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Wiesner-Herbst, Beate

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User innovation and active ageing in the maker movement in South Africa and Germany

Beate Wiesner-Herbst

A research report submitted to the Wits Business School in the University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Management in the field of Innovation Studies

Munich, 7th April 2025

ABSTRACT

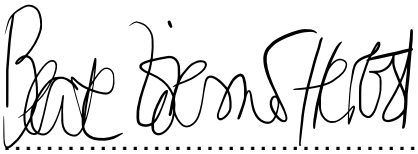
This study explores the intersection of user innovation (Von Hippel, 2005 & 2016) and active ageing (WHO, 2002), investigating how older individuals (50+) contribute to household-sector innovation within makerspaces in South Africa and Germany. Through qualitative research focusing on semi-structured interviews, the study examines the activities, contributions, and motivations of older members in makerspaces towards user innovation processes. Findings confirm that older individuals actively engage in user innovation, demonstrating adaptability, problem-solving abilities, and a willingness to integrate traditional craftsmanship with modern digital fabrication techniques. Their participation is driven by diverse motivations, including personal fulfilment, economic necessity, and knowledge sharing. Using the WHO (2002) framework of active ageing as a lens, this study finds that participation in user innovation activities in makerspaces supports cognitive engagement, social inclusion, and, in some cases, economic security for older individuals. While older innovators contribute significantly to both individual and collective household innovation, barriers such as limited documentation skills and commercialisation challenges, hinder the full dissemination of their efforts. Given the increasing awareness around the significance of household-sector innovation in the economy (De Jong et al., 2021), this study underscores the potential of older innovators as a valuable yet underutilised resource in the context of ageing societies.

KEY WORDS

User innovation, household sector innovation, maker movement, makerspaces, active ageing

DECLARATION

I, Beate Wiesner-Herbst, declare that this dissertation is my own unaided work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Management in the field of Innovation Studies at the Wits Business School in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other University.

Signature: 

Reworked version after examiner's and supervisor's comments
On this 2nd day of November 2025

Beate Wiesner-Herbst

Name

DEDICATION

To my parents,
whose unwavering love, encouragement, and wisdom have been my guiding light throughout this journey. You not only inspired the very idea behind this research, but also stood by me through challenges, and reminded me of my strength when I needed it most. This work is a testament to your enduring support and the values you have instilled in me. Thank you for always being my foundation.

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TABLE OF CONTENTS

ABSTRACT ..... **II**

KEY WORDS II

DECLARATION ..... **III**

DEDICATION ..... **IV**

ACKNOWLEDGEMENTS ..... **V**

LIST OF TABLES XI

LIST OF FIGURES XI

CHAPTER 1: INTRODUCTION **1**

1.1 PURPOSE OF THE STUDY 1

1.2 CONTEXT OF THE STUDY 2

1.2.1 User Innovation 2

1.2.1.1 The Maker Movement 3

1.2.2 Ageing Societies 5

1.2.2.2 Active Ageing 6

1.2.3 Summary 8

1.3 RESEARCH PROBLEM STATEMENT 9

1.4 SIGNIFICANCE OF THE STUDY 10

1.5 DELIMITATIONS OF THE STUDY 10

1.6 ASSUMPTIONS 11

1.7 DEFINITION OF KEY TERMS 12

1.8 RESEARCH QUESTIONS 13

1.9 OUTLINE AND STRUCTURE OF THE REPORT 13

CHAPTER 2: LITERATURE REVIEW **15**

2.1 INTRODUCTION 15

2.2 USER INNOVATION 17

2.3 MAKER MOVEMENT 22

2.4 ACTIVE AND HEALTHY AGEING 24
2.5 SELECTED PAPERS COMBINING OPEN INNOVATION AND ACTIVE AGEING 27
2.6 SUMMARY 28
2.7 THEORETICAL FRAMEWORK(S) 29
2.8 CONCEPTUAL FRAMEWORK 30
2.9 STATEMENT OF PROPOSITIONS 33
CHAPTER 3: RESEARCH METHODOLOGY 34
3.1 INTRODUCTION 34
3.2 RESEARCH DESIGN 35
3.3 SELECTION OF PARTICIPANTS 36
3.4 RESEARCH TECHNIQUES 37
3.4.1 Research Instruments 39
3.4.1.1 Document Analysis 39
3.4.1.2 Semi-structured Interviews 40
3.4.1.3 Site Visits, Observation 40
3.5 DATA ANALYSIS 41
3.6 LIMITATIONS OF THE STUDY 41
3.7 ETHICAL CONSIDERATIONS 42
3.8 RELIABILITY AND VALIDITY 43
3.9. SUMMARY OF RESEARCH STRATEGY AND METHODOLOGY 44
CHAPTER 4: PRESENTATION OF RESULTS 45
4.1. OVERVIEW 45
4.1.1 Brief Introduction 45
4.1.2 Background Profile of Respondents and Process Followed 46
4.2. PRESENTATION OF FINDINGS AND DATA RESULTS 47
4.2.1 Overview Makerspaces 47

4.2.1.1 Overview of Made In Workshop, Johannesburg, South Africa 48
4.2.1.2 Overview of FabLab Munich e.V., Munich, Germany 50
4.2.2 Results pertaining to Research Proposition 1 53
4.2.2.1 Results from Made In Workshop, Johannesburg, South Africa 53
4.2.2.2 Results from FabLab Munich e.V., Munich, Germany 56
4.2.3 Results pertaining to Research Proposition 2 60
4.2.3.1 Results from Made In Workshop, Johannesburg, South Africa 60
4.2.3.2 Results from FabLab Munich e.V., Munich, Germany 62
4.3. SUMMARY OF DATA PRESENTATION 64
CHAPTER 5: ANALYSIS OF RESULTS AND DISCUSSION 65
5.1 INTRODUCTION 65
5.2 BACKGROUND 65
5.3. DISCUSSION PERTAINING TO RESEARCH QUESTION 1 67
5.3.1 User Innovation among older people in makerspaces 67
5.3.1.1 Degree of Accomplishment: Idea, Invention, or Innovation 68
5.3.1.2 Individual vs. collective household innovation among older makers 68
5.3.1.3 Motivation and types of older household sector innovators 70
5.3.1.4 Diffusion of household innovation by older makerspace members 71
5.3.2 Summary 72
5.4 DISCUSSION PERTAINING TO RESEARCH QUESTION 2 74
5.4.1 Makerspaces as Age-Inclusive Innovation Environments 74
5.4.2 Variations in Age Representation Across Makerspaces 75
5.4.3 Collaboration and Intergenerational Exchange 75
5.4.4 Skill Development and Training for Older Makers 76
5.4.5 Exclusive "Senior-Only" Makerspaces? 77
5.4.6 Summary 78
5.5 DISCUSSION IN THE CONTEXT OF ACTIVE AGEING 78

5.6 SUMMARY OF RESULTS ANALYSIS AND DISCUSSION 80
CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS 82
6.1 INTRODUCTION 82
6.2 MAJOR FINDINGS 83
6.3 KEY CONCLUSIONS OF THE STUDY 85
6.4 RECOMMENDATIONS 87
6.4.1 Recommendations for Practice 87
6.4.2 Recommendations for Policy 88
6.5 SUGGESTIONS FOR FUTURE RESEARCH 88
REFERENCES 90
APPENDICES 98
APPENDIX A – RESEARCH INFORMATION 99
A.2. Participant Information Sheet 99
A.1. Permission Request to conduct Research 100
A.2. Participant Information Sheet 102
A.3. Participant Consent Forms 104
A.3.1. Consent Form for individual Participants 104
A.3.2. Consent Form for Management Participants 105
APPENDIX B – RESEARCH INSTRUMENTS 106
B.1. Interview Guides for Group 1 (members 50+ in makerspaces) 107
B.2. Interview Guides for Group 2 (members under 50 in makerspaces) 110
B.3. Interview Guides for Group 3 (management in makerspaces) 113
APPENDIX C – DATA PRESENTATION 115
C.1. MAKERSPACE SELECTION 116
C.1.1. Overview of Makerspaces in Gauteng, South Africa 116
C.1.2. Overview of Makerspaces in Munich, Germany 117
C.2. INTERVIEW RESULTS 118

C.2.1. Interview Results from MIW 118
C.2.2. Interview Results from FLM.....122
C.2.3. Interview Results Management Members 126
C.3. DOCUMENT ANALYSIS 128
C.3.1. Document Analysis MIW 128
C.3.2. Document Analysis FLM 130
C.4. SITE VISITS 132
C.4.1. Site Visits MIW 132
C.4.2. Site Visits FLM 134

LIST OF ABBREVIATIONS & ACRONYMS

CEO – Chief Executive Officer

COO – Chief Operations Officer

CNC – Computer Numerical Control

DIY – Do-it-yourself

Est. - Established

HHS – Household Sector

IP – Intellectual Property

FLM – Fab Lab Munich (FabLab München e.V.)

MIW – Made In Workshop

R&D – Research and Development

UN – United Nations

WHO – World Health Organization

WWA - Woodworkers Association of the Witwatersrand

LIST OF TABLES

Table 1 Overview Investigated Makerspaces

Table 2 Overview Interview Participants

Table 3 Overview of Participants' Activities and Projects

LIST OF FIGURES

Figure 1 Diagram of the Active Ageing Framework

Figure 2 Conceptual Framework

Figure 3 Overview HHS Innovation Types Found in this Study

CHAPTER 1: INTRODUCTION

1.1 PURPOSE OF THE STUDY

This qualitative study tries to explore how user innovation and the concept of active ageing can interact for mutual benefit. User innovation is concerned with how users or customers of certain products or services contribute to innovation by modifying or creating new versions of those products and services based on their specific needs, thereby emphasising the importance of open access and knowledge sharing (Von Hippel, 2005).

Active ageing, on the other hand, is a concept that promotes inter alia the participation of older individuals in various aspects of life, emphasising their continued involvement and contribution (WHO, 2002). A policy framework was introduced by the World Health Organization in 2002 and reinforced by the UN's declaration of the Decade of Healthy Ageing, 2020-2030 (United Nations, 2022) in recognition of worldwide ageing population trends. Both programs aim to enable initiatives to foster wellbeing for older people and support the creation of age-inclusive societies.

The study specifically examines the potential contributions that senior citizens can make to the user innovation field. This involves understanding how the skills, experiences, and perspectives of older individuals can positively impact innovation efforts. The study also investigates how innovation processes can be made more inclusive of different age groups, with a particular emphasis on engaging and involving older citizens in user innovation activities, i.e. how to identify, motivate, and engage older citizens to participate in those processes.

The research analyses the advantages and difficulties faced by older citizens when embarking on user innovation activities in makerspaces. This could include benefits such as diverse perspectives and contributions to innovation projects, as well as challenges, e.g. potential barriers to participation. The maker movement with its physical makerspace outlets offer a platform for various DIY activities, tinkering, and creative problem solving on household and community levels. They provide an

opportunity for individuals to participate in and pursue their own innovation efforts, thereby fostering philosophies of open access, shared resources and collaboration.

In essence, this research project explores how user innovation and active ageing can complement each other. By investigating the contributions of older individuals to the user innovation realm, as well as examining the age-inclusivity of innovation processes in makerspaces, the research aims to identify ways to effectively involve older people in collaborative innovation while examining the benefits and challenges associated with this approach. This could have implications for creating more age-inclusive and socially impactful innovation initiatives.

1.2 CONTEXT OF THE STUDY

1.2.1 User Innovation

In an age defined by interconnectedness and dynamic societal shifts, driven by fast-paced technological progress and shifting consumer demands, innovation has grown to become an increasingly more open and democratised concept in theory and practice (Chesbrough, 2012; Von Hippel, 2005). In contrast to the producer-centred innovation model which attributes major innovation to professional profit-oriented corporations, Eric von Hippel (2005) was among the first to observe a phenomenon he termed user innovation. Here, individuals, households or user-companies innovate individually or collaboratively towards their specific needs (Von Hippel, 2005).

They are driven by their individual preferences for which the market oftentimes fails to provide adequate solutions, marking an important information asymmetry between users and producers. Motivated by a desire to find custom-fit solutions to their specific problems, as well as an opportunity to learn or sometimes even the sheer enjoyment of inventive activity itself, user innovators set out to find new solutions, both individually and in groups. The process is frequently marked by a trial-and-error approach, where the emphasis is placed on practical problem-solving by application of individual skills as well as discretionary time and resources.

While user innovation broadly includes any innovation by end-users (including businesses and professionals), household sector innovation specifically involves non-professional, unpaid individuals creating solutions for use within their own households (von Hippel, 2016). Moreover, household innovators often rely on informal networks, online communities, or social media to share insights, collaborate with others, and refine their creations. This grassroots innovation contributes to a more decentralised and democratised model of technological and product development, which contrasts with the top-down approach of traditional industries.

As most users innovate for their personal benefit of using their invention themselves, they often choose to share their developments freely with likeminded individuals or communities (Von Hippel, 2005). They are enabled by easier access to new technologies, platforms, communities, and tools to drive and diffuse their user innovation efforts and account for an increasingly high share of innovation in modern economies (De Jong et al., 2021; Von Hippel, 2016).

In the producer-centred innovation context, this phenomenon is more and more recognised, and professional producers are seeking to “harvest” user innovation in addition to their own R&D-driven innovation efforts. As such, user innovation is related to open innovation, which is essentially concerned with breaking down internal barriers of organisations to seek external input as well as making internal innovation resources available to collaborators to drive the innovation process (Chesbrough, 2006). This study is focusing on user innovation at the household level as described by De Jong et al. (2021) and seeks to understand the emergence of household sector innovation among older individuals: their motivations, practices, and ways of contribution to the phenomenon.

1.2.1.1 The Maker Movement

The maker movement, with its foundation in the DIY (do-it-yourself) ethos and collaborative innovation, has emerged as a dynamic force within the broader context of user innovation (Halbinger, 2018). It is a cultural and technological phenomenon focused on DIY activities, where individuals create, modify, or repurpose objects using tools like 3D printers, electronics, and traditional craft techniques, all of which are accessible to individuals who may not have formal engineering or design expertise.

The maker movement emphasises personal creativity, hands-on learning, and sharing knowledge, often in community-driven spaces like maker fairs or workshops. It enables people to actively create solutions to problems within their own households or communities that mainstream markets have often overlooked or inadequately addressed. In many ways, the maker movement provides a platform for household sector innovators to experiment, tinker, and refine new ideas that can be tailored to their specific needs or desires.

Makerspaces play a pivotal role in this process by offering shared resources, tools, and expertise that might otherwise be out of reach for individuals working in isolation (Halbinger, 2018). These spaces foster an environment where people can collaborate, exchange knowledge, and work on projects ranging from home improvement solutions to more complex technological inventions. Within makerspaces, users have the opportunity to explore new technologies like 3D printing, electronics, and robotics, as well as to learn traditional crafting skills. This collaborative, hands-on environment encourages household innovators to move beyond mere problem-solving and into the realm of creativity and experimentation, whether alone or as part of a group.

Furthermore, the digital aspect of the maker movement amplifies its reach beyond physical spaces. Virtual communities and online platforms serve as critical outlets for the exchange of ideas, designs, and feedback (Halbinger, 2018). Makers from different backgrounds and parts of the world can collaborate on projects, share prototypes, and solve problems together, reinforcing the idea of global collaboration and inclusion in innovation (Saari et al., 2021). This network of virtual and physical interaction allows household innovators to refine their ideas, receive constructive feedback, and even share their creations for public use, contributing to a culture of openness and transparency in innovation.

In essence, makerspaces and the broader maker movement provide not only the tools and resources but also the collaborative environment necessary for household sector user innovation to thrive. These spaces allow individuals to experiment with new solutions and engage in a cycle of creation, feedback, and refinement, making it easier for everyday people to innovate outside of traditional corporate or professional settings. By doing so, the maker movement empowers individuals to develop solutions

that cater to their specific needs, enhancing the overall DIY culture and contributing to a more inclusive and accessible approach to innovation.

1.2.2 Ageing Societies

One social phenomenon that poses both opportunities and challenges for societies worldwide is the ageing of populations. Across the globe, individuals are enjoying longer lifespans. Presently, the majority can anticipate living well into their sixties and beyond (WHO, 2022). As advancements in healthcare and living standards contribute to longer life expectancies, a demographic shift is underway, resulting in a larger proportion of elderly individuals within populations.

While this phenomenon is a testament to improved quality of life and medical progress, it also brings about various economic, social, and healthcare challenges. One major concern is the strain on pension and healthcare systems as growing numbers of individuals retire and require increased medical attention. Furthermore, issues related to eldercare, social isolation, as well as the physical and mental health of seniors become more prominent.

Additionally, the shift in generational demographics poses questions about intergenerational equity and the potential strain on familial structures as younger generations may find themselves increasingly responsible for the care and support of ageing relatives. Addressing these challenges requires a comprehensive and collaborative approach that involves not only policymakers but also communities, healthcare professionals, innovators, and seniors themselves to ensure the well-being and inclusion of the elderly in an ageing society.

While all these points are valid to consider, the mentioned statements reflect the predominant deficit-focused view of ageing societies (Wegner, 2012). Enforced by media reporting, a bleak picture is painted of a future where the frailty and dependence of elderly individuals overwhelm society. But rather than focusing solely on challenges, exploring the positive aspects and untapped potential within elderly demographics offers a more comprehensive understanding.

This study encourages a shift from a problem-centric narrative to one that highlights the valuable contributions, experiences, and wisdom that older individuals can bring to society. Embracing the opportunities inherent in ageing populations fosters a more inclusive and optimistic vision for the future, promoting the idea that older individuals can continue to play vital roles in various aspects of community life, innovation, and societal well-being.

Research has for example focused on the "silver economy", which refers to the economic opportunities and market potential that arise from the needs and preferences of older individuals (e.g. Kohlbacher et al., 2014; Lipp & Peine, 2022; OECD, 2014; Van Dullemen, 2006). As societies around the world experience demographic aging, there is a growing recognition that seniors constitute a significant consumer demographic with distinct requirements and interests. The silver economy encompasses a broad selection of products and services tailored to meet the evolving needs of an ageing population.

Moreover, some researchers have paid particular interest in the co-creation and innovation potential of seniors (Peine et al., 2013). The co-creation of elderly persons within the silver economy emphasises a collaborative and inclusive approach that recognises the active participation and contributions of seniors in shaping products and services tailored to their needs, thus linking back to the concepts of user-centric innovation. In this context, co-creation involves engaging older individuals as active partners in the design, development, and evaluation of goods and services that cater to the ageing demographic.

1.2.2.2 Active Ageing

The World Health Organization addressed the issue of ageing populations through its policy framework on active ageing (WHO, 2002), which emphasises enhancing health, participation, and security opportunities to support better quality of life as people grow older. It involves staying engaged, physically and mentally, in social, economic, cultural, and civic activities. Active ageing involves more than prevention and the absence of disease or disability but encompasses the ability to lead a fulfilling and productive life as one grows older.

Three key components define the concept of active ageing (WHO, 2002): health, participation and security. Active ageing emphasises maintaining good health and well-being throughout the ageing process. This includes maintaining a healthy way of living through consistent physical activity, balanced nutrition, and proactive health care practices. It also fosters participation and engagement of seniors**.** Being actively involved in social, cultural, and community activities is central to active ageing. This includes staying connected with friends and family, participating in hobbies and recreational pursuits, and contributing to community life.

It also emphasises that continuous learning and skill development are important, not only to stay mentally fit but also to actively participate in contemporary debates and developments. Furthermore, active ageing promotes an environment where older individuals feel secure and safe. This encompasses aspects such as financial security, housing, and access to healthcare services. Maintaining independence and autonomy is another fundamental aspect of active ageing. This includes the ability to make choices, control one's life, and participate in decision-making processes.

Additionally, active ageing sets out to encourage a positive and realistic attitude towards the ageing process. This involves challenging stereotypes and negative perceptions associated with ageing, promoting a mindset that values the contributions and experiences of older individuals in younger generations (Karlin & Weil, 2016). It also aims at establishing the patterns of activity, health, and security throughout the life course (Walker, 2008).

Against this backdrop, this study explores how user innovation and active ageing concepts cross-fertilise each other. Through qualitative research, it examines how local makerspaces embrace, encourage and involve contributions and activities of older citizens. Equally, it analyses how older citizens engage in makerspaces and seek out opportunities for user innovation, and how this in turn contributes to the participative benefits proposed by the active ageing framework.

1.2.3 Summary

The study examines user innovation by older citizens in two makerspaces, one in South Africa and one in Germany. Both countries exhibit a vibrant and active maker movement (Rosa et al., 2017; De Beer et al., 2017). Population ageing statistics show a significant difference in both countries: while the South African population aged 65 or older represented 5.4% of the country's overall population in 2019 (projected to grow to 6,7% in 2030), the ratio for Germany already amounted to 21.6% in 2019 (26.2% in 2030) (United Nations, 2019). While the impact and societal shift of population ageing might appear more topical in Germany, African ageing populations feature similar challenges such as physical and spiritual health, economic hardship, dependence, and social isolation (Doh & Adusei-Asante, 2016; Van Dullemen, 2006).

Furthermore, as many countries worldwide, both South Africa and Germany witness the same underlying population aging trends. On the one hand, there are declining birth rates. For example, Germany's birth rate declined from 9.4 births per 1,000 inhabitants in 1995 to 8 in 2022. In the same period, South Africa's birth rate dropped from 25.6 to 19.6 per 1,000 inhabitants (FRED, 2025). On the other hand, people are leading longer and healthier lives. Life expectancies at birth was 64 years in 2020 in South Africa (compared to 61 years in 2000). In Germany, life expectancy grew from 78 years in 2000 to 80 years in 2020 (WHO, 2024).

While the silver economies mentioned above are expected to have a more significant impact in Western and Asian regions, the endorsement of innovation initiatives focusing on ageing populations at the community level could potentially initiate relevant solutions in both countries, South Africa and Germany. As such, the intergenerational dialogue between young and old actors in makerspaces as well as experience, skills, and knowledge contributions of older generations, and own invention/innovation efforts by seniors are examined in this study.

This study explores the engagement of older adults in user innovation within two makerspaces **-** one in South Africa and one in Germany **-** in order to identify common patterns across differing socio-economic and cultural contexts. Rather than focusing on national comparisons, the study aims to highlight shared motivations, practices, and challenges experienced by older individuals participating in household sector

innovation. By selecting two contrasting yet instructive cases, the research seeks to uncover how enabling environments such as makerspaces support creative contributions from older people, irrespective of geographic location. This approach emphasizes the agency and potential of older citizens as innovators, while acknowledging that these insights emerge independently of the broader structures of national innovation systems, which are not the primary focus of this investigation.

1.3 RESEARCH PROBLEM STATEMENT

Ageing populations are a worldwide phenomenon that poses both challenges and opportunities for societies, economies, and to the field of innovation. The UN Report on World Population Ageing (2019) shows that older populations are growing globally. In response to these trends, the World Health Organization proposed a policy framework for active ageing in 2002 (WHO, 2002) and together with the United Nations declared 2020-2030 as the “Decade of Healthy Ageing” (United Nations, 2022). Both programs aimed to enable initiatives to foster wellbeing for older people and support the creation of age-inclusive societies.

In the innovation context, researchers have not only identified the growing cohort of seniors as an emerging user and customer segment (innovation for the “silver economy”, e.g. Kohlbacher et al., 2014) but also as a valuable and rich resource to innovation processes (Peine et al., 2013). Von Hippel (2005) identified users and consumers as a major source of innovation. Users innovate by modifying or creating products and services based on their specific needs and due to non-availability of custom-fit solutions on the market. Wellner and Herstatt (2014) have investigated the motivations and determinants of user innovator behaviour among older users and have found significant potential to innovate among the elderly. They confirmed assumptions of the silver economy theory stating that older user-innovators are motivated to solve (age-specific) problems and certify a high rate of idea generation.

The maker movement, with its physical makerspace outlets offers an opportunity and a platform for user innovators to pursue their specific innovation needs (Halbinger, 2018). Rooted in the DIY community movement, makerspaces emphasise open, collaborative and inclusive approaches to problem-solving and creativity at household and community levels. As such, this study aims to contribute to research

on user innovation and active aging by examining the innovation potential of older individuals, specifically exploring seniors' user innovation efforts within the maker movement in South Africa and Germany.

1.4 SIGNIFICANCE OF THE STUDY

The study adds insights to the field of user innovation in makerspaces in South Africa and Germany with a specific focus on older people's motivation and encouragement to participate in these processes. It thus focuses on the age-inclusiveness of makerspaces on the one hand, and seniors' contributions and impact thereof to user innovation processes on the other hand. While ageing populations and associated economic and social effects may seem more topical in Germany and Europe (United Nations, 2019), some researchers already emphasise the relevance of addressing those topics on the African continent (Doh & Adusei-Asante, 2017; Van Dullemen, 2006). Therefore, including cases from both countries, South Africa and Germany, broadens the understanding of user innovation dynamics among older people in both socio-economic contexts.

1.5 DELIMITATIONS OF THE STUDY

This study is delimited to examining user innovation among older adults in makerspaces located in South Africa and Germany. It focuses on household sector innovation (De Jong et al., 2021), i.e. individual or collective household sector innovation as opposed to firm-user innovations (Von Hippel, 2005).

Furthermore, it focuses on the motivations, challenges, and opportunities that shape user innovation among older makers. The research does not attempt to provide a comprehensive analysis of the broader maker movement or innovation systems beyond the specific context of older individuals in makerspaces.

While the concept of active ageing (WHO, 2002) provides a useful lens for understanding the social and cognitive benefits of participation in user innovation activities in makerspaces, the study does not aim to validate or measure active ageing

as a formal framework. Instead, it treats active ageing as a complementary perspective rather than the primary object of analysis.

1.6 ASSUMPTIONS

This study is based on several foundational assumptions that guide the investigation into user innovation and active ageing in the maker movement in South Africa and Germany. These assumptions are derived from the current literature on user innovation (Von Hippel 2005, De Jong et al., 2021), and the associated role of makerspaces (Halbinger, 2018, Saari et al., 2021), particularly as they relate to older adults.

Older adults' capacity to innovate: This study assumes that older individuals are capable of engaging in user innovation within makerspaces, and that their experiences, knowledge, and skills allow them to contribute meaningfully to the creation of new goods and services.

Role of makerspaces: It is further assumed that makerspaces provide a conducive environment for user innovation, offering access to tools, resources, and communities that foster creativity, experimentation, and knowledge sharing. As such, makerspaces serve as crucial platforms for both the social and technical aspects of innovation, enabling older adults to engage with cutting-edge technologies in a supportive and collaborative environment.

Contribution to active ageing: Another assumption is that participation in makerspaces can contribute to the concept of "active ageing" (WHO, 2002) by offering older individuals an opportunity to participate in productive, fulfilling, and socially connected activities. It is posited that makerspaces help combat social isolation and promote cognitive and emotional well-being through hands-on, meaningful engagement with technology and innovation.

1.7 DEFINITION OF KEY TERMS

User Innovation refers to the development and modification of products, services, or processes by user firms or individuals, who are primarily motivated to find solutions that fulfil their own needs when existing market solutions are inadequate or not available (Von Hippel, 2005). In contrast to producer-led innovation, where companies drive innovation to create commercially viable products for a broad market, user innovators are motivated by personal utility rather than profit, often sharing their innovations freely within communities.

Household Sector Innovation is a form of user innovation which refers to innovation activities undertaken by individuals or groups outside of formal organisations. Von Hippel (2016) highlights that individuals develop novel solutions to meet personal or community needs, which contribute to broader knowledge sharing, open-source development, and grassroots problem-solving.

The **Maker Movement** is a global, grassroots movement that encourages hands-on creativity, innovation, and problem-solving through DIY (do-it-yourself) and DIWO (do-it-with-others) approaches. It is characterised by open sharing of knowledge, collaboration, and the use of digital fabrication tools (Halbinger, 2018).

Makerspaces as physical outlets of the maker movement are community-oriented, collaborative workspaces that provide access to tools, technology, and resources for making, prototyping, and innovation. They play a crucial role in democratising innovation and enabling grassroots technological development, particularly in contexts such as user innovation and household sector innovation (Halbinger, 2018).

Active ageing is a policy framework and concept introduced by the World Health Organization (WHO, 2002), which highlights the importance of older individuals remaining engaged in social, economic, cultural, spiritual, and civic life. It promotes well-being by encouraging lifelong learning, physical activity, social engagement, and autonomy in later life. Active ageing shifts the focus from ageing as a period of decline to one of opportunity, where older individuals contribute to society while maintaining their independence and quality of life.

1.8 RESEARCH QUESTIONS

Research Question 1: How do older people engage in user innovation activities in makerspaces?

Research Question 2: How age-inclusive are makerspaces?

1.9 OUTLINE AND STRUCTURE OF THE REPORT

This report is divided into six chapters, each building on the next to explore how older people engage in user innovation within makerspaces in South Africa and Germany.

Chapter 1 introduced the research topic, outlining its significance, objectives, and research questions. It provides key definitions relevant to the study and explains the rationale for focusing on user innovation among older adults in makerspaces.

Chapter 2 reviews existing literature on user innovation, the maker movement, and active ageing. It explores theoretical frameworks and establishes the conceptual framework for the study.

Chapter 3 details the research design and methodology employed in the study. It discusses the qualitative research approach, the research instruments, and the selection of investigation sites and units. The chapter also addresses data analysis aspects, validity, reliability and limitations of the study, as well as ethical considerations.

Chapter 4 presents the findings from semi-structured interviews, document research and site visits structured according to key themes that emerged from the data. The results highlight older makerspace members' experiences, motivations, challenges, and contributions to household sector innovation.

Chapter 5 is concerned with the analysis of research findings in relation to the literature, theoretical and conceptual frameworks discussed in Chapter 2.

Chapter 6 summarises the key findings and reflects on the study's contributions to research on user innovation and active ageing. It also suggests areas for further exploration.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

Innovation processes have become increasingly more open in many aspects. At the firm level, companies try to actively incorporate knowledge outside of the firm's boundaries to fuel their innovation efforts (Chesbrough, 2006). Democratisation of innovation is ultimately concerned with the diversity of innovation agents, their specific knowledge, skills, capabilities and ability to collaborate. While still much emphasis is given to corporate R&D, as well as the education of the youth and the qualifications of the active workforce, another cohort of potential innovators has been identified: the individual user or consumer of products and services. But even without companies seeking to actively involve their existing or potential customers in product or service developments, individuals embark on innovation journeys themselves for various reasons (Von Hippel, 2016). Among these user innovators, a growing cohort of older individuals at, or nearing the retirement age worldwide should also be considered potential innovation agents.

With regards to the sources of innovation, in the last decades of the 20th century several scholars started investigating alternative innovation models which differed from the then dominant manufacturer- or producer-centred model. Although even Adam Smith already observed innovative behaviour in users in the 18th century (as cited in Bogers et al., 2010), subsequent economic and innovation theory, building on Schumpeter's economic growth theories, established that producer-firms, driven by profit motives and equipped with resources for research and development, are the primary sources of new products and processes (Baldwin & Von Hippel, 2011).

Users of these products and processes played a significant yet secondary role by offering essential feedback to producers (Bogers et al., 2010). However, more recent studies challenge this producer-centric view by emphasising the important contributions that users make to the innovation process. For example, Baldwin and Von Hippel (2011) examine producer-driven innovation compared to other approaches like user innovation and open collaborative models. Their findings suggest that user

and collaborative innovations are increasingly competing with, and could potentially replace, traditional producer-led innovation as the primary force driving innovation across different sectors.

It was found that knowledge as a major input to innovation is distributed and dispersed also outside of companies and in society more generally (Bogers & West, 2012; Chesbrough, 2006). Exogenous technical factors such as sophisticated design tools, low-cost mass-communication and the internet (Chesbrough & Bogers, 2014; Von Hippel & De Jong, 2010) have enabled diverse innovation actors to seize more innovation opportunities, collaborate more efficiently and to challenge the monopoly of "solution information" formerly concentrated in the hand of producers (e.g. effective production and diffusion of innovation) (Baldwin & Von Hippel, 2011; Von Hippel & De Jong, 2010).

The opening of innovation processes in companies as well as the acknowledgement of important alternative innovation actors outside of established organisations contributed to the democratisation of innovation (Von Hippel, 2005). Diverse pools of knowledge were targeted, exchange of ideas was encouraged, and participation barriers were diminished. This obviously was embraced differently by the diverse actors in the innovating sphere, which gave way to two dominant, related, yet significantly different schools of thoughts evolved around the democratisation trend in innovation.

One research stream concentrated on instituting the open innovation paradigm (Chesbrough, 2006) where organisations are collaborating with actors outside their own boundaries to generate, develop and/or diffuse knowledge, ideas, inventions or innovations. This concept is still concerned with organisations as being the drivers and locus of innovation but acknowledges the importance of the use of dispersed knowledge and collaboration as means to optimise innovation efforts.

The other prominent research stream establishes consumers or users of goods and services as innovators and thereby provides an alternative view on the sources of innovation. Eric von Hippel (2005) posits that users, driven by their specific preferences and enabled by accessible technology solutions, engage in innovation by

modifying or creating products and services that they use or intend to use, and which are not readily available “on the market”.

In an era of ageing populations (WHO, 2022), research has focused on the "silver economy", which refers to the economic opportunities and market potential that arise from the needs and choices of older individuals (e.g. Kohlbacher et al., 2014; Lipp & Peine, 2022; OECD, 2014; Van Dullemen, 2006). Older people are recognised not only to constitute a significant consumer demographic but also for their abilities in co-creation and as potential sources of innovation (Peine et al., 2013; Wellner & Herstatt, 2014). This perspective aligns with the concept of active ageing (WHO, 2002), which emphasises the continued participation of older adults in all spheres of life. Rather than being passive receivers of innovation, those older individuals who take agency and engage in creative problem-solving for their specific needs do not only benefit by using the outcomes of their creations but also enrich their sense of autonomy and self-efficacy (Wellner & Herstatt, 2014).

Hereafter, an overview of the research literature relating to user innovation will be provided. Further, prior findings on user innovation in the maker movement will be presented, specifically in makerspaces as a relatively recent form of physical infrastructure for collaborative innovation at the household and community level. Finally, a recap of the literature on active and healthy ageing followed by a brief review on the sparse papers that combine perspectives on innovation with, by and for ageing populations will conclude the literature review. Drawing from the literature review, the final sections of this chapter present the theoretical and conceptual framework for the research project, followed by the research propositions.

2.2 USER INNOVATION

Eric von Hippel, as one of the first scholars to have investigated the user as a source of innovation, presented the user innovation paradigm (Von Hippel, 2005). He proposed that users, often take on a central role in innovation in contrast to the producer-centred innovation model which attributes major innovation to professional profit-oriented corporations. The producer-centred model is ultimately concerned with

commercialisation of innovation and therefore emphasises intellectual property rights as a means to secure competitive advantage in the market. Whereas most users innovate for their personal benefit of using their invention themselves and often choose to share their developments freely with likeminded individuals or communities (Von Hippel, 2005). They alter or develop goods and services that they use or intend to use, with highly specific requirements that are not readily available “on the market”. User innovators often play a vital role in the rise of new industries, where markets are small and uncertain and producers do not enter (yet) because of too few potential users in the field (Shah & Tripsas, 2007; Von Hippel & De Jong 2010). As such, user innovation can be seen as an important complement to producer-led innovation (Von Hippel et al., 2012)

In this context, users can be individual users or end customers as well as organisations which create and use the innovation in their operations but do not directly benefit from selling them (Von Hippel, 2005). They are developing products or services for themselves as lead users that also appeal to users with similar interests which provides a basis for their dissemination among that group of likeminded people or organisations. In fact, most of the earlier studies concerned with empirical research on user innovation was focused on firm user innovators (Von Hippel & De Jong, 2010). Naturally, user innovation at the household level is more complex to capture empirically, yet this field is experiencing more and more scholarly attention lately (e.g. De Jong & Von Hippel, 2022; De Jong et al., 2023).

According to Von Hippel (2005), users are motivated to innovate because of information asymmetries between users on the one hand, who know precisely what they need and how they intend to use certain products and services, and manufacturers on the other hand, who cannot fully anticipate user intentions but possess better solution knowledge and capabilities, e.g. highly professional and specialised design and production equipment. In the producer-centred innovation model, this leads to more generic, “one-size-fits-all” solutions which do not always suit individual user expectations. In the user innovation model, this “sticky knowledge” about own needs and preferences which cannot be easily transferred from the individual user to a producer or custom manufacturer, stays with the user because of different backgrounds and context information (Von Hippel & De Jong, 2010). It

triggers users to find own solutions when their desire to come up with a customised solution is higher than their willingness to compromise on their specific needs by accepting a generic solution (at a higher price). Moreover, most scholars emphasise that user innovation is primarily motivated by the expected benefit of using the custom-made solution. Other non-pecuniary factors especially for individual user innovators include the enjoyment of innovation activity itself (tinkering, do-it-yourself), autonomy in the solution finding process, eagerness to learn and self-develop, participation or affiliation with a certain industry or leisure groups, reputation gains, or a desire to stay up to date with the latest technology trends (Raasch & Von Hippel, 2013; Shah & Tripsas, 2007; Von Hippel, 2005, Von Hippel & De Jong, 2010;)

Raasch and Von Hippel (2013) distinguish between consumer-innovator related behaviour and associated motivations which focus on own use and/or sale of developed innovations, in contrast to process-related benefits that user innovators experience. These benefits include the pure joy of tinkering, problem-solving, do-it-yourself (DIY), staying up to date with latest technologies, an eagerness to learn and self-develop, helping others, as well as reputational gains, among others (Bogers et al., 2010, De Jong et al., 2023; Raasch & Von Hippel, 2013; Von Hippel, 2005).

Von Hippel (2016), as well as De Jong et al. (2023) (in a study conducted about informal innovation at the household level in South Africa) described four innovator types according to their prevalent motivations to innovate: user types are driven by a personal need which they seek to find a solution for, participator types mostly enjoy the process of innovation, helper types are motivated to solve other people's problems and enjoy the innovation process as well, producers/ vendors are mostly commercially orientated.

Researchers observed that especially user innovators at household level oftentimes share their insights freely with other users or communities of interest (Von Hippel, 2005). A well-known and frequently referenced example is open-source software, where the source code is publicly accessible, enabling individuals to examine, alter, and share it freely (Bogers & West, 2012; Von Hippel & De Jong, 2010). But also, physical product innovation by end-users, are regularly observed in research (Von Hippel, 2012) and free revealing is not uncommon, unless a competitive aspect is at

play (such as rivalling athletes innovating in their specialist sport) (Baldwin & Von Hippel, 2011). In fact, free revealing and collaboration with peers in a community is often seen as an advantage by user innovators, as collaborators can contribute by making suggestions for improvement or helping in the diffusion of the innovation (Von Hippel 2005). Other benefits of free revealing include information about alternative uses of a product or service, other user needs, confirmation of the relevance of an invention and reputation gains in a community (Shah & Tripsas, 2007). In contrast to the producer-led model of innovation which focuses on the protection of intellectual property in order to secure (future) profits, Von Hippel & De Jong (2010) state that users oftentimes frame sharing and collaborating on developments as opportunity rather than threat. This, of course, might also be related to the finding that end-user innovators are at least initially focusing on the intended own use of their invention, rather than selling them profitably (Von Hippel & De Jong, 2010).

Wellner and Herstatt (2014) have looked into the motivations and determinants of user innovator behaviour among older users and have found significant potential to innovate among the elderly. While older user innovators tend to innovate primarily in low-tech products, the authors confirmed assumptions of the silver economy theory stating that older user-innovators are motivated to solve age-specific problems. The study also showed that older user innovators produce a number of ideas, yet struggle to execute them, which might hint towards barriers to innovation for this age cohort.

The user innovation paradigm challenges the traditional producer-centred model by highlighting the significant role of individuals in developing new products and solutions. As Von Hippel (2005) and other scholars have shown, user innovators - whether individuals or organisations - create customised solutions based on their specific needs and often share their developments within communities. This aligns with the principles of open innovation, where knowledge flows beyond firm boundaries, enabling collaboration and the exchange of ideas. Nevertheless, user innovation is distinct from “open innovation” and “user-centric innovation”. Originally, open innovation was defined as the intentional exchange of knowledge to boost internal innovation within companies and expand the external use of innovations. It was based on the idea that businesses should capitalize on both internal and external ideas, as well as utilize both internal and external pathways to market in advancing their

technologies (Chesbrough, 2006). A review by Dahlander and Gann (2010) added meaningful details to the concept by presenting four different forms of openness:

1. **Revealing** is associated with outbound innovation without financial reward for the revealing company.
2. **Selling** is the commercial alternative of revealing.
3. **Sourcing** is associated with inbound non-pecuniary activity, i.e. finding "freely" available knowledge and/ or technology outside of the firm.
4. **Acquiring** describes how companies license-in or buy expertise and/or technology from outside.

Additions like these led to a refined and yet more general definition of open innovation, rendering the concept applicable to broader application base and thereby widening its scope (Chesbrough & Bogers, 2014). Open innovation therefore refers to a decentralised approach to innovation that deliberately facilitates the exchange of knowledge across organisational boundaries. It utilises both financial and non-financial mechanisms, in alignment with each organisation's business model. Knowledge flows may enter the organisation - by drawing on external sources and integrating them into internal processes - or exit the organisation - by applying internal expertise through external diffusion. Often, it involves a combination of both, connecting the acquisition of external knowledge with outward knowledge sharing and diffusion activities. (Chesbrough & Bogers, 2014)

As such, user innovation is related to, yet distinct from "user-driven" innovation in open innovation where companies actively seek to involve customers or users of their services and products into their innovation efforts (Von Hippel & De Jong, 2010). Customers and users are one source of external knowledge in the outside-in or inbound approach in open innovation (Chesbrough, 2006). Bogers and West (2012) observed that studies often either concentrate exclusively on user or open innovation, overlooking the other, or conflate the two concepts in ways that compromise conceptual clarity. This study focuses on the user innovation paradigm as introduced by Von Hippel (2005) and specifically, user innovation at household level (De Jong et al., 2021; Von Hippel, 2016).

2.3 MAKER MOVEMENT

The maker movement is a social and cultural phenomenon defined by a community of people involved in hands-on, do-it-yourself (DIY) and cooperative projects that centre around making, tinkering, and creating. It emphasises hands-on learning, creativity, and the use of various tools and technologies. Makerspaces, where individuals can access shared resources and work on projects, are often central to the maker movement, supporting a culture of innovation, skill-sharing, and DIY creativity (Saari et al.; 2021). Makerspaces and fab labs as two categories of maker movement outlets are basically the same, but the latter are recognised as official Fab Lab Network members (Fab9, 2018). The Fab Lab Network was officially launched around 2005 by MIT professor Neil Gershenfeld. Member outlets must use and provide a specific common set of procedures and tools (Van Holm, 2014). A fab lab or makerspace does typically provide traditional tools and workshops with woodworking, metalworking as well as a variety of hand tools complemented by digital infrastructure with computerised numerical control machines (CNC machines), such as laser cutters and 3D printers. A third category of maker facilities are hackerspaces which tend to focus more on IT infrastructure (Fab9, 2018). All three types of workshops are found to share very similar philosophies of open access, shared resources and collaboration. They attract similar kinds of users (makers, tinkerers, innovators, entrepreneurs, activists) and the categories of activities are related (Van Holm, 2014).

Due to the above mentioned characteristics, makerspaces have been analysed and linked to almost all of the above described forms of innovation: user innovation (Halbinger, 2018), open innovation and entrepreneurship in general (Zakoth et al., 2023), as well as open social innovation (Murray et al.; 2010; Saari et al.; 2021; Smith, 2017). Zakoth et al. (2023) focused on an industry-specific makerspace (facilitating photonics making) in Germany. They found that different user types leverage makerspace resources (identified as social, technology, knowledge and financial resources) in different ways. Professional innovators, motivated to commercially exploit their innovation efforts, use the makerspace as a facilitator. They focus on using the facility's technical infrastructure and mostly do not tend to embrace open collaboration. In contrast, hobby users tend to use available makerspace resources more exhaustively and mostly conduct their projects on an open-source basis. They

make extensive use of makerspace resources tailored to their specific needs and use the space as an incubator for their ideas (Zakoth et al., 2023). As such, it could be suggested that the benefits and ideals of makerspaces might be better exploited and valued by non-professional innovators and user-innovators seeking to use makerspace resources for their highly specific individual invention needs.

Saari et al. (2021) identify three kinds of openness in the maker movement:

1. the openness of physical spaces and their infrastructure for members to use and collaborate,
2. the openness to social inclusion and empowerment, and
3. the openness of the process of innovation and entrepreneurship.

They also claim that the physical location of makerspaces has an impact on the actual diversity of its member or user base. Smith (2017) acknowledges that through the sheer amount of maker projects in those spaces and the treasured values of openness and participation, these institutions can deliver towards more diverse social development approaches. He sees makerspaces contributing to innovation democracy and with the potential to advance transformative social innovation. Halbinger (2018) finds that makerspaces improve both opportunities to innovate for user innovators and diffusion of innovation. She attributes those findings to the collaborative nature of interaction in makerspaces (in contrast to “solitary” individual household innovation.)

Furthermore, both countries focused in this research project, South Africa and Germany, exhibit a vibrant and active maker movement (Rosa et al., 2017; De Beer et al., 2017), which supports the choice of makerspaces as the site of investigation for this research project to observe the above mentioned phenomena. The report on makerspaces in South Africa by De Beer et al. (2017) specifically acknowledges the intent of socio-economic inclusion of the majority of the maker communities analysed.

2.4 ACTIVE AND HEALTHY AGEING

Active and healthy ageing is a concept that has gained increasing attention in the fields of gerontology, public health, and social sciences. It refers to "the process of optimising opportunities for health, participation, and security in order to enhance the quality of life as people age" (WHO, 2002). The concept of active ageing was prominently endorsed through the WHO policy framework on active ageing (2002) and the UN launch of the Decade of Healthy Ageing 2021 – 2030 (United Nations, 2022). The active ageing policy framework encompasses three pillars (WHO, 2002):

1. **Health:** Physical and mental well-being are fundamental to active ageing. This pillar includes factors such as access to healthcare, healthy lifestyles, and the management of chronic conditions.
2. **Participation:** Social engagement, inclusion, and active involvement in various aspects of life contribute to active ageing. This pillar encompasses activities such as community involvement, employment opportunities, and continued learning.
3. **Security:** Economic and social security are crucial for ensuring a dignified and fulfilling later life. Financial stability, access to social support, and a safe living environment are essential components of this pillar.

According to the initial WHO (2002) framework, the pillars are influenced by eight active ageing determinants, such as culture, gender, health and social services, behavioural and personal determinants, physical environment, as well as social and economic determinants. The policy makers acknowledged that more research would be necessary to analyse each determinant's impact on the ageing concept, individually and combined. Figure 2 shows a comprehensive diagram of the policy framework.

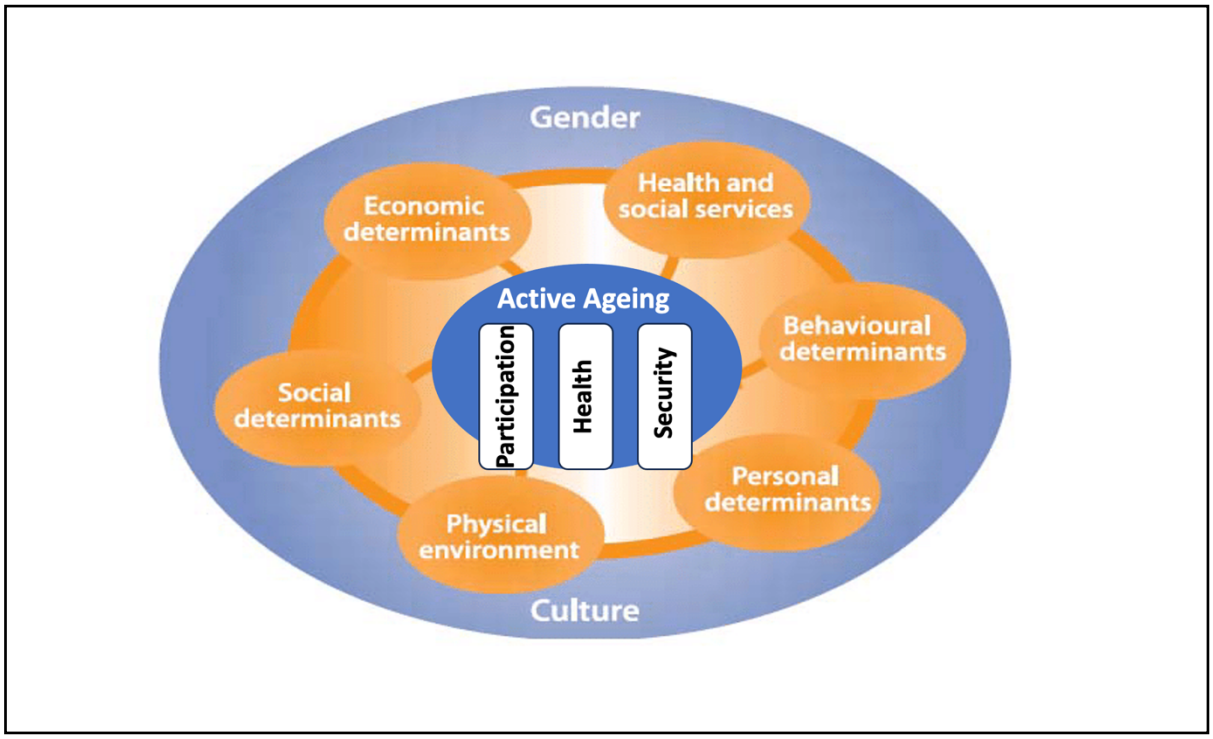

Figure 1. Diagram of the Active Ageing Framework (slightly modified from WHO, 2002). Source: World Health Organization (WHO), (2002). Active Ageing: A Policy Framework. https://extranet.who.int/agefriendlyworld/wp-content/uploads/2014/06/WHO-Active-Ageing-Framework.pdf and own modifications.

The concept of active and healthy ageing which considers a holistic interconnectedness of different aspects of life and emphasises overall wellbeing of older individuals supersedes former approaches to successful or productive ageing, which focused foremost on economic and social contributions of the elderly (Walker, 2002). Nevertheless, the active and healthy ageing participative pillar still emphasises the resourcefulness of senior citizens and encourages contribution and sharing thereof.

Boudiny and Mortelmans (2011) critique the active ageing concept as being too narrowly defined. They advocate for a flexible, life course- and individual context-driven interpretation of active ageing. In other words, they oppose the predetermined categories of active ageing and claim that the individual interpretation of activity is more important for the concept to be sustainable. Paúl et al. (2012) support this view in finding that objective as well as subjective variables contribute to active ageing. Furthermore, Boudiny (2012) points towards possible discrimination of the old-old compared to young-olds who might be able to more holistically embrace activity in

general. To this point, Walker (2008) emphasises the preventative orientation of the concept, i.e. that active ageing does not start when we get old but to recognise the fact that individual behaviour and choices in earlier life may impact our ability to lead a healthy and fulfilling life when we are older.

Karlin and Weil (2016) claim that active ageing cannot be done by older people alone but that it needs intergenerational dialogue and context-specific institutional support. WHO's Global Strategy and Action Plan on Ageing and Health (2017) acknowledges this notion in one of its strategic objectives, namely, enabling older people's engagement in society through greater recognition of their contributions as well as supporting institutions and platforms for engagement. Wysokinska (2014) encourages older citizens to engage in entrepreneurial activities and to share their experiences with younger generations, thereby also strengthening intergenerational ties.

Most of the research on active and healthy ageing cited above originates from Europe. This might stem from the more urgent need of *"the world's oldest region"* (Walker, 2008) to tackle the phenomenon of societal ageing. And indeed, as Walker (2008) reminds us, the very origins of targeted active ageing policies have been adopted by the European Commission. Nonetheless, some scholars also set out to reflect and analyse the concept's adoption and relevance in the African context (Doh & Adusei-Asante, 2016; Karlin & Weil, 2016; Mapoma, 2014; Roux & Viljoen (2018); Van Dullemen, 2006). Their findings show that most determinants of the WHO (2002) Active Ageing framework find application also in Africa. However, some country- or continent-specific contexts, such as residence (urban/ rural), implications of HIV or ever more weakening family ties need to be considered more closely (Mapoma, 2014). Doh and Adusei-Asante (2016) analyse that social interaction is a vital aspect of active ageing in Africa, yet they find this aspect has not been adequately incorporated into the participation pillar of the WHO. Roux and Viljoen (2018) examine the future potential for economic involvement of older age groups in South Africa. Their study shows that prevailing views on ageing in the country are negative (focusing on the deficit perspective on ageing), yet some positive connotations list seniors' experience and wisdom as well as willingness to share as potentially valuable contributions. Equally, Van Dullemen (2006) claims that more recognition of older people's contributions to society and (informal) economy is needed. She adds that older people

in Africa provide valuable repositories for crisis coping mechanisms, alternative technical and health knowledge. Moreover, Karlin and Weil (2016) propose that the marginal attention to ageing and corresponding policy (in contrast to a wide array of youth enabling measures) might pose some challenges to an “unprepared continent.”

2.5 SELECTED PAPERS COMBINING OPEN INNOVATION AND ACTIVE AGEING

In this section a brief selection of papers seeking to combine the perspectives on both research fields, innovation and active ageing, is presented. Due to the scarcity and specialisation of the researched context, these papers are presented as research snippets without cross-references to each other or shared contexts. Peine et al. (2013) identify active consumption patterns in the baby boomer generation in Europe, which is paired with life-experiences and lifestyle choices and thus contradict widely promoted deficit-oriented public opinions about older people. They argue that current design processes for products targeted at the elderly miss out on the co-creational power and tech-emancipation of their target audience. Consequently, they develop the concept of the “innosumer” which assigns an active role to older consumers, stating that their user experiences and technology configurations are valuable inputs for product innovation/ iteration which will lead to more successful and accepted gerontechnology products.

Carucci and Toyama (2019) in an action-based research approach, set up a temporary makerspace in a long-term care facility and found that residents (aged 80 and older) spent significant time in the space and came up with novel items that solved real issues in their daily lives, which also positively influenced both their autonomy and well-being. Smith (2017) cites an example from a Fab Lab in Lima, Peru which features a project that combines digital fabrication methods with traditional indigenous weaving methods contributed by older craftswomen from the communities, resulting in novel products. Saari et al. (2021) report on a special makerspace in the UK, “Men’s Shed”, which targets older men as users to support their mental well-being by providing a sense of community in offering activity around woodworking. Wegner (2011) gives an account of seniors teaming up with designers in a maker project called “Senior Design Zürich.” The seniors contributed almost forgotten traditional knitting patterns to new product

designs. The initiative not only recovered indigenous crafts but also fostered intergenerational collaboration.

2.6 SUMMARY

The user innovation concept is established as an important phenomenon in the innovation research landscape. It focuses on the user or consumer as an active developer of enhanced products and services tailored to their specific needs. User innovators often share those solutions freely with interested communities and likeminded users. The (commercial) dissemination of their inventions is at least initially not necessarily their primary motivation.

Similarly, the open innovation theory has gained numerous scholarly and practical attention and evolved into diversified concepts which find application in new unforeseen areas. Individual user innovations and (small-scale) open innovation attempts are increasingly generated through the maker movement and its' associated physical outlets, such as makerspaces. They provide the infrastructure, collaboration opportunity and are relatively easily accessible for individuals, entrepreneurs and tinkerers to embark on their innovation project journey.

Active and healthy ageing, on the other hand, has been a policy approach towards the phenomenon of ageing populations worldwide which was initiated in the early 2000's by the World Health Organization. It inspired predominantly retroactive research efforts which identify factors that contribute to successful ageing, including inter alia physical and mental well-being, social participation, and continued personal development. A few more recent studies present aspects of combined perspectives on active ageing and innovation. They also highlight the assumed potential of older people's valuable contribution and involvement in user innovation.

2.7 THEORETICAL FRAMEWORK(S)

The theoretical framework for this study draws upon the concept of user innovation (Von Hippel, 2005). This innovation approach describes how users or consumers seek to improve available products and/ or services to their specific needs or set out to invent new solutions which may or may not be commercialised. Oftentimes, these user-innovators, especially at the household-level, share their ideas freely with likeminded peers or in specialised user group communities (Von Hippel & De Jong, 2010). As such, the phenomenon is somehow related to Dahlander and Gann's (2010) "revealing" mode of open innovation (non-pecuniary publication of innovative ideas or concepts). Moreover, the motivation for users to engage in innovation activity in the first place is in many cases triggered by specialised (niche) needs, unavailability of custom-fit solutions, the joy of inventing itself, peer recognition etc. rather than monetary considerations (De Jong et al. 2021; Von Hippel, 2005). Wellner and Herstatt (2014) have examined the motivations and determinants of user innovator behaviour among older users and have found significant potential to innovate among the elderly. While their study focused on caravanning and camping equipment, they confirmed that older user innovators tend to innovate primarily in low-tech products. The authors confirmed assumptions of the silver economy theory stating that older user-innovators are motivated to solve age-specific problems and certify a high rate of idea generation.

In the context of the diffusion of household-sector innovation, Gambardella et al. (2016) establish a beneficial link between individual user-innovation and commercial producers by stating that companies should pay attention to, and leverage user innovation, either through commercialising them or by collaborating to develop them. This aspect was featured in some researchers' accounts of older people's contributions to innovation efforts by third parties (e.g. Peine et al., 2013; Smith, 2017; Wegner, 2011). The user innovation paradigm on household level (Von Hippel & De Jong, 2010, Von Hippel 2016, De Jong et al., 2021) shall be used to guide this research project. The investigated source of innovation are elderly people, a cohort with a rich yet sometimes underestimated resource repository.

2.8 CONCEPTUAL FRAMEWORK

This study draws from user innovation theory and connects to the concept of active ageing by investigating how innovation processes make use and potentially benefit from participation and contributions by older people. The user innovation theory has identified the user and consumer as a major source of innovation (Von Hippel, 2005). It shows how users contribute to innovation by modifying or creating products and services based on their specific needs, emphasising the importanceof open access and knowledge sharing. Von Hippel (2005) distinguished between firm user innovators and individual users. Many early studies in this research stream were focused on firm user innovators or "intermediary users" as termed by Bogers et al. (2010), as they were easier to capture empirically. This category also includes field experts such as scientists and surgeons, for example, all looking to optimise their professional operations by *using* the innovation, thereby maximising utility (Bogers et al. 2010).

More recently, the category of user innovators at the household level is experiencing significant scholarly attention. Individuals from resident households pursue innovation projects in their discretionary time, at their own costs, and for their own needs (Von Hippel, 2016). Oftentimes, they develop, share and disseminate their ideas within specific communities (Bogers et al., 2010), thereby valuing collaboration with other (likeminded) individuals or groups and diversifying the knowledge, skills and experience base of their innovation efforts. As Shah and Tripsas (2007) point out, when communities are made up of diverse people, the innovations they create are more likely to be unique and useful. Even though communities usually come together because they have similar needs, having diversity among their members can improve quality of their ideas. In this context, Wegner (2011), among others, emphasises the resourcefulness of older people and considers them "innovation engines."

Another aspect of the collaborative nature of user innovation is that different actors take on different roles in the process. Von Hippel (2016) describes four different types or roles in user innovation: users, helpers, participators and producers. Users are predominantly motivated to innovate by the prospect of using the developed solution themselves. Producers look to sell their inventions. Helpers are driven by the prospect of finding solutions for others. And participators mostly enjoy the process of innovation

and learning new skills. This classification suggests that individual engagement can range from driving user innovation to contributing to innovation processes. Equally, evidence suggests that older people are acting as user innovators themselves (e.g. Wellner & Herstatt, 2014), but also as contributors to innovation (e.g. Wegner, 2011).

Commercial motives for consumer innovation are discussed controversially in the literature. While user innovation, per definition, stages personal use as the dominant criterion, early studies and articles also acknowledge commercial motives. Raasch and Von Hippel (2013) find that 54% of consumer innovators are motivated by output-related factors, which they subsume as being personal use or potential profit or a combination of both. Shah and Tripsas (2007) identify user entrepreneurs who commercialise their ideas as a result of exposed own use and subsequent demand by other potential users. Von Hippel (2016), as mentioned above, acknowledges the "producer type" among household sector innovators, who are primarily motivated by selling and commercially profiting from their innovation efforts. He carefully distinguishes them from free innovators who are predominantly motivated by self-rewards. Ebbing and Lüthje (2020) establish consumer innovators driven by commercial motives as a hybrid between user innovators and traditional firm innovators. De Jong et al. (2023) find a higher share of vendor type innovators (equals Von Hippel's "producer type") among informal innovators in South Africa than in other countries. According to the above, this study will include commercially oriented innovation at the household level next to user innovation in the narrower sense in its research scope.

In this context, the participatory component of the active ageing policy framework (WHO, 2002) suggests mutual benefits: "activity" for the innovating or contributing senior and additional diversity of knowledge, skills and resources for the innovation effort at hand. While this study does not set out to validate the concept of active and/ or healthy ageing, it aligns with the views indicated in the literature which draw a beneficial perspective on active and participating seniors in society in general (e.g. Lu et al. 2022), and as a potentially valuable source of knowledge and innovation in particular (e.g. Peine et al. 2013; Wellner & Herstatt, 2014). It will thus particularly focus seniors' contributions to user innovation processes but will also pay attention

to the perceived benefits, rewards or barriers to older people's innovation activities.

Makerspaces are recognised as important intermediaries for user innovation and open innovation (Halbinger, 2018; Smith, 2017). Makerspaces provide a physical manifestation for user innovation activities, fostering collaboration, hands-on learning, and creativity. The maker movement in general is characterised by a community of individuals engaging in DIY and collaborative activities. It emphasises openness, inclusiveness and collaboration in creative processes for innovation. Moreover, associated makerspaces are often community-based, locally accessible outlets which allow for both individual as well as collaborative innovation activity and participation. They offer the unique opportunity to investigate user innovation and collaborative innovation projects at the household and community levels.

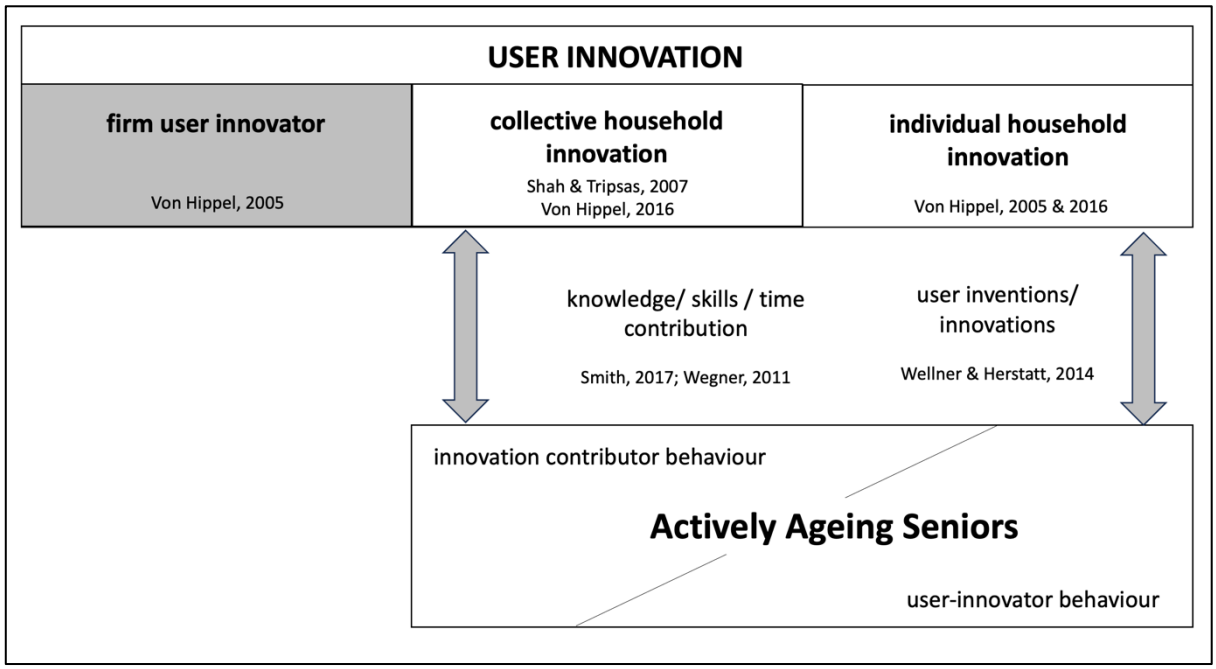

Figure 2. Conceptual framework.

2.9 STATEMENT OF PROPOSITIONS

Research Question 1: How do older people engage in user innovation activities in makerspaces?

Proposition 1

Combining the findings of previous research on older user innovators (Wellner & Herstatt, 2014) and makerspaces as important intermediaries for user innovation and collaborative innovation activities on household level (Halbinger, 2018), it is proposed that elderly people as active members of makerspaces are valuable sources of innovation. Building on the findings of Wellner and Herstadt (2014), Peine et al. (2013), as well as Carucci and Toyama (2019), who are all confirming innovative behaviour in senior citizens, the researcher suggests that older people pursue own user innovation efforts as well as to contribute to other people's innovation projects in makerspaces.

Research Question 2: How age-inclusive are makerspaces?

Proposition 2

Both countries, South Africa and Germany, exhibit a vibrant and active maker movement with a variety of makerspaces (Rosa et al., 2017; De Beer et al., 2017). In addition, Halbinger (2018) confirms makerspaces to be important intermediaries for household sector individual and collaborative innovation as well as their diffusion. Yet, accessibility of makerspaces is an important factor and is restricted for certain types of makerspaces (e.g. commercial makerspaces, tied to institutions or companies restrict access to their employees). Therefore, it is proposed that general purpose, open access, community-based makerspaces (Halbinger, 2018) are equipped to be age-inclusive in their approaches to member acquisition and retention. It remains to be seen, how actively they intend to attract, include and equip older individuals in their spaces.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the research methodology employed in investigating the intersections between user innovation and actively ageing seniors within makerspaces in South Africa and Germany. A constructivist approach is used to delve deeply into questions such as how older individuals perceive the possibility of participating in innovation processes and what factors influence their involvement. It provides an opportunity to explore the significance that older adults attach to their innovation efforts and what personal or social motivations drive them.

By deploying the constructivist approach, it will be discovered how they view their contributions and how their experiences play a role in this context. With regards to user innovation, it is crucial to understand how knowledge and ideas are created and shared within a community. The constructivist approach supports this by emphasising the collaborative nature of innovation processes and showing how older adults contribute to innovation through their own experiences and interactions.

A multiple case study approach is deployed in order to evaluate findings. Given the focus of my studies on innovation within the African context, it is a valuable opportunity to investigate this topic within a society distinguished by its relatively young demographic profile such as South Africa (United Nations, 2019). In contrast, since many years, my home country, Germany, faces growing shares of older populations (Bundesministerium für Arbeit und Soziales, 2024). A qualitative research design, combining document analysis, observation and semi-structured interviews, is chosen to delve deeply into the potential contributions and participation of older individuals in the dynamic innovation environments of makerspaces.

3.2 RESEARCH DESIGN

A qualitative approach was chosen for exploring the multifaceted interactions between user innovation and actively ageing seniors. Given the broad scope of the investigation, a case study research design was employed (Yin, 2018). In search for a suitable opportunity to investigate the phenomena, makerspaces were chosen as accessible outlets for DIY and creative activities. They are recognised as important intermediaries for user innovation (Halbinger, 2018).

Makerspaces emphasise openness, inclusiveness and collaboration in creative processes for innovation. By providing accessible physical, digital and social infrastructure, they attract a variety of different members (Van Holm, 2014) and improve the opportunity to engage in user innovation as well as their diffusion (Halbinger, 2018). In recent years, there has been a notable growth in numbers of makerspaces in both countries, South Africa and Germany (Rosa et al., 2017; De Beer et al., 2017), signifying a growing trend in the establishment and development of these collaborative labs, which provides for a good basis to analyse user innovation among older members and age-inclusivity in these spaces. Two makerspaces, one in South Africa and one in Germany, were chosen for the reasons mentioned above. The findings of both cases were analysed and are presented individually. However, as the two cases offer an opportunity to gain insights from two countries with different socio-economic settings, any resulting context-specific similarities and differences were observed as well.

Employed research instruments included document analysis and site inspections. The focused instrument were semi-structured interviews with members of the makerspaces. A rough scan of the makerspace landscape in South Africa (Gauteng) and Germany (Munich metropolitan area) provided the basis for the selection of two makerspaces as described in further detail below. Document analysis, i.e. website and social media accounts of those makerspaces were studied in order to establish a general overview of their facilities, equipment, and membership structure. Site inspections completed this perspective and offered opportunity to identify potential interview candidates. The main instrument were semi-structured interview guides which informed the discussion with members of the makerspace and explored their

maker activities, any inventive or user innovation activities as well as their motivations to pursue these efforts.

Furthermore, it was established whether those activities were conducted primarily alone or in collaboration with other members. The study focused on members aged 50 and above. However, younger members were also invited to interviews and their potential collaboration with older members was explored. Lastly, reflections on how (actively) makerspaces and their community members seek to engage with potential older members and vice versa were taken into account in order to elaborate on age-inclusivity of those spaces. The detailed selection process for interview candidates is described next.

3.3 SELECTION OF PARTICIPANTS

The study focuses on older individuals actively involved in makerspaces in South Africa and Germany. While there is no universally accepted definition of "older people" in research, the minimum age threshold for studies on user innovation and entrepreneurship in later life is 50 years (e.g. Wellner & Herstatt, 2014; Halvorsen & Morrow-Howell, 2017). This threshold appears reasonable when considering the differing life expectancies in South Africa (61 years) and Germany (82 years) as reported by the WHO (2024). Additionally, the concept of active ageing emphasises that ageing is a continuous process that begins well before retirement. Given that the usual retirement age is 60 in South Africa and 65 in Germany, defining "older people" as those aged 50 and above aligns with both demographic realities and the principles of active ageing.

Two makerspaces, one in Johannesburg (South Africa) and one in Munich (Germany) were selected. The chosen organisations resulted from an initial online screening of the local makerspace landscapes. The focus was on those makerspaces which promote a broad variety of maker activities showcased by the variety of tools, machinery and workshop facilities, as well as accessibility in terms of location and age-diverse membership structures.

Management of the selected makerspaces was approached first in order to obtain permission to conduct research in their organisations. Initial conversations led to establishing an overview of their user base, the facilities and the maker activities conducted in general. Two members of the makerspaces' management teams were invited to enter a semi-structured interview for the study which established general information on the space, the kind of maker activities conducted, with a special focus on cues to user-innovation-related undertakings as well as their views on age-inclusivity of the facility. They were also asked to identify members aged 50+ who could be invited to participate in the study, as well as those members who collaborated with older members in the space. Through interviews with the identified members, further recommendations for possible interview candidates were received. Additionally, users in the makerspaces were approached directly if an indication of their suitability for the study (e.g. age or user innovation related activities) was found.

3.4 RESEARCH TECHNIQUES

The study employs qualitative research techniques looking at the ways, reasons and impact of older people's user innovation efforts in makerspaces and their interactions in the makerspace communities. It has been established that makerspaces by providing accessible physical, digital and social infrastructure, attract a variety of different members (Van Holm, 2014) and improve the opportunity to engage in user innovation (Halbinger, 2018). The focus in the beginning, thus, lay on selecting two eligible makerspaces in both countries, South Africa and Germany, as investigation sites. The combination of document research, site visits and observations as well as semi-structured interviews contributed to a detailed understanding of the interaction between user innovation and active aging in these settings.

Document research, e.g. website and social media representations of the makerspaces were initially employed to identify and profile potential makerspaces in both countries before an initial site visit took place. De Beer et al.'s (2017) paper on the South African maker movement together with internet research provided the basis for the shortlisting of six makerspaces in the Gauteng province of South Africa (see Appendix C.1.1.). For the selection of a potential investigation site in Germany, an

internet search was conducted and resulted in a shortlist of four makerspaces in the Munich metropolitan area (see Appendix C.1.2.). Document analysis, i.e. website and social media accounts of those makerspaces were studied in order to establish a general overview of their facilities, equipment, and membership structure.

For the selection of the makerspaces in both countries, in line with Halbinger's (2018) findings, accessibility of the general public was a major criterion. As such, makerspaces, which are tied to institutions (e.g. universities) and therefore might cater for special audiences (e.g. students), were disregarded for the purpose of this study. The selection process was focusing on general purpose, open access, community-based makerspaces with a variety of facilities, machinery and tools which allow for different activities - digital and traditional crafts - to be conducted in the space. Special attention was given to early signs of age inclusiveness detected in the public online representation of the spaces, e.g. pictures of members and facilitators or owners of the space, which presumably fulfil the age criterion of 50+ or explicit statements about older members etc.

In the Gauteng area in South Africa, "Made in Workshop" in Randburg, Johannesburg was selected as a self-proclaimed innovation and craftsmanship hub (Made In Workshop, n.d.) which naturally blends traditional with modern techniques for making activities. The makerspace attracts a variety of different users from the area with state-of-the-art machinery and workshops as well as training and education facilities for new users and specialists. A specially targeted age profile was not apparent in the initial scan of the website and social media accounts, while a few members and facilitators of workshops at first glance seemed to be 50+ of age.

In the Munich metropolitan area in Germany, a similar makerspace was found with the Munich FabLab e.V. (FabLab München e.V., n.d.). The space offers open access for members to different traditional and digital fabrication tools. It is equally located in a commercial, yet near-residential area in Munich. Additionally, the FabLab actively promotes an age-inclusive membership structure, by engaging with different age groups ("from 5-99", FabLab München e.V., n.d.) who look for a space to embark on do-it-yourself making journeys.

After selecting the two spaces and obtaining consent for research, further on-site observations were conducted in the selected organisations. Furthermore, the founders or board representatives were invited to initial informal conversations which rendered additional information to the space. Together with the makerspace management, members fulfilling the age and / or user innovation characteristics were identified for the study and invited to the interviews. The study was conducted at Made In Workshop in Johannesburg South Africa during May and June of 2024. The corresponding investigation at FabLab Munich Germany took place in November and December of 2024. The research instruments will briefly be explained next.

3.4.1 Research Instruments

Three different instruments were designed to offer a thorough, qualitative insight into the roles and contributions of older adults in user innovation within the makerspaces studied. The focus was on semi-structured interviews with interview guides for older (aged 50+) and younger makerspace members, as well as makerspace managers to explore user innovation, intergenerational collaboration and age inclusivity in makerspaces.

3.4.1.1 Document Analysis

Document analysis was conducted through the examination of the makerspaces' websites and social media accounts. It enabled an assessment of the makerspaces' public representation, outreach, and any specific efforts to engage older individuals in innovation. By analysing makerspace websites and social media accounts, the study identified how these spaces engage with and support older members.

The website analysis focused on key elements such as mission statements, target audience, membership costs (including discounts for seniors and retirees). Additionally, projects, events, user testimonials, and visual content was assessed with focus on any presence and participation of older individuals. The social media analysis examined platform engagement through community interactions, hashtags, and promotional efforts related to involvement of older people. Visual content was analysed to determine the representation of older individuals in makerspace activities.

3.4.1.2 Semi-structured Interviews

Through semi-structured interviews with makerspace members, the involvement of older adults (50+) in user innovation within makerspaces was explored, focusing on their roles, motivations, and contributions. They also included questions on age inclusivity of makerspaces and intergenerational collaboration between younger and older members (18–50 years). The interview guide templates are attached in Appendix B.

The interviews were designed to analyse the kind of maker activities which were conducted in the space as well as to establish whether any user innovation activities were pursued - either alone or in collaboration with other members. This allowed for a detailed understanding of the ways in which older members conduct or contribute to user innovation in makerspaces. If interviewees fulfilled the age criterion of 50+, the interview questions additionally aimed at analysing the perceived motivations and benefits which caused the individuals to engage in maker activities (active ageing aspect). If the interviewed members were younger than 50, specific questions established whether any collaboration took place with older members in the space and if so, for what reasons. This allowed for an investigation as to whether those individuals profited from older members' advice or knowledge in their innovation efforts, i.e. innovation contributor behaviour in those older members. Also, at least two makerspace management members were formally interviewed and encouraged to propose relevant members and contributors worth including in the study.

3.4.1.3 Site Visits, Observation

Adding to the insights from document analysis and the interviews which were all conducted on-site, additional observations during these site visits were used to complete the study by documenting the physical environment, community interactions, and activities within the makerspaces, providing a contextual understanding of user innovation and age inclusivity. Informal conversations with members provided additional context on activities, senior engagement, barriers, and opportunities for improvement. Visual documentation, such as photographs, completed the assessment.

3.5 DATA ANALYSIS

The data analysis involved a comprehensive examination of information gathered through document research, site visits, and semi-structured interviews. Initially, an analysis of the online representations of makerspaces was conducted, such as websites and social media accounts, to profile the two case studies in both countries. This documentation phase established a foundational understanding of the selected makerspaces and analysed e.g. their promoted activities, member base, physical location, infrastructure etc. Subsequently, site visits to the physical premises provided a direct observation of the environment and interactions within these spaces, contributing to a more nuanced comprehension.

Semi-structured interviews with makerspace members and managers constituted the core data source. These interviews aimed at capturing diverse perspectives on the ways, motivations, and impact of older people's involvement in user innovation within makerspaces. The qualitative data collected from these interviews was systematically analysed. The raw data captured through notes and audio recordings of the interview sessions was revisited multiple times, systematically organising key insights in an excel table to maintain a clear overview and to distinguish between the perspectives of the different members. This allowed for the identification of common themes while also highlighting contrasting viewpoints. The different interview partners offered valuable multi-perspective insights into user innovation by older individuals within the makerspaces. This approach along with the triangulation of data sources (document research, site visits and semi-structured interviews) provided both depth and nuance, enhancing the reliability of the analysis.

3.6 LIMITATIONS OF THE STUDY

The study's focus on user innovation within makerspaces presents both opportunities and limitations. By selecting makerspaces as the research environment, the study highlights these spaces as crucial intermediaries for user innovation, also accessible for older individuals. However, they attract a special group of people who are already interested in technology. Because of this, the results may not be applicable to older

individuals in general, especially those who are not familiar with new technologies or aware of the existence of makerspaces.

One limitation was the small number of participants - only 19 people from two makerspaces, one in Johannesburg, South Africa, and one in Munich, Germany. Each makerspace has its own unique culture and focus, which affects the results. This means that the findings may not apply to other makerspaces or older adults in different locations. Additionally, because the two makerspaces have different areas of focus, different organisational set-ups and are settled within different socioeconomic contexts, direct comparisons between them are not entirely valid.

The study also faced potential biases inherent in qualitative research. Social desirability bias may have influenced participants' responses, as they might have presented their activities in a way they perceived as more socially acceptable or aligned with the intended goals of the study. Additionally, several participants were only at the initial phases of their inventive or innovative efforts, which made it challenging to evaluate tangible innovation results during the data collection period. A follow-up study conducted after several months could provide deeper insights into the actual impact and progression of these activities.

The timing of the study was another limitation. The research was done over six weeks, and only people who were present and willing to participate during that time were included. This means the study may not fully reflect all innovation activities in these makerspaces. Recognising and addressing these constraints where possible and acknowledging them in the discussion contributed to a more balanced interpretation of the results of this study.

3.7 ETHICAL CONSIDERATIONS

In conducting this research on user innovation activities in makerspaces involving older individuals, careful attention was dedicated to a comprehensive set of ethical considerations to safeguard the well-being, rights, and privacy of the participants. Informed consent was sought from all participants, emphasising the voluntary nature

of their involvement and ensuring their autonomy to withdraw at any point. Confidentiality was rigorously upheld, utilising pseudonyms and securely handling data to protect participants' identities. Privacy concerns related to data collected from makerspaces and innovation projects in particular were addressed diligently, emphasising the importance of respecting and protecting intellectual property, cultural differences and promoting inclusivity. Transparent communication was maintained throughout the research process, ensuring makerspace communities were fully aware of the study's objectives and potential implications. The principle of minimising harm guided all research procedures, and secure data storage and transmission practices were implemented to safeguard participants' information. The research adhered to inclusive recruitment practices, striving for equitable representation and avoiding any form of discrimination. This research project was from the beginning committed to upholding the highest ethical standards, seeking approval from the HREC (non-medical) ethics review board at the University of the Witwatersrand before commencement to ensure the ethical integrity of the study.

3.8 RELIABILITY AND VALIDITY

This research demonstrates rigor and competence through adherence to key qualitative research principles, including systematic data collection, thorough thematic analysis, and methodological transparency. The selection of makerspaces in two distinct countries enhances the study's transferability. By providing detailed descriptions of the chosen makerspaces and their online representations, future researchers may evaluate how relevant the findings are to different settings or situations. Thorough documentation of the research process - including document analysis, site visits, and interviews - enhances the study's potential to be applied in other contexts. The credibility of the research is strengthened by the use of multiple data sources. Document research, site visits, and semi-structured interviews offered a triangulation of perspectives, enriching the overall understanding of older individuals' contributions to user innovation in makerspaces. Additionally, the establishment of an age-profile criterion for participants adds specificity and credibility to the selection process. Confirmability of the research was addressed by employing a reflexive approach. The researcher's reflexivity, acknowledging personal biases and potential

influence on the study, enhances transparency. Moreover, the use of clear criteria for participant selection and the systematic analysis of data contribute to the confirmability of the findings.

3.9. SUMMARY OF RESEARCH STRATEGY AND METHODOLOGY

This chapter has outlined the research methodology adopted for investigating the relationship between user innovation and actively ageing seniors within makerspaces in South Africa and Germany. A qualitative research approach was employed, utilising a case study design to explore the experiences and contributions of older makerspace members in both countries. The study was guided by a constructivist perspective, allowing for an in-depth examination of how older individuals perceive their participation in innovation processes and the factors influencing their engagement.

Makerspaces were chosen as the research setting due to their accessibility and role as intermediaries for user innovation. Two makerspaces, one in Johannesburg and one in Munich, were selected based on criteria such as accessibility, diversity of maker activities, and potential age inclusivity. A combination of document analysis, site inspections, and semi-structured interviews was used to gather data. Management representatives provided insights into makerspace operations and age diversity, while makerspace members, both aged 50+ and younger, were interviewed to understand their engagement in user innovation and intergenerational collaboration.

The study followed a systematic data collection and analysis process, with thematic analysis employed to identify key patterns and themes across the data. Ethical considerations were carefully addressed, ensuring informed consent, confidentiality, and sensitivity to intellectual property concerns. Although the study offers valuable insights into the intersection of ageing and innovation in makerspaces, limitations such as participant selection, timing and potential biases were acknowledged.

CHAPTER 4: PRESENTATION OF RESULTS

4.1. OVERVIEW

This chapter presents the data gathered through document research, site visits, and semi-structured interviews for the study. It begins with an overview of the two selected makerspaces in South Africa and Germany, examining their key characteristics, including promoted activities, member demographics, physical location, and available infrastructure. This foundational analysis provides context for understanding the environment in which user innovation evolves in these spaces.

The chapter then delves into an in-depth analysis of interview findings, capturing diverse perspectives on the ways in which older individuals (50+) engage in user innovation within makerspaces, their motivations, and the impact of their involvement. A second aspect explored is the age-inclusiveness of makerspaces, assessing whether and how these spaces facilitate participation for older individuals. These insights are integrated with findings from document research, site visits, and interviews to offer a thorough understanding of the role of older makers in user innovation processes in makerspaces.

4.1.1 Brief Introduction

Makerspaces were selected as investigation sites due to their role as accessible hubs for DIY and creative activities, supporting user innovation and knowledge exchange. Two makerspaces, one in South Africa and one in Germany, were chosen to explore these dynamics. The research employed multiple methods to establish a comprehensive understanding of these spaces. Document analysis of websites and social media accounts provided insights into their facilities, equipment, and membership structures, while site visits further contextualised these findings and facilitated the identification of (further) interview participants. The primary research tool was semi-structured interviews with makerspace members, focusing on their maker activities, innovative efforts, motivations, and collaboration patterns.

Findings reveal that makerspaces facilitate user innovation, with older individuals engaging in inventive projects driven by both personal and practical needs, as well as

creative experimentation. Their innovations often combine traditional craftsmanship with modern digital tools, resulting in customised solutions. While some members work independently, collaboration and knowledge exchange within the community are also important factors.

4.1.2 Background Profile of Respondents and Process Followed

At MIW in Johannesburg, South Africa, seven male respondents participated, with three aged 50 or older and four under 50. Six of the seven were self-employed, and none were retired, though two were above the average retirement age of 60 years. The majority used the makerspace for business purposes, either as an extension of their own workshops (e.g., for access to CNC machinery) or to develop business ideas, while two participants were hobbyists engaged in non-commercial projects. Most respondents cited business aspirations, skill development, and access to specialised equipment as their primary motivations for joining MIW.

At FLM in Munich, Germany, eight male respondents were interviewed, with six aged 50+ (including five over 60) and two younger participants. In contrast to MIW, all participants were hobbyists using the space for non-commercial activities. In both spaces, motivations for joining revolved around a passion for crafts and making, access to specialised machinery, skill development, and the social aspects of engaging with like-minded individuals. Potential participants were either suggested by makerspace management or identified within the makerspaces and approached for interviews. Those respondents tagged 50+ in Appendix C.2. did not reveal their actual age but confirmed that they are over 50 or over 60 years old.

4.2. PRESENTATION OF FINDINGS AND DATA RESULTS

In this section, data results based on document research, site visits, and interviews are being presented. It first provides an overview of the two selected makerspaces. Afterwards, interview results are presented, focusing on how makerspace members and especially those older individuals aged 50 and above engage in user innovation efforts, their motivations, and mode of participation. Additionally, it examines the age-inclusiveness of makerspaces, integrating insights from all data sources to understand the role of older makers in these environments.

4.2.1 Overview Makerspaces

The overview of the makerspaces was mainly derived from the interviews with management members. Additional information was gathered by document research (through the analysis of the makerspaces' websites and social media accounts, see Appendix C.3.), and observations (i.e. during site visits, see Appendix C.4.).

The interviews with managers, founders or board representatives of the makerspaces were focused on getting an overview of the makerspace, including its mission, main activities and membership structure. Additionally, they helped in identifying potential interview candidates from the membership base. The interview guide and questions for this group (see Appendix B.3.) therefore differed to some extent from interviews with makerspace members (see Appendices B.1. & B.2.), and answers were not given from a maker perspective but from an observer's perspective. For ease of reference, this group will hereinafter be referred to as "management members", although organisational structures in both makerspaces differ. Two management members per makerspace were interviewed. Those interviews yielded insights on the initial establishment of the makerspaces, typical activities in the space, organisational aspects, their membership structure, and perceived collaboration patterns between members in general and contributions of older members (50+) in particular.

Questions 6 and 7 in management member interviews were focused on identifying potential interview candidates. They were asked to provide names of members who could be approached with an interview invitation. To ensure anonymity of participants in line with the ethics clearance obtained for this research project, answers to those

questions are not presented in the results overview in Appendix C.2.3. Furthermore, management members all gave their written consent to be identifiable in this report.

4.2.1.1 Overview of Made In Workshop, Johannesburg, South Africa

At Made In Workshop (MIW), interviews were conducted with the CEO and founder of MIW, Henry Levine, as well as with Joshua Lotter, the COO of MIW. Henry describes MIW as “an open-access workshop and shared fabrication studio” aimed at individuals or businesses looking to manufacture or prototype products. The space offers industrial tools and equipment for manufacturing and prototyping, inspired by makerspaces in the U.S., but tailored to meet South African requirements. Organised as a "corporate makerspace," it operates as a for-profit organisation and differs from traditional makerspaces by not having shared management or democratic decision-making structures.

The makerspace offers a comprehensive range of areas and equipment for fabrication and creativity, including metalworking, engineering, woodworking, CNC machining, and welding, with advanced tools like 3-axis CNC machining centres, CNC plasma cutters, lathes, tube bending machines, and a CO2 laser cutter. It also features a dedicated paint shop, 3D printers, as well as a café, community area, offices, and course rooms (see Appendix C.4.1.).

MIW management members do not track specific membership counts, but the makerspace has roughly 300-400 active and inactive users. A key performance metric used is the number of unique visits per day, which typically ranges from 20 to 25. These visits are tracked through a machine booking system available on the website. The makerspace's WhatsApp group has around 136 members, with approximately 100 of them being active (returning members). According to Joshua, the most popular membership plan is the 15-day access package. The primary target groups are small manufacturing companies and individuals interested in prototyping or product manufacturing. There are also some regional and larger corporations that outsource their manufacturing needs to the makerspace. A few resident companies also rent additional office space at the makerspace. The group of hobbyists, i.e. those members using the space for private projects, is representing the smallest participant group. Henry noted that:

> “Hobbyists are usually people who have a day job […] and they are doing it as a hobby. We found when we tried to cater for them exclusively, it was just not sustainable. They are not a sustainable market for a corporate makerspace.”

Nevertheless, MIW caters to a broad age range, from teenagers to individuals in their 60s and 70s. According to Henry, approximately 5% of participants are over 50 years old. An interesting feature is that MIW hosts regular meetings of the Woodworkers Association of the Witwatersrand (WWA). While WWA members are not individual members of the makerspace, they can use the woodworking facilities. Most WWA members are over 50 years old.

As MIW is primarily focused on small business owners and professional makers, it offers different membership packages to suit varying needs (Made In Workshop, n.d.). The monthly membership ranges from R8,358 to R10,999, providing access for up to three individuals tied to the package. There is also a 15-day package for individuals over two months for R4,992 and a three-day package valid for one month priced at R1,507. First-time members are required to pay a joining fee of R499. All memberships include unlimited access to the tools and machines available at MIW.

Collaboration between members is stated to occur frequently in the space, although not always specifically between younger and older members. Henry mentions that MIW does not trigger initiatives for more collaboration among members. In his own words:

> “We let them happen naturally. […] The person who is asking for the help must be big enough to say ‘I need help.’[…] When it is natural, it works. When you force it, it never works.”

When collaboration does take place, it often involves dynamic problem-solving, where members share their knowledge and expertise to address challenges. Both managers state that older members bring unique skills and experiences to MIW, particularly in the use of conventional tools and machinery. They contribute by sharing their knowledge gained from their profession or past experience. Henry mentions that those older members who have transitioned to newer technologies, such as CNC machines,

are most valuable sources of advice as they are combining traditional craftsmanship with modern advancements. Some older members offer classes to pass on their skills.

4.2.1.2 Overview of FabLab Munich e.V., Munich, Germany

At FabLab Munich (FLM), interviews were conducted with the founders and board members Birgit and Andreas Kahler. They founded the lab in 2010, inspired by developments in 3D printing, open hardware, and self-replicating machinery. Andreas recalls how he first became aware of the Fab Lab movement and wanted to join one. In his own words:

> "Unfortunately, there wasn't a FabLab in Munich. Then I found a few like-minded people, and we said: let's start an association and see what comes of it."

As one of the first Fab Labs in Germany, FLM is now entering its 15th year of existence. They focus on three main areas: open workshop with a membership base, educational initiatives, and research projects. The workshop area is inspired by the idea of collective making, where members can engage in creative projects and digital fabrication. It provides cutting-edge equipment for metalworking, woodworking, 3D printing, electronics, IT, as well as a community and storage area for members (see Appendix C.4.2.). Key machines include high-powered laser cutters, multiple 3D printers, CNC machines, a range of electronics tools (soldering stations, oscilloscopes, and microscopes), as well as specialised equipment like the FabMX metal 3D printer, vinyl cutters, embroidery machines, and even a dental vacuum forming machine (FabLab München e.V., n.d.). Additionally, the educational area is equipped with PCs, tablets, robotics kits, 3D printers, and interactive tools to support school programs and hands-on learning experiences (FabLab München e.V., n.d.).

FLM managers count approximately 380 members. The lab has a highly active community, with around 100 members regularly attending at least once a month. They do not focus on a special target group. Andreas said:

> “Basically, we want to give anyone who's interested in DIY and digital production the opportunity to put that into practice. That includes people of all ages, from different backgrounds – all sorts of people.”

Most of the members are between 25 and 35 years old, but age-inclusiveness is already promoted on the FLM website: “education for all, from 5 to 99+” (FabLab München e.V., n.d.). They are welcoming everyone from hobbyists to professionals in their open membership workshop. Their educational programs have a special focus on reaching schools and students from disadvantaged backgrounds.

Birgit and Andreas report that collaboration between younger and older members of the makerspace occurs naturally, on a daily basis. Older members, often retirees, use their additional time to work on personal projects, learn new skills, and socialise, contributing a wealth of experience to the community. Older members are more accessible for advice giving and hands-on support, with some even facilitating classes in the past, though the success of these sessions varied. Examples of successful collaboration include the development of an access system for machinery and open hardware windows, where both age groups contributed their unique perspectives and expertise. The founders recognised the wealth of knowledge and expertise across different fields among their members. Birgit said:

> "You will hardly find a topic that someone in the association doesn’t know something about."

The makerspace operates as an "eingetragener Verein" (registered association), a non-profit organisation, which attracts a wide range of members through its flexible membership scheme. Members pay a monthly fee ranging from EUR 10 to 28 (roughly R200 - R550) with an additional joining fee of EUR 50-100 (roughly R1000 - R2000). Discounted rates for retirees are available. Tool access is granted based on individual qualifications for each machine. The community is actively engaged through regular events, including weekly member meet-ups and annual gatherings like the Christmas party, fostering a sense of connection and collaboration among members.

Name	Location	Est.	area in sqm	Facilities / selected equipment (overview)	Members
Made In Workshop	Randburg, Johannesburg, South Africa	2017	1100	metalworking, engineering, woodworking, welding, paint shop, café, community area, offices, and course rooms advanced tools, e.g. 3-axis CNC machining centres, CNC plasma cutters, lathes, tube bending machines, CO2 laser cutter, 3D printers	no membership counts, approx. 20-25 unique visits per day
FabLab München e.V.	Munich, Germany	2010	500	member area with metalworking, woodworking, 3D printing, electronics, IT, community and storage area advanced tools, e.g. high-powered laser cutters, 3D printers, FabMX metal 3D printer, CNC machines, electronics tools, vinyl cutters education area with PCs, tablets, robotics kits, 3D printers, laser cutters	approx. 380 members

Table 1. Overview Investigated Makerspaces.

Sources: Interviews with Management Members (see Appendix C.2.3.), Websites (FabLab München e.V., n.d.; Made In Workshop, n.d.), Site Inspections (see Appendix C.4.).

4.2.2 Results pertaining to Research Proposition 1

The following section presents findings related to the first research proposition: that older makerspace members serve as valuable sources of innovation. The study explored how older individuals actively engage in user innovation, both by developing their own inventive solutions and by contributing their expertise to the projects of fellow makers. The investigation revealed the diverse ways in which older members apply their skills, experience, and creativity to problem-solving and collaborative making. Table 2 presents an overview of the interview participants (excluding management members) across both makerspaces.

	Total number of respondents	**Number of respondents aged under 50**	**Number of respondents aged 50+ (thereof aged 60+)**	**Total number of respondents engaging in some form of inventive / innovative activity (thereof respondents aged 50+)**
Made In Workshop	7	4	3 (2)	5 (3)
FabLab Munich	8	2	6 (5)	6 (4)

Table 2. Overview Interview Participants (excl. Management Members).

4.2.2.1 Results from Made In Workshop, Johannesburg, South Africa

At MIW, interview participants engaged in a diverse range of activities, including carpentry and furniture making, metalworking and manufacturing, engineering and custom fabrication. All respondents actively engaged in their own projects rather than solely assisting others. Some were involved in external collaborations (outside of the makerspace), particularly in specialised trades. The majority is focused on business activities, which reflects the type of members MIW attracts: small businesses, which use the makerspace for their manufacturing activities due to limited own workshop capacities or their lack of modern manufacturing equipment (e.g. CNC machinery). Nevertheless, several participants also engaged in inventive or user innovative activities, e.g. by designing furniture, tools, and mechanical devices tailored to their specific needs, rather than replicating existing models. The motivations for these activities vary from commercial intent to hobby usage and fun.

Out of the seven members interviewed, all seven reported on some form of activity where they created something new which was useful to themselves or others, three of them are in the age range of 50+, of which two were 60 years and older. Most of these user activities were motivated by own use, fun, learning and helping others. Two older respondents mentioned commercial intent aimed at monetising the outcome of their activities.

Younger members of MIW engaged in activities such as customisation, material experimentation, and functional design improvements. One respondent utilised YouTube tutorials to develop personalised furniture and household items, tailoring solutions to their specific needs. Another experimented with different materials and balance techniques to create unique metal spinners that deviated from standard designs, and which he used in his free time. A third respondent designed a one-of-a-kind foldable whiskey smoker, focusing on both aesthetics and functionality.

The three participants aged 50+ were equally motivated to engage in inventive activity. Participant ZA03, aged 73, only recently joined MIW. He initiated a sand-pattern casting project aimed at producing small-scale conveyor belt links. Recognising a gap in the market due to the reluctance of large foundries to manufacture small, specialised parts, he saw business potential in localised, small-batch production. He was motivated by the need to establish a business and generate income. He initially looked for a workshop space due to the downsizing of his family home and intended to use the makerspace to complement his own small workshop. Access to advanced machines was a key factor in his decision to join, although he initially expected more structured training and collaboration among fellow members. With respect to MIW, ZA03 noticed that:

> “It is much more production-oriented than what you find in a classic description of a makerspace, so with that you have got production deadlines and pressures impacting what is here. […] I am still going through quite a steep learning curve of understanding of what I can do and cannot do.”

Training opportunities were limited for him, as management was focused on running the facility, and other members had time constraints due to their own business

commitments. Despite these challenges, he remained committed to developing his project, leveraging the makerspace's resources to refine project activities. In addition to sand casting, he also focused on building a vertical CNC mill customised to fit his narrow garage. While outcomes of both activities are still pending, it is a very valid example of an older makerspace member who leverages his own skill base and adds new competences acquired in the makerspace environment for inventive activity.

Participant ZA08, aged 50+ (in his late 60s, according to other makerspace members), engages in woodworking activities at MIW. His own business focuses on furniture production. He recently planned to design and produce a specialised gaming table in collaboration with his son, with the goal of commercialising the product. This project blended a personal interest (of his son) with an entrepreneurial intent to commercialise the outcome. In addition to this initiative, he pursued other projects purely for private use, including unique light fittings and special doorways designed for humans to enter but keep dogs outside or inside a room, which according to respondent ZA08 were entirely original, not inspired by existing models, new and beneficial to himself. He also developed customised hand tools, such as planes and drum sanders, which he uses in his business operations. Apart from those, he does not intend to share his "private" inventions with others. Although he frequently provides general help on woodworking to other makerspace members, he would assess their motivation. In his words:

> "If you came to me and said, 'How do I make this?' and I would say if I know that you would only be doing it for yourself, 'I will help you.' If you say 'I need to make 10.000 of it', I would say 'Well, then you have got to pay me for my time.'"

Participant ZA09 is a teacher and bookstore owner by profession. He initially joined the makerspace to gain access to specialised machinery, particularly CNC equipment. To facilitate his use of the machines, he took on the role of an instructor, exchanging his expertise for free machine time. His first project involved moulding for a child safety seat invention, but this initiative was discontinued due to funding constraints. Currently, he is working on developing a specialised self-moving turntable arm inspired by a DIY online forum challenge. His design aims to eliminate friction caused by conventional turntable arms, allowing the stylus to follow the original record groove with greater

precision. He does not aim to commercialise the result but took on the challenge out of self-interest and joy for tinkering. In his words:

> “It is more like a hobby, something I wanted for myself.”

In addition to this, he created a customised foldable braai (barbecue) stand for his home use, which has been adopted by several of his friends. The braai stand also served as a training object in one of his classes at MIW.

4.2.2.2 Results from FabLab Munich e.V., Munich, Germany

Users at FLM also engage in diverse activities, including repair work, customised solutions, and participation in open hardware projects. Many focus on digital fabrication techniques like laser cutting, 3D printing, and plasma cutting. Projects range from home appliance modifications and spare part production to customised tools and furniture. Some members fabricate toys or give-aways for special communities, friends and families. Others focus on niche technical projects, like building specialised scientific equipment.

Most members use FLM facilities primarily for private recreational activities rather than for business purposes. Users pursue activities at the makerspace for various personal and creative reasons. Many enjoy tinkering, crafting, and making things, seeing it as an opportunity to channel their creativity and experiment with new technologies. Some are motivated by their own needs, whether for customised solutions or personal projects. Keeping up with technology trends and acquiring new skills are also key drivers, as members seek to expand their knowledge and stay engaged with evolving tools and techniques. Beyond personal interests, some members contribute to special FLM community projects and find it rewarding to give back to the FLM association. For many, the space serves as a way to keep busy, use their skills for hobbies, and simply find enjoyment in the process of making.

At FLM, from the eight members interviewed, six were in the age range of 50+, of which five were 60 and older. The two younger members reported on some form of collaboration with older members and were also suggested as interview partners for those reasons. Most respondents mentioned activities where they created something

new which was useful to themselves or others. One of the younger respondents, DE07, focuses on advanced technical projects, including a customised wire chamber and a customised scanning tunnelling microscope. His work sometimes benefits from the expertise of older makerspace members. DE07 recalls:

> “For example, how to work with that milling machine. [DE04] helped me a lot with that. In hindsight, you think: 'Well, of course, it’s obvious,' but on my own, I would have struggled with it for days.”

He also acknowledged that much of this specialised hands-on experience from older individuals cannot be found online (“cannot be googled”) but must be passed down through direct collaboration. The other younger respondent was engaged in designing the access management system to tools, machinery and facilities at FLM. While the project was generally a collaboration among volunteering members, one older member (DE05), as a seasoned electronics specialist, provided crucial input to the project which added to the security of the system. From the six older respondents (aged 50+), three reported on own activities while at least two contributed their knowledge and experience to other projects (as mentioned above).

Respondent DE02 (aged 61), reported on a customised version of an IKEA-inspired wall hook system as well as a customised tool cabinet from old bedside tables which he came up with. At the moment, he is working on a customised soldering aid ("third hand") based on a push-puppet-mechanism, inspired by discontent with market-available soldering aids. His activities cover a wide array of technologies and fields of interests. He stated that he is driven by both personal necessity and a deep enjoyment of tinkering. In his words:

> “I am a jack of all trades, master of none.”

When asked about diffusion opportunities or commercialisation of his inventions, participant DE02 acknowledges the potential of some of his creations but admits to lacking the entrepreneurial mindset required to pursue commercialisation. Additionally, he enjoys contributing to FLM open hardware projects, such as “eWindow” - an open hardware project initiated by a Fab Lab community in Italy. He

appreciates the sense of fulfilment that comes from contributing to the broader makerspace community while simultaneously enhancing his own knowledge and skills.

Another respondent, DE04, built a customised motorbike lifter to facilitate repair work and custom fittings to his bike. He developed the idea for the lifter since both did not find a ready-made solution on the market that fulfilled their needs and fitted to their motorbikes. Another project he reported on is a bespoke balcony railing, which he initially intended to share with the open hardware community but found it too complex to follow through. DE04 recalls:

> "The only thing I've ever considered is whether I should make that railing – I even made some drawings for it – available as open hardware. But I think it's too complicated."

A retired specialist in metalworking, DE04 uses FLM facilities to create unique, often unavailable or costly items. With more time since retirement, he appreciates the makerspace as a well-equipped environment to continue his craft and collaborate with fellow makers. DE04 even donated a range of tools and machines from his own workshop to FLM.

Nearing retirement but still working as a carpenter, respondent DE06 initially joined the makerspace to learn about and make use of its laser cutters. One of his most complex projects was a unique, intricately designed knight's castle for his grandson. With no commercial intent, he enjoys creating for himself, developing various toys and decorative objects for friends and family while experimenting with different materials. In addition to his personal projects, he actively contributes to the makerspace by designing safety tools for carpentry work, sharing his expertise on safe machinery handling, and building workbenches for the wood workshop. While he primarily focuses on his own work, he is always willing to assist others and support the community. As mentioned above, DE06 has become the primary expert on laser cutting at FLM and is frequently consulted also by younger members around the technology. Additionally, DE06 together with four other respondents aged 50 and

above actively contribute to FLM's maintenance team, taking responsibility for repairing tools and machines, as well as ensuring cleanliness and organisation.

The results from the interviews with participants in both makerspaces, MIW and FLM, indicate that older people could be a source of user innovation. An overview of the activities and projects conducted by the older participants is presented in Table 3. It also states whether the participants use the outcomes of their projects themselves.

	Participant number	**Activity / project**	**Own use of outcome?**
MIW	ZA03	Sand pattern casting project	no (intended commercialisation)
		Vertical custom-fit CNC mill	yes (intended use)
	ZA08	Customized gaming table	no (intended commercialisation)
		Unique light fittings	yes (in use)
		Unique dog doorway	yes (in use)
		Woodworking hand tools	yes (in use)
	ZA09	Self-moving turntable arm	yes (intended use)
		Foldable braai stand	yes (in use)
FLM	DE02	Customised wall hook system	yes (in use)
		Customised soldering aid	yes (intended use)
	DE04	Customized motorbike lifter	yes (in use)
		Bespoke balcony railing	yes (in use)
	DE05	Contribution to FLM access management system	yes (in use)
	DE06	Bespoke knights castle	yes (in use by grand son)

Table 3. Overview of Participants' Activities and Projects. (excl. Management Members).

4.2.3 Results pertaining to Research Proposition 2

This section presents findings related to the second research proposition: that accessible, community-based makerspaces are inherently age-inclusive in their member acquisition and retention strategies. The study explored whether and how these spaces actively seek to attract, support, and integrate older individuals into their communities. While makerspaces generally maintain an open-door policy, the findings provide insight into both the inclusive nature of these environments and potential gaps in targeted outreach or support for senior makers.

4.2.3.1 Results from Made In Workshop, Johannesburg, South Africa

Based on responses from seven MIW members, no special activities or initiatives were identified that specifically aimed at welcoming older individuals to the space. Their comments highlighted a general openness to all new members, regardless of age. Some members mentioned paying no special attention to this aspect, while others emphasised that the space is open to everyone. One member referenced the arrangement with the WWA but noted that their members typically do not mix with the makerspace community. The two management members confirmed that there are no specific activities aimed at recruiting older people as members but acknowledged that certain initiatives may appeal more to older potential members, such as phone call marketing and participation in web forums over social media platforms like LinkedIn or Instagram.

When asked about specific examples of age-inclusiveness, respondents mentioned that the community supports older members in learning new technologies and that no one debates age at the makerspace. ZA08 mentions that the MIW WhatsApp group is a valuable source of information and support for him. In his words:

> “[The MIW WhatsApp group] is worth the membership alone. Just because of what you can find. Somebody will always know the answer to any question you might ask.”

However, it was also noted by another member (ZA03) that he would have wished for more specialised training on CNC machinery in order to being able to pursue his project more diligently. While MIW offers introductory classes to different machinery,

crafting techniques, and even social media classes for entrepreneurs, (primarily on weekends and at extra costs), ZA03 would have hoped for more hands-on training and support from his fellow maker community.

Regarding initiatives aimed at supporting intergenerational interaction, management members reported that such interactions are not forced but develop naturally in the workshop. Some older members give e.g. classes to younger members, such as a panel saw safety course. Generally, management and other members recognised the contributions of older individuals to the MIW community but expressed mixed perceptions. Some older members do offer advice to other members, though this is perceived as sometimes being done in a rather condescending way. The best contributions seem to come from those who have upgraded to new (CNC) technology, allowing for a blend of traditional and modern methods. One particular older member is noted for his expertise in IT and has the potential to contribute more to the community. Another is well-versed in woodworking and frequently consulted for his specialised knowledge, which he enjoys sharing with other members, including younger ones.

Younger members generally expressed some frustrations about older members' attitudes. Some noted that older people are not always open to learning or change, preferring to stick to their ways, which causes friction in the community. Others pointed out that older individuals tend to resist using CNC machinery, limiting their progress within the makerspace. ZA05 explained:

> “One thing I have realised with your older woodworkers is they enjoy doing it the old way. So, they won’t use a CNC machine, they won’t use a lamination rack or jig or anything like that. They do it the old way. […] They don’t progress as everything else progresses.”

However, two younger members acknowledged the value of intergenerational knowledge exchange. They pointed out that older generations had more experience with hands-on experimentation due to the lack of advanced technology in their time, which provides valuable insights often missing among younger members. ZA04 shared a specific example of how a 65-year-old friend who helped him solve a material

problem when building a tool. He was trying to drill through a very hard steel and did not find a solution. In his words:

> "The old man looked at me and said, 'the harder the steel, the softer the tool.' And he was using high speed steel to cut through this insanely hard material …like butter. And I just…it made no sense."

But his friend's advice proved to be an effective solution that the younger member would not have considered. He further acknowledged:

> "There is something that we have lost, that the older generation knows a bit more. […] They didn't have the tools we have today. So, they just had to make a plan. And their way to make a plan works better than the stuff that we have."

4.2.3.2 Results from FabLab Munich e.V., Munich, Germany

At FLM, none of the respondents identified any specific initiatives aimed at welcoming older individuals to the makerspace. However, they emphasised that everyone is welcome, and no special activities are needed, as older individuals tend to find their way to the space on their own. Members share a common curiosity and enthusiasm for technology and tinkering, regardless of age. According to interview responses, the FLM community creates an inclusive environment where all individuals are treated equally. Likewise, FLM management members emphasised that while no specific activities are designed to target older individuals, certain measures, such as media coverage in a major German newspaper has drawn interest from older candidates. DE02 acknowledges "Open FabLabs" (open house events at FLM) to be a good opportunity to approach older interested potential members. In his words:

> "I am attending each of them. Now that I'm a bit older myself, older gentlemen also come up and talk to me. Recently, there was an older man – a retired industrial designer – who has now found an environment here where he can carry on with his work."

Additionally, one of the founders emphasised that older individuals are a valuable group due to their experience and technical knowledge. Retirees often use their additional time to work on personal projects, explore new skills and technologies, and engage socially within the makerspace. While their participation does not fundamentally differ from that of other members - since everyone contributes and shares knowledge - they are often more willing to offer advice, assistance and time. Their extensive experience was acknowledged by several members. However, passing on this knowledge in structured formats such as the educational programs of FLM proved to be difficult, as the highly skilled older makers are not necessarily effective teachers to others. Some older members have facilitated classes in the past, though with mixed success. Some have also contributed to the makerspace by donating machinery from their personal workshops after retirement.

As regards intergenerational collaboration, members commented that this happens naturally and frequently. A good opportunity occurs with the regularly scheduled weekly membership meet-ups where members exchange expertise, advice and ideas. However, it was also mentioned that exchange between generations outside of these meetings is hampered due to different attendance times at FLM - retired older members tend to use the space primarily during daytime on weekdays, whereas younger working individuals attend to FLM activities in the evenings and on weekends. DE04 concludes that he often benefits from knowledge of younger members and vice versa, but availability is a challenge. In his words:

> “Sometimes, when you're here during the week, you're completely alone. […] You have to actively seek people out, because no one is there ad-hoc.”

4.3. SUMMARY OF DATA PRESENTATION

The findings of this study confirm that makerspaces serve as environments that can facilitate user innovation, with older individuals (50+) actively engaging in innovative activities alongside younger members. Interviews revealed that motivations for pursuing user innovation vary widely, ranging from business applications to personal projects and creative experimentation. Participants leveraged both traditional craftsmanship and modern digital tools to develop unique solutions, often adapting existing knowledge to meet specific needs. Innovation efforts included both individual projects and collaborative initiatives within the makerspace community.

Both makerspaces studied were found to be generally age-inclusive, as they do not differentiate between older and younger members - everyone is welcome. However, little to no targeted effort is made to specifically attract older individuals as new members. Despite this, older participants integrate well into the makerspace environment, contributing both expertise and new ideas while benefiting from shared knowledge and collaboration.

CHAPTER 5: ANALYSIS OF RESULTS AND DISCUSSION

5.1 INTRODUCTION

This chapter discusses the data results presented in Chapter 4 by interpreting them in relation to the research questions in Chapter 1 and existing literature as presented in Chapter 2. Firstly, a brief recap of the research questions is outlined. The discussion is then structured along these research questions, exploring the key themes of user innovation efforts by and with older individuals as well as age-inclusivity of makerspaces in this context. Finally, a brief assessment of the active ageing framework in the context of the findings of this study is discussed followed by a summary of all discussion topics.

5.2 BACKGROUND

This study explores the role of older individuals (aged 50+) in user innovation within makerspaces in South Africa and Germany. While household-level user innovation research experienced more scholarly attention lately (e.g. De Jong & Von Hippel, 2022; De Jong et al. 2023), there is limited knowledge about the ways in which older individuals engage in innovation within grassroots, community-driven environments such as makerspaces. Given the increasing importance of lifelong learning, intergenerational knowledge exchange and integration of older citizens in the context of ageing societies (WHO, 2022), understanding the participation of older makers in innovation processes is both timely and relevant.

The first research question examines how older people engage in user innovation activities in makerspaces. It explores the ways in which they participate in makerspace activities, whether they pursue their own projects or offer their expertise to others for collaborative efforts. It will be established whether some of these activities resulted in qualified household-level user innovation. Drawing on Von Hippel's concept of user innovation (Von Hippel, 2005), the study considers whether older individuals develop new and useful solutions on their own or provide expertise to collaborative user innovation projects in the form of mentorship or knowledge sharing. The study further investigates the skills, competencies, and knowledge older individuals apply in

possible innovation projects. It also analyses their motivations for engaging in makerspaces and the perceived benefits of their participation which links to the active ageing framework (WHO, 2002).

The second research question focuses on the age inclusivity of makerspaces. While these spaces generally emphasise openness, collaboration, and community-driven innovation (Saari et al.; 2021), it is unclear whether they are equally engaging for older adults. The study examines the extent to which makerspaces actively encourage the participation of older individual. It investigates the community structures that facilitate or hinder their involvement. It also explores how seniors interact with the broader makerspace community and whether their contributions are valued. In addition, the study considers whether makerspaces serve as spaces for intergenerational exchange and dialogue, by supporting collaboration between older and younger makers. By exploring these questions, the study aims to provide insights into the factors that enable or constrain user innovation in later life as well as involvement of older people in makerspaces.

While the study presents findings of two cases, one in Johannesburg, South Africa and one in Munich, Germany, a direct comparison presents challenges due to significant socioeconomic and cultural differences in both countries (United Nations Development Programme, 2024), the different organisational structures of the two makerspaces as well as the number of respondents aged 50+ (three at MIW, six at FLM). From the presented data in chapter 4, one could already see that the makerspace members in Germany were generally more community-driven, with a focus on personal fulfilment, creativity and tinkering in their activities. Participants in South Africa often emphasised a need to develop income-generating projects due to lower socio-economic stability. Instead of a pure one-to-one comparison, this study focuses on understanding how local contexts shape user innovation, aiming to discuss the unique conditions that influence older individuals' participation and user innovation activities in makerspaces.

5.3. DISCUSSION PERTAINING TO RESEARCH QUESTION 1

5.3.1 User Innovation among older people in makerspaces

The findings revealed that older individuals in both makerspaces, MIW and FLM, engage in various forms of inventive activities. At MIW, all three older respondents reported involvement in some form of inventive or innovative activity. One respondent (ZA03) pursued a potential innovation project with purely commercial intent. He was focusing on a small-scale foundry project for conveyor belt links. Another respondent (ZA08) engaged in both commercially oriented projects, such as a specialised gaming table, and personal-use innovations, such as a specialised dog doorway and light fittings. The third respondent (ZA09) reported engaging in inventive activities purely for the joy of tinkering. He developed a self-pivoting turntable arm inspired by an online community challenge. Notably, two of the three MIW respondents were above 60 and 70 years old.

At FLM, five of the six respondents aged 50+ revealed that they were over 60 years old. Four of the six respondents reported working on projects that were new and useful to themselves or others. Three of them had completed projects currently in use, including a modular wall hook system (DE02), contributions to the FLM secure access management system (DE05), and a laser-cut customised knights' castle for a grandson (DE06). Additionally, two respondents were engaged in ongoing inventive activities, such as a customised soldering aid based on a push puppet mechanism (DE02) and a customised motorbike lifter (DE04). Unlike MIW, none of the FLM respondents expressed commercial ambitions for their projects. Instead, their innovations were intended for personal use or for the benefit of family and friends. At MIW, all three older respondents reported activities that were still in progress, with no final outcomes yet established. Only two respondents had already completed solutions for personal use: the specialised dog doorway (ZA08) and the customised foldable braai stand (ZA09).

These findings clearly indicate that older individuals actively engage in inventive activities within makerspaces. Notably, participants were generally hesitant to label their activities as new (as in "new and beneficial to either themselves or others" in the interview questions, see Appendix B). They were somewhat very humble about their

achievements and often downplayed the novelty aspect. They did not recognise specialised functionality needs or unavailability and unaffordability of market-ready alternative solutions resulting in the new developments of their inventions. Additionally, some ideas were still at the idea stage or in development, raising the question of what constitutes user innovation at the household level. This aspect will be shortly discussed next before addressing collaborative aspects, user innovator typologies, and the diffusion of user innovations.

5.3.1.1 Degree of Accomplishment: Idea, Invention, or Innovation

Korbel and Grosse (2020) provide a useful classification of user innovation in the household sector, distinguishing between potential user ideas, household sector (HHS) innovation activity, and actual HHS innovation. Potential user ideas exist before an actual outcome is created, while HHS innovation activity involves the creation and use of an outcome without broader diffusion. HHS innovation, by contrast, requires diffusion beyond the original creator.

Applying this framework, all nine respondents aged 50+ across both makerspaces were actively engaged in inventive activity. Three respondents remained at the idea stage, having expressed intentions without yet accomplishing tangible outcomes. Notably, two of these three had only recently joined their respective makerspaces, suggesting that their projects were still in early development stages. Six respondents were engaged in ongoing innovation activities. And only two activities could be classified as actual HHS innovation, as their outputs had been adopted beyond the individual inventor. These included the FLM access management system and the foldable braai stand developed by ZA09.

5.3.1.2 Individual vs. collective household innovation among older makers

The majority of respondents across both makerspaces reported working individually, albeit with varying degrees of consultation with other members. At MIW, where members often used the space for business-related activities, intellectual property (IP) concerns were highlighted as a potential barrier to collaboration. Most respondents at MIW were eager to shield their inventive activity, at least if the solution was easily adoptable, as competing small businesses worked next to them in the space. While all three older respondents expressed a willingness to offer general assistance to

fellow makerspace members, at least two were reluctant to disclose details of their own inventive projects due to their commercial ambitions. This confirms Zakoth et al.'s (2023) observation that "professional" makers tend to use makerspaces more as a facilitator and do not focus on collaboration as much as their hobbyist counterparts. One respondent expressed a need for training on CNC-specific machines, but given the business-oriented focus of MIW, skill transfer within the community was limited. Instead, this respondent relied primarily on MIW management for necessary training. These findings align with Wellner and Herstatt (2014). They identified that while older individuals possess a wealth of ideas, they often face barriers to executing them, such as technological skill gaps.

In contrast, collaboration was more prominent at FLM, where members primarily engaged in makerspace activities for recreational purposes rather than commercial gain. This confirms Zakoth et al.'s (2023) finding that hobby makers focus on collaboration and use makerspaces as incubation environments for their ideas. FLM explicitly promotes a collaborative ethos, exemplified by its motto, "Do it with others" rather than "Do it yourself" (Fab Lab München e.V., n.d.). This philosophy institutes knowledge exchange, with older members being valued for their expertise in traditional crafts, alongside newer technological proficiencies. For example, one respondent (DE06) became an expert in laser cutting and is frequently consulted by other members of the space. Additionally, the FLM community engages in joint innovation projects, such as their own access management system. An older member (DE05) contributed crucial electrical engineering expertise to the venture. The project was recognised as one of the most advanced open-source hardware solutions for access management. This aligns with the findings of Shah and Tripsas (2007) regarding the effectiveness of collaborative user innovation efforts, and especially highlighting valuable contributions of older members to the success of the initiative. These findings further support Wegner (2011) and Smith (2017), who emphasise the innovative potential of intergenerational knowledge exchange in community settings.

Makerspace organisational structures and financial models also appear to influence collaborative innovation dynamics. MIW's for-profit orientation and high membership fees necessitate efficient use of time and resources, limiting collaborative opportunities. Conversely, FLM members frequently emphasised the value of

community interaction and shared problem-solving, suggesting that collaboration is a core motivator for participation. As a result, the MIW community might be missing out on the collective innovation potential that thrives in more collaborative environments (Shah & Tripsas, 2007).

5.3.1.3 Motivation and types of older household sector innovators

Von Hippel (2005) identified motivation as a key characteristic of user innovation, noting that most users innovate for their own benefit, modifying or creating products and services that meet their specific needs. Von Hippel (2016) and De Jong et al. (2023) expanded on this by categorising household-level user innovators into four types based on their primary motivations: users (who innovate to meet personal needs), participators (who enjoy the innovation process itself), helpers (who solve problems for others while also enjoying the process), and producers/ vendors (who are commercially oriented).

All four types of user innovators were identified among older respondents across both cases. All respondents at FLM and one respondent at MIW fit into the user type category, as they pursued individual projects for personal use. Additional motivations ranged from the joy of tinkering and learning new skills (participator type) to contributing to their communities and helping others (helper type). At MIW, two respondents were primarily focused on the commercial potential of their activities. Their projects and activities at MIW were guided by economic necessity - the "need to earn a living." Statements from ZA02 and ZA08 align with findings by Halvorsen and Morrow-Howell (2017), who highlight how ageism and employment barriers push older individuals toward entrepreneurship. In the South African context, Roux and Viljoen (2018) identified high unemployment rates, mandatory retirement policies, and government incentives favouring youth employment as additional pressures. These factors contributed to MIW respondents being classified as vendor-type innovators under Von Hippel (2016) and De Jong et al.'s (2023) framework.

A finding by Wellner & Herstatt (2014) which could not be confirmed in this study is that older innovators primarily address age-specific problems and are motivated by finding solutions that address comfort and compatibility for their own use. The diversity of results in this study does not allow for such an interpretation. The accomplished

innovations, as well as the ongoing innovation activities, and ideas, are rather valuable to a broad (potential) user base not tied to a specific age group.

5.3.1.4 Diffusion of household innovation by older makerspace members

Von Hippel (2005) notes that user innovators often freely share their developments within communities of interest. Shah and Tripsas (2007) highlight the benefits of free revealing, including enhanced reputation, validation of an invention's relevance, and opportunities for collective problem-solving.

While free revealing was considered frequently at FLM, barriers such as complex documentation requirements hindered some of the older members from sharing their work. One respondent (DE04) wanted to share a customised balcony rail design via an open hardware community but found compiling the necessary documentation too complicated. Nonetheless, FLM fosters an open innovation culture through research initiatives and shared open-source projects. Questions around the access management system, developed within FLM, arise frequently by users from open-source communities outside of FLM, highlighting the reach of such initiatives.

At MIW, at least one example was given with the foldable braai stand which was shared freely and replicated by other users of the space through a metal work course facilitated by ZA09. The other respondents were not triggered to freely reveal the accomplished or planned outcomes of their projects as they intended to market them commercially.

At FLM, most user innovators expressed no commercial intent, with only one respondent (DE02) considering commercialisation but admitting lacking entrepreneurial skills. This finding aligns with literature emphasising the need for entrepreneurial leadership and policy support to facilitate older entrepreneurs' transition from invention to commercialisation (Yu, 2023).

Ruiu and Breschi (2019) argue that older individuals face higher barriers to entrepreneurship despite being equally likely to invent as younger individuals. Policies supporting "sustaining old-age entrepreneurship" could help address these challenges, particularly in rapidly ageing societies (such as Germany) where declining

entrepreneurship rates pose economic concerns. Haga (2015) further suggests that targeted entrepreneurial leadership initiatives may be necessary to help older individuals realise and harvest their innovation potential. Yu (2023) adds that commercial diffusion of HHS innovation may lead to more self-worth and purpose in innovating older adults. It should therefore be considered not only to alleviate general diffusion failure of valuable HHS solutions but also to benefit the older innovator personally. In addition, Halbinger (2018) found that collaboration is a strong predictor for commercial diffusion of solutions created in makerspaces. It could therefore be advantageous to stimulate and purposefully nurture more collaboration among members in makerspaces in order to support innovation diffusion.

Both makerspaces in this study do not actively train their members in entrepreneurial skills. FLM is part of the FabLab network, which supports inventive activity and emphasises the free sharing of maker outcomes. This means that business-oriented training is not part of its mission. MIW, on the other hand, does offer a social media class tailored for entrepreneurs. Beyond that, structured entrepreneurial training does not exist. Given the wealth of experience and creativity among older makers, there is untapped potential for business-oriented classes that could help them turn their innovations into sustainable ventures, as well as for training, guidance, and incentives on free revealing opportunity.

5.3.2 Summary

It was found that older individuals actively engage in user innovation within makerspaces, with projects ranging from purely personal use to potential commercialisation. While some efforts are at the idea stage, others result in tangible solutions that are either implemented and used by the creator alone or shared within user communities. Collaboration plays a role in knowledge exchange and skill development, but engagement varies depending on individual motivations and external constraints. Motivations ranged from personal fulfilment and learning to economic necessity, influencing whether respondents fell into user, participator, helper, or vendor categories.

Some older innovators share their developments openly, benefiting from peer validation and reputation gains, though challenges such as documentation complexity

can limit dissemination. While commercial intent among older makers is not as common, the transition from user innovation to entrepreneurship remains an area of potential growth.

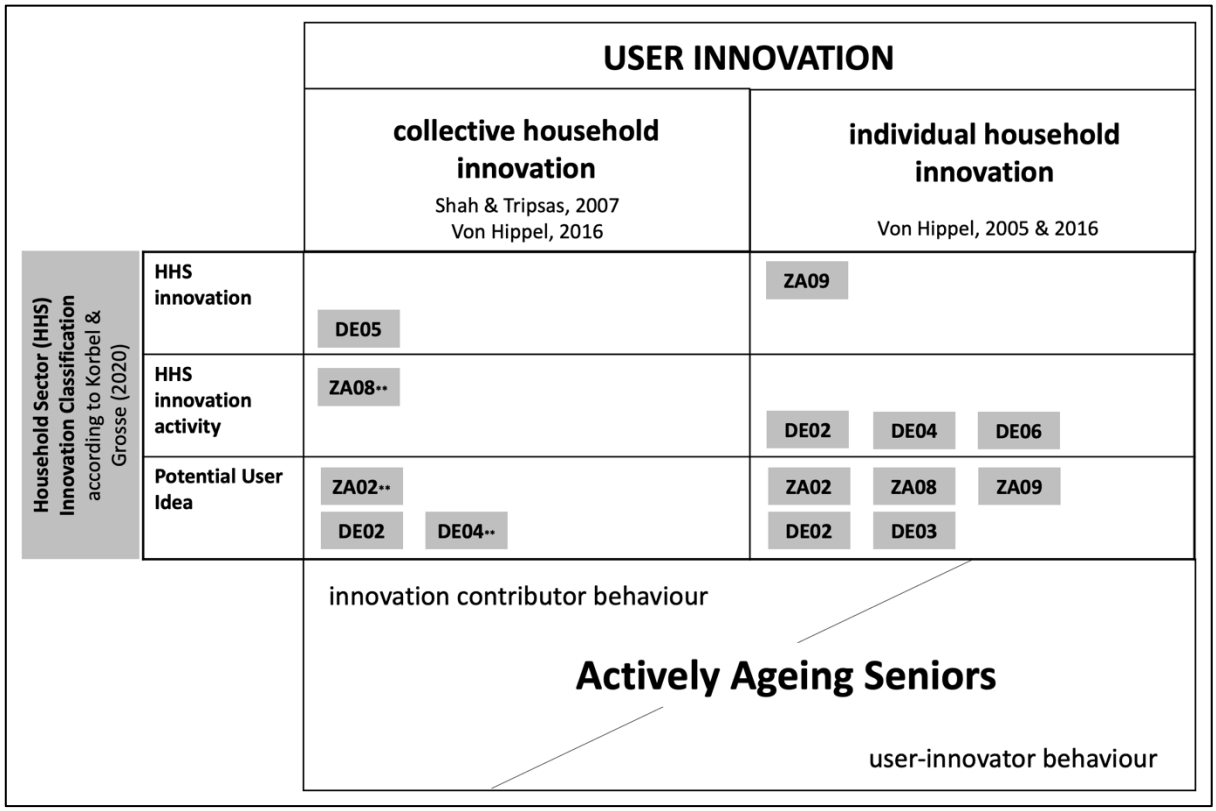

Figure 3. Overview HHS Innovation types found in this study* (with application of Korbel & Grosse's (2020) HHS Innovation Classification).

* Due to multiple projects, respondents can show in more than one field (for details, please refer to Appendix C.2.).

** ZA02, ZA08 and DE04 collaborate with individuals outside of their respective makerspaces.

The classification of user innovation by actively ageing seniors, as visualised in Figure 3, aligns with the household sector innovation classification framework by Korbel & Grosse (2020) and differentiation between individual and collective household innovation. The findings demonstrate that older makers contribute to innovation in multiple ways. Some engage in individual household innovation, where they develop solutions primarily for personal or household use, as seen in cases such as DE02, DE04, DE06, and ZA09. These examples highlight how older innovators actively identify and solve practical problems in their daily lives, showcasing their resourcefulness and problem-solving abilities. Others participate in collective household innovation, contributing to projects that benefit broader user communities, as in the cases of DE05 and ZA08. This suggests that collaboration is a key factor in

the innovation processes of some senior makers, reinforcing the value of shared development efforts (Shah & Tripsas, 2007). The presence of accomplished innovations further underscores the capacity of older individuals to contribute meaningfully to innovation ecosystems, despite potential barriers such as documentation complexity and commercialisation challenges.

5.4 DISCUSSION PERTAINING TO RESEARCH QUESTION 2

This section explores the extent to which makerspaces actively engage older members. It analyses the way older individuals engage with the makerspace community and how their contributions are valued. The findings indicate that while makerspaces are generally welcoming to all age groups, there are limited targeted efforts to recruit older individuals. Additionally, collaboration and knowledge exchange between generations are key aspects of makerspace culture, though their effectiveness depends on community dynamics and individual willingness to engage.

5.4.1 Makerspaces as Age-Inclusive Innovation Environments

The findings of this study support Halbinger's (2018) assertion that "general-purpose, open-access makerspaces" provide valuable opportunities for user innovation at the household level. This study extends that insight by demonstrating that such spaces are also effective environments for older individuals to engage in innovation. The volume of innovation activities among the older makerspace members in this study - ranging from idea generation to tangible project outcomes - confirms that these spaces are not limited to younger participants. They serve as important outlets for creative and entrepreneurial endeavours across various age groups.

Interviews across both makerspaces MIW and FLM revealed no explicit age bias among members. A commonly expressed sentiment was that "everyone is welcome." An FLM member specifically noted that the joy of tinkering and making unites members regardless of age. However, despite this general openness, no structured initiatives exist at either makerspace to actively recruit seniors or facilitate their engagement.

5.4.2 Variations in Age Representation Across Makerspaces

While older makers are present at both MIW and FLM, differences in the focus and structure of each space influence their participation levels. FLM, with its emphasis on hobbyist making, had a larger number of older members actively using the space. During the six weeks of on-site visits, it was easier to identify engaged older makers at FLM compared to MIW. In contrast, MIW had a higher proportion of younger members, likely due to its stronger focus on professional and entrepreneurial activities.

Several factors could explain these differences. FLM operates as a non-profit organisation with lower membership fees and external funding, making it more accessible to retirees and hobbyists in general. Additionally, FLM offers reduced membership fees for retirees, a financial incentive that may encourage senior participation. MIW, on the other hand, caters more to professional makers and small-scale manufacturers, which may naturally attract a younger demographic seeking business opportunities rather than purely recreational creative making.

5.4.3 Collaboration and Intergenerational Exchange

Intergenerational collaboration emerged as a key element of makerspace culture, though the extent and nature of such exchanges varied across the two cases. At FLM, collaboration was somewhat constrained by differing use times. Retirees typically visited the space on weekdays, while younger professionals and students attended during evenings or weekends. Despite this, opportunities for intergenerational exchange exist through structured community initiatives such as the weekly member meet-ups on Monday evenings. These events facilitate knowledge sharing, skill development, and collaboration on projects.

At MIW, it was mentioned that while older members contributed valuable insights and expertise, the way in which advice was given sometimes affected its reception. One MIW respondent noted that younger members did not always appreciate guidance when it was perceived as condescending. However, when knowledge was shared in an explanatory and experience-based manner, intergenerational exchange was more positively received. The younger respondents emphasised that exchange and collaboration with older members who “upgraded” to CNC and other newer technologies was easier and smoother as members are then able to discuss

professionally on an eye-to-eye level. Notably, there was no real interaction between the members of the Woodworkers Association of the Witwatersrand (WWA) who regularly use MIW facilities albeit mostly outside of working hours of the usual MIW members and during the weekend. WWA members are typically aged 50+ and focus on a rather hobbyist approach to woodworking. Nonetheless, it could be worthwhile connecting them with other more hobbyist-type users of MIW to stimulate collaboration, knowledge exchange, and community building.

Appreciation of the unique skill and experience repository of older makers was expressed by different members of both makerspaces. Additionally, Birgit from FLM acknowledged that older makers possess valuable experience and craftsmanship, often passed down through generations in a family. They are therefore an interesting target group for makerspace communities, but their knowledge transfer is not always effective. It requires structured facilitation to ensure accessibility and skill preservation. Overall, the findings indicate that while older makers contribute valuable knowledge, there is a need for strategies to enable smoother intergenerational collaboration. It should be ensured that knowledge-sharing methods align with the expectations and learning styles of younger makerspace participants.

5.4.4 Skill Development and Training for Older Makers

A key factor influencing older members' success in makerspaces is their ability to adapt to new technologies. While some older makers arrive with extensive technical expertise, others require training on digital fabrication tools such as CNC machinery and 3D printing. At FLM, this training often occurs informally during community meet-ups or casual exchanges between members. Some older members also join facility groups who take care of maintenance and cleaning of machines.

Both makerspaces offer dedicated courses around new technology skills and machine handling. At MIW, most of these courses require a certain technical knowledge base and are not dedicated to hobbyists, who might be looking to build certain crafting skills from scratch. In addition, MIW management emphasised that the most successful older makers were those willing to upgrade their skills and embrace new technologies. When older and younger members engage on an equal footing - combining traditional craftsmanship with digital tools - meaningful collaboration is more likely to occur.

Another potential training area for older makers is to enhance their abilities to pursue the diffusion of their innovations, particularly in areas such as documentation and market integration. This aligns with the literature emphasising the importance of entrepreneurial leadership and policy support in enabling older entrepreneurs to transition from invention to commercialisation (Yu, 2023; Ruiu and Breschi, 2017).

5.4.5 Exclusive "Senior-Only" Makerspaces?

The idea of a dedicated makerspace for older individuals has been explored in previous research. Lazar et al. (2021) studied the formation of a senior-led makerspace within a retirement community in the U.S., highlighting both opportunities and challenges. Carucci and Toyama (2019), in an action-based research approach, set up a temporary makerspace in a long-term care facility with residents aged 80 and older. While a senior-exclusive space could cater to the specific needs of older individuals, such as accessible tools and age-relevant project focuses, this study does not support the necessity of such a model. The findings suggest that older individuals (50+) can and do thrive within intergenerational makerspaces, where their skills and contributions benefit a diverse community. Moreover, a senior-only makerspace might struggle with issues of technology adoption and community formation. Lazar et al.'s (2021) study revealed that some participants exhibited technophobia, which limited the space's effectiveness.

Instead of creating age-segregated makerspaces, the findings of this study suggest that inclusive, intergenerational environments may be a more effective approach at least for the young-old (50+). This was true in both the South African and German contexts, where older participants generally preferred being part of mixed-age environments that enabled learning opportunity and exchange with the younger generations. However, subtle differences emerged: at the German makerspace, older makers expressed a desire for joint scheduled activities. In South Africa, economic motivation and resource access played a slightly stronger role in driving participation. These nuances reflect the broader socio-economic and cultural factors shaping how user innovation and active ageing intersect in each context.

5.4.6 Summary

This study finds that makerspaces do not exhibit explicit age discrimination. Their general-purpose, open-access nature makes them suitable environments for older individuals to engage in innovation. However, targeted initiatives to actively recruit and support senior makers are largely absent. While intergenerational collaboration occurs, it is influenced by community dynamics, communication styles, and the willingness of older members to adapt to new technologies.

Rather than establishing separate spaces for seniors, efforts should focus on fostering inclusivity within existing makerspaces by addressing challenges such as training gaps, communication barriers and scheduling conflicts. By doing so, makerspaces can enhance their role as environments for lifelong learning, intergenerational exchange, and meaningful HHS innovation for all age groups.

5.5 DISCUSSION IN THE CONTEXT OF ACTIVE AGEING

The findings of this study can be further analysed through the lens of active ageing, as conceptualised by the World Health Organization (WHO, 2002). The active ageing framework highlights three essential pillars - health, participation, and security - that together promote well-being and a fulfilling life as people age. This study provides evidence that makerspaces offer meaningful opportunities for older individuals within these three dimensions. However, it also identifies barriers and limitations that prevent older members from fully benefiting from these environments.

Health, as defined in the WHO framework, encompasses both physical and mental well-being. The study confirms that older makers actively engage in individual or collective household innovation, ranging from functional problem-solving to technical experimentation. Participants expressed feelings of accomplishment, pride, and satisfaction with their found solution. This aligns with Haga's (2015) findings that older people's involvement in innovation processes have a positive impact on their well-being. The cases from MIW and FLM both highlight how creative engagement keeps older individuals mentally active. This supports Walker's (2008) preventive approach, wherein lifelong activity sustains cognitive abilities in later years.

The participation pillar of active ageing emphasises social inclusion, continued learning, and community engagement (WHO, 2002). The findings demonstrate that makerspaces facilitate user innovation and intergenerational exchange, and that older members' participation is often self-driven. Doh and Adusei-Asante (2016) argue that social interaction is key to well-being in later life. In addition, Karlin and Weil (2016) argue that active ageing requires intergenerational exchange.

This study provides evidence of knowledge-sharing between age groups. However, this study also found that practical barriers limit interaction between younger and older members. At FLM, for instance, older members tend to use the space during daytime hours, while younger, working-age members visit in the evenings. At MIW, younger members occasionally perceived the advice of older makers as "condescending", highlighting that communication styles impact collaboration. Structured mentorship programmes, community initiatives or targeted training programs for older members could be established in makerspaces to facilitate intergenerational participation even more.

Security in active ageing refers to both economic stability and social well-being. The findings suggest that makerspaces can function as platforms for economic participation and social security, though structural challenges remain. At MIW, some older individuals engage in making as a commercial activity due to economic necessity. This aligns with Roux and Viljoen's (2018) study, which found that older South Africans face financial instability and employment barriers. At FLM, one respondent considered some of his creations as potentially marketable but admitted to lacking the necessary entrepreneurial skills to see through commercialisation of his idea. Late-life innovation and entrepreneurship could therefore be further supported by makerspaces through structured business mentoring or skill development programs.

This study demonstrates that makerspace activities provide valuable opportunities for actively ageing seniors, particularly in terms of participation (inclusion, intergenerational collaboration), but also affecting health (cognitive engagement, well-being) and security (economic and social stability) aspects of the active ageing

framework. However, while older makers create and collaborate in these spaces, their inclusion remains largely self-driven rather than institutionally supported. Makerspaces could introduce targeted initiatives to actively recruit and support older makers, ensuring that they remain fully engaged in the maker movement while also supporting intergenerational knowledge exchange and innovation.

5.6 SUMMARY OF RESULTS ANALYSIS AND DISCUSSION

This study found that older individuals actively engage in user innovation within makerspaces, developing solutions that range from personal use to potential commercialisation. Their contributions vary in scale, from early-stage ideas to fully implemented projects, with some being openly shared within user communities. While collaboration plays a role in knowledge exchange and skill development, the degree of engagement depends on personal motivations and external constraints. These motivations include personal fulfilment, continued learning, and economic necessity, influencing whether participants act as users, helpers, participators, or producers/ vendors (Von Hippel, 2016). Although commercial intent is not widespread among older makers, there is potential for greater entrepreneurial activity if structural support mechanisms are introduced.

The findings further showed that older makers contribute in multiple ways - some focus on individual household innovation, where they address practical needs in their daily lives, while others participate in collective innovation, working on projects that benefit a wider community. The study highlights the resourcefulness of older makers and their ability to solve real-world problems yet also reveals barriers such as difficulties in documentation and commercialisation. Despite these challenges, older individuals remain active contributors to the innovation ecosystem, demonstrating that HHS user innovation is not limited by age but rather by access to resources and support structures.

Makerspaces provide a generally inclusive environment for older individuals, showing no signs of age discrimination. However, targeted initiatives to encourage and support senior makers are largely absent. While intergenerational collaboration occurs, it is

shaped by community dynamics, communication styles, and the willingness of older members to adapt to emerging technologies. Rather than establishing separate spaces for seniors, efforts should focus on fostering inclusivity within existing makerspaces by addressing challenges such as scheduling conflicts, training gaps, and communication barriers. Strengthening these aspects would enhance makerspaces as platforms for lifelong learning, intergenerational knowledge exchange, and HHS user innovation across all age groups.

A final reflection concerns the dynamic relationship between innovation and active ageing: are older individuals innovative because they embody the traits of active agers, or are they perceived as active agers because of their participation in innovation activities supported by makerspaces? The findings suggest a reciprocal interplay. For instance, respondents who reported prior careers in engineering, design, or education (e.g. DE02, ZA08, DE05) entered the makerspace with pre-existing problem-solving skills and curiosity - traits associated with active ageing (Walker, 2008). However, their continued involvement in makerspace projects also encouraged new learning, peer collaboration, and emotional satisfaction, all of which reinforce key dimensions of the active ageing framework such as participation and mental well-being (WHO, 2002). In particular, cases like ZA09, DE05 and DE06 illustrate how innovation engagement enhances a sense of purpose and social recognition, suggesting that makerspaces can actively contribute to older individuals being regarded as active agers. This mutual reinforcement underlines the value of makerspaces not only as sites of innovation but also as environments that support and sustain active ageing trajectories.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

This chapter concludes the study by summarising the key findings, drawing conclusions, and providing recommendations based on the research conducted. The study explored the intersection of user innovation and active ageing, focusing on the user innovation efforts of individuals aged 50+ in makerspaces in South Africa and Germany. By examining how older individuals contribute to user innovation and how makerspaces facilitate or hinder their engagement, the research sheds light on the role of ageing populations in the broader innovation landscape.

User innovation, a concept emphasising the activities of end-users in modifying or creating products and services (Von Hippel, 2005), aligns with the active ageing framework, which promotes the continued participation of older adults in economic, social, and technological spheres (WHO, 2002). Makerspaces, as community-driven environments which enable collaboration, learning, and hands-on problem-solving, serve as a natural setting to investigate the intersection of these two frameworks.

The study adopted a qualitative approach, employing a case study methodology to examine two makerspaces - one in Johannesburg, South Africa, and one in Munich, Germany. Through document analysis, site visits, and semi-structured interviews with 19 participants, the research explored the nature of older individuals' involvement in user innovation as well as the age-inclusivity of makerspaces. Findings indicate that older individuals actively engage in user innovation activity in makerspaces, leveraging their knowledge and experience to develop solutions for personal use, community benefit, or even potential commercialisation. However, their engagement is shaped by a range of influences, including their motivation, skill levels, access to technology, and the social dynamics present within makerspaces. While these spaces are generally welcoming to all age groups, explicit efforts to attract and support older individuals are limited.

The chapter proceeds as follows: Section 6.2 presents the major findings of the study, highlighting key insights into user innovation among older makers and the age-

inclusiveness of makerspaces. Section 6.3 outlines the key conclusions drawn from the study. Section 6.4 provides practical recommendations for makerspaces and other stakeholders to enhance the participation of older individuals in user innovation. Finally, Section 6.5 offers suggestions for future research, identifying areas that warrant further exploration to deepen our understanding of the role of older individuals in user innovation and innovation ecosystems.

6.2 MAJOR FINDINGS

The findings of this study confirm that makerspaces serve as environments that can facilitate user innovation, with older individuals (50+) actively engaging in innovative activities alongside younger members in these spaces. Interviews revealed that motivations for pursuing maker activities among older individuals vary widely, ranging from personal projects and creative experimentation to business application. Participants leveraged both traditional craftsmanship and modern digital tools to develop unique solutions, often adapting existing knowledge and building on (newly) acquired skills in makerspaces to meet specific needs. Innovation efforts included both individual projects and collaborative initiatives within the makerspace community.

Both makerspaces studied were found to be generally age-inclusive, as they do not differentiate between older and younger members - everyone is welcome. However, little to no targeted effort is made to specifically attract older individuals as new members. Despite this, older participants integrate well into the makerspace environment, contributing both expertise and new ideas while benefiting from shared knowledge and collaboration.

It was found that older individuals actively engage in user innovation activity within makerspaces. While some efforts are at the idea stage, others result in tangible solutions that are either used and implemented by the creator or shared within user communities. Collaboration plays a role in knowledge exchange and skill development, but engagement varies depending on individual motivations and external constraints. Motivations ranged from personal fulfilment and learning to

economic necessity, influencing whether respondents fell into user, participator, helper, or producer/ vendor type categories (Von Hippel 2016).

Some older innovators share their developments openly, benefiting from peer validation and reputation gains, though challenges such as documentation complexity can limit dissemination. While commercial intent among older makers is not very common, the transition from user innovation to entrepreneurship remains an area of potential growth.

The classification of user innovation by actively ageing seniors, as visualised in Figure 3, aligns with the household sector innovation classification framework by Korbel & Grosse (2020) and differentiation between individual and collective household innovation (Shah & Tripsas, 2007; Von Hippel, 2005; Von Hippel 2016). The findings demonstrate that older makers contribute to user innovation efforts in multiple ways.

Some engage in individual household innovation, where they develop solutions primarily for personal or household use. These examples highlight how older innovators actively identify and solve practical problems in their daily lives, showcasing their resourcefulness and problem-solving abilities. Others participate in collective household innovation, contributing to projects that benefit broader user communities.

This indicates that collaboration plays a significant role in the innovation processes of some older makers, reinforcing the value of shared development efforts (Shah & Tripsas, 2007). The presence of accomplished innovations further underscores the capacity of older individuals to contribute meaningfully to innovation ecosystems, despite potential barriers such as documentation complexity and commercialisation challenges.

This study further finds that the two investigated makerspaces demonstrate age-inclusiveness, and their general-purpose, open-access nature makes them suitable environments also for older individuals to engage in innovation activity. However, targeted initiatives to actively recruit and support senior makers are largely absent. While intergenerational collaboration occurs, it is influenced by community dynamics,

communication styles, and the willingness of older members to adapt to new technologies.

This study further demonstrates that makerspace activities provide valuable opportunities for actively ageing seniors, particularly in terms of participation (inclusion, intergenerational collaboration), but also affecting health (cognitive engagement, well-being) and security (economic and social stability) aspects of the active ageing framework (WHO, 2002). However, while older makers create and collaborate in these spaces, their inclusion remains largely self-driven rather than institutionally supported.

6.3 KEY CONCLUSIONS OF THE STUDY

This study explored how older individuals engage in user innovation activities in makerspaces. Furthermore, it examined the underlying skills, competences, and knowledge applied by older individuals in their innovation attempts. It also explored their motivations to innovate and the perceived benefits they experienced in the process. Through the findings in this study, it could be confirmed that older individuals engage in makerspaces in diverse ways, actively participating in user innovation activities alongside younger members.

Their engagement takes multiple forms, including leading their own innovation projects, mentoring others, and contributing knowledge as well as expertise to collaborative projects. Older makers frequently combine traditional craftsmanship with modern digital fabrication tools, demonstrating adaptability and a willingness to learn. Their motivations vary widely, encompassing personal fulfilment, creative exploration, economic necessity, and knowledge sharing. Furthermore, the study finds that older makers actively participate in both individual and collective household innovation (Shah & Tripsas, 2007; Von Hippel, 2016), demonstrating their ability to address personal needs while also contributing to broader user communities.

The study's findings therefore support the proposition that older individuals are valuable sources of innovation, which aligns with previous research (Carucci & Toyama, 2019; Peine et al., 2013; Wellner & Herstatt, 2014). However, while some older innovators openly share their work, challenges such as documentation complexity can limit the dissemination of their innovations. Moreover, while some outcomes are used only by the inventor, others have the potential for commercialisation, indicating a latent opportunity for entrepreneurship among senior makers.

Another research objective was the assessment of age-inclusiveness of makerspaces, observing how makerspaces and their communities seek to engage older individuals. The study finds that the makerspaces examined are generally inclusive in that they welcome members of all ages without formal restrictions. While the two examined makerspaces do not explicitly exclude older members, they also do not actively seek to include them through targeted recruitment or support programs.

Intergenerational collaboration occurs naturally, but it is influenced by communication styles, technology proficiency, and community dynamics. Building on the work of Halbinger (2018), which identifies makerspaces as important intermediaries for household-sector innovation, this study suggests that this generally also holds true for older people as household innovators.

Applying the lens of active ageing, as conceptualised by the World Health Organization (WHO, 2002), the study findings confirm personal benefits for older user innovators who are active in makerspace communities. The active ageing framework highlights three essential pillars—health, participation, and security—that together promote well-being and a fulfilling life as people age. This study provides evidence that older individuals engage in user innovation in ways that align with these dimensions. Their innovation efforts contribute to cognitive engagement and well-being, foster intergenerational exchange and, in some cases, support economic and social stability. Older people's participation in innovation activities frequently boosts their sense of purpose and self-confidence, reinforcing the idea that lifelong creativity and problem-solving sustain mental and emotional well-being (Haga, 2015; Walker, 2008). Moreover, intergenerational knowledge-sharing, while varying in intensity,

offers mutual learning opportunities, with older innovators transferring expertise while also benefiting from fresh perspectives.

6.4 RECOMMENDATIONS

Recognising the user innovation potential of older individuals is essential in the context of ageing societies, where their contributions can help sustain and expand innovation ecosystems. Older individuals bring a wealth of experience, problem-solving abilities, and creativity to the innovation landscape. By ensuring their inclusion, societies can leverage their knowledge while also promoting active ageing.

In order to support older individual's user innovation potential and efforts, targeted measures at both practice-level and policy-level should be introduced. Makerspaces as physical outlets of the maker movement play a crucial role in democratising innovation and enabling grassroots technological development, particularly in contexts such as user innovation at the household level. While this study across two makerspaces confirmed that they are generally age-inclusive, their approach to attracting and supporting older individuals remains passive. At the same time, the broader innovation ecosystem has yet to fully recognise and harness the innovation capacity of older people, especially in light of demographic ageing and the growing relevance of non-institutional, user-driven innovation.

6.4.1 Recommendations for Practice

Makerspaces and similar innovation environments should take a more active role in encouraging and supporting older individuals. Structured outreach, mentorship pairings, and tailored support programs could facilitate greater engagement of older individuals. Dedicated workshops and training initiatives would help bridge skill gaps, allowing older innovators to integrate more seamlessly into innovation communities.

Older innovators possess valuable expertise, but their knowledge transfer is not always effective. Structured facilitation is needed to ensure accessibility and skill preservation. Programmes that actively connect senior innovators with younger innovators, such as intergenerational mentorship and collaborative innovation teams,

could enhance learning exchanges and bridge generational divides. Addressing communication barriers and promoting dialogue across age groups would further strengthen collaboration.

Keeping up with emerging technologies is crucial for older innovators to fully realise their ideas. Many possess strong technical skills but require support in adapting to digital tools and software. Providing targeted training on these topics would enhance their ability to document, refine, and share their ideas and innovations more effectively. Makerspaces and other innovation environments also benefit from a diverse member base. Encouraging participation not only from individuals of different age groups, but also genders, socioeconomic backgrounds, and professional experiences enables richer knowledge exchange and interdisciplinary collaboration.

6.4.2 Recommendations for Policy

At the policy level, the role of older individuals in household-sector innovation should receive greater recognition. Given that household-sector innovation represents a significant share of innovation activity in an economy (De Jong et al., 2021), this study highlights that older individuals possess substantial potential in that regard. Policymakers should recognise this potential, particularly in ageing societies, and develop strategies to harness this valuable resource for broader economic and social benefit.

In addition, policy frameworks around innovation and ageing should be better integrated. Innovation policies often focus on start-ups and younger entrepreneurs, while ageing policies emphasise care and dependency. Recognising older people as active contributors - rather than passive recipients - could lead to more holistic, future-oriented strategies. Public funding could be directed towards inclusive innovation spaces that demonstrate outreach to and engagement with older populations.

6.5 SUGGESTIONS FOR FUTURE RESEARCH

This study set out to add to existing research at the intersection of user innovation at the household level and active ageing, focusing on older user innovators' activities in

makerspaces. While it provides insights into their motivations, skills, and user innovation contributions, several areas remain open for further exploration.

Future research could examine the diffusion of household-sector innovation, particularly regarding how older individuals can better share and commercialise their ideas. Investigating policy measures or institutional frameworks that support senior-led innovation and entrepreneurship could yield practical recommendations for increasing the impact of their contributions. Additionally, exploring how structured intergenerational collaboration models enhance innovation outcomes could provide valuable insights into knowledge transfer and mutual learning.

Future research could also examine how different socio-economic backgrounds and levels of technological literacy impact the innovation capacity of older individuals. A comparative study across various demographic groups could offer a more thorough understanding of the determinants that influence engagement in user innovation. Another avenue for future research is the long-term impact of participation in innovation ecosystems on older individuals' well-being, cognitive function, and social inclusion. Longitudinal studies could assess how sustained engagement in innovation activities affects quality of life over time.

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APPENDICES

APPENDIX A – RESEARCH INFORMATION

A.1. Permission Request to conduct Research

A.2. Participant Information Sheet

A.3. Participant Consent Forms

A.3.1. Consent Form for individual Participants

A.3.2. Consent Form for Management Participants

A.1. Permission Request to conduct Research



University of the Witwatersrand,
Wits Business School

[makerspace xyz, contact person, address]

[Date]

Dear Sir/Madam,

Re: Permission to conduct research at [makerspace xyz].

My name is Beate Wiesner-Herbst. I am a Masters student in Innovation Studies at Wits Business School (WBS), University of the Witwatersrand. As part of my studies, I have to undertake a research project. I am investigating user innovation in makerspaces under the supervision of Professor Diran Soumonni. The title of the research project is **"User innovation and active ageing in the maker movement in South Africa and Germany"** and the aim is to investigate specifically how older people are engaging in user innovation activities in makerspaces. With this letter /email I am seeking permission to conduct my research at your [makerspace xyz].

The study will initially involve some analysis of your organisation's website and social media accounts as well as site visits to get an overview of the makerspace activities and facilities. During the site visit, I intend to take photos of the facilities which may be reviewed and approved by you before use in the final written report.
Furthermore, users/members of your makerspace (with a focus on senior members aged 50+) as well as you as the manager will be invited to take part in interviews. If interview candidates agree, they will be asked to participate in an interview of 60-75 minutes at the makerspace. Equally project owners who purposefully collaborated with

seniors on innovative projects in the space are invited to participate as well. The interviews will be audio-recorded.

Participants will be asked to give their written or verbal consent before the research begins. Their responses will be treated confidentially, and identities (their names and organisations if applicable) will be anonymous unless otherwise expressly indicated. Individual privacy will be maintained in all published and written data resulting from the study. The results will be communicated in the research report submitted to Wits Business School and I will gladly provide a copy to your organisation.

The research participants will not be advantaged or disadvantaged in any way. They will be reassured that they can withdraw their permission at any time during this project without any penalty. There are no foreseeable risks in participating in this study. The participants will not be paid for this study. All research data will be stored in a password-protected computer.

I therefore request permission in writing to conduct my research at your organisation. May I kindly ask for a formal permission letter to be issued on your organisation's headed paper, signed and dated, specifically referring to myself by name and the title of my study, and including consent to your organisation's name being used and presented in the final written report.
Please let me know if you require any further information. I look forward to your response as soon as is convenient.

Yours sincerely,

Beate Wiesner-Herbst
Mobile: +27 (0)63 450 8224
beate.wiesnerherbst@students.wits.ac.za

Supervisor: Professor Diran Soumonni
Phone: +27 (0)11 717 3646
Diran.Soumonni@wits.ac.za

A.2. Participant Information Sheet



Dear Sir / Madam,

Re:Participant Information Sheet.

My name is Beate Wiesner-Herbst and I am a Masters student in Innovation Studies at Wits Business School, University of the Witwatersrand, Johannesburg. As part of my studies, I have to undertake a research project, and I am investigating user innovation in makerspaces under the supervision of Professor Diran Soumonni. The title of the research project is **"User innovation and active ageing in the maker movement in South Africa and Germany"** and the aim is to investigate specifically how older people are engaging in user innovation activities in makerspaces.

As part of this project, I would like to invite you to take part in an interview. This activity will involve answering a number of questions related to the topic and will take around 1 hour. With your permission, I would also like to audio record the interview using a digital device. This recording will be stored in a password-protected computer and only my supervisor and myself will have access to this recording.

There will be no personal costs to you if you participate in this project, You will not receive any direct benefits from participation but there are no disadvantages or penalties if you do not choose to participate or if you withdraw from the study. You may withdraw at any time or not answer any question if you do not want to. The interview will be completely confidential, and the information you give to me will be held securely in a password-protected computer and not disclosed to anyone else other than my supervisor and myself. I will be using a pseudonym (false name) to

represent your participation in my final research report. If you experience any distress or discomfort at any point in this process, we will stop the interview or resume another time.

If you have any questions during or afterwards about this research, feel free to contact me on the details listed below. This study will be written up as a research report. If you wish to receive a summary of this report, I will be happy to send it to you. The data collected from this research project will be stored in a password-protected computer. With your permission the data collected from this research project may be used by other researchers in an anonymised format. If you have any concerns or complaints regarding the ethical procedures of this study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za

Yours sincerely,

Beate Wiesner-Herbst

Researcher:

Beate Wiesner-Herbst

Email: beate.wiesnerherbst@students.wits.ac.za

Supervisor: Professor Diran Soumonni

Phone: +27 (0)11 717 3646

Email: Diran.Soumonni@wits.ac.za

A.3. Participant Consent Forms

A.3.1. Consent Form for individual Participants



User innovation and active ageing in the maker movement in South Africa and Germany

Researcher: Beate Wiesner-Herbst

I, ……., agree to participate in this research project. The research has been explained to me and I understand what my participation will involve. I agree to the following:

(Please circle the relevant options below).

I agree that my identity will be anonymized in the final written report using a pseudonym (false name)	YES	NO
I agree that the researcher may use anonymous quotes in her research report	YES	NO
I agree that the interview may be audio recorded	YES	NO
I agree that the information I provide may be used in an anonymized format after this project has ended, for academic purposes by other researchers, subject to their own ethics clearance being obtained.	YES	NO

…… (signature)

…… (name of participant)

…… (date)

…… (signature)

…… (name of person seeking consent)

…… (date)

A.3.2. Consent Form for Management Participants



User innovation and active ageing in the maker movement in South Africa and Germany

Researcher: Beate Wiesner-Herbst

I, ……., agree to participate in this research project. The research has been explained to me and I understand what my participation will involve. I agree to the following:

(Please circle the relevant options below).

I agree that my identifying characteristics, name and age, will be used in the final written report along with my organisation's name	YES	NO
I agree that the researcher may use selected quotes in her research report	YES	NO
I agree that the interview may be audio recorded	YES	NO
I agree that the information I provide may be used in an anonymized format after this project has ended, for academic purposes by other researchers, subject to their own ethics clearance being obtained.	YES	NO
I agree to photos being taken during site visits of the makerspace. Their use in the final written report is subject to approval by the makerspace management. If photos feature individual or member groups, separate consent has to be obtained from them.	YES	NO

…… (signature)

…… (name of participant)

…… (date)

…… (signature)

…… (name of person seeking consent)

…… (date)

APPENDIX B – RESEARCH INSTRUMENTS

B.1. Interview Guides for Group 1 (members 50+ in makerspaces)

B.2. Interview Guides for Group 2 (members under 50 in makerspaces)

B.3. Interview Guides for Group 3 (management in makerspaces)

B.1. Interview Guides for Group 1 (members 50+ in makerspaces)

I) participant background
1) What is your current occupation or what was your last occupation before retirement?
2) Are you still working in that profession? → if answer is yes, proceed to (3) → if answer is no: 2.1) About how long have you been retired? 2.2) What is the usual retirement age in your profession?
3) How did you first become aware of this makerspace and/or makerspaces in general?
4) What were your motivations and expectations when you first joined the makerspace?

II) Specific research questions related to research question 1
5) Could you share specific activities or projects you have been pursuing or in which you were involved within the makerspace that were new and beneficial to yourself or to society?
6) Was it your own project or did you participate in someone else's project? → if answer is "own project", proceed to (7) → if answer is "participate": 6.1) How did you get involved in the project? 6.2) Are there any other projects that you initiated yourself? → if answer is "no", proceed to (11) → if answer is "yes": 6.3) Could you please share more details about your own project? → then proceed to (7)

7) Do you/ did you engage with other individuals or groups in the makerspace during the project? → if "yes", proceed with (a) questions → if "no", proceed with (b) questions

collective user innovation	**individual user innovation**
8a) Could you share your experience? How did they contribute?	8b) Did other people from outside of the makerspace contribute to the project (e.g. friends and family)? → if "yes", continue with (8a) and rest of the (a) questions → if "no", continue with (9b)
9a) How did the project benefit from the collective effort?	9b) What are the reasons for conducting the project alone?
10a) How did the project members benefit from the collective effort?	10b) In your opinion, would the project have benefited from collaboration with others? (How?)
11) What happened to the project since? 11.1) Are you using the outcome of the project yourself? 11.2) To the best of your knowledge, have any other people adopted it?	
12) Do you, alone or with others, currently run a business which commercialises the outcome of the project? → if "no", proceed to (13) → if "yes": 12.1) Did the business exist before the project or was it established as a consequence of the project outcome?	
active ageing	
13) What was your initial motivation to pursue/join this project? (own use, sale, learning, contributing, helping others, fun, spend time meaningfully, other reason?)	
14) Which skills, competences, or knowledge did you built on to pursue/take part in the project?	
15) How do you personally benefit from your activities at the makerspace?	

II) Specific research questions related to research question 2
16) Have you observed any specific initiatives or activities aimed at welcoming and

engaging older individuals in the makerspace community?
17) Could you share a personal anecdote or experience that illustrates the inclusivity (or lack thereof) of the makerspace towards older individuals?

III) Additional reflections
18) Is there anything else, you would like to add?
19) Could you kindly suggest any other persons to interview?

Thank you for your time, input, and for granting this interview at short notice.

B.2. Interview Guides for Group 2 (members under 50 in makerspaces)

I) participant background
8) What is your current occupation (or what was your last occupation before retirement)? 9) Are you self-employed?
10) How did you first become aware of this makerspace and/or makerspaces in general? And what made you join Made in Workshop?
11) What were your motivations and expectations when you first joined the makerspace?

II) Specific research questions related to research question 1
12) Could you share specific activities or projects you have been pursuing or in which you were involved within the makerspace that were new and beneficial to yourself or to society?
13) Was it your own project or did you participate in someone else's project? → if answer is "own project", proceed to (7) → if answer is "participate": 6.1) How did you get involved in the project? 6.2) Are there any other projects that you initiated yourself? → if answer is "no", proceed to (11) → if answer is "yes": 6.3) Could you please share more details about your own project? → then proceed to (7)

14) Do you/ did you engage with other individuals or groups in the makerspace during the project? → if "yes", proceed with (a) questions → if "no", proceed with (b) questions	
collective user innovation	**individual user innovation**
8a-1) Could you share your experience? 8a-2) Were there any people aged 50+ or	8b) Did other people from outside of the makerspace contribute to the project (e.g. friends and family)?

retirees involved? How did they contribute?	→ if “yes”, continue with (8a) and rest of the (a) questions → if “no”, continue with (9b)
9a-1) How did the project benefit from the collective effort? 9a-2) How did the project benefit specifically from the input of older members?	9b) What are the reasons for conducting the project alone?
10a) In your opinion, how did the project members benefit from the collective effort?	10b) In your opinion, would the project have benefited from collaboration with others? (How?)
20) What happened to the project since? 11.1) Are you using the outcome of the project yourself? 11.2) To the best of your knowledge, have any other people adopted it?	
21) Do you, alone or with others, currently run a business which commercialises the outcome of the project? → if “no”, proceed to (13) → if “yes”: 12.1) Did the business exist before the project or was it established as a consequence of the project outcome?	
active ageing	
22) What was your initial motivation to pursue/join this project? (own use, sale, learning, contributing, helping others, fun, spend time meaningfully, other reason?)	
23) Which skills, competences, or knowledge did you built on to pursue/take part in the project?	
24) How do you personally benefit from your activities at the makerspace	

II) Specific research questions related to research question 2
25) Have you observed any specific initiatives or activities aimed at welcoming and engaging older individuals in the makerspace community?
26) Could you share a personal anecdote or experience that illustrates the inclusivity (or

lack thereof) of the makerspace towards older individuals?

III) Additional reflections
27) Is there anything else, you would like to add?
28) Could you kindly suggest any other persons to interview?

Thank you for your time, input, and for granting this interview at short notice.

B.3. Interview Guides for Group 3 (management in makerspaces)

I) participant background
1) Can you please share your current role at (makerspace) with me?
2) Can you provide an overview of (makerspace), its mission, and the types of (innovation) projects typically undertaken here? What motivated its establishment? // How long have you been involved with the makerspace and what motivated you to work here?
3) How many members do you have (active / passive)?
4) What are the primary target groups of the makerspace and why?
5) How would you describe the age diversity within the member community, particularly in terms of members aged 50+?

II) Specific research questions related to research question 1
6) Can you identify members or staff aged 50+ in the makerspace community who were involved in some form of innovation activity in the makerspace? (innovation refers to newly created or significantly modified products)
7) Can you identify younger members (aged 18 – 50 years) who have actively collaborated with older individuals on projects/ innovation projects?
8) Could you share specific examples of a project or initiative where collaboration between younger and older members led to innovative outcomes?
9) How do older members typically participate in innovative activity within the makerspace? (e.g., leading projects, mentoring, providing expertise, commercially oriented vs. own use/need-driven)?
10) In your mind, which unique skills, experiences, or contributions do these older members bring to (makerspace) and its community?
11) Does (makerspace) actively seek to engage with or recruit senior people as members? If so, for what reasons?
12) Are there any specific initiatives or activities aimed at welcoming/recruiting older individuals into the makerspace community?
13) Are there any specific initiatives or activities aimed at encouraging collaboration between older and younger members at (makerspace)?

14) Do members generally pursue individual projects or do they engage with others to accomplish their projects?

→ if "yes", proceed with (a) questions → if "no", proceed with (b) questions	
collective user innovation	**individual user innovation**
14 a) In your opinion, how did those projects benefit from the collective effort?	14 b) To the best of your knowledge, do those members collaborate with people from outside of the makerspace community to advance their activities (e.g. friends and family)?
15 a) Were there any people aged 50+ or retirees involved? How did they contribute? 16 a) If yes, How did the project benefit specifically from the input of older members?	15 b) What are the reasons for those members to conduct the project alone?
17a) In your opinion, how did the project members benefit personally from the collective effort?	17 b) Are they generally engaging with other members? How?

III) Additional reflections
18) Is there anything else, you would like to add?
19) Could you kindly suggest any other persons to interview?

Thank you for your time, input, and for granting this interview at short notice.

APPENDIX C – DATA PRESENTATION

C.1. MAKERSPACE SELECTION

C.1.1. Overview of Makerspaces in Gauteng, South Africa

C.1.2. Overview of Makerspaces in Munich, Germany

C.2. INTERVIEW RESULTS

C.2.1. Interview Results MIW

C.2.2. Interview Results FLM

C.2.3. Interview Results Management Members

C.3. DOCUMENT ANALYSIS

C.3.1. Document Analysis MIW

C.3.2. Document Analysis FLM

C.4. SITE VISITS

C.3.1. Site Visits MIW

C.3.2. Site Visits FLM

C.1. MAKERSPACE SELECTION

C.1.1. Overview of Makerspaces in Gauteng, South Africa

Space	Location	Link	Comments	About
Tshimologong Makerspace	Wits University Braamfontein	https://tshimologong.joburg/incubation-acceleration/makerspace/	attached to Wits University, targets younger audiences	"We empower young, innovative people to become employable, self-employed or start their own business." "The Makerspace promotes and enables access to innovation through collaborative making, training, upskilling and experimentation / purposeful play (R&D). We are Makers specializing in digital Tech solutions."
Made in Workshop	Randburg Johannesburg	https://madeinworkshop.co.za	"traditional" makerspace, since 2017, no open evenings, info and tours can be arranged	"Providing professional manufacturers, hobbyists, and makers with access to industrial tools and machinery. Our vibrant shared workshop is your new creative home, where your ideas come to life." "The Largest Shared Workshop & Makerspace in South Africa."
House4Hack	Centurion, Lyttleton Pretoria	https://www.house4hack.co.za	focus on IT (?), some selected projects featured on website	"Tuesday night is House4Hack night – bring your projects, open-mind, beer and visit us after 18.00 on any Tuesday night! We are open till late (normally past 12) and it is an opportunity to socialize, hack, dream, scheme with like-minded people. "
MakersVillage , Makersfoundation	Centurion	https://makers.villagepeople.co.za	seems socially focused, not much content on website , seems not active at the moment	"The Makers Foundation believes in a socially inclusive society in which everyone can participate. Welcome to our Makers Family!"
Makers Valley	Lorentzenville Johannesburg	https://www.makersvalley.org.za	socially focused, no typical maker facilities, only very basic tech tools	"The name 'Makers Valley' refers to the growing presence and activities of many forms of creative entrepreneurialism in the area." "The evolving community culture builds on versions of the Makers Movement within the 4th Industrial Revolution which encourages creativity, sharing, giving, learning, participation, mutual support and positive change. "
eKasi Labs	different Townships, Gauteng metropolitan area	https://www.theinnovationhub.com/business-incubators/ekasi-labs-4	focus business incubation in townships, fab lab for prototyping, few infos online	The eKasiLabs programme is an extension of The Innovation Hub's service offering. It is micro innovation hub facilities spread across the 5 economic corridors in Gauteng where we foster and cultivate a culture of innovation and entrepreneurship in townships. The facilities are located in Mohlakeng, Sebokeng, Garankuwa, Soweto, Tembisa, Alexandra, Mamelodi, Kagiso, Kathorus and Mabopane.

C.1.2. Overview of Makerspaces in Munich, Germany

Space	Location	Link	Comments	About
Unternehmer TUM Maker-space	Munich, Garching	https://www.maker-space.de	attached to University (TU) Campus in Munich, focus students but also open to public	"Auf einer Fläche von 1. 500 m^2 in Garching (TUM Campus) und 1. 200 m^2 in München (Munich Urban Colab) bieten wir in unseren öffentlich zugänglichen High-Tech-Werkstätten hochwertige Maschinen, neueste CAD-Software, eine kompetente Crew und große Community aus vielen kreativen und hilfsbereiten Menschen, damit du schnell, kostengünstig und in einem ansprechenden Umfeld an deinem Projekt arbeiten kannst." "Unsere Zielgruppen sind ambitionierte Studierende, Start-ups, Professionals, Kunstschaffende und Selbstständige."
Munich Urban Colab	Schwabing, Munich	https://www.munich-urban-colab.de	an urban branch of the Garching maker-space of TU Munich in cooperation with Munich municipality focused on smart city initiatives and projects?	"Wir wollen nachhaltige Lösungen für urbane Herausforderungen für eine lebenswerte Stadt der Zukunft entwickeln - am Puls der Zeit und im Herzen von München. Gestaltet die Zukunft unserer Städte, inmitten einer starken und innovativen Community!" "Im Munich Urban Colab entwickeln und testen Start-ups, etablierte Unternehmen, die Wissenschaft, Talente und die Stadt München zusammen mit Bürgerinnen und Bürgern innovative Konzepte."
FabLab München e.V.	Laim, Munich	https://www.fablab-muenchen.de	since 2010, first FabLab in Munich all typical maker activities and machinery trans-generational exchange promoted, DIWO-focused (instead of DIY) one focus: kids maker activities and classes	"Die offene Hightech-Werkstatt ist seitdem ein Anlauf- und Sammelpunkt für alle Kreativschaffenden, Techniker, Maker, Tüftler, Erfinder, Schüler, Lehrer und Familien; für einfach ALLE, die am Selbermachen interessiert sind." "BILDUNG FÜR ALLE VON 5 BIS 99+ JAHREN"
Munich Maker Lab	Neuhausen, Munich	https://www.munichmakerlab.de	open evenings Thursdays from 6pm non-profit small capacity: only 7 members allowed in space at the same time (Info 2021)	"The Munich Maker Lab is a non-profit organization, creating an open community workspace, where you can learn, teach, share, make, hack, create, enjoy or simply relax. We try to create an environment that supports the do-it-yourself-, hacker-, and maker-culture by providing workspace, tools and infrastructure to our members and everyone else."

C.2. INTERVIEW RESULTS

C.2.1. Interview Results from MIW

	Participant Background				
Participant Number	**age (range)**	**1) current occupation or last occupation before retirement**	**2) retired?**	**3) awareness of makerspace**	**4) motivations and expectation makerspace**
ZA01	under 40	IT Consultant (recently relocated from Cologne, Germany, to Johannesburg, South Africa)	no	online research for makerspace in Johannesburg area (due to recent relocation), decision for MIW due to accessibility and available tools and machines	finding a similar space like the makerspace in Cologne ("Dingfabrik"), making as hobby, started carpentry during Covid pandemic as a recreation activity
ZA03	73	self-employed since 30 years (IT consulting and product development), last formal position: IT manager, retrenched in 1990, self-employed since then	no	- followed MIW on the web and social media for a while - initially interested in woodworking, now also learning metal work - member since 2 months	- motivated to establish a business through activities at MIW, needs to earn a living - was looking for a workshop, due to downsizing of family home, to complement his own small workshop at home - access to different (new) machines - expected to have more training / onboarding /guidance on machines in the makerspace than what is offered, through the community - MIW is more production-oriented, people have to know how to handle the machines - no capacity to train laypeople in MIW, management is busy running the place, but help whenever they are free; other members have time constraints and business needs, cannot spend time on training other members
ZA04	under 50	business owner, welding (machinery for mining)	no	- first encounter with the space through a seminar at MIW and then realised that space could be "rented" (2023)	- extending his business - extending his own workshop - access to CNC machines
ZA05	under 40	self-employed woodworker	no	- research online for a rentable workshop	- setting up his own business in woodworking - decided to join MIW because of the community, to be able to get advice and training from others, exchange of ideas and experience - learning new skills (metal working)
ZA06	under 50	carpenter	no	- online search	- extension of own workshops - mainly for tools that he does not own
ZA08	60+	- master cabinet maker	no	- through Witwatersrand Woodworkers Association (WWA) meeting which took place at MIW 3 years ago	- negotiated a package deal for WWA members to use the woodworking workshops during some days in the week - extension of own workshop and machines he does not own - upskilling to CNC machinery (business motivation: scaling of production and reduction of staff)
ZA09	50+	Teacher (STEM) and bookstore owner	no	- looked for milling machine for a project that required a special mould in 2017 and found it MIW	- access to machinery - joined the then established instructor program at MIW: gave classes to be able to use the machines for free

	User Innovation			
Participant Number	**5) activities in makerspace**	**user idea / innovation activity / innovation**	**6) own activities or participating**	**7) collaboration with others**
ZA01	mainly carpentry (at MIW: patio furniture)	accomplished (but not in South Africa at MIW, and therefore not considered results): adoption of youtube solutions for own use, e.g. desk, office furniture, fitness bench, cutting boards, chess board other: reports about 50+ members in German makerspace with user innovation in furniture design and customized photovoltaics energy storage	own	getting advice from other members (particularly in German makerspace), not much collaboration experience at MadeInWorkshop (MIW) in Johannesburg so far because of only recent membership
ZA03	- all projects still in the making because he joined only recently - casting project with a friend: sand-pattern making for foundries (large sand-casting companies don't have capacities to manufacture sth like this on short notice) - wooden projects: boards and trays with special designs - vertical CNC mill to fit his new narrow garage	still in the making: - sand castings for small scale foundry to produce conveyor belt links (unavailability, localisation), each link weighs about 100g idea stage: - vertical CNC mill to fit garage, customized to his needs	- cooperation with other like-minded "retirees" from outside of the makerspace, who also need to generate income	- see (6) - would love to get more guidance from other members, see (4)
ZA04	- most of the time business-related mining equipment - recent special project: one-of-one custom-made knock-on hub for a Triumph bike - tools for his business and things for his house - own steel targets for shooting range (are too expensive to buy) - metal spinners (fiddly toy to keep himself busy, for relaxation, creativity, experimentation)	accomplished: - metal spinners (tried out different materials, outside of the norm, balance etc.)	- own	- collaboration with ZA05 on the Triumph project - exchange on metal spinners with one likeminded MIW member - exchange and sparring with a woodworker on table making
ZA05	- most things are business-related, pure manufacturing - combined whiskey smoker and cigar holder that folds into itself - special packaging wooden box for the Triumph bike custom made part of ZA04	accomplished: - whiskey smoker (own design, functionality, one of a kind)	- own	- collaboration with ZA04 on Triumph project - exchange with other disciplines, learns metalworking through the community now - helps others in the space with woodworking questions - facilitates a woodworking class at MIW
ZA06	- purely business-related - private projects pursued in own workshop	accomplished: - nothing done at MIW, but e.g. towel hook with new functionality and design created in own workshop	- own	- business-related collaborations at MIW, other disciplines (e.g. metal working) - some collaboration on projects with ZA08 (where ZA08 learned from him) - exchange of ideas and expertise - sometimes support through MIW management for machine handling, exchange of ideas / expertise
ZA08	- working on a project in furniture field - production of furniture - projects in own workshop / "at home": special light fittings, special doorways for dogs (humans can use, dogs don't), tools - all invented for his own use	still in the making: - customised furniture (a gaming table to be designed and developed together with his son) accomplished projects: - special light fittings - special doorways for dogs (humans can use, dogs don't), - all invented for his own use, not copied version of existing stuff, not inspired by youtube or the likes, not intended to market - special hand tools (plains and drum sanders)	- own	- not for his business, but he helps other members with questions around woodworking - also ran some classes at MIW in the past
ZA09	- initial project: moulding for a child safety seat invention (was discontinued) - current project : special turntable arm inspired by a diy online forum to eliminate friction caused by conventional turntable arms, enabling the stylus to follow the original record groove - furniture for himself - foldable braai (barbeque)	still in the making: self-pivoting turntable arm accomplished: - foldable braai	- own	- not for his own products - he is always happily sharing his expertise on machines etc. with the community members (contributed to a lot of projects in the space, also due to his former position as an instructor at MIW)

User Innovation (continued)								
Participant Number	8a) how did people contribute	9a) benefits of collaboration for project	10a) personal benefits of collaboration	8b) contributions of people outside of makerspace	9b) why no collaboration	10b) potential benefits from missed collaboration	11) outcome of project (own use, adoption by others)	12) commercialisation
ZA01	advice from father-in-law (50+) and other experienced makerspace members (carpentry specialists, mostly 50+), e.g. explaining of different tools and machinery, more emphasis on community spirit in German makerspace	safety (trainings and collaboration), learning how to do it safely, natural exchange of ideas (doing with others)	learning new skills, social exchange (more focus on social aspects due to society structure of makerspace in Germany)	father-in-law no makerspace membership	n.a.	n.a.	own use, presents	no
ZA03	- generating business ideas - bringing in their expertise	- exchange of expertise (from different fields) - building of trust	- learning from each other - problem solving by just talking about it, process it	- see (6) and (8)	n.a.	- would be very open to contribute more to the community, share his expertise - in his opinion: one of the reasons for not collaborating is confidentiality issues reg (IP), people don't want to share and to keep business to themselves	- potential to create a business and earn a living (casting project) - own use in own workshop (vertical CNC mill)	yes (planned)
ZA04	- exchange of ideas - exchange between different disciplines	- contributing different expertise	- helping with each other's businesses - helping each others - learning	- 65 year old friend who helped him with a material problem to build a tool (for a very hard steel to drill through), solution was to use a very soft steel to drill through the very hard steel, which he would not have thought possible	- IP protection (e.g. patented parts to be manufactured for mining industry - details cannot be shared)	- acknowledged that older generations learned and experimented more due to lack of technology, this experience is lost in younger generations (see 8b)	- mostly commercial motives or personal use	- yes
ZA05	- exchange between different disciplines	- contributing different expertise	- learning new skills	n.a.	n.a.	n.a.	- mostly commercialisation of manufactured products or personal use - if there is a market, also looks to commercialise own use creations in future (e.g. whisky smoker) - lack of time to pursue "own" ideas / projects for own use	- yes
ZA06	- exchange and contribution of different disciplines (e.g. metal working)	-	- exchange of ideas and expertise	- yes, through his own workshop	n.a.		- mostly commercialisation of manufactured products - if there is a market, also looks to commercialise own use creations	- yes
ZA08		- funding of new business through family members	- support his business, earn more money (through collaboration with family members) - enjoys to share his woodworking knowledge with MIW members who are approaching him with questions - learn new technology (CNC machinery)	- family (for customised furniture), who will use it and is looking to commercialise it	- protection of business	n.a.	- running of his business	- yes
ZA09	n.a.	n.a.	- learn new technologies - appreciates help of the community - also likes personal exchange	n.a.	n.a.		- braai: own use and friends/ family who asked him to replicate it for them - turntable arm: applied for provisional patent in the US	- yes, but not primarily (own use first)

	Active Ageing			Age inclusiveness of makerspace		
Participant Number	**13) motivation to pursue project**	**14) Which skills / competences used**	**15) personal benefit from makerspace activities**	**16) special initiatives for older people**	**17) examples of age inclusiveness or lack thereof**	**other comments**
ZA01	fun and hobby, making things for own use or presents, making something productive, learning new skills	newly acquired carpentry skills, affinity for working with wood	fun, spending time meaningfully	not aware of special activities for older people	no	makerspace in Germany functioned as a registered society, which requires members to contribute services and tasks to the society, for the benefit of all members and has far more affordable membership fees than MIW in ZA, more focus on "hobbyist" members more emphasis on training activities in German makerspace (by members for members) MIW more business oriented, buy membership as a service, focus on industrial machinery, no hobbyist members focused
ZA03	- need to earn a living, creating a business	- all of his experience and skills - believes in lifelong learning	- learn new skills - earning an income - tangible results (other than in IT, you can touch your product), accomplishing things with your own hands	- very good initiatives to win new members regardless of age		needs to still generate income, because pension does not suffice
ZA04	- business	n.a.	n.a.	- no special activities, everybody is welcome	n.a.	- older people are not always open to learn / to change, they stick to their ways, causes friction in the community, annoys everyone else
ZA05	- mostly business	n.a.	n.a.	- paid no special attention to this - open to everyone	- community will support older members to learn CNC techniques	- older people do it their way, don't want to use CNC machinery, they don't progress - no older members in his classes
ZA06	- mostly commercial reasons	- professional carpentry skills	n.a.	- open to everyone	- no-one debates age at MIW	- takes a lot of forbearance to collaborate with older experts in the profession (they do things differently)
ZA08	- mostly commercial reasons	- woodworking ran in the family, learned the craft through his father	- upskilling in other fields than woodworking (CNC machines) - exchange with community members (from different fields), also online (via MIW the whatsapp group)	- nothing specific for older members, but everyone is welcome	- MIW is age-inclusive, but no special anecdote	
ZA09	- self-taught	- self-taught skills and professional knowledge (STEM teacher, IT and accounting)	- joining a community of likeminded yet diverse people - personal development - hobby, enjoyment - business	- only special arrangement with the WWA members, but they don't typically mix with MIW members	n.a.	- acknowledges the broad skill and expertise spectrum of the MIW WhatsApp group - WhatsApp group also facilitates collaboration on business projects between members - acknowledges skill / knowledge exchange between older and younger members for mutual benefit of both

C.2.2. Interview Results from FLM

	Participant Background				
Participant Number	**age (range)**	**1) current occupation or last occupation before retirement**	**2) retired?**	**3) awareness of makerspace**	**4) motivations and expectation makerspace**
DE01	50+	early retiree ("Privatier"), Software Engineer before retirement	yes	- through a trade fair and a maker fair in the area - and through friends who were members before him - visited the open day at FLM	- interested in crafting - access to machinery - playing with opportunity of new technology without needing to "produce" something (hobbyist approach) - not expensive (membership fee) - community, social belonging
DE02	61	studied graphic design but active in very diverse professions	no	- through radio broadcast about the makerspace	- making stuff, repairing things - tinkering
DE03	65	industrial product designer	yes	- scans makerspace scene in Munich since 2012 - joined another makerspace first (was too expensive, too professional, too business oriented) - now tries FLM as a hobbyist / tinkerer since retirement - only recently joined FLM	- very open to learn additional traditional (metal working, sewing) and newer technologies (3D printing, lasercutting etc.), not focused on special outcome for the moment - most interested in makerspace community, hopes for fruitful exchanges with members, to help him learn new technologies - also interested in education program at FLM
DE04	60+	industrial product designer	yes (since 5 years)	- through online research for open workshops	- enthusiasm for crafts and making - inspired by his father (was an engine mechanic) and his workshop - access to machines which one cannot afford to own / store in own workshop - wanted to make things that are either not available or too expensive to buy
DE05	63	electrical engineering master technician	no	- at a trade fair in the area	- wanted to learn 3D printing, lasercutting - learning new technologies, staying up-to-date - looked for meaningful recreation activity next to the job
DE06	62	Carpenter	no	- visited open day at FLM	- wanted to learn lasercutting - learning new technologies, staying up-to-date
DE07	under 30	Student	no	- online research for makerspaces during covid pandemic - decision for FLM because other makerspaces were too expensive and he new some people at FLM	- space to pursue tinkering activities with / in a community - socialising - access to new machinery
DE09	34	electrical engineer	no	- researched for makerspace near his apartment	- knew makerspace concept from other cities in Germany - looked for a community of likeminded peers for tinkering - wanted to be part of a maker community

	User Innovation			
Participant Number	**5) activities in makerspace**	**user idea / innovation activity / innovation**	**6) own activities or participating**	**7) collaboration with others**
DE01	- tinkering with special 3D folding cards at the moment - experimenting with 3D printing	n.a.	- own activities	- asks for advice from other members (mostly fabrication/ manufacturing skills), and helps where he can in return
DE02	- a lot of repair work - participating in FLM open hardware projects - customized solutions for own use (see right)	accomplished: - customized version of an IKEA-inspired wall hook system - customized tool cabinet from old bedside tables still in the making: - customized soldering aid ("third hand") based on a push-puppet-mechanism, inspired by discontent with market-available soldering aids idea stage: - customized tool storage backpack	- mostly own projects - few projects "for" FLM or its initiatives (e.g. participation in open hardware projects, e.g. "eWindow", "citizen lasercutter")	- see (6) - frequent exchange between members - it is possible to learn almost anything through the community and exchange among members - more exchange from young to old, younger members are more knowledgeable of new technologies
DE03	- plans to start with activities in lasercutting, 3D printing, plasma cutters - envisioned projects: - special bike gloves with integrated indicator lights for better visibility in traffic - clothes/ fabric that alter their appearance / surface according to emotions of the person who wears them (inspired by octopi skins)	idea stage: - special bike gloves with integrated indicator lights for better visibility in traffic - clothes/ fabric that alter their appearance / surface according to emotions of the person who wears them (inspired by octopi skins)	- own, but also open to collaboration	- definitely wants to look out for collaboration in the makerspace
DE04	- customized motorbike lifter, which enables him to move his bike in his garage for repairs and fittings - customized fittings for home appliances - spare parts (3D prints and metal) - customized balcony railing - course facilitator for metal workshop (e.g. lathe) - etc.	still in the making: - customized motorbike lifter accomplished: (- customized balcony railing)	- mostly own, but consults community members for questions on metal working	- consults community members for specialised questions
DE05	- making spare parts for home appliance - some woodworking, sewing - does not use his home workshop anymore, better infrastructure at FLM	accomplished: - contributed to FLM access system (open hardware)	- own for home use - participating in FLM special projects and maintenance team	- learned 3D printing skills through the community (mostly younger members)
DE06	- mostly lasercutting: - give aways for a basketball club he is volunteering in - toys for his grandson - decoration for house and garden - soap bubble machine	accomplished: - knights castle for his grandson - special dice toy for his grandson - develops safety tools for carpentry work at FLM for other members to use and handle carpentry machinery safely	- own	- helps and shares carpentry knowledge with other members, especially safety measures - builds workbenches for the FLM wood workshop - collaboration with other member for electronics (e.g. soap bubble machine)
DE07	- fabricates things he cannot buy, which are not available on the market or are too expensive; e.g. customized "wire chamber" and "scanning tunnelling microscope" to share with open hardware community	still in the making: - customized "wire chamber" - customized scanning tunnelling microscope	own and participating (in FLM special projects), "do it with others"	- for FLM projects - helps maintaining machinery in FLM
DE09	- a lot of electronics, 3D printing - community work - participated in FLM access system project	accomplished: - FLM access system ("only available open source solution with that kind of security level") - provided the hardware components for the system	- mostly participating in FLM projects	- yes, a lot

User Innovation (continued)								
Participant Number	**8a) how did people contribute**	**9a) benefits of collaboration for project**	**10a) personal benefits of collaboration**	**8b) contributions of people outside of makerspace**	**9b) why no collaboration**	**10b) potential benefits from missed collaboration**	**11) outcome of project (own use, adoption by others)**	**12) commercialisation**
DE01	n.a.	- efficiency	- social exchange - learning new skills	n.a.	- would be open, but no opportunity as of yet	n.a.	- own use - presents for friends	- definitely no
DE02	n.a.	n.a.	- good conscience of "giving back" to FLM as an association (open hardware projects)	n.a.	n.a.	- commercialisation of projects would be an opportunity that he misses due to lack of entrepreneurial spirit	- own use	- no, would be open and sees potential in some of his projects, but lacks entrepreneurial spirit
DE03	n.a.	- mindset: 1+1=3, i.e. if a team / collaborators work well together, the potential of great outcomes rises	- foresees great potential to learn from other FLM members	n.a.	n.a.	n.a.	- own	- not intended
DE04	n.a.	- exchange of skills and experience	- learned soldering through the community, which he now uses for his own projects - facilitates own courses at FLM for metal workshop machinery (e.g. lathe)	- develops motorbike lifter together with his son	- FLM is scarcely frequented by members during weekdays (when younger people need to work)	n.a.	- own use - intends to provide balcony rail design as open hardware solution (but too complicated for now)	- no
DE05	n.a.	n.a.	-sharing own experience, being able to contribute	n.a.	n.a.	n.a.	community use	no
DE06	- consults other specialised members e.g. on electronics for soap bubble machine	- exchange of skills and experience	- socialising - joint problem solving, exchanging views with other members	n.a.	n.a.	n.a.	- own use and family and friends - no intention to share e.g. design of his knights castle with a wider community (open hardware communities)	- no
DE07	- consults other specialised members e.g. on electronics	- benefit through wealth of experience from other members, saves time in project, finding solutions quicker through consulting with others	- social exchange - learning new skills	- through exchange in online forums	n.a.	n.a.	- believes in sharing knowledge, experience and results with a wider community, firm believer in open hardware movement - shares through own website and online communities	- no, not yet, sees potential in some of his projects, but lacks entrepreneurial know-how
DE09	- software part for access management system was contributed by other members - admin support through Sonja (member aged 50+): documentation & fund raising	- finding solutions quicker through joint efforts - solution better accepted by FLM community if multiple members are involved in solution shaping	- personal accomplishment - being able to contribute to community safety	n.a.	n.a.	n.a.	- implemented at FLM for the whole community, continuous improvement and optimisation - a lot of requests from other communities through open source forums	- no, (open source)

	Active Ageing			Age inclusiveness of makerspace		
Participant Number	**13) motivation to pursue project**	**14) Which skills / competences used**	**15) personal benefit from makerspace activities**	**16) special initiatives for older people**	**17) examples of age inclusiveness or lack thereof**	**other comments**
DE01	- staying up to date with latest technology - tinkering, crafting, "making stuff"	- hobby crafting skills	- social belonging - staying up to date with technology - spending time meaningfully, with the community	- no	- no differentiation between young and old, it is not an issue	- repairs the FLM equipment, e.g. sewing machines, compressed air machine, pipes - maintenance is not focused by younger members (against registered association ethos)
DE02	- own need (e.g. soldering aid) - joy of tinkering - learning new things - contributing to the good of FLM (FLM projects)	- "jack of all trades, master of none" - curiosity, joy of tinkering	- joy of tinkering - staying up to date with technology, learning new skills - being able to craft the things he needs	- open fab labs, presence	- nothing special	- sees potential in older members to be especially useful to the association, because they possess wealth of experience and knowledge (e.g. conventional fabrication knowledge, knack, sourcing for materials, repair spirit)
DE03	- joy of design - own creativity which needs to be channelled - fascination of new technologies - no commercial intent	- carpentry skills - design skills - 3D modelling	- spend time meaningfully - use additional time for own interests - make use of own skills for own project - social aspect of joining a community of likeminded individuals (makers)	- no special activities noticed, everyone is welcome	- did not yet spend enough time at FLM to give examples	- only recently joined FLM, new member
DE04	- additional time, enjoyment - use skills for his hobbies	- uses his professional skills (industrial design) - skills obtained from his father (also repairs his own car)	- learning new skills (e.g. soldering, lasercutting, 3D printing) from younger members - enjoys sharing own skills with the community - contribute to the community / association - enjoyment of being able to make stuff, make things he needs - sharing his own skills - being part of a community, getting in touch with new people (cross-generational)	- nothing specific	- nothing noticed	- member since 12 years, but became more active member only since retirement, because additional time available after retired from his job - exchange between generations hampered due to different attendance times at the makerspace
DE05	- keep oneself busy - experimenting with new technologies	- electrical expertise	- being able to contribute to the community, FLM infrastructure - learning new skills / technologies - spend time meaningfully, finds relaxation in tinkering	- no special initiative - older people find their way to FLM alone, everybody who looks for a place like this finds it	n.a.	- engages in community work for FLM, member of the 3D printer maintenance team - established maintenance team for machines at FLM - established the buddy system at FLM (mentoring for new members)
DE06	- learn something new - staying up to date with latest technologies	- carpentry skills - curiosity in new technology in the field	- pride of being able to contribute (e.g. give aways for basketball club) - spend time meaningfully - being part of a community - collaborating with other members - helping others with own knowledge / skills - contributing to FLM association	- no, but all have curiosity and joy for (latest) technologies and tinkering in common, regardless of age	- no ageism, very inclusive	
DE07	- being able to built it on his own - joy of tinkering with technology, find their own solution	- university studies, self-trained tinkering skills, also learns a lot in addition in online forums	- being part of a community - collaborating with other members - pride and satisfaction to help others e.g. in open hardware online communities (peer feedback)	no, everybody is welcome	nothing noticed	- teams up with other members for machine maintenance - acknowledges wealth of experience in older generation, e.g. of DE04 on metal works machinery, learned a lot from him "cannot be googled", can only be passed on through collaboration, also regularly consults with DE06 on any lasercutting questions - DE04 donated a lot of machinery to FLM (see also Birgit's comment, DE10) and enjoy that machines are being used also by younger members
DE09	- being able to contribute to a community project - challenges to find customized hardware solutions	- professional skills (electrical engineer) - 3D printing skills	- social belonging - exchange and various input from community members, inspiration - recognition of FLM community and open source community (for access management system)	no special initiative, everybody is treated equally at FLM	- mentions DE04 as an example who became a member and also donated his machinery to FLM after retirement	

C.2.3. Interview Results Management Members

	Participant Number	name	1) current role in makerspace	2) overview of space	3) number of members	4) primary target groups	5) age diversity in makerspace	8) examples of collaboration between younger and older members	9) how do older members contribute to activities / innovation activities?
MIW	ZA02	Henry Levine	CEO and founder of MIW	- open access workshop & shared fabrication studio targeted at individuals or businesses to manufacture products - for-profit-organisation, "corporate makerspace" - no shared management, no democracy patterns like in other makerspaces - its foundation inspired by makerspace in the US, but tailored to SA requirements	- no membership counts (roughly 300-400 active and inactive users) - metric used is unique visits per day (usually 20-25); measured through machine booking system available on website	- small manufacturing companies or individuals - few regional and larger corporations (outsource their manufacturing to MIW) - few resident companies which rent additional office space at MIW - very few hobbyists (smallest group)	roughly 20-75	- one example of a trained CNC wood worker who visited a few classes for traditional woodworking and "worked his way backwards", because he felt he needed these skills to complete his expertise in woodworking	- give advice on the side - sometimes in a rather condescending way - best contributions of those who "upgraded" to new (CNC) technology, "best of both worlds"
	ZA07	Joshua Lotter	COO of MIW (since 2018)	- a makerspace providing industrial tools and equipment for manufacturing and prototyping	- indication: 136 members on the MIW WhatsApp group, approx. 100 of them active (returning members) - 15 day membership is the most favourite membership package	- very broad spectrum: prototypers to manufacturers, to hobbyists	- from teenagers to people in their 60's/70's - approximately 5% are 50+ - MIW hosts regular meetings of the Woodworkers Association of the Witwatersrand (WWA - WWA members are not members of MIW individually, but can also use the woodworking workshop, most WWA members are 50+)	- collaboration happens all the time, not necessarily between younger and older members due to membership structure - dynamic problem solving: gather knowledge of members in the space if necessary	- most members are focusing on their own business, but also: - giving classes - bring apprentices to the space - mentions one older member being "hard-headed" - wants to do things his way, not open to other solutions, but also sees this member potentially getting more involved and giving back to the community in IT specific questions (as this was his professional background) - mentions another older member very knowledgeable on all things woodworking who is often consulted for his practical advice - prefers to share knowledge with other / younger members
FLM	DE08	Andreas Kahler	Founder and Chairman of the board of FLM	a makerspace with three focus areas: - makerspace / open workshop with membership structure - education, - research projects - foundation inspired by original fablab movement in conjunction with 3D print developments, open hardware and self-replicating machinery back in 2010 as one of the first Fablabs in Germany	- approximately 380 members, of which approx. 50 visit at least once a month	- everyone interested in making and digital production, from the very young to older people, no specific target group defined	- most members between 25-35 years, but generally very diverse	- happens almost daily naturally, intergenerational exchange	- retirees often use their time to work on own project (recreational, useful use of additional time after retiring) - learning new skills, technologies - socializing
	DE10	Birgit Kahler	Co-founder, board member and course instructor, focus area education	- makerspace / workshop: inspired by collective making and possibility to produce spare parts for broken things - education: bring making into schools and school curricula - research projects	- approximately 380 members, of which 100 are active members, and a lot of younger members	- at the makerspace: everyone welcome - in education: focus on schools, because more kids also from disadvantaged backgrounds can profit	- diverse, majority of youth and student members	- happens all the time - two special examples: development of access system to machinery for members and open hardware windows	- acknowledges treasure trove of experience of older members, sometimes does not transfer well, needs canalisation - older people are more willing / accessible in providing advice and help to other members - some also facilitated classes in the past, but not always successful - if you are in expert in something, does not mean you are a good "teacher" for kids

	Participant Number	name	10) unique skills experiences, contributions of older members	11) active recruiting of older members	12) any specific activities targeted at older individuals	13) any specific activities targeted at encouraging collaboration between young and old?	14) generally more self-conducted or collaborative projects	14a) benefits of collaboration for project	15a) involvement of people 50+?	16a) special benefits for project from older member involvement	17a) personal benefits of collaboration	14b) contributions of people outside of makerspace	15b) why no collaboration	17b) other engagement between members	other comments
MIW	ZA02	Henry Levine	- use of conventional tools and machinery - own tool making (tool and die makers) - share their experience "on the project" (finding solutions)	some initiatives rather speak to older potential members, e.g. phone call marketing, web forums (rather than linked-in or Instagram)	nothing specific	- nothing in particular - not forced, develops naturally in the workshop - some older members give classes to younger members (e.g. panel saw safety course)	- mixture: some individual, some do collaborations (e.g. outsourcing of specific disciplines or getting things done in time, but reasons for collaboration are more business-driven)	n.a.	n.a.	- one example of a tool making process with very hard steel, advice from an older tool maker who specialised in hard stell grinding, he used a soft steel to grind a very hard steel tool, that can only come from experience and provided the unique solution for the problem of the young tool maker	n.a.	- see 16a) answer	- profit, want to do business for themselves	n.a.	- no commissioned work done by MIW themselves, only provide machinery
	ZA07	Joshua Lotter	- experience - traditional manufacturing methods	- yes, e.g. via facebook advertisements - but sometimes hobbyists are overwhelmed by the professional set-up of the makerspace - it is not necessarily for fiddling after you retire	- not specifically - classes are usually a good way to recruit new members and are open to everyone - father's day initiative	- collaboration is always focused, not necessarily between generations - management introduces different members to each other who might be able to help/support each other	- both	- growing their business	n.a.	- sharing of experience, gaining new skills	- sharing of experience, gaining new skills, different perspectives on solution shaping - collaboration not always for the benefit, sometime bad blood	n.a.	- protecting own business, no time	n.a.	n.a.
FLM	DE08	Andreas Kahler	- do not generally differ from other members, everyone brings knowledge and shares	- nothing specifically targeted at older people, but some activities attract older people, e.g.news coverage in German newspaper (Sueddeutsche Zeitung)	- reduced membership fees for retirees, but those also exist for students	- repair cafe was an initiative, but not continued anymore	- both: individual and collaborative projects	- exchange of ideas, knowledge and experience leads to better project results - (informal) knowledge transfer in the community is focused in FLM - do-it-with-others instead of do-it-yourself	n.a.	- exchange of knowledge - socialising, making friends, community - making use of time meaningfully - link to personal interests	n.a.	n.a.	- some members just prefer to work on their own	n.a.	n.a.
	DE10	Birgit Kahler	- huge experience in older generations of makers - craftsmanship, sometimes handed over in family businesses over generations (skills need to be preserved)	- nothing specifically, but interesting target group because of experience and sometimes also equipment, some members donated their machinery from their own workshops to FLM	- open Fablab best initiative to recruit new members, see all machinery in action, try stuff, and usually yields up to 10 new members afterwards, but not focused on older people	- meet-and-make-events are a good opportunity, but discontinued during Covid pandemic and not necessarily set-up for intergenerational exchange - sees no need to focus collaboration between young and old, because happens naturally - more effort needed to increase gender diversity (women) in FLM	- both: individual and collaborative projects - collaborative projects are often linked to FLM	- exchange of knowledge - you will find at least one member with knowledge in the most random field of expertise, very diverse knowledge pool	- those who want to contribute do it regardless of their age	n.a.	- socialising - feeling of self-worth after retirement - pride to contribute, do something meaningful	n.a.	n.a.	n.a.	- focused on education activities of FLM, not too much insight in makerspace activities

C.3. DOCUMENT ANALYSIS

C.3.1. Document Analysis MIW

Website Analysis Made In Workshop	
Website URL	https://madeinworkshop.co.za
Date of analysis	23.05.2024
Layout and structure	Home page, About us section, Machines, Pricing, Workshops, News, Contact details
Mission and goals	*"Providing you with the tools, machines and the space for you to design, build and fabricate your product, project or idea.* *Made In Workshop (MIW) is a shared workshop and fabrication studio. Not just a workshop with a collection of tools and machines but a community of like-minded fabricators, manufacturers, and designers."* → emphasizes community and /workshop focus
Target audience	*"Industrial tools and machines and not DIY"* (from machines section) → Primary focus on industrial machine use, professional manufacturing, not DIY "*membership options that cover all types of customers ranging form professionals to hobbyists"* (from pricing section) "*From a cash flow perspective, a makerspace is ideal for startup entrepreneurs looking for workshop space and equipment without the high upfront costs."* *"The advantages of spaces like these – like Made In Workshop – is that they're geared towards innovation and entrepreneurship."* **(**Quotes from MIW CEO, Henry Levine, in different news section articles) → primary focus on SME makers → no age specific target group hints
Membership schemes	3 options available: 3-day membership (valid over a month) 15-day membership (valid over 2 months) Monthly membership (incl. storage and dedicated working area) Plus joining fees for first-time members → No discounts / special packages for retirees / pensioneers
Projects and events	Selection of regular classes offered to non-members and members, mostly intro courses to techniques and machines (e.g. woodworking, metalworking, welding, laser cutting) Some classes aimed at families (parents with kids), some for youth Social media marketing classes → no special events for older members / potential makers
User testimonials and engagement	Some articles posted on member usage of the space in the News section → very diverse, but no special articles about older makers/ members

Resources and support	See projects and events (classes) *"We often have new members who do not know how to use the machinery. We provide them with training, but we often find that their interaction with other members improves their confidence and abilities on the machinery. If we have an open attitude towards training and spreading knowledge on manufacturing techniques, users become more willing to help each other. This is the main reason we provide most of our training on the machines free of charge to members."* Quotes from MIW CEO, Henry Levine, in a news section article on makerspaces as co-working institutions
Visual content - demographic representation	Mostly young males, but most focus on facilities and machinery
External collaborations	No partnerships except for business members presented in news section
Facilities presented	Detailed "machines" section with overview profile of all major machines in the space *"Seven studios* *Four dedicated workshop spaces* o *Metal fabrication workshop* o *Woodworking workshop* o *Engineering workshop* o *Assembly workshop* *Private storage* *Spray booth* *Fully industrial, manufacturing-quality machines* *Dedicated 460 amps, three-phase power"* From a news article about move to new premises, March 2020
Own social media accounts listed on website	Facebook Instagram Youtube

Social Media Account Analysis Made In Workshop	
Platform & user name/handle	facebook Made In Workshop
Date of analysis	23.05.2024
Visual content	Pictures and videos of workshop spaces and machinery Videos featuring Henry Levine, CEO of MIW, promoting MIW Graphics promoting classes Few selected maker products presented Only few pictures featuring older people (e.g. participants in classes)
Hashtags and keywords	Hashtags only used since beginning of 2024 Nothing particular to older members / prospect members
Events and community feedback	Promotion of classes (metalworking, welding, woodworking, laser cutting, etc.) One class in 2023 offered by an older instructor Nothing particular offered to target older people
Other	Focus on presentation of machinery and facilities of the space, as well as promotion of classes and membership packages

C.3.2. Document Analysis FLM

Website Analysis FabLab Munich	
Website URL	https://www.fablab-muenchen.de
Date of analysis	15.11.2024
Layout and structure	Home page, About us section, lab presentation section incl. workshop facilities and machinery overview, Join us section incl. membership information and events, Education section, Calendar section, Wiki, Contact
Mission and goals	"*The open high-tech workshop has since become a meeting and gathering place for all creatives, technicians, makers, tinkerers, inventors, students, teachers, and families—for simply EVERYONE who is interested in making things themselves."* "*True to the FabLab motto 'Make - Learn - Share,' it is also a place where people can learn and teach, as well as exchange ideas with like-minded individuals."* *"Education for all from 5 to 99+ years"*
Target audience	*"for simply EVERYONE who is interested in making things themselves"*
Membership schemes	Different options available: Single membership Discounted membership (for students, unemployed, retirees) Family membership (for up to 5 family members) Supporting membership
Projects and events	Introductory courses on machines and digital fabrication techniques offered to members and non-members on a regular basis (e.g. laser cutting, 3D printing) Get-in-touch sessions for potential new joiners on selected Monday evenings (during member meet-ups) Open Fablabs once or twice a year for non-members (open day) Focus on kids/youth education: over 200 workshops for schools and private courses offered on weekends and during school holidays (fablab kids) Special community projects: open hardware development, DIY electronics prototyping, and STEM empowerment for young girls
User testimonials and engagement	Introduction of the board members and instructors for educational activities Potential members are being motivated to contribute to the association and wider maker community by engaging with other in the space and wider community, share their skills, document their work, join the educational efforts as instructor or supporter
Resources and support	See projects and events (classes)
Visual content - demographic representation	Focus on Making in action, machinery and facilities, Those pictures displaying people: focus on kids / youth, some also display older makers
External collaborations	Comprehensive list of donors, supporters (focus educational program) Special Cooperations for open hardware projects e.g. with Fraunhofer Institute and universities

Facilities presented	lab presentation section incl. workshop facilities and machinery overview featuring a comprehensive inventory of available machines and tools incl. how to use videos and a 360° visual tour of the lab
Own social media accounts listed on website	Facebook Youtube Instagram Github LinkedIn Muenchen.social Bluesky

Social Media Account Analysis FabLab Munich	
Platform & user name/handle	facebook FabLab München e.V.
Date of analysis	15. + 16.11.2024
Visual content	Focus on education activities Pictures and videos of workshops with kids, incl. results Graphics promoting classes and events
Hashtags and keywords	No hashtag use Tagging of relevant cooperation partners
Events and community feedback	Promotion of classes and school programs Regular reach-out for support / donors for education program Nothing particular offered to target older people
Other	Not specifically targeting the member / potential membership base for the association, focus on educational offering for kids and youth

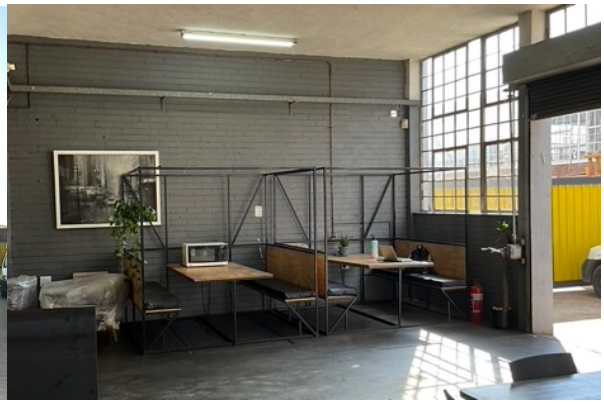
C.4. SITE VISITS

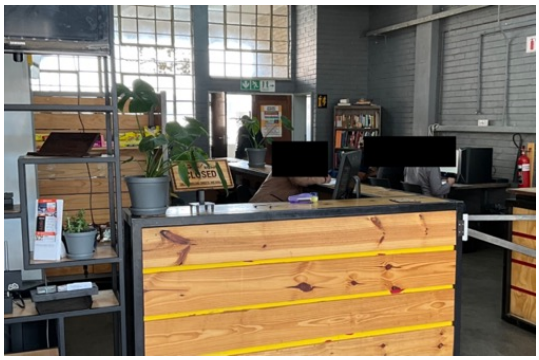
C.4.1. Site Visits MIW

Documentation Site Visits Made In Workshop	
Dates	27./28./30. May 2024 05./06./08. June 2024
Location	Made In Workshop, 10 Naaf Street, Strydompark, Randburg, Johannesburg, South Africa
Size and Layout	1 100sqm, 2 storey industrial building communal area with tables chairs, benches, coffee shop, hand tool area 4 different workshop areas, + office space + class rooms +
Workshops and equipment	Metal workshop and laser cutter area Individual work station area Woodworking workshop Paint booth Industrial CNC machines, conventional woodworking and metal working machines, hand tools, computer work stations
Age Diversity of members observed	mostly male, under 50 years, approx. 1-2 out of 20 people present is 50+ exception: WWA workshop (08. June) → more 50+ people on site
Interactions	Lots of business-related interactions, members know each other, a lot of interaction between members and management, business meetings in communal area No interaction between WWA workshop participants and core MIW member base (08. June)
Age-specific features	Nothing specific
Other noteworthy observations	Communal area hosts a cafe which is frequented by neighbouring businesses

Pictures of MIW

















C.4.2. Site Visits FLM

Documentation Site Visits FabLab Munich		
Dates	18. November 2024 + 02./09./16. December 2024 (member area, all visits during weekly member meet-ups on Monday evenings) 22. December 2024 (only visit to the education area of FLM)	
Location	FabLab München e.V. Gollierstraße 70, 80339 München, Germany	
Size and Layout	Approx. 500 sqm, ground floor area in a business park, industrial building ground floor Dedicated member area and separate education area Member area with 5 rooms / workshops + storage area Education area with 5 rooms/ workshops	
Workshops and equipment	Member area: Metal workshop Wood workshop Laser cutter area Electronics area 3D printer area CNC machines, conventional woodworking and metal working machines, hand tools, computer work stations, soldering and electronics work stations, sewing machines, communal area and drinks vending machine	Education area: Computer work stations 3D Printers Lasercutter Preparation and storage area hand tools exhibition shelves Kitchen Class rooms Overall cleaner, more colourful and child-friendlier set-up than member area
Age Diversity of members observed (member area)	Age-diverse community on weekly Monday evening member meet-ups (young adults, middle aged and 50+), predominantly male, approx. 4-5 out of 20 people present is 50+	
Interactions (member area)	Members know each other well, joint dinner & drinks in communal area, young adults mostly focus on IT and electronics activities in communal area, older adults mix and mingle but put more focus on their projects or maintenance work in the specialised areas, more outreach for help or consultation/ interaction from old to young	
Age-specific features	Nothing specific	
Other noteworthy observations	Maintenance of machines and workshop rooms done diligently by older members, new potential members are invited to tour the lab on Monday evenings (hosting done by different members)	

Pictures of FLM member area











Pictures of FLM education area







