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

Completed Research Paper

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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.

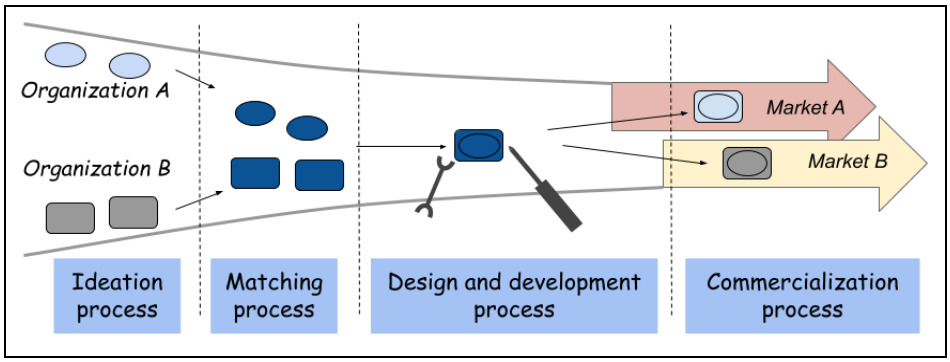

Figure 1. Global Innovation Process Modified From (Pawlowski 2013)

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

<table>
<tr><th>Code</th><th>Barriers</th><th>Code</th><th>Barriers</th></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>BR2</td><td>Age discrimination
(Anca et al. 2013; Sellers et al. 2010)</td><td>BR9</td><td>Do not know how to work with the other generation (Kurniawan 2008)</td></tr>
<tr><td>BR5</td><td>Different mindset
(Edge 2014; Sellers et al. 2010)</td><td>BR24</td><td>Lack of empathy (Brücknerová and Novotný 2017; Sellers et al. 2010)</td></tr>
<tr><td>BR7</td><td>Different interests (Boulton-Lewis et al. 2007; Icenogle 2001)</td><td>BR25</td><td>Lack of respect (Brücknerová and Novotný 2017; Sellers et al. 2010)</td></tr>
<tr><td rowspan="2">BR15</td><td rowspan="2">The other generation's resistance (Anca et al. 2013; Fernández-de-Álava et al. 2017; Sellers et al. 2010)</td><td>BR37</td><td>Lack of (interpersonal) trust (Cresci et al. 2010; Edge 2014)</td></tr>
<tr><td>BR17</td><td>Lack of awareness of differences with other generation (Edge 2014; Fernández-de-Álava et al. 2017)</td></tr>
<tr><td colspan="4">Technical and Operational Barriers
barriers associated with technology and operational use</td></tr>
<tr><td rowspan="2">BR1</td><td rowspan="2">Different technological background (Binda et al. 2017; Boulton-Lewis et al. 2007; Brücknerová and Novotný 2017; Charles and Charles 2016; Cresci et al. 2010)</td><td>BR21</td><td>The investment cost for technology(Anca et al. 2013; Boulton-Lewis et al. 2007; Cresci et al. 2010)</td></tr>
<tr><td>BR19</td><td>Lack of independence
(Amaro et al. 2016)</td></tr>
</table>

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.

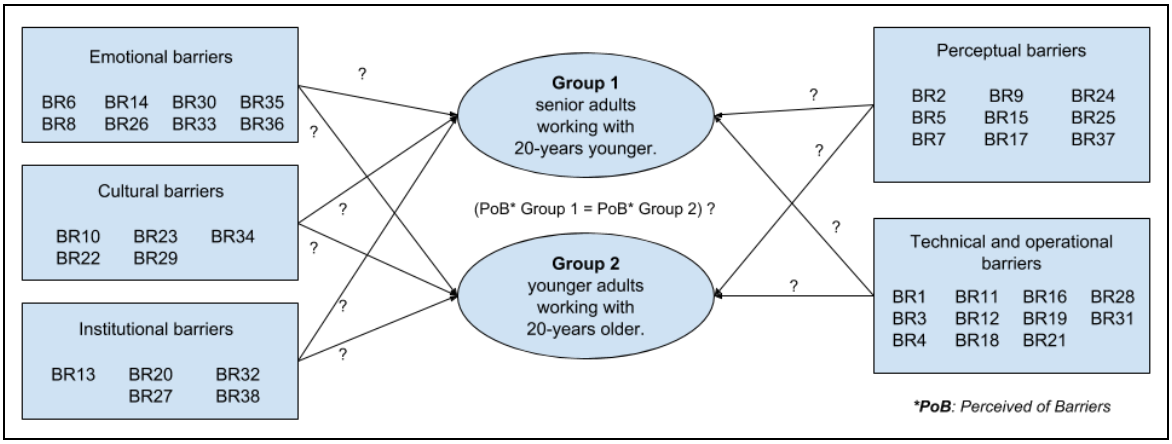

Figure 2. Overview of the Study aim on Barriers to Intergenerational Collaboration

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.

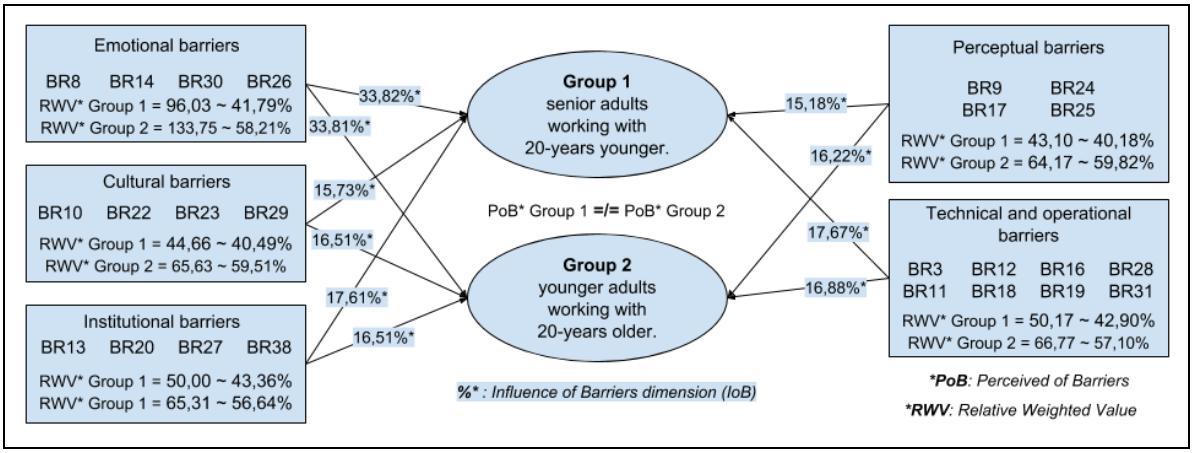

Figure 3. Influence Percentage of Barriers Dimension to Intergenerational Collaboration

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.

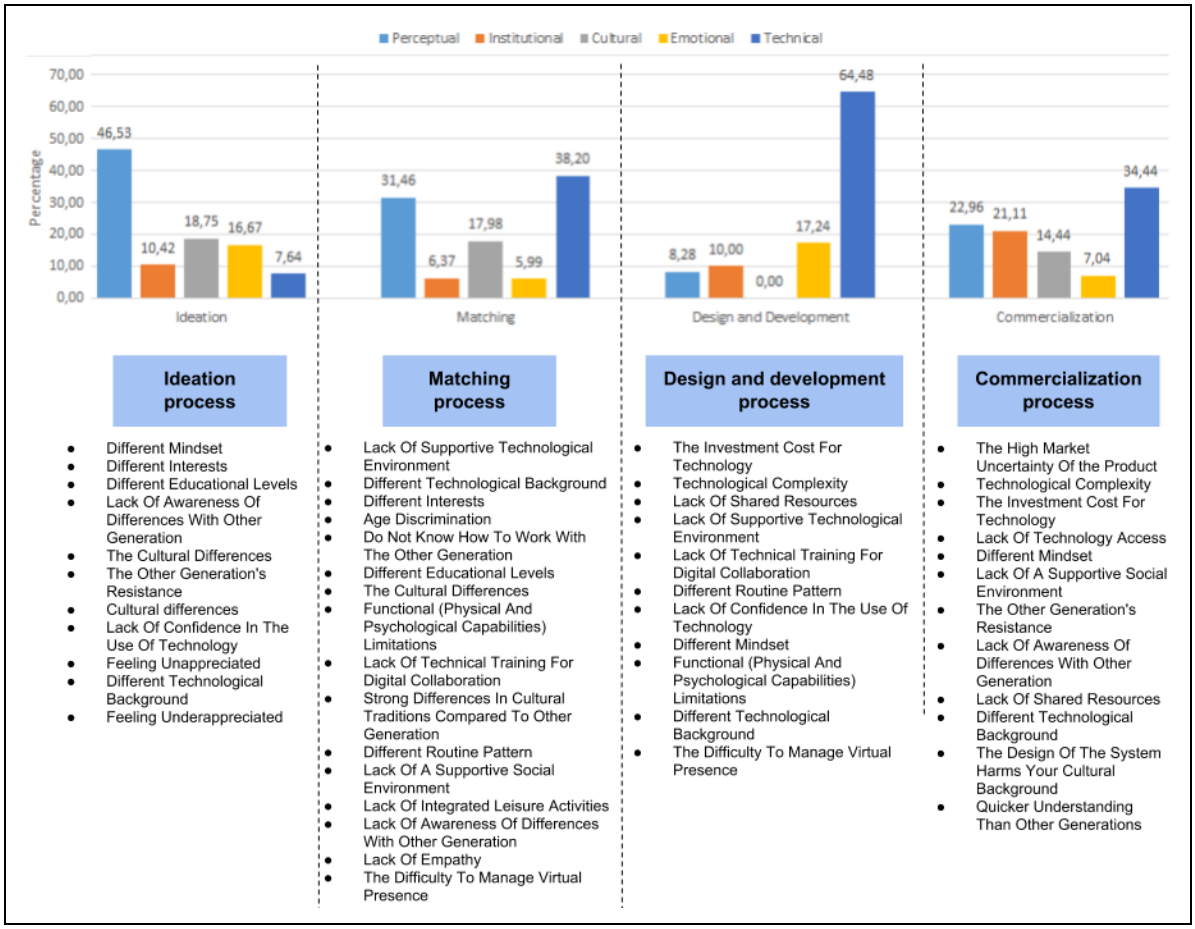

Figure 4. Top Third-Quartile of Intergenerational Barriers to Innovation Process

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.

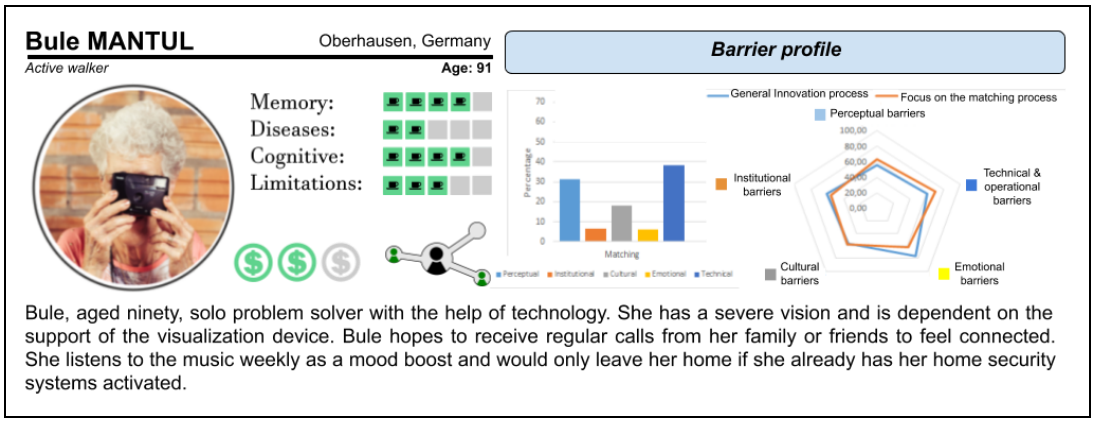

Figure 5. Personas for the Matching Process of Intergenerational Innovation

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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