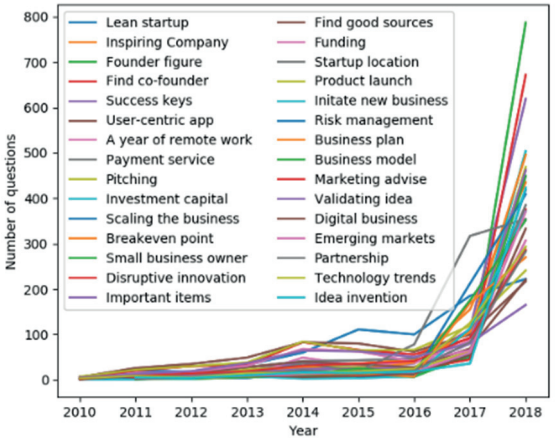

Figure 2: Number of questions per year of topic concerns.

First, we found that some topics were not queried in the first year, 2010. The topics that appeared for the first time in 2011 are pitching an idea, investment capital, scaling business, small business, important resources, finding good sources, startup location, well-prepared business, business model, digital business, emerging markets, partnership, and idea generation. However, some of the concerns receive more attention from SEs to discuss in the SQA.

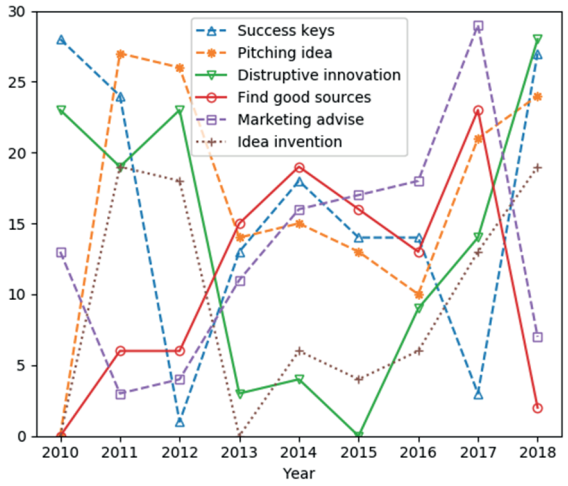

Figure 3: Dynamic changes in popularity over time of positive concerns relative to other concerns.

Next, we present the dynamic changes in popularity of the concerns over time (for Figure 3 to 6, on the x-axis, the years, and the y-axis, the ranking of the concerns relative to each other based on the number of questions asked in that year, the higher the ranking, the more questions asked relative to other concerns in that year). Figure 3 shows the top positive concerns based on Table 1 (pitching, finding good resources, idea generation, marketing advice,

disruptive innovation, and keys to success), and Figure 4 shows the top negative concerns and those that have changed significantly over time (Figures 5 and 6).

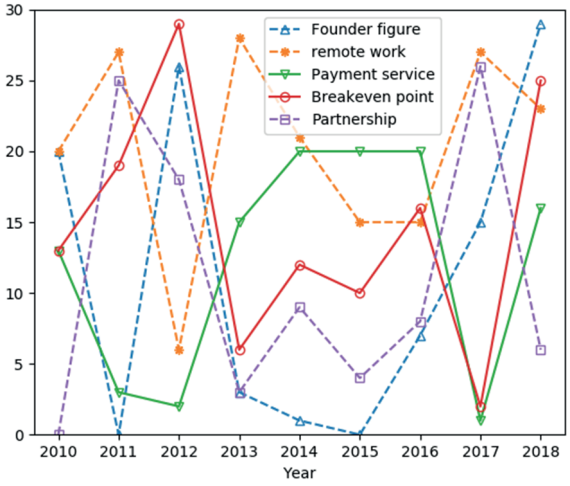

Figure 4: Dynamic changes in popularity over time of negative concerns relative to other concerns.

As shown in Figure 3, the topic of concern about disruptive innovation has received more attention from 2015 to 2018 than other concerns that show more positive sentiment. Meanwhile, the topics of marketing advice and finding good sources fall from the top in 2017.

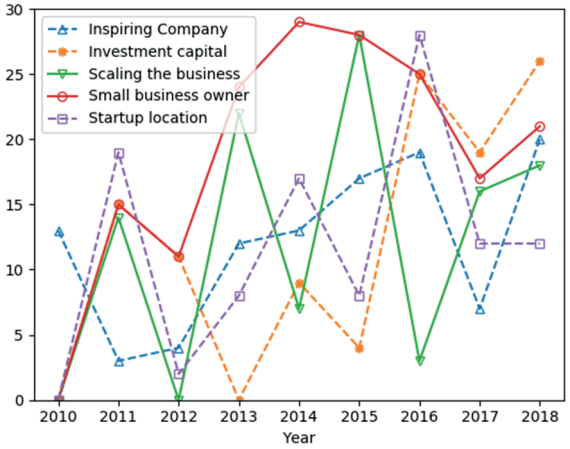

Figure 5: Concerns that show increasing trends in popularity compared to other concerns.

Moreover, we can observe in Figure 3 that there are significant shifts in all concerns in 2014. On the other hand, in Figure 4, in 2015, there were no concerns about the "founder figure," Three years later, the concern was the highest in the group of negative concerns. Thus, overall, the negative concerns group did not show a consistent significant trend over time.

An interesting pattern that shows improvement over time is presented in Figure 5 regarding the concerns of the inspiring company, investment capital, scaling the business, small business owner, and startup location. Those concerns consistently show positive tendencies and can be a signal for providing content learning materials in that regard.

Also, four topics of concern show negative popularity among the graphics: lean startup, user-centered app, product launch, and technology trends. Many reasons might push the concern popularity to be reduced, for instance, the availability of learning sources outside the SQA.

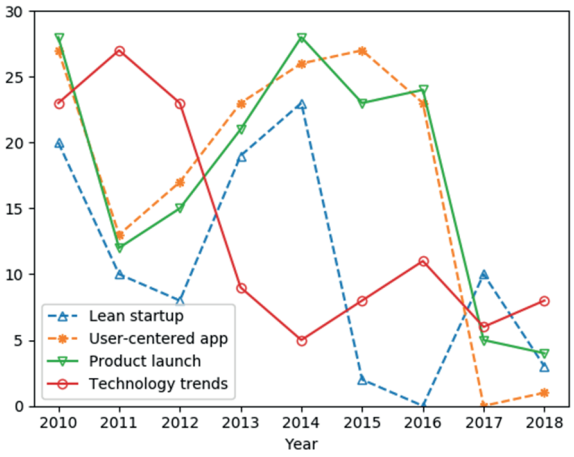

Figure 6: Concerns that show decreasing trends in popularity compared to other concerns.

The following section will discuss the study's implications, including limitations and recommendations for further study.

5 DISCUSSION

Based on the identified concerns from the SQA, further research can use the proposed designation and validate it empirically with SEs based on different types and sizes of businesses, SEs characteristics (Chandra et al., 2016), or the current entrepreneurial journey process. To fit the context of the SEs study, the list of competing concerns may be prioritized, modified, combined, or, if necessary, expanded to include new concerns.

In comparison to earlier research (Giardino et al., 2015; Wang et al., 2016), this study discovered two new dimensions: role model and international startup development. Pitching and product launch were also

discussed in the SQA, which shows the importance of startups in the digital age in terms of customer acquisition (Giardino et al., 2015). Technology trends and digital business also shows that the challenges were also prevalent for SEs in the digital age, which was previously discovered only from the social media data of SE status on Twitter (Saura et al., 2019), but from the direct interview and observation study (Giardino et al., 2015; Wang et al., 2016).

Furthermore, the study demonstrates how topic modeling and sentiment analysis may be used to uncover SE concerns based on questions posted on an SQA. We also confirmed SEs' usage of SQA in an open virtual community forum to find preferences and responses to their bewilderment, challenges, and queries as concerns, which had previously been generated by qualitative methods such as surveys, literature studies, and personal interviews with SEs (Giardino et al., 2015; Ratinho et al., 2020; Shneor & Flåten, 2015; Wang et al., 2016).

Nonetheless, this study has a few limitations. First, we only studied one SQA that uses English. Further research can be conducted with other SQA platforms and combine multilingual data collections. Current research on language translation enables topic modeling to mature in English by translating the other language into English before applying the English-based topic modeling. Also, we only looked at the questions and excluded the answers. By supplementing the dataset with responses, additional information can be gathered that will aid in determining the size of the issue at hand.

Furthermore, topics may overlap in meaning or have almost identical meanings; since we only use the log-likelihood value to select the number of topics, other criteria (e.g., coherence value) can also be used. In further studies, the related questions can be included in the analysis to form the label and validate the label with experts and SE directly. Besides, while the study was limited to 2018, based on the identified topics, the LDA model presented in Table 1 with words and the associated coefficient can predict a topic in new documents or questions. Future research may indicate dynamic shifts in the popularity of concern about a particular event, such as before and after the Covid 19 pandemic.

6 CONCLUSION

Our research explores the SEs concern pattern and shows that SQA can be reliable knowledge management and entrepreneurship study tool. We have identified thirty competing concerns that are coupled with SEs' emotional preferences. In the future, it is possible to conduct more empirical explorations based on the thirty issues raised.

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V

DEVELOPING A COMPETENCY FRAMEWORK FOR INTERGENERATIONAL STARTUP INNOVATION IN A DIGITAL COLLABORATION SETTING

by

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Developing a Competency Framework for Intergenerational Startup Innovation in a Digital Collaboration Setting

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Keywords: Competency Framework, Intergenerational Innovation, Global Start-up, Digital Collaboration, Computer-Supported Collaboration, Cross-generational Collaboration.

Abstract: This study proposes a framework for the collaborative development of global start-up innovators in a multigenerational digital environment. Intergenerational collaboration has been identified as a strategy to support entrepreneurs during their formative years. However, integrating and fostering intergenerational collaboration remains elusive. Therefore, this study aims to identify competencies for successful global start-ups through intergenerational knowledge transfer. We used a systematic literature review to identify a competency set consisting of growth virtues, effectual creativity, technical domain, responsive teamwork, values-based organization, sustainable networking, cultural awareness, and facilitating intergenerational safety. The competency framework serves as a foundation for knowledge management research on the global innovation readiness of people to collaborate across generations in the digital age.

1 INTRODUCTION

This research aims to highlight the competencies for intergenerational collaboration in the digital age of start-ups. Entrepreneurs today can expand globally due to technological advancements. However, many significant barriers to developing global start-ups have been identified, including geographic isolation, lack of trust, and aversion to imitation (Jensen, 2017; Zakaria et al., 2004). One significant stumbling block is a lack of competencies and successful characteristics (Clercq et al., 2012; Giardino et al., 2014; Nurhas et al., 2020), particularly in the early stage when strategic organizational decisions are often urgently needed (Clercq et al., 2012; Giardino et al., 2014). One promising approach is an intergenerational collaborative innovation (Matlay & Gimmon, 2014; Underdahl et al., 2018), defined for this study as collaboration in a virtual environment for innovation activities between senior and younger adults with an age difference of 20 years and more (Brečko, 2021; Nurhas et al., 2020).

However, it remains unclear how to 1) integrate generational competencies and 2) promote intergenerational collaboration for global start-up innovation. Although society's generations change every twenty years, managing age and intergenerational disparities for innovation remains a concern for companies of all sizes (Brečko, 2021). Moreover, entrepreneurship research has identified entrepreneurial competencies (Arafeh, 2016; Bacigalupo et al., 2016; Dijkman et al., 2016; Kyndt & Baert, 2015). However, little to no research incorporates and integrates intergenerational start-up entrepreneurship competency research into a cohesive block of our knowledge.

Therefore, based on a systematic literature review (Webster & Watson, 2002), we conceptualized and discussed a required competencies for the study context with two startup cofounders. This review combines mature studies of required competencies from multiple domains, such as entrepreneurship, global innovation, intergenerational and digital collaboration. The study proposed an eight-competency-group framework, with each group encompassing a different activity level related to global innovation, intergenerational collaboration, and digital activities.

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2 BACKGROUND

Although the terms competency and competence are often used interchangeably to describe a skill or required knowledge for a particular state or function (Holtkamp et al., 2015) , we used the term competency. The term competency typically refers to the knowledge, skills, and abilities required to solve specific problems in specific contexts. In this study, we consider integrating attitudes (Bosma & Schutjens, 2011), which include individual preferences, virtues, and character traits (Bosma & Schutjens, 2011; Karlson & Fergin Wennberg, 2014). At the organizational level, organizational capabilities combine individual and group competencies as human resources that complement each other to form a specific set of expertise (Saa-Perez & Garcia-Falcon, 2002). Therefore, it is critical to examine the individual competencies required for start-ups to develop as an organization.

The decision to engage in intergenerational collaboration is not an easy path for organizations; several barriers have been identified, including individual, perceptual, and technical/operational (Giardino et al., 2014; Nurhas et al., 2020). Technology is being widely used to support intergenerational collaboration and demographically segregated teams, becoming increasingly important in the era of digitalization (Lyashenko & Frolova, 2014; Nurhas et al., 2020; Shi et al., 2019; Underdahl et al., 2018).

Being an entrepreneur in a multigenerational environment, on the other hand, requires a unique set of skills, especially if the goal is to (transition to) an international business model. As a result, current research on identified competencies needs to be expanded and complemented by global innovation. Previous research has identified different types of competencies for entrepreneurs, such as self-confidence and autonomy (Arafeh, 2016; Lans et al., 2010; Mitchelmore & Rowley, 2010), taking calculated risks and recognizing opportunities (Arafeh, 2016; Kyndt & Baert, 2015), creativity, and problem-solving (Jensen, 2017; Mitchelmore & Rowley, 2010; Rasmussen et al., 2011; Wu, 2009), The entrepreneurs also required to take action by transforming information into actionable strategy (Arafeh, 2016; Bacigalupo et al., 2016; Kyndt & Baert, 2015). Concerning global innovation, critical elements such as creativity, cultural empathy, teamwork, networking, and organizational space and vision can serve as a basis for categorization (Griffith et al., 2016; Jensen, 2017; Lombardi, 2010). This may pave the way for the identification of complementary competencies for this study context as needed for intergenerational collaboration in various settings, including family businesses (Miller et al., 2003; Shi et al., 2019), professional and knowledge-intensive workplace organizations, and higher education. There is still a need to understand what competencies are required for successful intergenerational collaboration, especially when using digital technologies.

3 METHOD

Systematic Literature Review (SLR) was used in this study. SLR helps develop conceptual models based on fragmented research (Webster & Watson, 2002) The following research question was proposed in response to the issues presented in the introduction: *Which competencies are required for global start-up entrepreneurs working in intergenerational settings?*

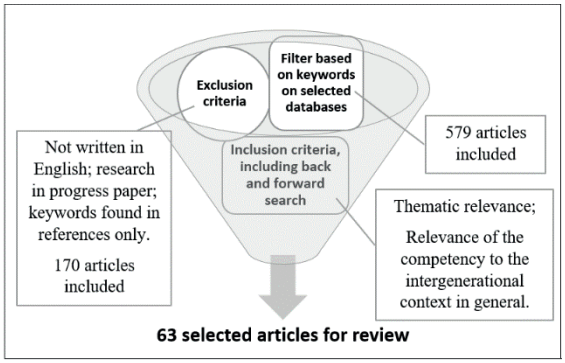

Figure 1: Systematic literature review process.

For the SLR method, the guideline of conducting SLR (Webster & Watson, 2002) was applied. The research phase begins with the planning process, based on the identified research question. The selection of keywords was defined. On October 27, 2017, the following keywords were searched for: [[competence OR competency OR capability OR skill OR attitude OR behavior] AND ["global innovation" OR "Intergenerational Innovation" OR "intercultural Innovation" OR "cross-generational Innovation"] AND [entrepreneurs OR start-ups]]. Scholarly databases of related disciplines such as Springerlink, AIS e-Library, ACM Digital Library, Sciencedirect, and information systems senior scholar “basket of eight” journals were used to find relevant articles. For the inclusion criteria: an article should be written in English, highlighting the importance of studying competencies and articles that focus on providing relevant competencies for intergenerational learning context, entrepreneurship, digital collaboration, and start-ups development. For the exclusion criteria: "Research in Progress," or short articles, an opinion article should be removed from the list, also an article

that does not focus on competencies or impacts of competencies.

Based on the selection process, the final 63 papers were selected for review. Manual and iterative coding for content analysis and conceptualization was used to develop a more abstract level of capabilities to cover a wide range of individual-level competencies. Each competency mentioned or discussed in the selected literature was noted. The identified competencies were assigned to an initial classification of global innovation: creativity, cultural empathy, teamwork, networking, and organizational space and vision (Jensen, 2017; Knight & Cavusgil, 2004) or, if not relevant, were grouped into new categories. The label concept for the group of competencies was refined based on the collection of competencies. The development of the conceptual framework was fundamentally abductive. It resulted in an attempt to determine the best way to describe the competencies and competency groups found in the selected literature.

4 RESULT

Table 1 depicts the conceptual matrix (Webster & Watson, 2002) of intergenerational start-up competency in the digital age following the explanation of each competency category for the study context, which includes growth virtues (Gv), effectual creativity (Ec), technical domain (Td), responsive teamwork (Rt), values-driven Organizing (Vo), sustainable networking (Sn), cultural awareness (Ca), and intergenerational safety facilitation (Is). While there is only one category labeled "intergenerational," other categories are also used in this setting.

Growth virtues are a characteristic valued by the individual or social group; in this context, we derived the growth virtues competency from personal competencies. We define growth virtues as values that belong to intergenerational start-ups' innovators to evolve and grow to meet various global innovation challenges. Five virtues fall into this competency group: grit, self-determination, conscientiousness, intergenerational reflection, and resilience. These five competency virtues are included in the virtues of growth because they referred to individual values acquired through learning and shared experience and practiced in developing digital start-ups. Growth virtue must be present to develop and innovate further amid global innovation and intergenerational collaboration challenges.

Effectual creativity is associated with institutional creativity for global innovation. Foresight thinking and global design thinking are two competencies included in this category. By focusing on global innovation, both competencies are related to creating a global business model focused on available capital, local values, and stakeholders. Effectual creativity creates products or services by managing future performance based on the availability of resources.

Technical domain expertise. In this category, several competencies are remarkably similar, namely the operationalization of specific skills and the use of tools. Competency in this category includes financial negotiations, digital information fluency, legal analysis, financial negotiations, and digital competency associated with operating digital devices to optimize digital information for innovation collaboration purposes.

Responsive teamwork is a group of competencies highlighting the importance of constructive peer feedback for teamwork progression. The competencies included in this category are active listening, conflict resolution, intergenerational orientation, auxiliary skill. These competencies share common features supporting interpersonal relationships in working with teams within a generation or different generations. Furthermore, auxiliary skill is vital to help their peers overcome their challenges and difficulties, supporting their organization in long-term collaboration.

Value-driven organizing. For the fourth category, the focus of the capability covered by this dimension is on competencies for managing and empowering the resources based on the shared belief. The competencies in this category include visioning, personal resource allocation, quality orientation, decisiveness. Visioning shows the important role of value in providing direction for defining organization strategy. In addition to global innovation, the ability to manage and optimize human resources, focusing on the quality and decisiveness by simplification steps to make the organizational strategy more natural to implement and minimize all forms of risk.

Sustainable networking brings together all the skills closely linked to professional bonds outside the organization. Three competencies for this group are influencing, transparency, effective communication. In the context of global innovation, global start-up innovators require the optimization of long-term professional networks. This provides the ability to influence professional networks' functions and ensure transparency and communication effectiveness of different channels and foreign languages.

Cultural awareness is about competencies that underline the importance of valuing cultural differences. Under this category, a global start-up innovator travels to another country with a different culture, searching for partners, developing products and services based on the global and local value in line with its objectives. Two skills we need to

Table 1: Concept matrix.

literature	Concepts							
	Gv	Ec	Td	Rt	Vo	Sn	Ca	In
Abbott et al., 2013		x		x	x	x	x	x
Arafeh, 2016	x	x			x	x		
Audzeyeva & Hudson, 2016					x	x		
Bacigalupo et al., 2016	x	x	x	x	x			
Bala et al., 2017	x			x	x	x		
Barrett, 2014							x	x
Bharadwaj et al., 2010	x		x					
Blackburn et al., 2003	x		x	x	x	x	x	
Boughzala et al., 2012		x				x		x
Cheng & Huizingh, 2014	x	x						
Czarnitzki & Lopes-Bento, 2014			x					
Davis et al., 2009	x			x	x			
Dijkman et al., 2016	x	x	x	x	x			
Dimitratos et al., 2014	x			x	x	x		
Dohmen et al., 2014	x					x		
Dong & Wu, 2015		x			x			
Duckworth et al., 2007	x							
Duhan et al., 2001	x	x	x		x	x		x
European Communities, 2006	x		x			x	x	
Fantini & Tirmizi, 2006	x					x	x	x
Foster-Fishman et al., 2001		x		x			x	
Getha-Taylor, 2008				x			x	x
Goldsmith & Eggers, 2005		x		x	x	x		x
Griffith et al., 2016					x			x
Hamel, 2008	x	x						
Hammer et al., 2003				x				x
Hertel et al., 2006	x	x				x	x	x
Igbaria & Baroudi, 1993		x			x			
Kohli & Grover, 2008			x				x	
Kollmann et al., 2009		x			x			
Kungwansupaphan & Siengthai, 2014	x							x
Kyndt & Baert, 2015	x	x			x	x		
Lans et al., 2010		x		x	x			x
Li et al., 2016	x	x	x	x	x	x		
Lim et al., 2013	x	x	x					
Liu, 2016						x		
Lombardi, 2010							x	x
Markham & Lee, 2013	x	x	x			x		
Martins & Terblanche, 2003	x	x		x	x			x
Martinsons & Ma, 2009			x		x	x		
Miranda & Kavan, 2005				x				
Moro et al., 2014		x			x			
Newman et al., 2017			x					x
Nielsen, 2015		x		x	x	x		x
Ojala, 2016	x	x						
Quadros Carvalho et al., 2013	x	x	x		x			
Rasmussen et al., 2011	x	x						
Rasmussen et al., 2014	x	x						
Reid & Brentani, 2015					x			x
Reid et al., 2014		x			x			x
Ritter & Gemünden, 2003			x			x		
Sahay, 2004			x		x	x	x	
Sánchez, 2013	x				x			
Sarker & Sahay, 2003	x				x	x	x	x
Várhegyi & Nann, 2011						x	x	x
Vuorikari et al., 2016			x		x			
Watts et al., 2013	x			x	x	x	x	x
Wei et al., 2011			x					x
Wu, 2009	x		x	x	x	x		x
Xu et al., 2007			x					x
Zakaria et al., 2004						x	x	
Zimmermann & Ravishankar, 2014						x	x	x
Zimmermann et al., 2013	x			x	x	x	x	

consider in this category are pluralistic thinking and digital empathy. Digital empathy is closely linked to cultural empathy, which is required to understand cultural cues in virtual environments.

Intergenerational safety facilitation deals with nurturing psychological safety in intergenerational collaboration. Competencies include are: intergenerational flexibility, intergenerational digital adaptability, and intergenerational leadership. Intergenerational flexibility can help provide a feeling of safety to express opinions and accept differences of opinion regarding new ideas or approaches. In digital collaboration, each generation can have a different background for the use of technology. Therefore, facilitating safety for both generations requires intergenerational digital adaptability to facilitate workforce diversity, and no generation feels excluded.

5 CASE STUDY

As an initial evaluation, the proposed comprehensive list of competencies and competency groups of inter-Generation startups-innOvators for globAL innovation (iGOAL) can be used in the context of human resource development to identify competency gaps and initiate appropriate interventions (in the form of training, matching, or recruitment processes). For instance, a readiness indicator based on this study result can be developed, which can be used for self-assessment of the startup actor (s). Two case studies were presented. We asked two different startup founders in two different countries about required competencies for startup development and discussed the proposed list of competencies and the competency group.

Case Study 1: an Indonesian IT company founded in 2015 develops an integrated app for waste management. The company connects community and financial institutions for turning waste into digital money, helping the government in decision making to design a smart city and collaborate with consumer-goods industries for trash management. In the context of intergenerational collaboration, the founder (29 years old) stated, *"…very important, but right now it is not a problem for us, because most of our team is at the same generation age..."* and currently at the stage for expanding their business model in other countries "…*The internationalization process of the business model right now is on the planned stage, since now we are preparing our collaboration with abroad partners...*"

As for the assessment tool, the founder notes that the tool could be helpful for their organization. The founder suggests a mutual assessment with the internal and external organization to reduce distortions in the assessment ("…*This readiness assessment tool will be maybe helpful for our organization, but it needs an independent assessment scoring because if we asses by our self, there could be a bias with the score…*"). Furthermore, the founder also recommends an online version of the tool for multiple uses, which allows the historical assessment result of the organization to be tracked ("*I think this tool should be running on mobile/web-based platform and can be used for several times, so that it can track the development of the existing score into the target score.*").

Case Study 2: a start-up was founded in 2019 by three cross-generational co-founders (<30 years old, mid 40, and >70 years old). The startup's focus is to provide personal consultancy and recruit new employees for specific vacancies, mainly in engineering industries. For this study, the younger co-founder described the current status of their organization in terms of global innovation and intergenerational collaboration. Despite the start-ups currently focus on the local market ("…*the company is strongly oriented towards the North-Rhine-Westphalia region (Germany). Due to the demand for personal service, an expansion on a national or even international level could only be implemented by a significant increase in the number of employees..*"), the intergenerational collaboration plays an integral part of their startup ("*Due to the joint founding with three members from different generations, it is an integral part of the business concept. The older generations bring experience and important business contacts to the business, while the younger generation is responsible for the implementation in a digital working environment..*").

The founder took the prototype of the assessment tool and gave some feedback, first referring to the usefulness of the self-assessment as a starting point to reflect the condition of current start-ups (*"In particular, the competencies and rubrics taken into account enable a neutral assessment of one's own status. Here, it is interesting to reflect on the relevant contexts in order to be able to question one's own approach critically…, the tool can certainly reveal helpful starting points..."*).

Furthermore, for improvement, the founder proposed to add some examples for the competency and to compare the result with peers to get a better overview of the organization ("more detailed explanations or examples could contribute to understanding…"). And ("*…The evaluation is already very well presented at this point in time, but as a participant, I can only estimate the result to a limited extent without comparison. Here, individual recommendations for action derived from the results would be a huge added value for the participants…*").

The initial assessment of the proposed list of competencies and competency groups through two case studies demonstrates the potential of the study result for startup founders, but also for further investigation of the Startup Global Innovation Readiness Assessment in the context of intergenerational collaboration. The next section discusses the research findings and proposes a comprehensive overview of the study findings, limitations, and future research directions.

6 DISCUSSION

This paper offers a comprehensive set of intergenerational start-up innovation competencies for the digital age. Previous research has found that vision (Knight & Cavusgil, 2004) and personal characteristics (soft skills) are important (Bauman & Lucy, 2019; Karlson & Fergin Wennberg, 2014). More importantly, we offer a comprehensive view of innovation in an era of global digital collaboration and workforce diversity. We supplement previous research on global innovation success (Bauman & Lucy, 2019; Jensen, 2017; Knight & Cavusgil, 2004) and intergenerational competencies in start-up development (Bauman & Lucy, 2019). (for example, intergenerational flexibility, intergenerational leadership, intergenerational reflection, and orientation).

The concept of a competency group can be defined as a group of people who complement each other's skills. Group competency is more than just intrapersonal or group human capital. Start-ups can develop group competencies by matching individual

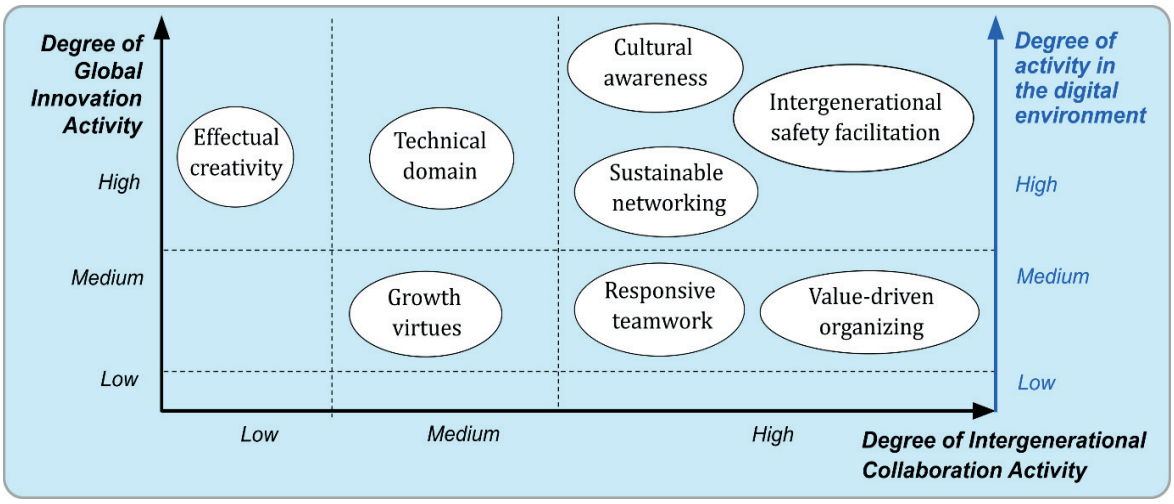

Figure 2: Intergenerational competency framework of global startup innovators in the digital age.

skills in a global and intergenerational setting. This research enlarges eight human-based start-up capital competencies (Jensen, 2017; Knight & Cavusgil, 2004). Between generational differences, effectual creativity that can support unique product development or global idea generation (Knight & Cavusgil, 2004), value-driven organizing and cultural awareness of other generations, quality focus, and cultural empathy are important (Jensen, 2017). The proposed list of group competencies highlights growth virtues, sustainable networking, responsive teamwork, and a group competency of intergenerational mobility safety facilitation that focuses on intergenerational mobility safety facilitation.

Developing a group competency based on individual competencies may enable founders to concentrate on their strengths. The framework can assist start-up stakeholders in matching and partnering (Bauman & Lucy, 2019). Furthermore, educational institutions can prioritize courses or curriculum development for start-up actors based on individual competencies. As a result, start-up actors can cultivate critical individual competencies and form appropriate partnerships. The findings could also be applied to developing supportive learning systems for global start-ups (Pawlowski et al., 2018).

In conclusion, we provide an overview of the conceptual competency framework for the study context shown in Figure 2, which can enable an intergenerational ecosystem. The framework can be used to understand and support innovation activities based on the identified concepts from the literature and the competency group related to the three activities: global innovation, intergenerational collaboration, and the use of digital technology. This study also provides an initial qualitative assessment of the proposed approach through open-ended questions in two case studies. The proposed framework could be a basis for future empirical studies on the competency of startup founders and promote intergenerational collaboration for startup internationalization.

Certain limitations should be noted. First, the literature review may not include all relevant disciplines and literature. Therefore, this study developed a higher/abstract competency group that encompasses a more general level of competency. A new relevant study that comes after the review process, if it contains a specific competency, can be assigned to one of the predefined categories. In addition, the proposed conceptual framework can be used as groundwork for future research. It can be validated empirically with experts and start-ups entrepreneurs.

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VI

AN INTERGENERATIONAL COMPETENCY FRAMEWORK: COMPETENCIES FOR KNOWLEDGE SUSTAINABILITY AND START-UP DEVELOPMENT IN THE DIGITAL AGE

by

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An Intergenerational Competency Framework: Competencies for Knowledge Sustainability and Start-up Development in the Digital Age

Competencies for global entrepreneurs in intergenerational settings

Keywords: intergenerational competency, sustainable start-ups, start-ups entrepreneurs, global innovation, intergenerational innovation,

Abstract: In this study, we looked at the competencies and changes in the competency spectrum required for global start-ups in the digital age. Specifically, we explored intergenerational collaboration as an intervention in which experienced business-people from senior adult groups support young entrepreneurs. We conducted a Delphi study with twenty experts from different disciplines, considering the study context. The results of this study shed light on understanding the necessary competencies of entrepreneurs for intergenerationally supported start-up innovation by providing twenty-seven competencies categorized as follows: intergenerational safety facilitation, cultural awareness, virtues for growth, effectual creativity, technical expertise, responsive teamwork, values-based organization, and sustainable network development. In addition, the study results also reveal the competency priorities and the minimum requirements for each competency group based on the global innovation process and can be used to develop a readiness assessment for start-up entrepreneurs.

Keywords: intergenerational competency, sustainable start-ups, start-ups entrepreneurs, global innovation, intergenerational innovation

1. Introduction

"Born global or die local: A scalable start-up usually necessitates a local population of more than 100 million people. However, only a few countries meet this criteria, including the United States, China, Russia, Brazil, India, and Indonesia. Most countries do not have a large enough population to sustain start-up scale with only their local market, and must instead be global players from the outset." - Steve Blank –

Intergenerational collaboration is a promising approach to support emerging start-ups

through mentoring and sharing entrepreneurial expertise (Basly, 2007; Edelman et al., 2016; Matlay & Gimmon, 2014; Underdahl et al., 2018) for succession and business internationalization (Shi et al., 2019) and to develop sustainable business model (Perez-Encinas et al., 2021), particularly in family-based business (Bjuggren & Sund, 2001; Shi et al., 2019). There could be an untapped nexus between older and young potential entrepreneurs who are not in a family business. Thus, the diversity of perspectives and competency backgrounds could provide a balance for organizational development in the knowledge economy (Østergaard et al., 2011; Won et al., 2021), which is highly linked to sustainable business development and knowledge succession, regardless of family ties (Littunen & Hyrsky, 2000; van Kleef & Roome, 2007).

However, appropriate skills are critical to intergenerational collaboration, and researchers have emphasized the importance for global start-up founders to identify both competency and success characteristics (Giardino et al., 2014; Massis et al., 2018; Pirkkalainen & Pawlowski, 2014; E. S. Rasmussen & Tanev, 2015; Tanev, 2012; van der Westhuizen & Goyayi, 2020; Yin & Luo, 2018), especially in the early stages of business development, when strategic organizational decisions are often urgently needed (Basly, 2007; Giardino et al., 2014; E. S. Rasmussen & Tanev, 2015; Tanev, 2012). Given the variety of perspectives on innovation, in this study, we understand the innovation as processes and activities that add strategic value to the current status quo. In this regard, processes and activities that related to the internationalization of digital start-ups.

Human factors are one of the three pillars of innovation in digital business development (Ramdani et al., 2021) which include skills and abilities, or competencies (Foucrier & Wiek, 2019; Littunen & Hyrsky, 2000; Sánchez, 2013; van Kleef & Roome, 2007; Wu, 2009). Managing available knowledge, networks and resources is an important part of developing an internationalization strategy for global start-ups (Bailetti, 2012). Therefore, start-up stakeholders need to understand various competencies in order to act quickly and adapt human capacities to global requirements (Jensen, 2017; Li et al., 2016; Littunen & Hyrsky, 2000; Massis et al., 2018). On the one

hand, the Entrepreneurship and Business Development studies identified different personal competencies for entrepreneurs and business internationalization (Arafeh, 2016; Bacigalupo et al., 2016; Colombo & Piva, 2008; Dijkman et al., 2016; Jensen, 2017; Wu, 2009), to overcome a variety of challenges, particularly in the development of digital start-up in global scale (Bailetti, 2012; Edelman et al., 2016; Müller et al., 2019; Tanev, 2012). On the other hand, however, little attention has been given to the dynamic changes in the required competencies of global innovation process (Chang, 2012; Santoro et al., 2019), the importance of intergenerational collaboration for global innovation (Shi et al., 2019), as well as in the age of digitalization, with higher degree on the use of digital technology to support collaboration and business model development (Hevner & Gregor, 2020; Li et al., 2016; Pilková et al., 2022; Vuorikari et al., 2016). Therefore, this study aims to investigate which competencies should be prioritized for start-up entrepreneurs' leveraging intergenerational setting to support the global innovation process in the digital age?

Fostering global start-ups innovation through intergenerational collaboration in the digital age consists of multiple domains (Jensen, 2017; Wu, 2009), furthermore, prioritizing specific requisite competencies for innovation processes and practices necessitates expertise, experiences, or profound understanding (van Gelderen et al., 2021). Numerous studies have highlighted the importance of understanding the framework of entrepreneurial competencies to run a successful business (Dijkman et al., 2016; Kyndt & Baert, 2015; Shi et al., 2019; Vuorikari et al., 2016; Wu, 2009), especially in the digital age and in the age of demographic change (Harvey, 2012; Pilková et al., 2022; Shi et al., 2019). In this study, we developed a competency-based intergenerational collaboration framework for global start-ups entrepreneurs. The competency-based framework was built iteratively by incorporating the domains of digital learning and innovation (Li et al., 2016; Lyashenko & Frolova, 2014; Müller et al., 2019; Pilková et al., 2022; Vuorikari et al., 2016), intercultural and intergenerational collaboration (Jensen, 2017; Martins & Terblanche, 2003), and global innovation (Jensen, 2017; Zakaria et al.,

2004) into the entrepreneurial domain. The overlap of the various domains was chosen to support the study setting in light of past research that has the potential to enrich the status quo and complement the previously existing competency framework for global innovation and entrepreneurship (Bacigalupo et al., 2016; Jensen, 2017; Wu, 2009).

The study's outcome is an eight-group competency framework that includes, including intergenerational safety facilitation, growth virtues, effectual creativity, technical domain, responsive teamwork, value-driven organizing, sustainable networking, and cultural awareness. The sub-competencies of each competency group, more or less consist of competency regarding intergenerational and digital context. The results of the study will contribute twofold. First, we expand the current literature on the competencies of start-up entrepreneurs in global and intergenerational innovation. From a management perspective, we have identified the eight competency groups as the human capital needed by start-ups to internationalize innovation by leveraging intergenerational collaboration and finding partners to complement the competency requirements. Moreover, as a practical contribution based on the proposed framework, we have presented a self-assessment tool that can be used by young start-up entrepreneurs to reflect on the current state of readiness for global innovation and to identify competencies to foster intergenerational collaboration within their start-ups.

2. Theoretical Background

Advances in the digital economy and information technology management over the last decade have enabled start-ups to shift from local business development to global knowledge-intensive digital business innovation. Start-ups are similar to small and medium-sized businesses, based largely on the use of technology, while having limited resources and little to no operating track record (Giardino et al., 2014). It is important to conduct research on start-ups since they have emerged as a primary driver of global economic development in the digital age (Ramdani et al., 2021), particularly for technology oriented business model (E. S. Rasmussen & Tanev, 2015; Tanev, 2012),

which are currently prevalent, particularly across Asia, Africa, and Latin America (Chege et al., 2020; Quinones et al., 2020; Wamuyu, 2015). Despite the opportunities offered by information technology and the shift to global business, challenges and barriers to the development of global start-ups remain, for instance cultural and linguistic differences (Jensen, 2017; "Blinded for review"), geographical distance, lack of trust, or fear of imitation, as well as lack of skills (Jensen, 2017; "Blinded for review"; Pirkkalainen & Pawlowski, 2014; Zakaria et al., 2004). A more nuanced approach could address these issues through intergenerational collaboration (Matlay & Gimmon, 2014; Underdahl et al., 2018). Intergenerational collaboration has attracted a great deal of interest due to the challenges of demographic change and the workplace's current diversity, which can cover a diversity of generations (Becker et al., 2020; "Blinded for review").

In this study, global start-ups are defined as technology-based companies that have target markets in more than one country, have limited resources, and are still searching for the right business model. Global start-ups are an important phenomenon to study, partly because of local market constraints (Knight & Cavusgil, 2004; E. S. Rasmussen & Tanev, 2015), but also because globalization offers young entrepreneurs in different countries the new market opportunity to collaborate across borders, help start-ups scale, and drive local economic development as well as knowledge and technology transfer between countries, not only between developed and developing countries, but also between developing or developed countries themselves (Boutellier et al., 2013; Halewood & Kenny, 2008; Jensen, 2017; E. S. Rasmussen & Tanev, 2015; Tanev, 2012)

Identifying competencies and how to manage organizational knowledge in digital age (Carayannis et al., 2021; Müller et al., 2019) for global innovation (Bailetti, 2012; Boutellier et al., 2013; Pawlowski, 2013; Tanev, 2012) and intergenerational collaboration (Becker et al., 2020; Bjuggren & Sund, 2001; Sabri et al., 2016) have quickly become an important issues for start-up innovation due to the sustainability of workplace diversity as one of the main sources of global innovation (Becker et al., 2020;

Gordon, 2018; Müller et al., 2019; "Blinded for review"), the promotion of sustainable business through mentorship and knowledge sharing (Basly, 2007; Matlay & Gimmon, 2014), fostering entrepreneurial well-being (Wiklund et al., 2019) and global business development (Basly, 2007; Paul & Rosado-Serrano, 2019; Shi et al., 2019).

The terms competence and competency are used interchangeably in many cases to describe a skill or required knowledge for an activity or process (Holtkamp et al., 2015). We used the term competency for this study. The term competency usually refers to knowledge, skills, and abilities to solve problems in a specific context (Holtkamp et al., 2015; Pawlowski & Holtkamp, 2012). In this study, we consider integrating attitudes (Bosma & Schutjens, 2011), including individual preferences, virtues, and traits (Bosma & Schutjens, 2011; Karlson & Fergin Wennberg, 2014), to solve a problem in a given context. At the group level, individuals' competencies were combined as human resources that complement each other to form a specific group of expertise or organizational capabilities (Saa-Perez & Garcia-Falcon, 2002). In the context of start-ups, the competency set is one of the most important prerequisites for assessing the potential success of start-up development (Colombo & Piva, 2008; Hafeez et al., 2002; Yin & Luo, 2018).

Intergenerational collaboration is characterized for this study context as a collaboration between younger and older adults in work environments where the age difference is 20 years or more ("Blinded for review"; Pilotte & Evangelou, 2012). The decision to engage in intergenerational collaboration is not an easy path for organizations; several barriers have been identified, including individual, perceptual, and technical/operational (Giardino et al., 2014; "Blinded for review"). Moreover, intergenerational collaboration in global environments becomes even more complex as it depends on dynamic changes in global innovation activities (Foucrier & Wiek, 2019; "Blinded for review"; Shi et al., 2019). As a result, technology is being widely used to support intergenerational collaboration and demographically segregated teams,

becoming increasingly important in the era of digitalization (Lyashenko & Frolova, 2014; "Blinded for review"; Shi et al., 2019; Underdahl et al., 2018).

The collaboration between different age groups, known as intergenerational collaboration, is widespread in entrepreneurship and business engineering (Shi et al., 2019). For example, intergenerational collaboration can occur in family businesses (Basly, 2007; Edelman et al., 2016), in the workplace (Gordon, 2018), in knowledge-intensive organizations (Harvey, 2012), higher education (Lyashenko & Frolova, 2014) and global business development (Shi et al., 2019). On the one hand, the competency of entrepreneurs have been studied in research for decades (Wu, 2009). In the age of digitalization and globalization, start-up founders as entrepreneurs are expected to have global intercultural competence and collaborate across borders and age groups (Shi et al., 2019; Underdahl et al., 2018). Being a global entrepreneur in a cross-generational environment requires different competencies, including social and communication (Bandera & Thomas, 2018; Jensen, 2017; Wu, 2009), confidence (Arafeh, 2016; Lans et al., 2010), a shared understanding and vision, creativity, problem-solving, taking calculated risks (Arafeh, 2016; Hevner & Gregor, 2020; Knight & Cavusgil, 2004; Kyndt & Baert, 2015; Lyashenko & Frolova, 2014), making informed decisions, and developing a sense of urgency (Arafeh, 2016; Griffith et al., 2016). Other aspects of intergenerational collaboration also include responsiveness and flexibility (Edelman et al., 2016; Lyashenko & Frolova, 2014; Martins & Terblanche, 2003; Underdahl et al., 2018).

However, the intergenerational competency for start-up entrepreneurs is mainly discussed in family businesses, although intergenerational collaboration can also occur outside the family business context. There are currently few approaches to assessing specific competencies that encompass intergenerational and global innovation, especially in the digital age and outside the family business context. On the other hand, established competency frameworks focus only on identifying competencies without further exploring the dynamic changes in required competencies, complex depending on the particular start-up phase or activity (Foucrier & Wiek, 2019). Thus, when it comes to

enhancing or finding suitable partners, start-up entrepreneurs may need to find a super-collaborator with a complete set of competencies at once and narrow down the potential of collaboration based on a specific point of collaboration activity, in the global innovation process. Therefore, based on the previously presented studies on gaps and limitations, this study aims to answer the main research question:

How do the required competencies of global start-up entrepreneurs dynamically evolve as they innovate in an intergenerational space?

To answer the main research question, it is important to first identify the (relevant) required competencies and then determine the pattern of importance. In the next section, we will explain the method used in this study in more detail.

3. Method

To answer the main research question, we conducted an online Delphi study (Linstone & Turoff, 1975) to provide flexibility in location and time for participants. The Delphi method was employed as the primary method for developing a competency-based system because it allows researchers to explore critical phenomena on a given topic based on expert preferences. The Delphi method was used to evaluate and validate the competency analysis build consensus, and prioritize competencies (Heiko, 2012; Holtkamp et al., 2015).

The list of the issue to be assessed in the Delphi method can be developed in two ways (Holtkamp et al., 2015; Kendall, 1977; Linstone & Turoff, 1975): first, from scratch and based solely on the expert panel's suggestions; second, by recommending an initial list of competencies to be improved (combined, added, or deleted) and evaluated by experts panel. The second choice was selected for this study. Initial issues of competencies were created by listing competencies mentioned in the literature ("Blinded for review"), intending to gain insights from the scientific community before sending it to the expert panel that can trigger the improvement of the competency list in the Delphi process.

An initial competency group was created from combining the competency framework that focuses on family business succession of different generations which are open-mindedness, risk-taking, social and communication, value orientation, and different type of personal characteristics (Samei & Feyzbakhsh, 2015), with framework of global innovation that include creativity, cultural empathy and collaboration (Jensen, 2017). Based on literature review [Blinded for review], several competencies were assigned, including having vision, networking skills, ability to act, perseverance, continuous development, and financial competency under the entrepreneurial aspect (Arafeh, 2016; Bacigalupo et al., 2016; Jensen, 2017; Knight & Cavusgil, 2004; Wu, 2009). Flexible and pluralist thinking, conflict management and mediation, support each other, listening skill, reflection and open leadership for aspect of intergenerational collaboration (Dohmen et al., 2014; Harvey, 2012; Lyashenko & Frolova, 2014; Shi et al., 2019), and creativity and legal aspect (Griffith et al., 2016; Jensen, 2017; Knight & Cavusgil, 2004) were also added for the initial competencies. Manual and iterative content analytic coding and back-and-forth searches were used to expand the initial list (Elo & Kyngäs, 2008). Similar concept in term content and context based on the verb and object in the sentences are combined to create a more abstract level of competency to cover a wide range of different competencies. The overall conceptual framework development was ultimately an abductive process typical of the conceptualization process (Dong et al., 2015). Abductive reasoning was used to find the best way to describe the competencies and group of competencies found in the literature. The overall process is presented in the Figure 1.

[Figure 1 – near here]

Figure 1: Research process

In the first round, we created a questionnaire in the form of a six-point Likert scale (1 [strongly disagree]-6 [strongly agree]) to assess the importance, accuracy, understandability, and relevance of each competency for start-up entrepreneurs in the

digital age for the global innovation process. Example of the form for the first phase can be seen in Table 1.

[Table 1 – near here]

The average Likert scale score for each competency was calculated and sorted. The result of the first round was used as the predetermined ranking for the second round. In the next round question form, the competencies were displayed pre-sorted, based on the ranking from the previous round for the overall ranking. Participants were asked to read the ranking carefully and, if they had a different opinion, to reorder the ranking and provide more insight. We identified the criteria for consensus-building (Heiko, 2012). We calculated the value of Kendall's coefficient in each round (Kendall, 1977). The ranking was considered to have consensus if the Kendall coefficient was greater than 0.5. There were no significant proposed changes. The number of participants in the round was at least half the number of participants in the previous round (Kendall, 1977).

Participants in the Delphi study were selected based on their knowledge and suitability for the Delphi study (Heiko, 2012; Linstone & Turoff, 1975). Comprehensive international representation was ensured through objective sampling based on their expertise. To recruit experts for the panels, we assembled a list of experts using the networking connections of members of a study group focused on global innovation. Second, several senior advisory associations were contacted and asked to notify their members of any interest in participating in the study. A total of 20 academic and industry experts (presented in Table 2), including four senior experts from professional organization, participated in the study (number of participant:20; country origin= less-developed: 30%, developed: 60%; gender= male:85%, female:15%; workplace-background= academic:40%, industry/startups:30%, both:30%; educational-background= practical or vocational training: 5%, bachelor's: 5%, master's: 30%, PhD-candidate: 20%, PhD: 25%, other:15%; member of an association of senior experts= senior-expert-organization: 20%; other organization:80%). Each Delphi round began with a standardized email containing a unique link to the panel's survey and binding

instructions. The online survey ensured that no data were lost. Up to three reminder emails were sent to participants who did not respond.

[Table 2 – near here]

A Delphi study was conducted in two rounds. The first round suggested the restructuring of competencies, modified, combine or the addition of new competencies that are important in the digital era. The calculation results of Kendal W in the first round also indicate values below 0.5 (W=0.11). All of these conditions suggest the need for a second round. For the second round, 11 panels of experts participated in the online analysis. The expert panel's participation rate was over 50%, enabling us to use the findings for review and consensus-building. We also provided open-ended questions for the pooling of competencies and questions to select the global innovation process's top ten competencies (the process of ideation, matching, design and development, and commercialization). No significant suggestions were made in the second round, and new competencies were included. Besides, the Kendal coefficient was assigned a value of 0.92, which means that the coefficient value met the consensus criterion.

4. Result: A competency-based framework of global start-ups' innovators in intergenerational settings

[Figure 2 – near here]

Figure 2: Intergenerational competency framework for digital start-ups entrepreneurs in global innovation process

Based on the observation of literature that iteratively developed through the list of competencies, comments, and recommendations from expert panels in Delphi rounds, we identified twenty-seven competencies. The competencies based on the similarity of content, verb and object were grouped into eight categories. The overview of the competency framework is shown in Figure 2. The result of the Likert scale provides a higher overall score (>3). The framework earned a mean score of 4.84 for

understandability, 4.86 for significance, and 5.02 for importance. Some remarks were made about the completeness of the competency framework:

(P15): "Very complete, slightly too detailed..."

(P16): "Complete competency for digital people..."

(P17): "The list contains the essential criteria for a successful foundation as well as successful company management..."

Next, we present eight classification of the competency and the ranking results on the competency of start-ups in global and intergenerational innovation, including references, comments and the importance rank of particular competency to the more specific innovation process. It is important to remember that only one specific category of competencies has the phrase "intergenerational" in its name. However, other groups of competencies are also used in this sense.

4.1. Intergenerational safety facilitation

The capability that deals with nurturing psychological safety in intergenerational collaboration. Competencies include are:

[Table 3 – near here]

- Intergenerational flexibility: Open-mindedness, especially when working with different generations and with new ideas (Fantini & Tirmizi, 2006; Griffith et al., 2016; Lim et al., 2013; Martins & Terblanche, 2003; Reid et al., 2014; Reid & Brentani, 2015; Várhegyi & Nann, 2011; Watts et al., 2013). Moreover, intergenerational flexibility was classified as top ten competency in matching (5th place) and in the process of design and development (3rd place). Based on the Delphi study, some participant provides comments related to the competency:

  P13: *"..the ability to swiftly changing perspectives in generating new ideas or approaches. It is the result of the ability to provoke one's mind to explore and probe the matter at hand.."*

  P9: *"Pursuing instead of change."*

- Intergenerational digital adaptability: Ability to optimize the use of digital media to fit into new, intergenerational innovation space (Boughzala et al., 2012; Fantini & Tirmizi, 2006; Goldsmith & Eggers, 2005; Griffith et al., 2016; Sarker & Sahay, 2003; Wei et al., 2011; Xu et al., 2007; Zimmermann & Ravishankar, 2014)
- Intergenerational leadership: Ability to actuate people from different generational backgrounds toward the desired destination coordinately (Boughzala et al., 2012; Duhan et al., 2001; Getha-Taylor, 2008; Hertel et al., 2006; Lans et al., 2010; Nielsen, 2015; Watts et al., 2013; Wu, 2009; Xu et al., 2007)

Intergenerational flexibility helps provide a sense of safety and encourages expressing rich and diverse opinions and ideas. Through the use of digital technology, each generation may have different experiences and backgrounds. Consequently, improving virtual working conditions requires intergenerational digital adaptability for diversity in the workforce, and no generation feels left out. Besides, the importance of intergenerational leadership in intergenerational differences helps to achieve innovation goals better.

4.2. Cultural awareness

This competency group is about competencies that emphasize the importance of esteeming cultural differences between generations and foreign partners. In this category, a global start-up innovator seeks to travel to another country with a different culture, find partners, and develop products and services based on the global and local values in line with their goals. Two competencies to consider in this category are:

[Table 4 – near here]

- Pluralistic thinking: Ability to avoid a negative judgment on the heterogeneity of cultural and physical functions of different generations (Abbott et al., 2013; Blackburn et al., 2003; Fantini & Tirmizi, 2006; Hertel et al., 2006; Sahay, 2004;

Várhegyi & Nann, 2011; Watts et al., 2013; Zakaria et al., 2004; Zimmermann et al., 2013; Zimmermann & Ravishankar, 2014). Moreover, pluralist thinking was classified as top ten competency in ideation process (7th place). Some remarks were made about the completeness of the competency framework:

P13: *"pluralist thinking is growing in importance since working with diverse co-workers, clients, and employees are inevitable... The definition is quite accurate, although it is still not satisfying. "*

- Digital empathy: The ability to appropriately understand and express feelings to other generations or emotions in digital environments (Fantini & Tirmizi, 2006; Getha-Taylor, 2008; Sahay, 2004; Sarker & Sahay, 2003; Várhegyi & Nann, 2011; Wu, 2009; Zimmermann et al., 2013). Moreover, digital empathy was classified as top ten competency in design and development (10th place), and commercialization (10th place). Based on the Delphi study, some participant provides comments related to the competency:

  P13: *"empathy is a subject of growing importance since it is something that embedded in humans and cannot be transferred... The emphatic digital skill requires a higher degree of empathy compared to that exercised in the physical environment."*

  P7: *"This skill is very difficult. And usually, it needs a more developed self-awareness."*

Pluralistic thinking is necessary to develop a mindset about cultural diversity and avoid negative judgments between generations and cultures. At the same time, digital empathy is closely linked to the cultural empathy needed to understand cultural cues in virtual environments.

4.3. Growth virtues

Virtues are a characteristic valued by an individual(s); in this context, we derived the growth virtues competency from personal competencies. Growth virtues was defined as

values that belong to start-ups' actor(s) to evolve and grow to meet various global innovation challenges in the intergenerational setting. Five competencies fall into this group, namely:

[Table 5 – near here]

- Grit: Passion for striving of long-term goals (Arafeh, 2016; Bacigalupo et al., 2016; Bala et al., 2017; Duckworth et al., 2007; Hertel et al., 2006; Kyndt & Baert, 2015; Watts et al., 2013; Wu, 2009) the competency was found both in the domain of global innovation and intergenerational collaboration, the competency focuses on the personal competency that has low to moderate involvement of technology. Moreover, grit was classified as top ten competency in ideation (5th place), and design and development (5th place). Based on the Delphi study, some participant provides comments related to the competency:

  P7: *"personal matters are significant, too. Supporting the family situation,.."*

  P13: *"grit is acknowledged as the single ability that predicts success."*

- Self-determination: The ability to confidently make independent decisions (Arafeh, 2016; Bacigalupo et al., 2016; Dimitratos et al., 2014; Hertel et al., 2006; Kyndt & Baert, 2015; Martins & Terblanche, 2003; E. Rasmussen et al., 2011, 2014; Sánchez, 2013).
- Conscientiousness: Passion for an effective accomplishment of organizational objectives (Arafeh, 2016; Bacigalupo et al., 2016; Bala et al., 2017; Blackburn et al., 2003; Dijkman et al., 2016; Dimitratos et al., 2014; Duhan et al., 2001; Hertel et al., 2006; Li et al., 2016; Markham & Lee, 2013; Ojala, 2016; Quadros Carvalho et al., 2013; Sánchez, 2013). Moreover, conscientiousness was classified as top ten competency in commercialization process (9th place).
- Intergenerational reflection: Continuous learning through self-and other generational experiences (Bacigalupo et al., 2016; Bala et al., 2017; Blackburn et al., 2003; Dijkman et al., 2016; Duhan et al., 2001; Fantini & Tirmizi, 2006;

Hertel et al., 2006; Kyndt & Baert, 2015; Li et al., 2016; Martins & Terblanche, 2003; Wu, 2009; Zimmermann et al., 2013).

- Resilience: The capacity to recover from failure physically and emotionally (Arafeh, 2016; Bacigalupo et al., 2016; Dohmen et al., 2014; Lim et al., 2013; Martins & Terblanche, 2003; Sarker & Sahay, 2003).

These five competencies are included in growth virtues because they referred to individual values acquired through learning and experience and practiced in developing start-ups. Growth virtue must be present to develop and innovate further amid religion's global innovation and intergenerational cooperation challenges.

4.4. Effectual creativity

This competency group is associated with creativity start-up actor(s) of utilizing local and available resources for global innovation. Two competencies are included in this category:

[Table 6 – near here]

- Foresight thinking: The ability to validate factors influencing the formulation of innovative strategies for the future of the business (Arafeh, 2016; Dijkman et al., 2016; Duhan et al., 2001; Goldsmith & Eggers, 2005; Kyndt & Baert, 2015; Lans et al., 2010; Li et al., 2016; Lim et al., 2013; Martins & Terblanche, 2003; Nielsen, 2015; Ojala, 2016; Quadros Carvalho et al., 2013; E. Rasmussen et al., 2011, 2014; Reid et al., 2014; Reid & Brentani, 2015; Watts et al., 2013; Wu, 2009). Moreover, foresight thinking was classified as top ten competency in ideation (4th place) and commercialization (8th place).
- Global design thinking: The ability to systematically demonstrate global products/solutions based on local value/design (Abbott et al., 2013; Bacigalupo et al., 2016; Boughzala et al., 2012; Dimitratos et al., 2014; Duhan et al., 2001; Hertel et al., 2006; Kyndt & Baert, 2015; Lans et al., 2010; Markham & Lee, 2013; Quadros Carvalho et al., 2013; E. Rasmussen et al., 2011, 2014; Watts et al., 2013;

Wu, 2009). Moreover, global design thinking was classified as top ten competency in ideation (3rd place), matching (7th place), as well as design and development (2nd place).

By focusing on global innovation, both competencies are related to creating a global business model focused on available capital, local values, and stakeholders. Effectual creativity creates products or services by managing future performance based on the availability of resources. (Jensen, 2017) stressed the importance of global ideas and innovative thinking in supporting the global innovation culture.

4.5. Technical domain expertise

In this category, several competencies are remarkably similar, namely the operationalization of specific technical abilities and the use of tools. Competencies in this category include:

[Table 7 – near here]

- Financial negotiations: The ability to gain and leverage funding (Bacigalupo et al., 2016; Kyndt & Baert, 2015; Li et al., 2016). Moreover, this competency was classified as top ten competency in ideation process (10th place) and commercialization (2nd place).
- Business storytelling: The ability to formulate an engaging narration of the desired business idea(s) (Li et al., 2016; Watts et al., 2013). Business storytelling was proposed through external validation. Moreover, business storytelling was classified as top ten competency in all innovation process including ideation (6th place), matching (3rd place), design and development (9th place), and commercialization (3rd place). Some remarks were made about the completeness of the competency framework:

  P20: *"The most important competency of the founder is a great sales affinity for customer acquisition. And the ability to put oneself in the position of the customer and his wishes without ignoring one's own goals and ideas."*

- Digital information fluency: The ability to analyze and optimize the use of digital information and technology (Blackburn et al., 2003; Duhan et al., 2001; Li et al., 2016; Lim et al., 2013; Martinsons & Ma, 2009; Sahay, 2004; Vuorikari et al., 2016; Wei et al., 2011; Wu, 2009; Xu et al., 2007). Moreover, digital information fluency was classified as top ten competency in matching (9th place), and in the innovation process of design and development (6th place).
- Legal analysis: The ability to assess the intellectual property's potential value for innovation (Dijkman et al., 2016; Markham & Lee, 2013; Quadros Carvalho et al., 2013)

Business storytelling is associated with specific presentation skills and presents a business idea. Financial negotiations require technical knowledge of financial returns and losses to present and determine the business's economic value to all stakeholders (e.g., customers and investors) — the digital capabilities associated with operating digital devices to optimize digital information for innovation collaboration purposes.

4.6. Responsive teamwork

Responsive teamwork is a group of competencies highlighting the importance of start-up actor(s) on providing constructive peer feedback for teamwork progression. We classified these competencies to this capability:

[Table 8 – near here]

- Active listening: The ability to confirm understanding of what others express verbally (Dimitratos et al., 2014; Watts et al., 2013). Some remarks were made about the completeness of the competency framework:

  P13: *"...In the era of openness (open innovation, open leadership, open business model, etc.), only those who can effectively listen can craft meaningful values for others."* Moreover, active listening was classified as top ten competency in ideation (8th place), matching (10th place), and commercialization (7th place).

- Conflict resolution: The ability to turn any potential for social conflict into an opportunity(Bala et al., 2017; Blackburn et al., 2003; Martins & Terblanche, 2003). Moreover, conflict resolution was classified as top ten competency in matching process (6th place).
- Intergenerational orientation: Passion for empowering intergenerational cooperation in the innovation process (Bacigalupo et al., 2016; Dijkman et al., 2016; Li et al., 2016; Martins & Terblanche, 2003; Nielsen, 2015; Watts et al., 2013). Moreover, intergenerational orientation was classified as top ten competency in matching process (1st place) as well as the process of design and development (4th place).
- Auxiliary skill: The ability to support others in making progress (Dijkman et al., 2016; Goldsmith & Eggers, 2005; Lans et al., 2010; Li et al., 2016; Martins & Terblanche, 2003; Wu, 2009; Zimmermann et al., 2013). Based on the Delphi study, some participant provides comments related to the competency:

  P13: *"in the digital era, organizational assets are manifested not only by ownership of machinery or facilities. More importantly, they are represented by ownership of a vital role in the strategic partnership. The ability to capture a vital position or role is largely determined by auxiliary skills. It helps us to instil trust in others."*

This competency group shares common features supporting interpersonal relationships in working with teams within a generation or different generations. Furthermore, auxiliary skill is vital to help their peers overcome their challenges and difficulties, supporting their organization in long-term collaboration.

4.7. Value-driven organizing

For this category, the competency group for start-up actor(s) focuses on empowering human capital based on shared value. The competencies associated with this category are:

[Table 9 – near here]

- Visioning: The ability to clearly pursue and coordinate team goals and standards with other (generations) team members. Imagine the business's future (Arafeh, 2016; Audzeyeva & Hudson, 2016; Bala et al., 2017; Blackburn et al., 2003; Dijkman et al., 2016; Goldsmith & Eggers, 2005; Sarker & Sahay, 2003; Watts et al., 2013). Moreover, visioning was classified as top ten competency in all innovation process including ideation (1st place), matching (2nd place), design and development (1st place), and commercialization (1st place). Based on the Delphi study, some participant provides comments related to the competency:

  P14: *"..having a clear goal and convince the team.."*

  P13: *"..in the era of abundance, vision is becoming even more important. We will found ourselves in pressing need of purpose to screen and prioritize activities and resources.."*

- Personal resource allocation: The ability to optimally mobilize the use of personal resources (Audzeyeva & Hudson, 2016; Bacigalupo et al., 2016; Bala et al., 2017; Dijkman et al., 2016; Duhan et al., 2001; Goldsmith & Eggers, 2005; Griffith et al., 2016; Lans et al., 2010; Li et al., 2016; Martins & Terblanche, 2003; Quadros Carvalho et al., 2013; Vuorikari et al., 2016; Watts et al., 2013; Zimmermann et al., 2013). Moreover, personal resource allocation was classified as top ten competency in ideation process (9th place).

- Quality orientation: Consistent focus on the quality to be achieved (Arafeh, 2016; Kyndt & Baert, 2015; Martinsons & Ma, 2009; Watts et al., 2013; Wu, 2009). Moreover, quality orientation was classified as top ten competency in design and development (7th place), and commercialization (4th place).

- Decisiveness: The ability to quickly put calculated risks into actionable policies (Arafeh, 2016; Dimitratos et al., 2014; Goldsmith & Eggers, 2005; Lans et al., 2010; Li et al., 2016; Martins & Terblanche, 2003; Nielsen, 2015; Quadros Carvalho et al., 2013; Reid et al., 2014; Reid & Brentani, 2015; Sahay, 2004;

Sánchez, 2013; Watts et al., 2013; Wu, 2009). Moreover, decisiveness was classified as top ten competency in design and development (8th place).

P13*: "Decisiveness is so important in promoting innovation… Without the ability to exercise good judgment related to the risk and benefits, the rapid process of innovation will be suffered, and progress will be hampered."*

Visioning is included in this category due to the essential role of value in guiding corporate strategy's conceptual development. In addition to global innovation, the ability to control and maximize human capital, emphasis on quality and determination by simplified action is more natural in implementing the organizational strategy and minimizing all risk types.

4.8. Sustainable networking

This competency group category brings together all the competencies closely linked to professional bonds outside the organization. Three competencies are:

[Table 10 – near here]

- Influencing: The ability to influence other (generations) from a specific perspective (Abbott et al., 2013; Arafeh, 2016; Bala et al., 2017; Blackburn et al., 2003; Boughzala et al., 2012; Dimitratos et al., 2014; Goldsmith & Eggers, 2005; Kyndt & Baert, 2015; Li et al., 2016; Sarker & Sahay, 2003; Várhegyi & Nann, 2011; Watts et al., 2013; Wu, 2009). Moreover, quality orientation was classified as top ten competency in matching (4th place), and commercialization (6th place).
- Transparency: The ability to share clarified and updated information with others (generation) (Blackburn et al., 2003; Dohmen et al., 2014; Hertel et al., 2006; Martinsons & Ma, 2009; Zakaria et al., 2004; Zimmermann et al., 2013)
- Effective communication: Ability to communicate comprehensively by all necessary means (Abbott et al., 2013; Audzeyeva & Hudson, 2016; Blackburn et al., 2003; Duhan et al., 2001; Fantini & Tirmizi, 2006; Goldsmith & Eggers, 2005; Hertel et al., 2006; Li et al., 2016; Markham & Lee, 2013; Nielsen, 2015;

Sahay, 2004; Watts et al., 2013; Wu, 2009; Zimmermann & Ravishankar, 2014). Moreover, effective communication was classified as top ten competency in ideation (2nd place), matching (8th place), and commercialization (5th place).

In the context of global and intergenerational innovation, global start-up innovators require the optimization of long-term professional networks with partners and senior collaborators. This requires the ability to influence professional networks' functions and ensure transparency and communication effectiveness of the use of different channels and foreign languages. This section developed and validated a competency-based framework for global start-up entrepreneurs in intergenerational settings. Next, we will discuss the implications of the study findings.

5. Discussion

This study examines the competencies required to promote intergenerational collaboration for global start-up entrepreneurs in the digital age. We took a Delphi poll. The results provided a set of competencies and competency groups for the study context. In this section, we discuss some implications of the study as important takeaways for start-up management research that leverages intergenerational collaboration for sustainable knowledge management.

5.1. Theoretical contributions

This study uncovers 27 competencies cover the concept of competency in a broader sense, including values, virtues, and mindsets. The broad coverage also complements previous studies on entrepreneurship and innovation management that focus more on (social) competency and knowledge (Bandera & Thomas, 2018; Fligstein, 1997) but little attention was given to the importance of values or virtues. Previous studies demonstrate the need for digital skills and entrepreneurship (Foucrier & Wiek, 2019; Vuorikari et al., 2016; Wu, 2009). While there is no consensus on the complexity of internationalization and business growth, there is little awareness that different phases require different

competencies (Chang, 2012; Foucrier & Wiek, 2019; Santoro et al., 2019). This study, on the one hand shows the general ranking of competencies in intergenerational settings, on the other hand, shows the importance of competencies in more detail in different activities within innovation process.

Fostering all competencies requires time, energy, and human resources, which can negatively impact entrepreneurs' well-being (Wiklund et al., 2019). Information and communication technology is an important innovation tool. However, it can also pose challenges to innovation processes. Often, collaborative technologies facilitate communication with others. However, in other contexts, such as cultural differences, technical expertise, and different technological infrastructures, face-to-face communication may work better with tangible materials such as paper or whiteboards.

Different features of technologies force people to be more versatile and adapt to the situation at hand. In this study, we show that specific competencies are needed more or less in the digital age. We have studied the complex changes in required competencies and shown that certain competencies are relevant at certain stages of the innovation process (in other words, it is not necessarily essential to have all competencies simultaneously). These development conditions are dynamic and depend on the organization and the phase within the innovation process itself. The findings also validate research on the importance of visioning work needed at the forefront of all global innovation processes (Arafeh, 2016; Dijkman et al., 2016; Hevner & Gregor, 2020). Therefore, based on the competency group dynamics presented in this study, we suggest that start-up actors can develop certain competencies by focusing on which stages of the innovation process they are currently in and matching the state with the required competencies that process (Chang, 2012; Foucrier & Wiek, 2019; Santoro et al., 2019).

Moreover, the study suggests fostering a flexible and inclusive leadership style that promotes diversity collaboration (Won et al., 2021) between younger and older generations to support start-up innovation. To make sure it is an environment where every generation feels safe, for sustainable knowledge society (Perez-Encinas et al., 2021;

Qian et al., 2019; Won et al., 2021), digital technology needs to be more adaptable to different ages' needs (Perez-Encinas et al., 2021; Qian et al., 2019). The present findings show various competencies that can be used for developing system requirements (Klendauer et al., 2012) for an intergenerational context.

5.2. Practical contributions.

For practical contributions, this study can assess the intergenerational readiness of start-up entrepreneurs at various stages of global innovation processes (Foucrier & Wiek, 2019; "Blinded for review"). The result can be used as a self-assessment tool to understand target competencies and help start-ups find a qualified partner to complement current competencies. Investors can also use the competencies to assess start-ups' readiness to collaborate and leverage cross-generational collaboration for innovation (Kleine & Yoder, 2011; Yin & Luo, 2018). A competency-based rubric can be developed as an example of an application of the study result.

[Figure 3 – near here]

Figure 3: Web-based interactive self-assessment tool for start-up readiness in global and intergenerational innovation

In Figure 3, a web-based rubric was developed based on the proposed competency-framework to assess entrepreneurial competencies by asking entrepreneurs to rate their competency level for each competency, modifying each competency level criteria (Dijkstra, 2012; Popovic, 2003). The prototype for instance can be developed as open source html5 app that can be downloaded in open repository[1]. The interface of self-assessment rubric prototype can be seen in Figure 3. After the self-assessment of competencies is completed, the result provides a score for readiness for intergenerational

[1] [Blinded for review] (last accessed: 16.11.2021)

collaboration. The Delphi study results can be used as a basis for weighting the competency scores and provide information for a more detailed analysis of the global innovation process.

Besides, universities offering entrepreneurship programs can support a competency-based curriculum by using the competency framework (Kleine & Yoder, 2011; Panadero & Romero, 2014). The competency-based approach has been shown to increase student learning outcomes and improve career-related behaviours. Colleges and universities can use game-based learning to identify, develop, and assess essential competencies (Hafeez et al., 2002). Finally, the study results can be used for organizational management to support innovation through actor(s) in intergenerational collaboration, provide training and assessment for actor(s) development (Carayannis et al., 2021; Dorado, 2005; Reid & Brentani, 2015; Saa-Perez & Garcia-Falcon, 2002) that promotes intergenerational entrepreneurship to support the rapidly changing work environment in the digital age. The detailed results can be used for human resource development management to identify competency gaps and initiate appropriate interventions (in training or hiring processes).

5.3. Limitations and recommendations

Several limitations of the study were identified. First, the limitation relates to the literature, which may not cover all relevant literature due to the study context's broader disciplines. However, the literature was only used to develop the initial conceptual model of competencies, which was validated and refined through several rounds of Delphi study and abductive thinking. Each new relevant study that comes after the literature review process will be assigned to one of the predefined concepts. Further studies could focus on finding the relevant literature by focusing on a specific field of study. Resources outside the literature can also be used to analyse and develop the framework, e.g., blogs, online magazines, and social media discussions. Second, regarding the limited number and demographic characteristics of participants, a further study could include more

expert participants, equal numbers of participants of all genders and from developed and developing countries, more detailed information on the age of participants to allow further analysis, and a limited number of use cases to generalize the results of the proposed study.

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(Blinded for review)

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Table 1: design form of the first round

Please evaluate the proposed competencies of the start-up in the intergenerational collaboration to support global innovation by marking [x] of each evaluation criterion on the „Likert scale“

Competency and the description	*Evaluation criteria and rating point (1 : strongly disagree – 6 : stongly agree)*																							
	I understand the meaning						*The description of the competency is accurate.*						*The competency is relevant for the intergenerational and global (iGOAL) context.*						*The competency is important for the start-up innovation in the iGOAL context.*					
	1	*2*	*3*	*4*	*5*	*6*	*1*	*2*	*3*	*4*	*5*	*6*	*1*	*2*	*3*	*4*	*5*	*6*	*1*	*2*	*3*	*4*	*5*	*6*
Pluralist thinking																								
The ability to suspend judgment and actively engage with social diversity (multi-perspective view) without leaving one's own identity.	*Space for opinion, proposed modifications (competence name and the description):*																							
..other competency																								
Description of other competency ….	*Space for opinion, proposed modifications (competence name and the description): …*																							

Table 2: list of expert panels for the Delphi study

ID	Origin country (classification)	Fields of Expertise							Years of Expertise
		DI	*DL*	*Et*	*GI*	*HR*	*IcC*	*IgC*	
P1	Less developed	X	X						3-7
P2	Less Developed	X		X	X	X			1-2
P3	Developed	X	X		X		X		1-2
P4	Developed							X	7-10
P5	Less developed		X			X			3-7
P6	Developed		X		X		X		8-10
P7	Developed	X	X	X	X		X	X	>10
P8	Developed	X	X	X					3-7

P9	Developed		X	X	X		X	X	>10
P10	Developed	X	X	X		X	X		>10
P11	Less developed	X	X	X					3-7
P12	Developed			X	X	X		X	>10
P13	Less developed			X					>10
P14	Developed		X				X		>10
P15	Developed	X	X	X	X	X	X		>10
P16	Less developed		X			X		X	1-2
P17	Developed	X		X	X	X	X	X	>10
P18	Developed			X		X		X	>10
P19	Developed	X		X	X	X	X	X	>10
P20	Developed			X	X	X		X	>10

Field of Expertise:
DI: Digital Innovation
DL: Digital Learning
Et: Entrepreneurship
GI: Global Innovation
HR: Human Resource Development
IcC: Intercultural Collaboration
IgC: Intergenerational Collaboration

Table 3: Ranking of competencies for intergenerational safety facilitation

competency (sorted based on final Rank)	*rel*	*ranking*			
		1st round		*2nd round*	
		$\bar{x}$	*rk*	*$\bar{x}$*	*final-rk*
Intergenerational flexibility	4,95	6,00	2	4,13	2
Intergenerational leadership	4,89	13,67	16	17,06	19
Intergenerational digital Adaptability	4,21	23,33	25	24,94	27

$\bar{x}$: mean ranking; final-rk: final rank; rk: rank; rel: relevancy

Table 4: Ranking of competencies for cultural awareness

competency (sorted based on final Rank)	*rel*	*ranking*			
		1st round		*2nd round*	
		$\bar{x}$	*rk*	*$\bar{x}$*	*final-rk*
Pluralist Thinking	4,68	20,67	23	21,13	23
Digital empathy	4,45	24,67	26	23,31	26

$\bar{x}$: mean ranking; final-rk: final rank; rk: rank; rel: relevancy

Table 5: Ranking of competencies for growth virtues

competency (sorted based on final Rank)	*rel*	*ranking*			
		1st round		*2nd round*	
		$\bar{x}$	*rk*	*$\bar{x}$*	*final-rk*
Grit	4,84	9,33	5	5,63	3
Self-determination	4,84	13,00	13	8,25	6
Conscientiousness	4,95	10,67	8	8,81	7
Intergenerational reflection	4,90	13,67	15	11,38	13
Resilience	4,89	13,00	12	13,00	14

$\bar{x}$: mean ranking; final-rk: final rank; rk: rank; rel: relevancy

Table 6: Ranking of competencies for effectual creativity

competency (sorted based on final rank)	*rel*	*ranking*			
		1st round		*2nd round*	
		$\bar{x}$	*rk*	*$\bar{x}$*	*final-rk*
Foresight thinking	5,10	10,33	7	8,88	8
Global design thinking	4,75	18	22	19,63	21

$\bar{x}$: mean ranking; final-rk: final rank; rk: rank; rel: relevancy

Table 7: Ranking of competencies for technical domain expertise

competency (sorted based on final rank)	*rel*	*ranking*			
		1st round		*2nd round*	
		$\bar{x}$	*rk*	*$\bar{x}$*	*final-rk*
Financial negotiation	4,80	6,67	3	7,00	5
Business storytelling	Proposed by panel expert			11,05	11
Digital information fluency	4,95	11,33	11	15,38	18
Legal analysis	4,74	17,67	21	22,94	25

$\bar{x}$: mean ranking; final-rk: final rank; rk: rank; rel: relevancy

Table 8: Ranking of competencies for responsive teamwork

competency (sorted based on final Rank)	*rel*	*ranking*			
		1st round		*2nd round*	
		$\bar{x}$	*rk*	$\bar{x}$	*final-rk*
Intergenerational orientation	5,21	14,00	18	6,25	4
Conflict resolution	4,95	10,33	6	17,75	20
Active listening	4,95	17,33	20	19,81	22
Auxiliary skill	4,74	21,33	24	21,25	24

$\bar{x}$: mean ranking; final-rk: final rank; rk: rank; rel: relevancy

Table 9: Ranking of competencies for value-driven organizing

competency (sorted based on final Rank)	*rel*	*ranking*			
		1st round		*2nd round*	
		$\bar{x}$	*rk*	$\bar{x}$	*final-rk*
Visioning	5,35	2,67	1	3,19	1
Personal Resource Allocation	4,68	9,00	4	9,69	9
Quality Orientation	4,68	12,50	15	13,06	15
Decisiveness	5,00	15,33	19	14,06	16

$\bar{x}$: mean ranking; final-rk: final rank; rk: rank; rel: relevancy

Table 10: Ranking of competencies for sustainable networking

competency (sorted based on final Rank)	*rel*	*ranking*			
		1st round		*2nd round*	
		$\bar{x}$	*rk*	$\bar{x}$	*final-rk*
Effective communication	5,20	11,00	9	10,56	10
Transparency	4,89	11,00	10	11,06	12
Influencing	4,74	13,33	14	14,88	17

$\bar{x}$: mean ranking; final-rk: final rank; rk: rank; rel: relevancy

Figure 1

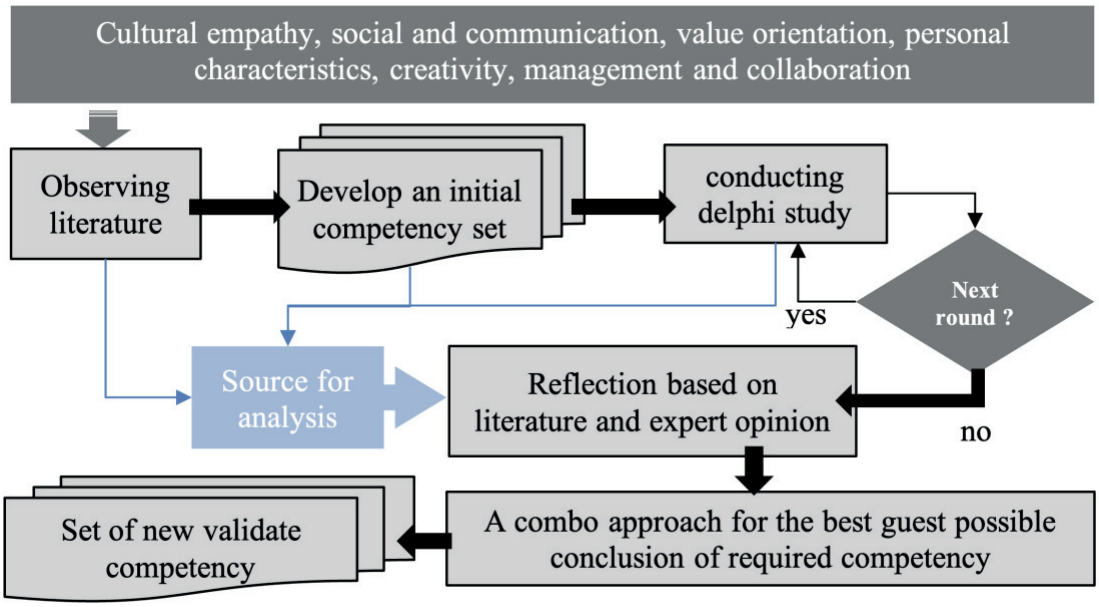


Figure 2

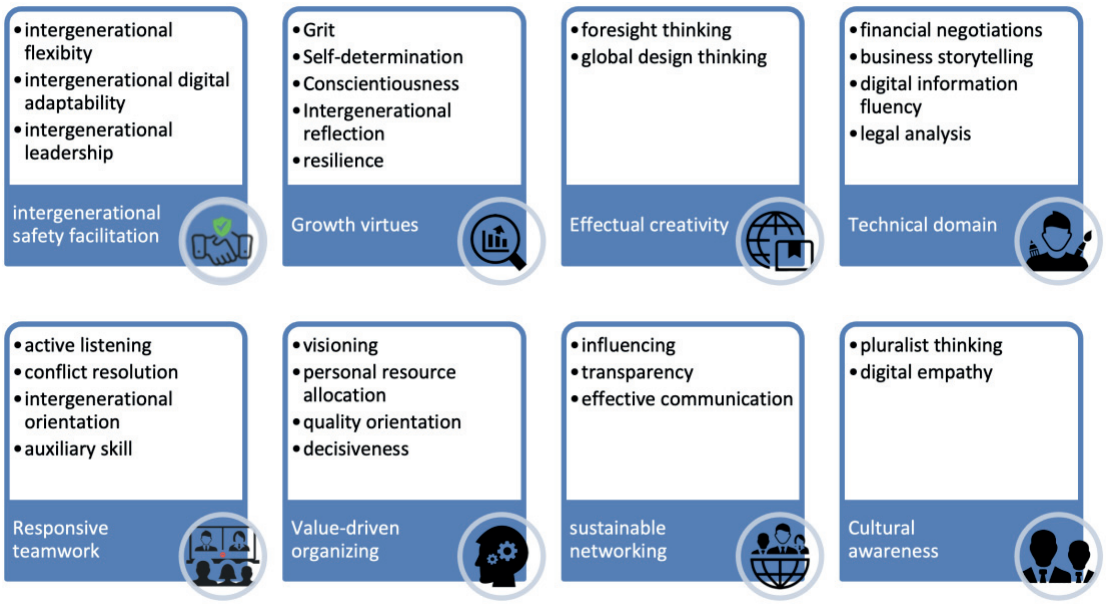
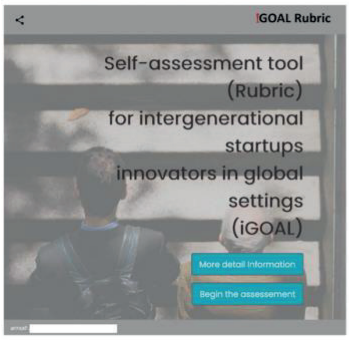
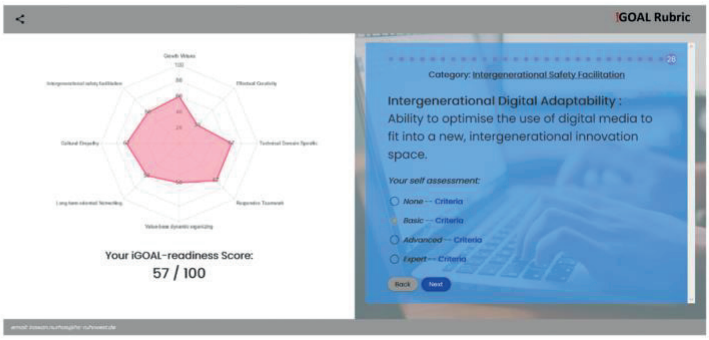
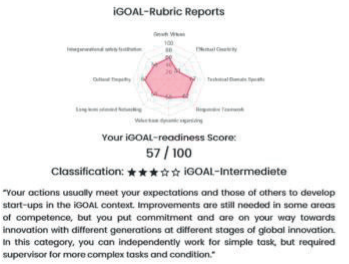


Figure 3







Readiness Analysis based on innovation process

Global Innovation Process	Ideation process	Matching process	Design and Development	Commercialization
Readiness percentage (%)	87	82.25	85.13	85
Group of competence				
Growth Virtues	Ready	Ready	Ready	Ready
Effectual Creativity	Half Ready	Half Ready	Half Ready	Half Ready
Technical Domain Specific	Ready	Ready	Ready	Ready
Responsive Teamwork	Ready	Almost Ready	Ready	Ready
Value-based dynamic organizing	Almost Ready	Ready	Almost Ready	Almost Ready
Long-term oriented Networking	Almost Ready	Half Ready	Ready	Almost Ready
Cultural Empathy	Ready	Ready	Ready	Almost Ready
Intergenerational safety facilitation	Ready	Almost Ready	Half Ready	Ready

VII

WHY SHOULD THE Q-METHOD BE INTEGRATED INTO THE DESIGN SCIENCE RESEARCH? A SYSTEMATIC MAPPING STUDY

by

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WHY SHOULD THE Q-METHOD BE INTEGRATED INTO THE DESIGN SCIENCE RESEARCH? A SYSTEMATIC MAPPING STUDY

Research paper

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Abstract

The Q-method has been utilized over time in various areas, including information systems. In this study, we used a systematic mapping to illustrate how the Q-method was applied within Information Systems (IS) community and proposing towards integration of Q-method into the Design Sciences Research (DSR) process as a tool for future research DSR-based IS studies. In this mapping study, we collected peer-reviewed journals from Basket-of-Eight journals and the digital library of the Association for Information Systems (AIS). Then we grouped the publications according to the process of DSR, and different variables for preparing Q-method from IS publications. We found that the potential of the Q-methodology can be used to support each main research stage of DSR processes and can serve as the useful tool to evaluate a system in the IS topic of system analysis and design.

Keywords: Q Sort, DSR, Q Technique, Q Methodology, IS Method.

1 Introduction

In 1988, Kaplan and Duchon (1988) used the Q-method to validate user statements, in a case study related to user perceptions of the relation between work and the use of computer information systems. A premiere introduction of the Q-methodology to the Information Systems (IS) community was initiated in 2002 (Thomas & Watson, 2002). The authors introduced using the Q-method within IS studies by providing an example and several key points IS researchers must consider when implementing the Q-method. The Q-method still has not gained broad popularity within the IS community (Wingreen & Blanton, 2018). Nonetheless, there are IS-studies using the Q-method published in the Basket-of-Eight Journals (see Appendix 1), known as the best journals in the IS field (Lowry et al., 2013). IS researchers not only use the Q-method to identify a problem (Sutton, Khazanchi, Hampton, & Arnold, 2008) but also propose its use to evaluate a system adoption for better results based on user preference (Matzner, Hoffen, Heide, Plenter, & Chasin, 2015). Both problem identification and system evaluation are essential parts of the process in Design Science Research (DSR) (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007). They have already gained popularity, but researchers still seek "the missing link" they can use to support a social-technical view of design science (Carlsson, Henningsson, Hrastinski, & Keller, 2011). Therefore, this study aims to promote the use of the Q-method as a tool to support the DSR process.

The main goal of this paper is to elaborate on integrating the Q method into different phases of the Design Science Research process, to improve the result of subjectivity-driven Information Systems studies purposefully designed and evaluated by subjective human perception (Larsen, Sørebø, & Sørebø, 2009; Venkatesh & Davis, 2000), considering their significant influence on the design for both organizations and the information technology (Larsen et al., 2009). Therefore, integrating the subjectivity of the user experience with the system design process takes a vital role within IS studies (Schepers & Wetzels, 2007). User experience is one critical point in the design of systems. Currently, the focus is changing toward well-being (Pawlowski et al., 2015) and measuring subjectivity in personal experience (Calvo & Peters, 2014). User-system experiences differ; by correctly identifying the subjective requirements of a technological environment (Calvo & Peters, 2014), researchers can provide insight into sustainable use of a system for a particular user and context. This can help the organization choose the design of the system or evaluate the implemented system-design solution (Pawlowski et al., 2015).

In 1953, Stephenson developed the Q-method to measure subjectivity (Jung et al., 2009; Stephenson, 1953). The Q-method or Q-sort combines qualitative and quantitative approaches to measuring human subjectivity (Dziopa & Ahern, 2011; Jung et al., 2009; Newman & Ramlo, 2010). In other words, the Q-method tries to get the users' perceptions or opinions on the statements; then evaluate and order the statements by importance in a "forced-choice" distribution form known as Q-sort, in order to reach consensus (Dziopa & Ahern, 2011; Stephenson, 1953). The Q-method is already in extensive use in social-science research (Doody, Kearney, Barry, Moles, & O'Regan, 2009; Jung et al., 2009), to evaluate educational technology (Kurt & Yıldırım, 2018; Wharrad & Windle, 2010), theory building or theory testing (Yang, 2016), and proposed IS-design solutions (Doherty, 2012; Gottschalk, 2002; Mettler & Wulf, 2018). An active Q-method community has consistently organized conferences each year since 1983.[1]

In design science, three categories constitute the main sources of artifact theory or design: people, processes, and products (Cross, 1999). The first category reflects subjective opinions and perception of human experiences (Cross, 1999). Therefore, IS researchers should initiate integrating Q-method into design science as one tool for studying subjectivity (Thomas & Watson, 2002). A research essay (Oberländer, Röglinger, Rosemann, & Kees, 2018) in the *European Journal of Information Systems*

[1] https://qmethod.org/qconference/ last accessed on 29.01.2019

(EJIS) discusses the use of DSR process integrating Q-method (Hrastinski, Carlsson, Henningsson, & Keller, 2008). Unfortunately, the IS community lacks IS studies exploring the potential use of the Q-method for the DSR process. Therefore, this study pioneers the initial step toward the future integration of the Q-method in the DSR process by providing an overview of its current implementation in IS studies. This paper aims to answer the main research question: "Why should the Q-method be integrated into the DSR process?"

This study uses systematic mapping (Petersen, Feldt, Mujtaba, & Mattsson, 2008) because of the lack of suitable studies (Petersen et al., 2008), notably in the context of the Q-method in DSR processes. The systematic-mapping study comprises an option for systematic reviews (Petersen et al., 2008) and could be suitable for the condition where there is little or no empirical evidence to apply a systematic review directly (Engström & Runeson, 2011). A mapping study was performed with the aim of understanding research gaps and assembling evidence to motivate future research (Engström & Runeson, 2011). Therefore, despite systematic mapping requiring less effort than a literature review, it still provides a more granular overview (Barbosa, Santos, Alves, Werner, & Jansen, 2013) for study purposes. This study contributes to extending the use of the Q-method into the DSR process within the IS community, and provides an overview of optimizing the full potential of the Q-method, which has been implemented minimally, if at all, within IS studies so far.

This paper is structured as follows. First, the mapping process is provided, including the construction of the guideline questions, selection of publications, and data extraction. Next, the results are presented based on the selection process and the variables for classification in the guideline questions. Then, the results and paper contributions are discussed, leading finally to identifying limitations and further research directions.

2 The Systematic-Mapping Process

The systematic mapping for this study followed the guideline for administering a structured-mapping process (Petersen et al., 2008). The mapping process begins with the construction of a framework in the form of guideline questions. Then publications are chosen according to inclusion and exclusion criteria. The mapping process was conducted based on the extracted data and the paper classified by following the constructed guideline framework.

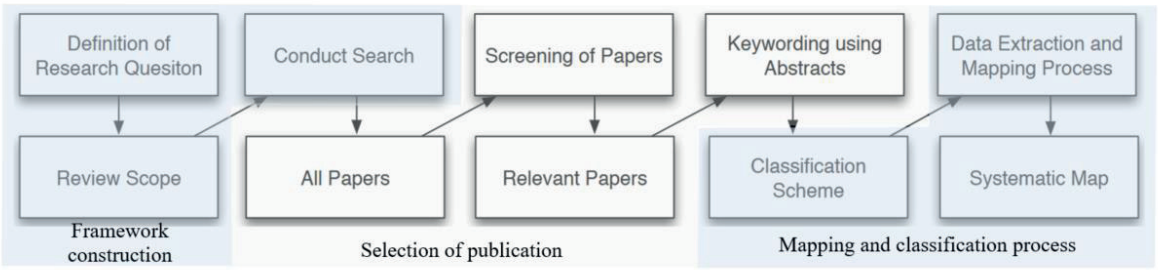

Figure 1. The systematic mapping process adopted from (Petersen et al., 2008)

2.1 Construction of guideline framework for the mapping study

The explanation of the guideline questions as a framework for conducting the mapping process takes the major part of section 2. The guideline framework directs the grouping and data-extraction process that includes both searching strategies and the classification. The guideline questions are one of the sources for discussing and analyzing the contribution of this study. Therefore, the construction of the guideline questions also takes a role as background theory. In this study, the main topic is DSR and the Q-method. Then, guideline questions were constructed from both study topics by providing essential variables that allowed an overview and answering the main research question.

2.1.1 The Q-method for information systems studies

Extracting information related to the use of the Q-Method in IS publications provides an overview of gaps and opportunities for further Q-Method implementation. Publications on the use of the Q-method in IS studies were classified based on IS topics/thematic classification, to identify the possible fields of use. One difference between the systematic mapping and systematic review is the thematic classification of publications (Petersen et al., 2008). The thematic classification here followed core topics for the IS curriculum (Topi et al., 2010), including:

- IS foundation as an overview of the overall key topics in the field of IS.
- The data and information management cover study about knowledge management, database-management system, and business intelligence.
- The enterprise architecture.
- IS project management and Information Technology (IT) Infrastructure.
- The system analysis and design, covering an aspect of process design and analysis, evaluation of system, tools, method, and technique to identify requirements of IS and improve a system.
- The IS strategy, Management, and Acquisition.

The Q-method consists of *a concourse* or a list of statements, opinions, or the sum of all that people say or think about the investigated topic collected from various sources (Watts & Stenner, 2012; Yang, 2016). Statements are essential to preparation and can be used to represent the feelings and opinions of the user/object of study (Watts & Stenner, 2012). Preparing "the phenomena of mind" involves researchers who implement the Q-method, so the participants can easily understand (Watts & Stenner, 2012) the sorting process (Q-sort). The conventional way to collect the initial statements is interviewing or direct interaction with the system user (Wharrad & Windle, 2010), or by asking experts' opinions (Chang, 2012; Segars & Grover, 1998). Researchers can also collect statements from indirect interaction, such as through the literature-review process (Chang, 2012; Watts & Stenner, 2012). Alternatively, any digital sources (e.g., blogs, news websites, videos, images, social media status) (Davis & Michelle, 2011; Orchard, Fullwood, Morris, & Galbraith, 2015) or any type of big data could be used (Lynch, Adler, & Howard, 2014; Watts & Stenner, 2012). One of the strong points of the concourse in the Q-methods is the flexibility to collect the statements from various sources (Watts & Stenner, 2012). If a concourse is already prepared, it will be presented and sorted by using manual card sorting (Watts & Stenner, 2012), offline computerized software (Watts & Stenner, 2012) or an online system (Watts & Stenner, 2012). In the Q method, a study depends on human subjectivity and cannot be performed without it. Furthermore, providing a large number of respondents for the sorting of statements and the use of different tools is not the main focus (Stephenson, 1953; Watts & Stenner, 2012). Therefore, debate persists about the ideal number of participants in the sorting process of the concourse. The type of sources, the role of the Q-method in the studies, and the topic of publication influence the sorting process and analysis (Watts & Stenner, 2012), and can support understanding the current use of Q-method in the IS community. Therefore, understanding how those three variables were applied differently for each process of DSR leads to the Guideline Question (GQ) related to the Q-method implementation in IS studies: *GQ1) How do IS researchers use the Q-method?*

2.1.2 Design Science Research (DSR)

DSR is an iterative process for problem-based system design (Peffers et al., 2007). Its main aim is to design toward a perfect artifact by improving the status quo (Gregor & Hevner, 2013). DSR requires IS researchers to focus on a holistic view of artifact evaluation. The attention of IS scholars on the use of DSR for IS studies continues to grow and is now firmly established design process and method within the IS community (Prat, Comyn-Wattiau, & Akoka, 2014). Nonetheless, there are different genres of DSR (Iivari, 2015; Peffers, Tuunanen, & Niehaves, 2018) that require different understandings. IS researchers sometimes have difficulty identifying and presenting DSR study contributions (Peffers et al., 2018). This study's purpose is best seen as using the perspectival lens of DSR as a research process (Peffers et al., 2007) that can be started and deliver IS artifact at each stage of the DSR process

(Peffers et al., 2007). From this perspective, Peffers et al. (2007) present six main processes for DSR, starting from problem identification and motivation, followed by the process to define the solution, the design and development of the system, the demonstration of the system in the form of a working prototype or a case study, system evaluation, and finally, the communication of the study result (Peffers et al., 2007) to get feedback and reflection for the iterative process. Hevner and Chatterjee (2010) simplify the whole process and conclude that IS scholars should develop IS artifacts by addressing the critical problems (problem-driven process), designing and demonstrating the artifacts (solution-driven process), and evaluating and predicting the potential benefits and risks of the proposed artifacts (evaluation-driven process). The three main processes of DSR serve for this study as the variables (the type of the process) within the process. The other classification of the variables is the contribution from the literature.

For DSR studies, Gregor and Hevner (2013) provide a knowledge-contribution framework by classifying the contribution into four groups. The DSR study can provide a new solution for a new problem (contribute as an invention) or for known problems (contribute to an improvement). In the mature solution, two more classifications were added; the exaptation of extending the known solution to new problems; and the study made no major contribution or only applied known solutions to known problems (Gregor & Hevner, 2013). Understanding the paper's contribution of applying the Q-method, as well as the process and activities within the DSR process (Baskerville, Pries-Heje, & Venable, 2009) can support analysing the integration of the Q-method into the DSR process. Accordingly, the next GQ is used for the mapping study: *GQ2) To which DSR processes can IS researchers apply the Q-methodology?*

2.2 Selection of publications

This section briefly explains the filtering of selected publications, including the inclusion and exclusion criteria. First is selecting Basket-of-Eight journals as primary sources for the journal collection. These journals are known as trusted and high-quality journals for IS scholars (Lowry et al., 2013). Also, automatic searches of the AIS Digital Library (AIS DL) specifically focusing on the publication database for IS studies were implemented. Using different keywords (e.g., "Q-method," "Q sort," "Q-methodology," "Q technique") on January 21, 2019, resulted in 47 publications from Basket-of-Eight journals and 211 publications from the ACM Digital Library. After implementing inclusion criteria (i.e., only journal publications, only research articles or literature-review articles) and removing duplicates, by applying to 70 publications the exclusion criteria (i.e., not written in English) and keyword location filters (i.e., keyword only found in the list of reference and not actually used in the study), the final 45 selected publications were identified.

2.3 Mapping and classification process

The classification and data-extraction process began with ordering the publications by year and journal name to find the distribution of the papers. As mentioned in the guideline framework, different variables shaped the classification (e.g., theme, source of the concourse, the comparable process of DSR, and the study contribution). Then, the classification related to the use of the Q-method of each publication was identified. Concerning the role of the Q-method in a publication, the Q-method can be used as the primary research method or as a supporting method to strengthen the main study method. The role of the Q-method was identified as the main method/review if it was the only method used in the study and is mentioned in the title, abstract, or keywords section. Moreover, use of the Q-method as the support method was identified as major support (if the author mentioned that the Q-method was used in the study with proper explanation and analysis) or minor support (without further detail, information, implementation, and analysis).

Furthermore, whether a paper provides a paragraph that explains the Q-method also aided in the classification based on the role of the Q-method. Three classifications of DSR process (i.e., problem identification, solution definition, and evaluation) and four classifications of knowledge contribution (i.e., no significant knowledge contribution, exaptation, improvement, and invention) were identified and

analyzed for each publication. Classification in terms of the source of the concourse (expert opinion; user interviews; literature review; observation; not scientifically based digital media including tweets, post, images, or videos) was extracted from each paper and converted to the number of types of sources used, with or without literature. The result is presented in the following section.

3 Result

The publication date and the journal channel of each article create an overview of the paper distribution (see Appendix 1 and Appendix 2). Although the time interval for the year of publication was not limited, no publications used the Q-method before 1988 (e.g., *MISQ* has existed since 1977). Approximately 35 years elapse from the first introduction of the Q-method in 1953 (Stephenson, 1953) to first use of the method for IS study in 1988 (Kaplan & Duchon, 1988), and still only a limited number of IS studies employ the Q-method. Even though the number of publications each year is still fewer than 10, the use of the Q-method for IS subjects since 2010 regularly appears each year and grows in term of the number of means, compared to years before 2010 (mean of number of publications since 2010 = 2.77 publications; before 2010 = 1.58 publications). The filtering process yielded 20% of papers published in the *Journal of MISQ*, 13.3% in *EJIS*, and 13.3% in *Journal of Management Information Systems*. Other selected journals each have less than 10% (Appendix 1 shows the complete journal distribution). The overview of mapping for 45 publications is listed in Table 1, sorted by the time of publication. Then, following Petersen et al. (2008) to represent the mapping scheme in the form of bubble plots, Figure 2 and Figure 3 show the bubble plot for the systematic mapping based on the percentage of two variables combined.

Publications The first author (year)	The role of the Q-method	Type of sources for concourse	Comparable DSR process	IS Topic	Study contribution
Kaplan (1988)	Minor support	2 without literature	Evaluation	System Analysis & design	Exaptation
Kendall (1994)	Major support	1 not from literature	Solution definition	IS Strategy, management and acquisition	Invention
Grover (1995)	Minor support	1 not from literature	Problem identification	System Analysis & design	Exaptation
Tractinsky (1995)	Main method/review	3 incl. from literature	Solution definition	System Analysis & design	Invention
Kettinger (1997)	Minor support	2 incl. from literature	Solution definition	IS project management	Invention
Gottschalk (1997)	Major support	2 incl. from literature	Problem identification	IS Strategy, management and acquisition	Improvement
Moody (1998)	Minor support	1 not from literature	Evaluation	System Analysis & design	Invention
Segars (1998)	Major support	1 not from literature	Solution definition	IS project management	Improvement
Segars (1999)	Minor support	2 incl. from literature	Solution definition	IS Strategy, management and acquisition	Invention
Morgado (1999)	Major support	only from literature	Problem identification	System Analysis & design	Exaptation
Gold (2001)	Minor support	only from literature	Problem identification	Data and Information Management	Invention
Bhattacherjee (2002)	Minor support	only from literature	Solution definition	System Analysis & design	Invention
Thomas (2002)	Main method/review	2 incl. from literature	Solution definition	System Analysis & design	Exaptation

Saeed (2005)	Minor support	only from literature	Evaluation	System Analysis & design	Invention
Chang (2005)	Minor support	only from literature	Solution definition	System Analysis & design	Invention
Burton-Jones (2006)	Minor support	only from literature	Solution definition	System Analysis & design	Improvement
Jahng (2007)	Minor support	only from literature	Evaluation	System Analysis & design	Exaptation
Nadkarni (2007)	Minor support	2 incl. from literature	Evaluation	System Analysis & design	Exaptation
Sutton (2008)	Minor support	1 not from literature	Problem identification	Enterprise architecture	Improvement
Klaus (2010)	Main method/review	1 not from literature	Evaluation	Enterprise architecture	Invention
Techatassanasoontorn (2010)	Major support	1 not from literature	Solution definition	System Analysis & design	Invention
Smith (2011)	Minor support	only from literature	Evaluation	System Analysis & design	Exaptation
Lu (2011)	Minor support	only from literature	Solution definition	IT Infrastructure	Invention
Luo (2012)	Minor support	2 incl. from literature	Evaluation	System Analysis & design	Invention
Sun (2012)	Major support	2 incl. from literature	Evaluation	System Analysis & design	Invention
Wolf (2012)	Minor support	only from literature	Solution definition	IS Strategy, management and acquisition	Exaptation
Messerschmidt (2013)	Minor support	only from literature	Problem identification	IT Infrastructure	Exaptation
Ou (2014)	Minor support	2 incl. from literature	Evaluation	System Analysis & design	Improvement
Gerlach (2015)	Minor support	1 not from literature	Evaluation	System Analysis & design	Improvement
Grgecic (2015)	Minor support	1 not from literature	Solution definition	System Analysis & design	Improvement
Gerow (2015)	Major support	only from literature	Solution definition	IS Strategy, management and acquisition	Invention
Campbell (2015)	Major support	not mentioned	Evaluation	System Analysis & design	Exaptation
Benlian (2015)	Major support	1 not from literature	Evaluation	System Analysis & design	Exaptation
Wisniewski (2016)	Minor support	only from literature	Evaluation	System Analysis & design	Exaptation
Gautier (2016)	Main method/review	2 without literature	Evaluation	System Analysis & design	Exaptation
Laumer (2016)	Major support	only from literature	Evaluation	System Analysis & design	Improvement
Vitari (2016)	Major support	2 incl. from literature	Evaluation	Data and Information Management	Exaptation
Gefen (2017)	Minor support	2 incl. from literature	Solution definition	System Analysis & design	Exaptation
Sarkar (2017)	Main method/review	3 incl. from literature	Solution definition	IS Strategy, management and acquisition	Invention
Laumer (2017)	Major support	2 incl. from literature	Evaluation	System Analysis & design	Invention

Mettler (2017)	Main method/review	3 without literature	Solution definition	System Analysis & design	Invention
Wingreen (2018)	Main method/review	3 incl. from literature	Solution definition	IS Strategy, management and acquisition	Invention
Mettler (2018)	Main method/review	2 incl. from literature	Solution definition	System Analysis & design	Invention
Walther (2018)	Minor support	only from literature	Evaluation	System Analysis & design	Improvement
Söllner (2018)	Major support	2 incl. from literature	Evaluation	System Analysis & design	Improvement

Table 2. Overview of the systematic mapping for the Q-method in IS publications.

The overall mapping results in Table 1 show the significant role of the Q-method in the IS studies as a "support method," with 82.2% (53.3% as minor + 28.9% as major support). This compares to use of the method as the "main method" at only 17.8%. The difference in the role of use is not surprising, since only two journal publications in the list focus on characterizing Q-method use in the field of IS (Mettler et al., 2017; Thomas & Watson, 2002).

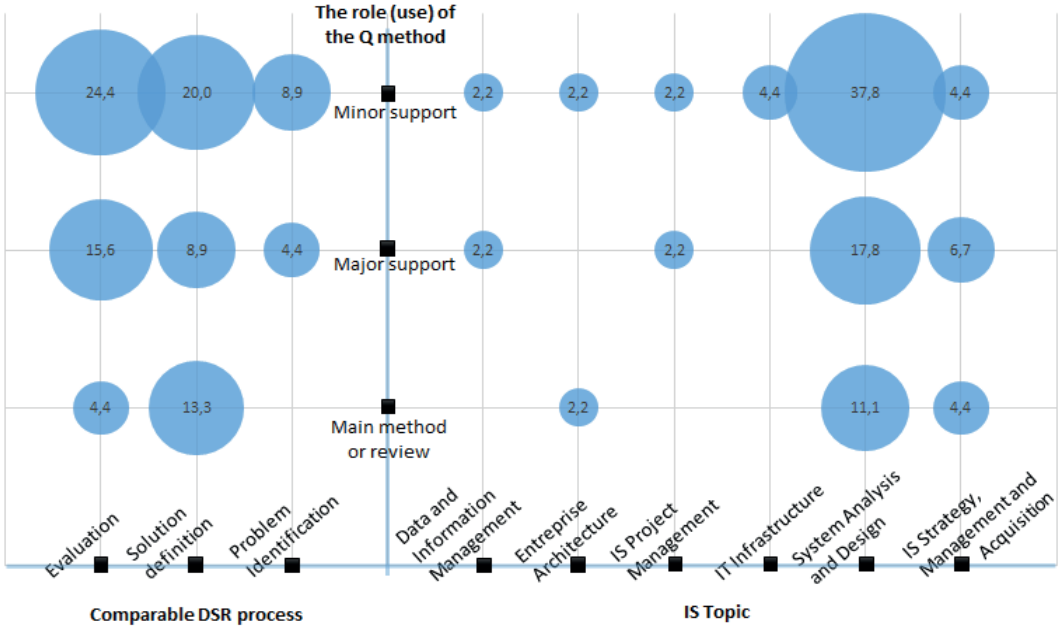

Figure 2. Mapping the result by the role of the Q-method, DSR comparable process, and the IS core topics.

Interestingly, no publications explicitly pointed to the use of DSR in their studies. This is also an indication of the existence of a gap in applying the Q-method in the DSR process. Concerning the type of sources for concourse, the result of overview mapping shows that 68.9% of publications that use the Q-method include scientific literatures or publications as part of the source to collect statements; 48.4% use literature only as the main source; and 51.6% combine the literature with other types of sources. Next, we present the mapping of the result for DSR processes. Figure 2 shows that 24.4% of the papers used the Q-method to support (minor) evaluation studies and 20% aim to define a solution, but no studies use the Q-method as the main method to identify problems. The use of the Q-Method as the main method relates mainly to the process of solution definition.

Based on IS topics in Figure 2, an interesting finding related to publication contribution appears mainly in the IS topic of "system analysis and design," with 37.8% showing the Q-method being used as minor support.

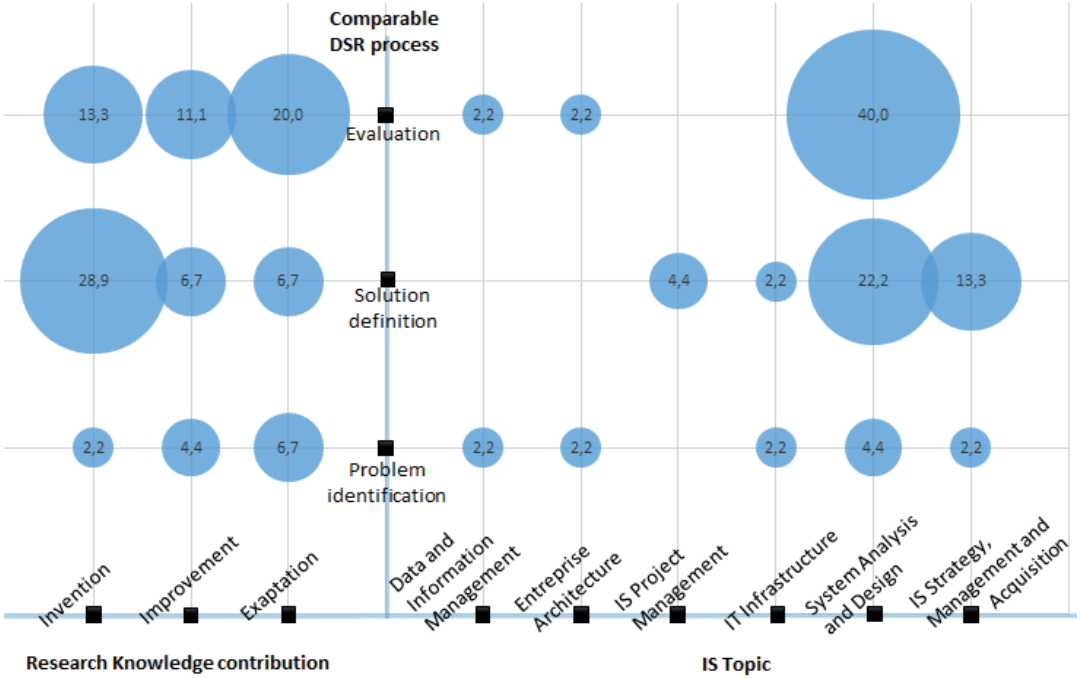

Figure 3. Mapping the result by the DSR comparable process, study contributions and the IS core topics.

Moreover, no significant difference exists between the uses of the Q-method as a major-support or as the "main method" for IS topic "system analysis and design." Furthermore, based on the knowledge contribution of publications, the process of "definition of solutions" that contributes to "the invention" of knowledge is in first place, as shown in Figure 3, with 28.9%, followed by 20% classified as "improvement" for the process "evaluation." Concerning the correlation between the DSR process and the IS topic, 40% of the publications using the Q-method were identified as "evaluation-driven" in the IS topic "the system analysis and design."

4 Towards the Integration of the Q-method into DSR Studies

The following analyzes and discusses the systematic-mapping result based on the two guideline questions (GQ1 and GQ2) to answer the main question and explain why the Q-method should be integrated into the DSR process in IS studies.

4.1 GQ1: How do IS-researchers use the Q-method?

The Q-method is commonly used by integrating with another method: This study shows that the Q-method can be flexibly integrated into IS studies in terms of implementation. IS researchers commonly support the DSR method with other methods—for example, using DSR with Grounded Theory (Gregory, 2011) or with a case study (Nabukenya, 2012). On the one hand, the majority of IS researchers are still not familiar with the Q-method (Wingreen & Blanton, 2018). On the other hand, the mapping shows the use of the Q-method as a support tool for IS researchers was able to provide publications with knowledge contributions in all three essential quadrants of the DSR Knowledge Contribution Framework (Gregor & Hevner, 2013).

Literature-driven as the basis for the concourse of Q-method for IS studies: The second interesting result is that the majority of IS studies used the literature review as a starting point for sources in the development of the list of statements, which can also be combined with other sources for the sorting process. Nevertheless, the Q-method has the potential to collect nonscientific digital data, such as social media or blogs (Davis & Michelle, 2011; Lynch et al., 2014; Orchard et al., 2015; Watts & Stenner, 2012). Although IS studies have not fully optimized this potential, found in only two pub-

lications (Gefen and Larsen, 2017; Mettler et al., 2017), the future use of the Q-method can also optimize the potential of big data for IS studies (Abbasi, Sarker, & Chiang, 2016). All together (big data as a source of the concourse, the Q-method, and DSR) can become fully implemented as one Q-method for DSR-based IS study.

Strengthen the result of IS studies related to the system analysis and design: The third important point related to the Q-method implementation in the IS studies is the high percentage of method use in the analysis and design of the system. That is also the main objective of DSR, i.e., to construct problem-based solutions or reflection-based system improvements (Peffers et al., 2007). The use of the Q-method as the main method also takes second place in the topic of IS strategy design and management. However, the Q-method was also employed as a minor support method for all IS topics. Therefore, this study supports previous studies in using the Q-method as a powerful method for understanding perceptions and representation of societal phenomena (Gautier et al., 2016) in the IS studies. Also, the method can support studies related to technological design (Mettler et al., 2017; Söllner et al., 2018) and different types of IS-topics.

The three answers to GQ1 about the Q-method practice enable an incremental understanding of the Q-method practice in the IS context. The results of the study support earlier studies on the ability of Q-methods to uncover social phenomena in IS (Thomas & Watson, 2002), important for design science. The flexibility of the Q-method both in integrating with other methods and in collecting concourse (also, the less exploited potential of the Q-method to develop concourse from any nonscientific digital data) shows how the potential of the Q-method for integration into different IS topics relates mainly to the analysis of system development. By using the literature as a basis for creating concourse in the Q-method, IS researchers can use the Q-method and deliver knowledge contribution to the IS community by using design sciences based on a study of subjectivity (Cross, 1999). Next is the analysis of the result in response to GQ2.

4.2 GQ2: To which DSR processes can the Q-methodology be applied by IS researchers?

The Q-method can be used to support all the main DSR processes to answer the question about use of the Q-method for comparable processes in DSR. First, in the identification of problems, challenges or barriers, no publication used the Q-method as the main method. The role of the Q-method is argued only as a supporting tool because the method itself handles the process of concourse development, explained as the main method of a study to identify the problem (Watts & Stenner, 2012). Subsequently, the Q-method was used as a validation (Burton-Jones & Straub, 2006; Jahng et al., 2007; Walther et al., 2018) of the identified problems, in the form of a study proposition with the sorting process in the Q-method. However, on the other hand, the role of the Q-Method in solution determination is a large part of its adoption as the main method, compared to its use in other processes (Figure 2). The importance of determining the best method by user preference (Matzner et al., 2015) increases the appropriateness of using the Q-method as the main method, as this method is reliably achieves consensus, particularly in system design (Figure 3). Therefore, the Q-method can be used as a tool to support research in every critical phase of the DSR process.

Q-method as the main tool for evaluating IS system based on user preference: The mapping clearly shows that the Q-method with 66.6% dominates the IS-topic system analysis and design, compared to other IS-topics (see Figure 2). The mapping results support the previous study on the use of Q-methods to explore one's own opinion and reflect one's own experience (Matzner et al., 2015), which plays such an important role in system development. Also, the Q-method has also been used as both main and support method in the evaluation process (Jahng et al., 2007; Nadkarni & Gupta, 2007; Saeed et al., 2005; Smith et al., 2011; Söllner et al., 2018). Therefore, IS researchers may consider the use of the Q-Method as the main tool to support the evaluation process of a system (Figure 3), empirically proven in previous studies as the best method to evaluate a system based on user preferences (Matzner et al., 2015). A practical suggestion is to use the statements in the usability evaluation tools as a source of the concourse, to find consensus on whether a system is usable. By using the Q-method

to measure usability, because of the nature of the Q-method, system analysts receive both quantitative and qualitative evaluation results on system usability.

The two answers for GQ2 regarding the comparable DSR process for implementing the Q-method enable an incremental understanding of the Q-method in the DSR process. The Q-Method can be applied to any core DSR process, with an emphasis on the validation and evaluation of propositions and proposed artifacts.

4.3 Proposing the integration of the Q-method into a Design-Science-Research study.

This study does not justify the Q-method as the best and only method for the IS community in the DSR process, but rather demonstrates in the mapping result the potential of the Q-method as a complement to the critical process in the DSR. The close link of the Q-method to the human perspective and the existence of genre diversity in DSR (Iivari, 2015; Peffers et al., 2018) speaks to the limitation of the Q-method as well as the strength of the Q method to provide a human-centered IS artifact. The Q-method is not optimal for DSR when a DSR study is based on laboratory experiments or software-based tests, where the influence of the human perspective on the resulting artifact is minimal, such as the simulation-based DSR study in the genre of explanatory design theory (Peffers et al., 2018). Figure 4 summarizes the discussion on the integration of the Q-method, illustrating the proposed framework (including outcomes for each process and integration activities) for the implementation of the Q-method in a DSR study, followed by the explanation.

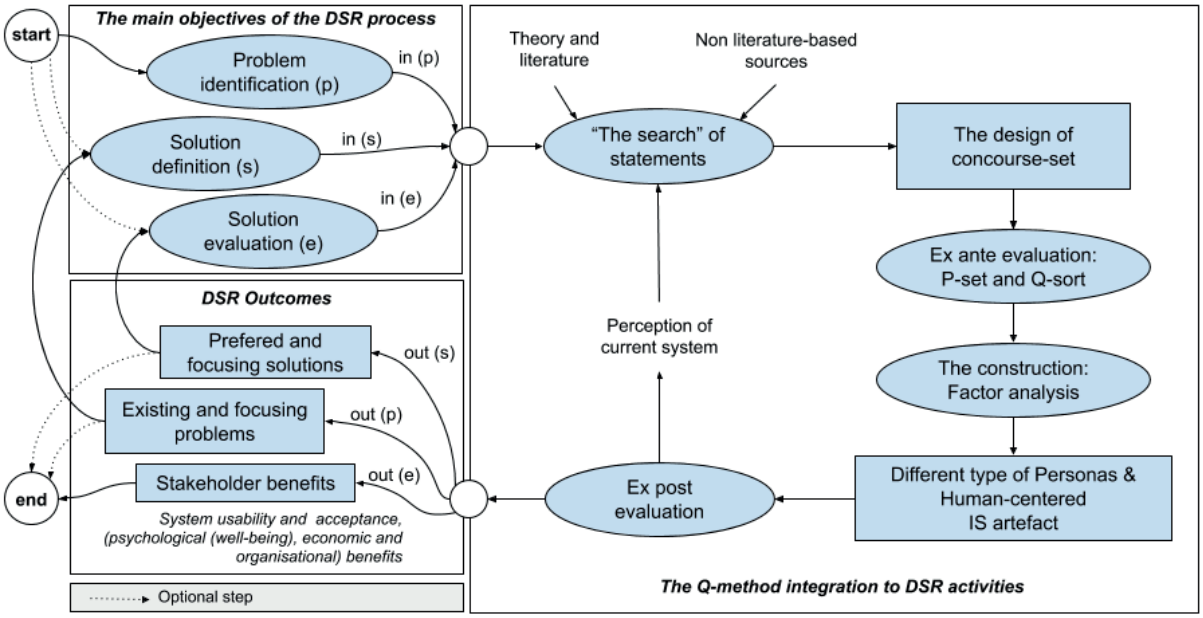

Figure 4. Towards the integration of the Q method into a DSR study, modified from (Baskerville et al., 2009).

Since this study is based on a process view of DSR (Peffers et al., 2007), the Q-method can generally be applied for each genre of DSR (Peffers et al., 2018). However, the integration of the Q method depends on the importance of people being involved in the design of the IS artifact. For the DSR genre of IS design theory, the formation and testing of the proposition becomes the central part (Peffers et al., 2018). The Q-method can help confirm the existence of different statements for a proposition and filter the statements to focus on a particular statement before testing a hypothesis (Burton-Jones & Straub, 2006; Laumer et al., 2017; Saeed et al., 2005). In the DSR Methodology (DSRM), which focuses on the development of applicable artifacts (Peffers et al., 2007; Peffers et al., 2018), the Q method can support all processes, from selecting focus problems and classifying user types based on statements, to selecting the applicable artifact (Mettler & Wulf, 2018; Peffers et al., 2018) by user type

and evaluating user preferences (Matzner et al., 2015) that affect both usability and system acceptance (Gefen & Larsen, 2017). In the design-oriented genre of DSR, where the benefit to stakeholders is one of the main topics (Peffers et al., 2018), the Q-method can be used to obtain stakeholders' views on the benefits of the artifact generated by the DSR study. (e.g., the associated benefits of technological interventions for the wellbeing of the user (Mettler et al., 2017; Mettler & Wulf, 2018; Wingreen & Blanton, 2018) which currently can drive the development process of IS design (Pawlowski et al., 2015). While research in DSR with action-design focuses on the reflection and involvement of stakeholders in the creation of an artifact (Peffers et al., 2018; Sein, Henfridsson, Purao, Rossi, & Lindgren, 2011), the Q-Method will be useful both in problem solving and in reflecting the proposed design based on stakeholder opinions.

DSR will affect the design of the concourse of the Q method in which statements in the IS study are formed from two complementary primary sources, namely literature-based, which strongly depend on the use of theory and nonliterary statements. A statement can be in the form of a problem-sentence in the problem-identification process; design principle or propositions in the solution-definition process, and benefits in the form of psychological, economic, or organizational benefits in the evaluation process. For non-literature-based statements including self-reports on experiences with the existing system, digital data collection in the form of large data sets, newspapers, or experts' views can also be used to complement literature-based statements for the concourse. The advancement of the technology and the big-data analysis can serve as a basis for collecting the statements from social media that can be used for the Q-sorting. Besides, in the Q-method, DSR researchers who perform factor analysis can categorize the list of participants (P-set) and identify different gains and pains experienced by the diverse stakeholders. Furthermore, based on the results of systematic mapping and the general process and activities in the Q-method (Watts & Stenner, 2012), which is centralized on the concourse, the integration can be done by focusing on activity level for both DSR and the Q-method. Adopting the episodic DSR represents activities in the DSR process (Baskerville et al., 2009) consisting of search activity, ex ante evaluation, construction activity, and activity related to ex post evaluation.

Moreover, an empirical study proves that the use of the Q-method provides better results compared to rating, ranking, or maximum different scaling assessment method to measure technological preference (Matzner et al., 2015). The use of the Q-method provides a way to fill the gap between quantitative and qualitative debate for the methodological option (Davis & Michelle, 2011) in the design research process. The method can be used as a mixed method with a limited number of respondents (Davis & Michelle, 2011), useful for evaluating the proposed IS artifact in the demonstration process of DSR. Besides, the mapping supports the previous study on the use of the Q-method for theory building (Yang, 2016), as shown in Table 1. The Q-method contributes 44% to the invention of knowledge as one of the main objectives of DSR (Gregor & Hevner, 2013; Gregory, 2011) in the IS community. The Q-Method means not only scores, but also subjectivity, and thus more humanistic investigation (Cross, 2004; Eden, Donaldson, & Walker, 2005) that can discover a balance between freedom and determinism in knowledge interpretation (Dryzek & Braithwaite, 2000). However, the use of the Q-method for DSR depends on the importance of subjectivity for the researchers in their study. The further question to be answered in the DSR-based IS studies is why the Q-method is suitable to include subjectivity.

5 Outlook, Limitation and Future Work

This study proposes the use of the Q-method in the DSR process, supplemented by analysis from the results of the mapping on the use of the Q-method in IS studies. It answers the main purpose of the research with a systematic process of mapping that begins with the identification of guideline framework questions. The results of the analysis and discussion of each of the questions are accompanied by an explanation about the study limitations and future research suggestions. Toward this end, IS Scholars are challenged to study and use the Q-method in the DSR-based IS-study to show how the Q-methods can help to generate either rigorous knowledge or applicable artifact for the IS community.

The study design tries to overcome three limitations. First, this study deals only with journals for systematic mapping. To overcome the first limitation, other journal publications were included in the IS

field from AIS DL. The publications from AIS DL provided more representation of the Q-method implementation in the IS community. In the future, proceedings papers could be included in a systematic literature review study and use case examples. Secondly, the mapping employed a limited number of variables for the classification. To support the development of a Q-method-based evaluation tool in further study, a different type of IS dimensions could be included (for instance, personal, technological, or organizational dimensions). The third limitation is the selection of the IS core curriculum as a topic for classification. The result of this study provides basic arguments for IS researchers to apply the Q-method for the DSR process in a different area of IS. The IS core topic of system analysis and design still covers a wide range of IS subtopics. Therefore, further study can map the publications based on the subtopic of system analysis and design, and then explore the criteria to implement the Q-method for a different subtopic. The IS subtopic will provide a more detailed picture of the potential corresponding IS topic support by the Q-method.

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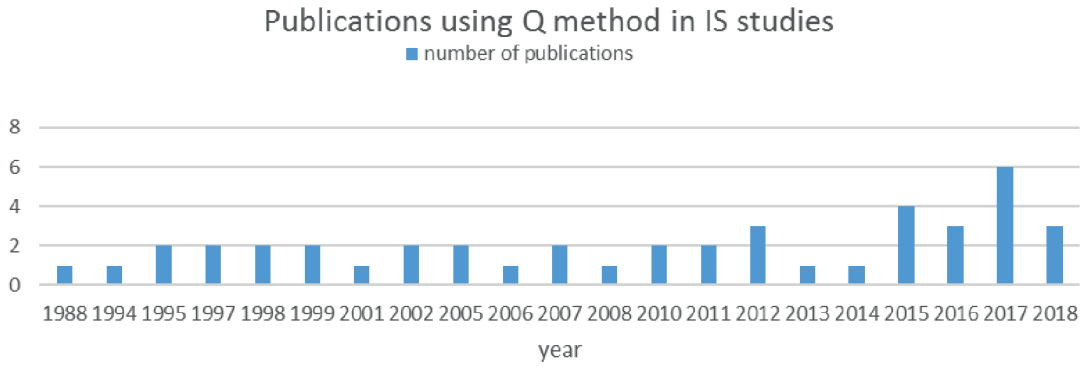
7 Appendix

Appendix 1: The distribution of the publication in the IS journals that utilized the Q-method.

Journal	Number of publications	Percentage
AIS-THCI (AIS Transaction on Human Computer Interaction)	1	2,2
PAJAIS (Pacific Asia Journal of the Association for Information Systems)	1	2,2
SJIS (Scandinavian Journal of Information Systems)	1	2,2
FJMIS (French Journal of Management Information Systems)	2	4,4
ISJ (Information Systems Journal)	2	4,4
JITTA (Journal of Information Technology Theory and Application)	2	4,4
JSIS (Journal of Strategic Information Systems)	2	4,4
CAIS (Communications of the Association for Information Systems)	3	6,7
ISR (Information Systems Research)	3	6,7
JAIS (Journal of the Association for Information Systems)	3	6,7
JIT (Journal of Information Technology)	4	8,9
EJIS (European Journal of Information Systems)	6	13,3
JMIS (Journal of Management Information Systems)	6	13,3
MISQ (Management Information Systems Quarterly)	9	20,0

Appendix 2: The distribution of publications in years and quantities



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