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The Role of Sense of Community on Knowledge Sharing Behavior in Makerspaces

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THE ROLE OF SENSE OF COMMUNITY ON KNOWLEDGE SHARING BEHAVIOR IN MAKERSPACES

A Dissertation

by

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ABSTRACT

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Using the Sense of Community Theory and the Knowledge Sharing Behavior this study explores the motivation of members of makerspaces to share technical and non-technical knowledge in this type of creative spaces. In makerspaces, individuals are expected to share what they know with others to solve design and fabrication problems. Most of the sharing occurs when experienced makers transfer knowledge to the novice makers. This behavior is what motivates this dissertation. Unlike traditional knowledge sharing that happens in formal organizations, makerspace participants engage in the knowledge sharing behavior differently; they share in an informal manner creating value for makerspaces and its members.

This dissertation explores knowledge sharing behaviors as outcome of two factors of the sense of community theory construct. More specifically, what is the role of personal investment and emotional safety in the sharing of technical and non-technical knowledge. Using data collected from a panel using Amazon Mechanical Turk (MTurk), this study found meaningful relationships. First, the efforts a member of a makerspace invest in the makerspace is a meaningful predictor of their technical and non-technical knowledge sharing behavior. Second,

cognitive, and affective trust are meaningful predictors of knowledge sharing behavior in makerspaces for technical and non-technical knowledge. Additional findings related to the moderation variables of makerspace type, use of public amenities and entrepreneurial motivation are included in this study.

KEYWORDS: Sense of Community, Maker Community, Knowledge Sharing, knowledge acquisition, Product development

DEDICATION

Completing my Doctoral Degree is the result of many years of sacrifices and efforts from many individuals that have touched my person during my academic journey. Specially, my wife Susana, my Son Jesus, and my mother Bertha. They motivated and supported me during my journey. Friends, professors, and colleagues also inspired and supported me by during journey. Thank you for your care, patience, and love.

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CHAPTER I

INTRODUCTION

Background of the Research Problem

In the past, independent innovators worked on their own spaces such as garages and basements. One potential problem for that type of setup is that those innovators have limited access to critical resources that help their innovation flourish and go to market. Makerspaces began emerging around the world providing a gathering place for this type of innovators (Gershenfeld, 2005). These spaces are community workshops where individuals pay membership fees to gain access to tools and workspace and experiment with variations on their designs without spending much time and money (van Holm, 2015a, p. 25). In this type of spaces, individuals are expected to share what they know with others to solve design and fabrication problems (Aldrich, 2014). The movement is about sharing designs, working collaboratively in a shared space, raising funds from a broad community of interest, or presenting your project at events such as Maker Faire (Mohomed & Dutta, 2015, p. 41). Makerspaces provide a flexible and creative environment that support members when they transform ideas into reality (van Holm, 2015a, p. 28).

Makerspaces and the maker movement has caught the attention of mainstream media. Lou (2016) wrote an article for Popular Science describing the trend of makerspaces as "exploded in popularity all over the globe—user-reported numbers show nearly 1,400 active spaces, 14 times as many as in 2006". Louise Stewart (2014) did an article for Newsweek

Magazine explaining how primary and secondary education schools may look in the future if the learn by making strategy is adopted. The author presented the case of San Diego's High-Tech High that adopted a non-traditional strategy. According to the author, the school "looks something like a cross between a science center and a museum of modern art created by kids in grades K-12". Bajarin (2014) wrote an article for Time Magazine presenting an extract of an interview with Intel's CEO Brain Krzanich. In the interview, the CEO of Intel explained why the company was presenting at Maker Faire; "This is where innovation is occurring, and Intel has a great interest in helping spur innovation". Simmi P. Singh (2018) in an article for MIT Sloan Management Review presented the following four elements of the maker movement that are relevant for the business environment: 1) nurturing the creativity on the individual; 2) fostering networking between makers and others; 3) erasing knowledge and discipline silos; and 4) giving value to playing with innovation and iteration.

Makerspace are initiated as a standalone infrastructure or as part of anchor facility by a "sponsor". Some makerspaces emerge as the result of the organic organization of members and the creation of a governing body (formal or informal) of the space. In other cases, makerspaces are founded as a private sector venture (e.g. TechSpace – no longer in operation). Other makerspaces are the result of a decision of an anchor sponsor to initiate the space. Some of those anchor sponsors are public libraries, universities, or public schools. In most of the cases, members of makerspaces pay dues in order to access tools and workspace (van Holm, 2015a, p. 25).

Browder, Aldrich, and Bradley (2019) decompose the maker movement in the following dimensions: 1) actors that collaborate; 2) knowledge created and shared; and 3) shared technological resources. They argue that the knowledge sharing dimension is the most important

and that it functions as a mediator of the outcomes of makerspaces. As explained by the authors, knowledge is where social and technology converge to support the creation, modification or repair of artifacts.

Makers gain from knowledge sharing in diverse settings, and that it is important to analyze and understand the ways it contributes to the enrichment of members. Knowledge is shared in makerspaces via formal and informal encounters. For example, members have access to formal classes ranging from introductory courses to mastery level seminars on the use of equipment and materials common at the makerspace. They are also required to take some courses to certify that the member can use the tools available in the space. The second way knowledge is shared is through informal mechanisms. For example, members have access to other members to talk about projects, ask directions on how to advance their projects and develop a network of resources related to skills, experience and training (van Holm, 2015a, p. 25).

This study will investigate the motivation of members to share knowledge. I will use the work of McMillan and Chavis (1986) on sense of community. They define sense of community as ”a feeling that members have of belonging, a feeling that members matter to one another and to the group, and a shared faith that members' needs will be met through their commitment to be together” (McMillan & Chavis, 1986). The theory is presented with the following four dimensions: 1) membership refers to the feeling of belonging or a feeling of personal relatedness; 2) influence refers to the feeling of making a difference in the group; 3) integration and fulfillment of needs refers to the feeling that individual needs will be met by being part of the group; and 4) shared emotional connection refers to the connection of shared histories, places, time, and experiences (McMillan & Chavis, 1986).

Statement of the Problem

Makerspaces are organizations that attract members because of the social interactions, knowledge and technology resources that are available (Browder et al., 2019). Knowledge is the most important resource at a makerspace because it mediates the outcomes of how members advance their projects (Browder et al., 2019). Members are the agents that share knowledge to other members in a makerspace. Makerspaces have a limited regulatory control on the knowledge sharing behavior of members (van Holm, 2015a, p. 25).

There is substantial research in the knowledge sharing behavior field, however there is a limited amount of research in the area of knowledge sharing behavior on non-profit or voluntary organizations (Ragsdell, Espinet, & Norris, 2017, pp. 1–2). Makerspaces are organizations with a high proportion of volunteers/workers ratio; having a high number of volunteers limits the control of the organization on the sharing behavior of members. As explained by Benz (2005), one important difference between for-profit and non-profit firms are the amounts of volunteers that are part of the operation.

Knowledge sharing has been primarily examined in formal organizations that have tight structures (e.g., Holtham & Courtney, 1998). In such organizations, knowledge sharing tends to be formal and structured (Alavi & Leidner, 2001). Knowledge shared therefore is often technical and company specific. Such knowledge sharing may be often governed by organizational rules and culture. Makerspaces are loosely structured organizations, and this characteristic unlocks the opportunity to increase the understanding of how knowledge is shared in loose organizations.

Purpose of the Dissertation

The purpose of this dissertation is three folded. The first aspect that I want to untangle are some of the factors that contribute to the individual knowledge sharing behavior activity at a

makerspace. Makerspaces are physical location where individuals work on ideas and projects and knowledge mediates how individuals are able or not to use the resources available at those spaces. Individuals are sharing knowledge without an agent that regulates or incentivize the behavior. I will identify factors that affect the individual motivation to share knowledge in makerspaces.

The second intention is to better understand what the role of types of knowledge. Most of the knowledge sharing occurring at makerspaces relates to tools or equipment. Knowledge that is being used to make progress in while developing products or artifacts. This dissertation will explore technical or non-technical knowledge sharing. Technical knowledge refers to the knowledge that is needed to advance a project a member of a space is pursuing. In the case of non-technical knowledge, the knowledge sharing occurs with knowledge that is unrelated to the technical needs of the projects being developed at the maker space.

The third aspect that this dissertation explores relates the organizational factor and their impact on knowledge sharing. Knowledge is critical for makerspaces to function and this dissertation intends to increase the understanding of organizational factors that nurture the individual motivation to share knowledge. This study focuses only the layout factor that could increase the personal interaction and connections; places such as a kitchen or lounge. This dissertation will untangle the roles of some aspects of layout in the knowledge sharing behavior of members.

Research Questions

This research study seeks to understand the motivation of members of makerspaces to share knowledge; technical or non-technical. Past research suggests that individuals attend this type of civic infrastructures for equipment, knowledge and socialization (Browder et al., 2019).

This dissertation only focuses on makerspaces as knowledge repositories and the motivation of members to share knowledge. This knowledge sharing occurs as part of the culture and not as the results of an external regulation entity that oversees this behavior. I seek to understand what is the role of feeling part of the community; I will use Sense of Community theory to increase and clarify the behavior of members of makerspaces, I will examine knowledge sharing behaviors as outcome, and the role of sense of community as predictor. The following reflects the research questions to be examined in this study:

- What is the role of trust and personal investment of members of a makerspace in their sharing behavior of technical or non-technical knowledge at a makerspace?
- What is the effect of members' use of social amenities (characteristic of the physical layout of the makerspace) on theirs knowledge sharing behavior?
- What is the role of the member's entrepreneurial motivation in their knowledge sharing behavior?
- What is the role of makerspace type (member driven versus other) on members' knowledge sharing behavior?

Contributions of the Dissertation

Makerspaces present an ideal opportunity to increase the understanding of knowledge sharing behavior in a different type of organization; a loose (unstructured) organization. The first contribution relates to the role of technical versus non-technical knowledge sharing behavior. Most of the literature on the field of knowledge sharing behavior explores knowledge sharing without making a distinctions of types of knowledge and the factors that contribute to the flow of different types (Durst & Runar Edvardsson, 2012; Nonaka, 2007). This study will explore and present some of the factors that contribute to the knowledge sharing behavior for technical and non-technical knowledge. The second contribution will focus on the role of trust and personal investment of members in makerspaces. I extend the understanding of the feeling of being a member of an organization and the behavior to engage in knowledge sharing behavior in loose organizations (makerspaces) (Cress, McPherson, & Rotolo, 1997; McAllister, 1995;

Schaubroeck, Lam, & Peng, 2011; Stamper, Masterson, & Knapp, 2009). This contribution is centered on how members of makerspaces increase their knowledge sharing behavior based on their feeling of affective or cognitive trust or the feeling of investing their personal time or effort in the makerspace. The third contribution will present the importance of layout components such as kitchens and lounge areas and their role in the knowledge sharing behavior of members of the space. There is an important research stream in the area of physical layout (Appel-Meulenbroek, Vries, & Weggeman, 2016; Hua, Loftness, Kraut, & Powell, 2010; Inalhan & Appel-Meulenbroek, 2010; Weijs-Perrée, Appel-Meulenbroek, Arentze, & Romme, 2018). However, I extend our understanding of the importance of physical layouts in the area makerspaces and the role of social amenities on the behavior of knowledge sharing of members of a makerspace.

Outline of the study

The reminder of the document will be organized as follows: Chapter 2 presents the literature review of makerspaces, and knowledge sharing. Chapter 3 develop the research theory and research model and present the research hypothesis. Chapter 4 focuses on the research methodology. In chapter 5 the reader finds the empirical results of the dissertation. In chapter 6, the findings are presented, with concluding remarks, limitations and future research.

CHAPTER II

LITERATURE REVIEW

Chapter Overview

The purpose of this chapter is to provide a detailed overview of the empirical research in the areas of interest for this dissertation. The literature review draws primarily from research in the makerspace and maker movement phenomenon and knowledge management field. This chapter is comprised of four major sections. In the first section, this study examines the literature on makerspaces and maker movement using a bibliometric technique. In the second section, a literature review of the most important and relevant literature on the maker movement related to my research questions is presented. In the third section, literature on the area of knowledge management is explored. The fourth section presents in more detail knowledge sharing.

Bibliometric and co-citation analysis of the makerspace and maker movement

To have a better understanding of the literature on makerspaces and the maker movement, a bibliometric analysis was conducted. This type of analysis is used to measure the output of scientific work. The bibliometric and co-citation analysis was conducted to answer the following questions: 1) Which journal do scientists mostly publish their articles? 2) Which keywords are mostly being use? 3) How does the keywords are clustered?

The keywords used for the data collections included “makerspace”, “maker space”, “FabLab” and “maker movement”. The study used the Scopus database and searched using the

previous terms the by “title, abstract, keywords”. Only printed and in process “journal” articles were include. Books, conference papers, and chapter of books were excluded. The initial search resulted in a total of 273 articles. The breakdown of the search results for the four searches and refinement stages can be seeing in table 1. The results of the search were stored in a BibText format that included all the essential citation information such as title, affiliation, author name, abstract, references and keywords. From the initial list of 273 papers, each article was revised to validate that the document was relevant to the research interest and removed 22 articles that did not met the criteria of study. The last step was to combine the four list of articles into one to eliminate duplicate articles. The final list was saved in a BibText format for further analysis.

Table 1: Search results

Search keywords	Initial results (no. of papers)	Results after refinement (no. of papers)
"makerspace"	92	86
"maker space"	25	24
"FabLab"	35	31
"maker movement"	121	110
Total papers	273	251
Total papers (no duplication)		224

The Bibtext file was then used in Bibliometrix analysis application (Aria, M. & Cuccurullo, 2017) to conduct further analysis. Table 2 shows the top 14 publishing journals by from 2010 to 2019. Approximately 88% of all papers were published between 2015 and 2018, showing the current interest in the phenomenon. Historically, the first two journals that had a contribution were *Journal of Science Education and Technology* and *Engineering and*

Technology. The Journal of Science and Education focuses on '*the intersection of science education and technology with implications for improving and enhancing science education at all levels across the world*[1] showing the initial interest from the perceptive science education. The other journal that had a contribution in 2010 was *Engineering and Technology* with a focus on *"the engineering sciences, its core interest lies in issues concerning material modeling and response"*[2] presenting the interest on makerspaces and material modeling. The top five journals with the highest contribution are the following: *1) Library Hi Tech,* "*concerned with technology-assisted information systems that support libraries & cultural memory, education & the academy, health & medicine, and government & citizenship.; 2) Techtrends that focuses on "professionals in the educational communication and technology field."; 3) International Journal of Child-Computer Interaction that "serves as a forum to communicate original, high-quality research in child-computer interaction and interaction design and children."; 4) Interdisciplinary Journal of Problem-Based Learning publishes articles of "research, analysis, or promising practice related to all aspects of implementing problem-based learning (PBL) in K–12 and post-secondary classrooms."; and 5) Journal of Library Administration that "informs readers on research, current developments, and trends related to the leadership and management of libraries.* These five journals contribute with 31 articles for a 14% of the total publications in the list that was used for the analysis. From these results, I could see that there is academic production on makerspaces in the areas of library management, science education, material and engineering.

[1] https://link.springer.com/journal/10956
[2] http://everant.org/index.php/etj

Table 2: The top 14 publishing journals by year

Source	Publication year										
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Library Hi Tech					1	5	1	2	2		11
Techtrends						1	2	1	3		7
International Journal of Child-Computer Interaction						1	1		3		5
Interdisciplinary Journal of Problem-Based Learning									4		4
Journal of Library Administration							1	2	1		4
Equity and Excellence in Education					1				3		4
Journal of Science Education and Technology	1							2	1		4
Business Horizons							1	3			4
Interaction Design and Architecture(S)							3	1			4
Mondo Digitale						1	1		1		3
Journal of Digital Learning in Teacher Education									3		3
Public Library Quarterly					1		1		1		3
Journal of Extension						1		2			3
New Library World						1	2				3
Total	1	0	0	0	3	10	13	13	22	0	62
Publications not listed	1	1	0	6	9	19	18	54	49	5	162
Total publications	2	1	0	6	12	29	31	67	71	5	224

The next step of the analysis was to investigate patterns of the keywords used by the authors when classifying their articles and the Keyword-Plus index[3]. The twenty-five most predominant keywords used by authors in the articles in the dataset are presented in table 3. Using the keywords used by authors, the following clusters were created: 1) Public libraries (Academic libraries, Public libraries); 2) Learning by making (Constructionism, Learning, Education, maker education, pedagogy); 3) Fabrication and technology (3d Printing, Digital fabrication, Arduino, technology), 4) Entrepreneurship and Innovation (innovation, entrepreneurship, professional development, additive manufacturing, digital fabrication). The keyword analysis shows that makerspace research focuses on issues related to making in libraries, learning by making, fabrication and technology, and makers, entrepreneurs and innovation.

[3] *KeyWords Plus*® are index terms automatically generated from the titles of cited articles. KeyWords Plus terms must appear more than once in the bibliography and are ordered from multi-word phrases to single terms. *KeyWords Plus*augments traditional keyword or title retrieval.

Table 3: Twenty-five most predominant keywords

Author Keywords	Articles	Keywords-Plus	Articles
Maker movement	43	3d printers	15
Makerspace	32	Manufacture	12
Makerspaces	29	Engineering education	10
3d Printing	18	Human	8
Making	17	Maker movement	8
Innovation	14	3-d printing	7
Academic libraries	12	Design	7
FabLab	12	Digital fabrication	7
Stem	9	Fabrication	7
Digital fabrication	8	Innovation	6
Public libraries	8	Printing	6
Constructionism	7	Equipment design	5
Learning	6	Microfluidics	5
Technology	6	Open systems	5
Additive manufacturing	5	Students	5
Arduino	5	Technology	5
Creativity	5	Article	4
Education	5	Calibration	4
Entrepreneurship	5	Computer aided instruction	4
Maker	5	Education	4
Maker culture	5	Engineering	4
Maker education	5	Internet	4
Makers	5	Library	4
Pedagogy	5	Makerspace	4
Professional development	5	Male	4

The next step was to conduct a Multiple Correspondence Analysis (MCA) of the keywords identified in the dataset. Figure 1 presents the conceptual structure of the keywords used by the authors. The data presented in the analysis shows three primary clusters. The first cluster contains words that can be associated with makerspaces as physical places. The representative keywords in this cluster are: library services, mobile makerspaces, communities of practice, stem education, intellectual property, librarians. The second cluster contains words that

can be associated with Technology and Knowledge to Fabricate. It contains some of the following keywords: 3d printing, Arduino, open innovation, addictive manufacturing, FabLabs, design, digital fabrication, teacher education, stem, participation. The third cluster identified by MCA is the Maker as learner. It contains the following keywords: maker, professional development, curriculum, training.

Figure 1: Conceptual Structural Map

In summary, the bibliometric analysis shows that from the period 2010 to Feb. 2019 a total of 224 documents from 158 sources were published. From the analysis, it is possible to identify growing trend in the publication of articles related to makerspaces. Most of the activity occurred from 2015. Appendix A shows the list of articles with the higher number of citations. citation from the keyword analysis, the following clusters or areas were identified: makerspaces as civic locations, makerspaces as market igniters, makerspaces as knowledge repository, makerspaces as technology hubs and making as an educational strategy. The following section will present relevant literature of the following clusters: makerspaces as civic locations, makerspaces as market igniters, and makerspaces as knowledge repository

Makerspaces

Makerspaces provide a flexible creative environment that supports members when they transform ideas into reality (van Holm, 2015a, p. 28). For makers, the space allows them to invent, design and enter the business world with a minimal risk (Schön, Ebner, & Kumar, 2014, p. 17). While working with common tools, members have the opportunity to modify products they own and often look to meet their own needs. (van Holm, 2015a, p. 28). By building physical models, designers can reduce sunk costs associated with the continued development of flawed ideas by discovering these flaws prior to production. (Barrett t, Pizzico, Levy, & Nagel, 2015). Makers act in local and global markets as producers by leveraging shared access to knowledge and tools applying technology in their own projects (Dougherty, 2016).

An innovation opportunity is an opportunity to create a new design. Innovators generate value or benefits by converting an innovation opportunity into a new design, and later into a useful product, process or service (Baldwin & Hippel, 2010). Each innovation has two dimensions, the technological dimension that is concerned with how an artifact works – and the

social dimension that is concerned with why it is built and how it will benefit society (Russell E. Browder, Howard E. Aldrich, & Steven W. Bradley, 2017). Makers decide to pursue a replication or a recreation of something produced elsewhere, or an innovation, to produce a meaningful new form (van Holm, 2015a, p. 25). Makers produce artifacts mainly for three reasons: for their personal use as user innovators; to sell the product to others or as producer innovation; and open collaborative innovation project.

Dougherty explains that makers enrich their life by creating new products and acquiring new skills. (Dougherty, 2012, p. 11) For him, tinkering used to be a basic skill that is used when people fix their own vehicle or improve your home (Dougherty, 2012, p. 11). It is important to mention that makers are producing artifacts, or something made with skill. Artifacts means "something made with skill." (Simon, 1996). "Artifacts reflect both "an 'inner' environment, the substance and organization of the artifact itself, and an 'outer' environment, the surroundings in which it operates" (Simon, 1996). Another important concept is that some makers get involved in adhocist project that is not planned, but assumes that each step will be figured out as it is needed (Toombs, Bardzell, & Bardzell, 2014).

A group of makers are motivated to innovate and make products by the expectation of making profits (Baldwin & Hippel, 2010). Producers must sell innovation-related products or services to users, generating value when users are willing to pay for their creations (Baldwin & Hippel, 2010). Browder, Aldrich and Bradley (2017) presented the following types of makers in regards to their *entrepreneurial intent. Amateur or hobbyists are users that* are making artifacts or products with no commercial intentions. These individuals enjoy the process of making and have no intention of selling their products. The second group can be described as *lifestyle entrepreneurs. These users of makerspaces are creating* consumer-focused products and

are using platforms such as Kickstarter or Etsy.com to fund or distribute their projects. The third type is *Growth entrepreneur*. *This type of user* enters the maker space with a clear image of an innovative product. The shared facilities and tools help them overcome resource constraints that would have been a limitation previously. The last group is *corporate innovators* leverage the resources and knowledge of the makerspace. Some corporations buy maker space memberships and offer them as incentives for employees to problem solve and innovate where they have greater flexibility, more tools, and new collaborative partners to share ideas with.

On the most important characteristics of makerspaces is knowledge sharing. Members are generally willing to teach each other skills or machine operations with which they have experience (van Holm, 2017, p. 165). Other appreciate the convenience of finding a mentor help and guide during a project (Bean, Farmer, & Kerr, 2015) The movement is about sharing designs, working collaboratively in a shared space, raising funds from a broad community of interest, or presenting your project at events like Maker Faire to other makers (Mohomed & Dutta, 2015, p. 41).

One characteristic is that makers enjoy conversations with a variety of people at community spaces and is one of the most important differences with makers of the past that worked in the garage of the basement (Russell E. Browder et al., 2017). Makers get input on their projects in the process of creation and potentially allowing them to improve the design with the feedback (van Holm, 2015a, p. 29). Collaborative projects may attract individuals that are motivated to help with the incentive of learning, gaining reputation, and the fun of participation (Baldwin & Hippel, 2010).

There is no formal training or certification required to gain access to the resources of Maker Spaces such as 3D printers, etc. (Russell E. Browder et al., 2017). Makers must gain

expertise in the use of these tools through formal or informal knowledge sharing. Experienced makers transfer knowledge to the novices; individuals are expected to share what they know with others to solve design and fabrication problems (Aldrich, 2014). The way makers learn was listed in the 2013 Innovative Pedagogy report as "learning by making" that "encourages novel applications of technologies, and the exploration of intersections between traditionally separate domains and ways of work" (Sharples, M., McAndrew, P., Weller, M., Ferguson, R., FitzGerald, E., Hirst, T., and Gaved, M., 2013). Besides the learning by making, makerspaces offer classes such as: how to use safely the tools and other classes (van Holm, 2015a, p. 25).

The "maker identity" refers to the individual's identification with the maker movement (Toombs et al., 2014). The mindset of individuals supporting and visiting makerspaces is described as open, friendly, supporting and creative (Schön et al., 2014, p. 17). The identity is associated with the development of a tool and material sensibility; the adoption of an adhocist attitude toward make projects and tool use; and an engagement with a local community of makers (Toombs et al., 2014).

Makerspaces have dense networks that support idea creation and development (van Holm, 2015a, p. 28). The Maker movement is also connected with other events such as TEDx conferences, BarCamps, Dorkbots, Hackathons, Startup Weekends, creative industry conferences, Arduino workshops and Maker Faires (Lindtner, 2014, p. 155). Makers that become part of a local makerspace, join a local network and have access to a larger network of different makerspaces. The internet helps makers connect to a global network that allows them to share their ideas and expertise through the Internet, Maker Faire conferences and through local "maker spaces" provide communal access to tools and resources (Russell E. Browder et al., 2017). For example, a makerspace developed the Makerspace Passport to stimulate and encourage

collaboration between individuals in different Maker Spaces in a different location (van Holm, 2015a, p. 29). One characteristic is that networking occurs in micro-communities defined by a particular hobby or activity (Dougherty, 2012, p. 12). Makerspaces are built around tools were individuals get feedback from other users as well as community members to benefit their product. This is different than user communities that are built around products or specific activities such as mountain biking (van Holm, 2015a, p. 29).

The Maker Movement identifies a group of individuals that create any object or artifact (van Holm, 2015a, p. 25). This movement focuses not only on technology and digital products but on physical things too or artifacts (Lindtner, 2014, p. 148). For Russel E. Browder, Howard E. Aldrich, and Steven W. Bradley (2017) the maker movement consist of people utilizing technology to collaborate in creating tangible, material artifacts. For the founder of Make Magazine, Dale Dougherty, making is part of any human activity such as cooking, knitting, and gardening (Dougherty, 2012). The Maker movement is also connected to the do-it-yourself movement. The reduction of cost of materials and technical equipment, and the dissemination of knowledge via online videos and the web, have made making more accessible to more community members (Mohomed & Dutta, 2015, p. 41).

The maker movement is composed of several elements connecting makers and allowing them to network. Some of those points are physical and some are virtual. Maker Faire conferences are events attended by DIY enthusiasts to share their creations, interact with other makers and learn what others are doing (Dougherty, 2012). There are several “categories” of

Maker Faires [4]. The most important Maker Faires are called “Flagship Maker Faires”. This category is organized and produced by the Maker Media team. This organization is the primary motor of the maker movement. The next level of Faires is Featured Maker Faires. This type of events are operated by local community members but have a large regional scope. The last type are Mini Maker Faires that are organized and produced by the local community.

In the past, individuals use to “make” artifacts in their own spaces such as garages or basements. In the mid-2000s, the emergence of makerspaces around the world offered an option for individuals to “make” their artifacts using shared tools offered by these makerspaces (Gershenfeld, 2005). Makerspaces are community workshops where individuals pay fees to gain access to tools and workspace (van Holm, 2015a, p. 25). Makerspaces are shared fabrication places that “modify the conception of the traditional sites of production and recast the notions of the studio, workshop, laboratory, gallery, and atelier into new settings for the integrated design, production, and distribution of products” (Bianchini & maffei, 2012). These spaces attract individuals who identify as makers and support members by spreading the cost of industrial tools and gathering the community to share knowledge, time, and effort on projects (van Holm, 2015b). These organized spaces are equipped with tools that many makers could not afford on their own (Aldrich, 2014).

Makerspaces have received different names such as Maker Spaces, FabLabs, Hacker Spaces, etc. (Schön et al., 2014, p. 15). Makerspaces have the following three characteristics that are instrumental: the use of digital desktop tools, a culture of sharing and collaborating, and the

[4] https://makerfaire.com/map/

use of common design standards to facilitate sharing and fast iteration (Halverson & Sheridan, 2014). The Fab Lab foundation describes four essential characteristics of FabLabs: Public access, a common set of tools, participation in the FabLab network, and they have to sign the FabLab Charta. (Schön et al., 2014, p. 16).

Equipment and tangible resources play an important role in the attraction of members to makerspaces. For this reasons, makerspaces attract members from certain geographic radius (Holman, 2015) Users of makerspace include a great diversity of such as hobbyists, engineers, hackers, artists, and students (Papavlasopoulou, Giannakos, & Jaccheri, 2017, p. 58). According to a survey, the majority of makers are well-educated, male and with money (Holman, 2015). Other studies identified that women involved in the movement denied the existence of gender barriers and were of the mindset that men and women have equal access and opportunity to make (Bean et al., 2015). They also found that women participate in the Makerspace for the tools and workspace it provides (Bean et al., 2015).

The work of Crumpton (2015) presents two different dimensions of makerspace governance. First, who is sponsoring or paying for the makerspace? The second question explores the different configurations that makerspaces adopt to operated and structure their governance. The author identifies the importance of startup cost, operating cost and sustaining the space. For example, the wear and tear on the equipment and the materials like filament or staff. Other interesting aspects are the issues of liability. Governance also has the impotence to establish rules and penalties for members.

Appendix B presents a summary of the some of the most important literature discussing makerspaces. The table presents the authorship, the year, the research method used, key findings and focus.

Knowledge Sharing Behavior

The work of Kakabadse, Kakabadse, and Kouzmin (2003) presents the importance of distinguishing between knowledge, information, and data. They mention that the terms information and knowledge are used inter-changeably but it is important to understand the difference between them. The work of Bhatt (2001) present the difference between data, information, and knowledge in the following way: “data are considered as raw facts, information is regarded as an organized set of data, and knowledge is perceived as meaningful information”. Knowledge can be defined as “complex, accumulated expertise that resides in individuals and is partly or largely inexpressible" (Becerra-Fernandez & Sabherwal, 2001). Knowledge can be viewed as an object if the intention is the manage knowledge stocks or can be seeing as a process is the focus is in the flow of knowledge and the creation, distribution and sharing of knowledge stocks (Alavi & Leidner, 2001). Knowledge can be conceived as the information put to productive use (Kakabadse et al., 2003). By having meaning, information becomes knowledge (Bhatt, 2000).

Researcher distinguishes individual and collective knowledge. Individual knowledge refers to the knowledge that is held by one person; collective knowledge is embedded in the interaction of a group of people (Cabrera & Cabrera, 2002). The individual is the agent that creates knowledge (Nonaka, 2007, p. 163) and organizations provide the support that individuals require for the creation of knowledge (Ondari-Okemwa, 2006). Individual knowledge is instrumental for the development of the knowledge-base of an organization and is not the addition or aggregation of individual knowledge (Bhatt, 2000). It is also important to have a common knowledge-base for individuals to have similar interpretations of data or information (Alavi & Leidner, 2001). Individual knowledge should be shared with other knowledge agents

and groups to impact the organization allowing discussion, debates, and discarding of knowledge that is not needed (Inkpen & Dinur, 1998). Organizational knowledge is constructed through the interactions of people, technologies, and techniques; shaped by the history and culture of the organization (Bhatt, 2001).

Knowledge alone has a limited commercial value and that needs to be bundled with something to increase its value (Kakabadse et al., 2003). People who are knowledgeable have information and the skills to integrate information with their expertise, judgment and experience (Grover & Davenport, 2015).

Tacit knowledge can be defined as the skills, ideas, and experiences that knowledge agents have in their minds and are difficult to transfer to other individuals. Tacit knowledge consists of beliefs, mental models, and perspectives cast how agents see environment around us (Nonaka, 2007, p. 164). This type of knowledge is context-specific making it difficult to formalize and transfer to other knowledge agents (Nonaka, 1994).

Some of the dimensions of tacit knowledge are: embraided, embodied, encultured, embedded, and encoded knowledge. 1) embraided knowledge relates to conceptual skills and cognitive abilities; 2) embodied knowledge is acquired by doing, and embedded in particular contexts; 3) encultured is the knowledge related to a common understanding, culture and socialization; 4) embedded knowledge is found in systems and routines; and encoded knowledge is codified in documents such as books, manuals, etc. (Matzler, Renzl, Müller, Herting, & Mooradian, 2008, pp. 303–304).

Knowledge can by explicit or codified, this type of knowledge can be communicated, stored, and distributed in many different types of medium such as books, documents, procedure,

etc. Explicit knowledge is the knowledge that is easy to transmit using a formal and systemic language. Explicit knowledge is presented as words and numbers shared systematically as data, specifications, manuals, etc. (Becerra-Fernandez & Sabherwal, 2001). Explicit knowledge is easy to articulate, capture, and distribute in different formats (Bhatt, 2000). Explicit knowledge is formal and systematic. It can be easily communicated and shared, in product specifications or a scientific formula or a computer program (Nonaka, 2007, p. 164). It can be codified in manuals, training tools, guides, etc. (Inkpen & Dinur, 1998).

Knowledge management (KM) facilitates the individual knowledge so that it is amplified and embedded into the organizational knowledge-base (Nonaka, 1994). KM plays an strategic role in organizations because when knowledge is managed, it will impact the outputs produced by an organization (Darroch, 2005). KM refers to changing corporate culture and business procedures to make sharing of information possible (Bhatt, 2001). KM can have the objective of exploitation of existing knowledge or exploration of new knowledge (Swan, Newell, Scarbrough, & Hislop, 1999). Knowledge management depends on motivation, opportunity and ability (Argote, McEvily, & Reagans, 2003). (Durst & Runar Edvardsson, 2012) defines KM as "the processes and structures provided in SMEs to support different knowledge processes, such as transfer, storage, and creation".

Different authors have enumerated the parts of KM. For example (Bhatt, 2001) refers to KM as the following processes: the process of knowledge creation, validation, presentation, distribution, and application. According to the author, those processes are instrumental for an organization to learn, reflect, and unlearn and relearn, core-competencies. (Darroch, 2005) presents KM the following three flows of KM: knowledge acquisition, knowledge dissemination and responsiveness to knowledge. (Kakabadse et al., 2003) identified three processes that

contributes to the integration of knowledge to the organization's competencies: organizational routines, directives, and self-contained task teams.

An important process of knowledge management is knowledge transfer. (Alavi & Leidner, 2001) explain that the flow of information and the communications are the main drivers of knowledge transfer in organizations. Knowledge transfer happens at various levels: between individuals, from individuals to repositories, between groups, from individuals to groups, across groups, and from the group to the organization. (Gupta & Govindarajan, 2000) conceptualized knowledge transfer in organizations using the following elements: 1) perceived value of the source of the knowledge; 2) disposition of the source to share the knowledge; 3) existence and richness of the transmission channel; 4) disposition of the receiving using; 5) absorptive capacity of the receiving unit. Knowledge transfer can be formal or informal. Formal channels could limit the creativity in the organization (Alavi & Leidner, 2001).

The work of (Alavi & Leidner, 2001) focuses on knowledge repositories that transfer impersonal knowledge. The authors also mention that organizational memory is instrumental for the storing of knowledge and the reduction of resources in replicating work that was done before. Organizational memory resides in a variety of forms such as formal documentation, electronic databases, codified knowledge in expert systems, formal procedures and processes and tacit knowledge. Organizations have many different types of repositories such as its culture, tools, individuals routines, documents or systems (Argote & Miron-Spektor, 2011).

The work of Argote and Miron-Spektor (2011) present the importance of environmental context that includes knowledge outside the boundaries of the organization such as competitors, clients, institutions, and regulators. They present the idea of an active context where learning occurs and a latent context that influences the active context. For example, the latent context are

the members of the organizations, what tools available, and the activities that are performed in the organization

The work of Joe, Yoong, and Patel (2013) explores the question of what types of knowledge does a knowledge-intensive SME risk losing when older experts leave. They use a multiple case research approach and interviewed 17 informants from five SMEs. Initially, they wanted to understand what the valuable knowledge is. They found that subject matter expertise and experience are at the core of organizations. Second, they found that knowledge about relationships, social networks, social processes, and coordination are also important for the organization

Levy (2011) explores how organizations limit the loss of valuable knowledge when facing high levels of retirees. The study uses a multi-case method. The study found that retention efforts that define the scope, document the planning and implementation and integrate back the knowledge limit the amount of knowledge loss. More specifically, the research found that the areas of best practices and unexpected situations are the ones that create more value.

The work of Caroline Martins and Meyer (2012) focuses on identifying the factors that influence the retention of knowledge in organizations. The study concentrates on tacit knowledge. The authors used a quantitative empirical research methodology. They were able to identify the following nine key factors: knowledge behavior, strategy implementation, leadership, people knowledge loss risks, knowledge attitudes and emotions, power play, knowledge growth and development, performance management, and organizational support and encouragement.

The work of Bartol and Srivastava (2002) examines the role of reward systems in knowledge sharing. Individual motivation to share knowledge plays an important role in the knowledge sharing process. They explain that sharing requires the effort of the knowledge agent to accomplish the sharing of information. They define knowledge sharing as "individuals sharing organizationally relevant information, ideas, suggestions and expertise with one another". The authors propose four mechanism of knowledge sharing: 1) Contributions to databases; 2) knowledge sharing in formal interactions; 3) Knowledge sharing in informal interactions; and 4) knowledge sharing in communities of practice (e.g. nurtured but not controlled by the organization).

Reinholt, Pedersen, and Foss (2011) present that the position of the individual in a network creates the knowledge sharing opportunity. They also mention that autonomous motivation leads to more positive outcomes than a controlled motivation. When the individuals feel pressure from an external source or regulation motivational leads the individual to put the minimum required effort. Their study collected data from 7,500 employees at an IT firm

Chang and Chuang (2011) present some of the benefits knowledge contributors get by sharing knowledge. The authors mention that individuals show that they possess valuable expertise, their self-image is improved, and they receive recognition and build their reputation. They studied virtual communities and found that altruism and reputation were the main benefits contributors mentioned.

The literature review of Wang and Noe (2010) presents five areas of research in the knowledge sharing area: cultural characteristics, individual characteristics, organizational context, interpersonal and team characteristics, and motivational factors. Their research identifies

that justice and trust are factors important for knowledge sharing because when individuals share they expect some reciprocity

Connelly, Zweig, Webster, and Trougakos (2012) explain the concept of knowledge hiding. They define knowledge hiding as “an intentional attempt by an individual to withhold or conceal knowledge that has been requested by another person”. They also present some possible reason for individuals to hide knowledge such as instrumental or laziness.

The work of Mascitelli (2000) explores the role of tacit knowledge sharing behavior on breakthrough innovations. Tacit knowledge can be gained through “learning by doing” through a combination of work experiences and formal education. Th author mentions the importance of tacit knowledge sharing of multidisciplinary problem-solving skills in the development of breakthrough innovation. Individuals with these capacities are able to navigate different specialties, combining multiple facets of technology. The author mentions the importance of motional commitment and deep personal involvement to allow the flow of tacit knowledge sharing. The author also mentions the importance of using models and prototypes throughout the design process create opportunities for individuals to experiment and learn. The author also mentions the importance of tacit knowledge sharing, but the challenge to guide and shape the innovation force without putting obstacles that limit the enthusiasm. The author presents the following methods for encouraging the explication and sharing of tacit knowledge among design team members: foster the emotional commitment and deep personal involvement of team members; encouragement of face-to-face interaction between innovators during product development.

Jones (2005) explores facilitators of tacit knowledge sharing in three organizations implementing enterprise resource planning. They author conducted a series of semi-structured

interviews to six to ten representatives in each of the three firms. The author classified tacit knowledge sharing facilitators into two categories: structure of team interactions and atmosphere of the team. Structure of the team refers to factors that determine or structured team member interactions; some examples include physical workspace, hierarchy of team relationship, and explicit efforts to foster knowledge sharing. In the case of atmosphere of the team, the author explains that this factor is less tangible but with influence in what acceptable behavioral norms should be within the team. The author found that firms with amount of tacit knowledge sharing had atmospheres that encouraged ideas, regardless of whether they were fully formed or could be immediately supported with hard data. Second, they found that atmosphere conductive to tacit knowledge sharing not necessary carry over to the team's interactions. The third finding is that an atmosphere that is not conducive to tacit knowledge sharing does appear to carry over interactions with others.

Lin (2007) explores the relationship between distributive justice, procedural justice, and cooperativeness and tacit knowledge sharing. The author uses organizational commitment and trust in co-workers as mediators. A total of 212 usable questionnaires were finally collected from students of the service industry They study found that tacit knowledge sharing is related to procedural justice, distributive justice, and cooperativeness via organizational commitment. Also, distributive justice, instrumental ties, and expressive tie via trust in co-workers

The work of Yang and Farn (2009, p. 210) investigates an employee's tacit knowledge sharing and behavior within a work-group using the social capital and behavioral control theories. By using a multi-informant questionnaire design, the author surveyed 306 employees in 102 work-groups across 67 organizations. The study presents the following findings: first, tacit knowledge sharing intention can be induced by affect-based trust; second, internal control has a

positive effect on tacit knowledge sharing intention, and third external control moderates positively the interaction between tacit knowledge sharing intention and behavior.

The work of Holste and Fields (2010) focuses on the role the relationship of affect-based and cognition-based trust of co-workers on the willingness of professionals to use and share. Individuals acquire tacit knowledge through close observation and interaction from other individuals as apprentice learns from a master craftsman. They used a sample of 202 business professionals of an international organization. They found that affect-based trust has a greater effect on the sharing of tacit knowledge. They found that cognition-based trust have a greater impact in the willingness to use tacit knowledge. They explain that cognition-based trust is constructed in the perception of others competence and reliability. In the case of affect-based, the trust is built as a result of care and concern for each other, value for the relationship and sentimental reciprocity.

The study of Suppiah and Sandhu (2011, p. 462) investigates the relationship of organizational culture on tacit knowledge sharing behavior in Malaysian organizations. The authors collected survey data from 362 participants from seven organizations. Multiple regression was used to assess the research model. The study found that clan culture have a positive influence on tacit knowledge sharing behavior. In the case of market and hierarchy have a negative effect in tacit knowledge sharing behavior.

Wang and Wang (2012) explores the relationship between knowledge sharing, innovation and performance. The study uses data from 89 high technology firms in China. The result demonstrates that tacit and explicit knowledge sharing affect innovation and performance. They found that explicit knowledge sharing has more significant effects on innovation speed and financial performance. They also found that tacit knowledge sharing effects on innovation

quality and operational performance. They mention that innovation quality may be defined by variables such as: amount, effectiveness, features, reliability, timing, costs, complexity, innovation degree, or value to the customer. They also present some of the barriers to tacit knowledge sharing such as willingness to share or use the knowledge, awareness, or difficulty of presenting the knowledge.

The work of Hau, Kim, Lee, and Kim (2013) explorers the key factors of knowledge sharing intentions via individual motivations and social capital. The study uses data from 2010 employees in a variety of industries. The results reveal that organizational rewards effect negatively tacit knowledge sharing intentions and positively in the case of explicit knowledge sharing. The results reveal that reciprocity, enjoyment, and social capital enhance knowledge sharing intentions. They also found that those factors have a higher effect on tacit knowledge in comparison to explicit knowledge sharing.

Nistor, Daxecker, Stanciu, and Diekamp (2015) investigated the relationships between the following communities of practice variables: time spent in the community, centrality and socio-emotional interpersonal knowledge, the socio-emotional component of sense of community and participants' acceptance of knowledge sharing in face-to-face academic communities of practice. The study used a sample of 136 German and Romanian scholars. The results shows that the socio-emotional interpersonal knowledge is the strongest predictor for socio-emotional sense of community and knowledge sharing acceptance. They also found that sense of community socio-emotional mediates the effect of centrality on the organization and time spend in the organization. As explained by Taminiau, Smit, & Lange, 2009, p. 44, formal knowledge sharing is comprise of all the knowledge shared in the organization that is controlled by management. In the case of Informal knowledge sharing comprise of all the knowledge

sharing that occurs that is not controlled by the management of the organizations (Taminiau et al., 2009, p. 45).

Knowledge sharing and Third Sector Organizations

Lettieri, Borga, and Savoldelli (2004) present that the non-profit sector or the ``third sector" is composed of organizations that aim to create value for society and recognize that their main goal is not creating profit for the owners of the organization. Their explorative study used a survey of Italian non-profit firms. The authors present that NPO faces with fragmented knowledge. The knowledge is heterogeneous, widespread, rarely formalized and unstable. Normally, the staff is limited and the other type of human resource that support the operation of the NPO are volunteers. This type of individuals have characterized by heterogeneous knowledge and experience, intense motivation, high rate of turnover and non-continuous presence. This case study highlighted common groups of knowledge types: (1) Accounting/administrative knowledge; (2) Managerial/organizational knowledge; (3) Teaching/training knowledge; (4) Fund raising/public relation management; (5) Operational knowledge; and (6) Miscellaneous, non-characteristic knowledge.

Benz (2005) explains that the third sector utilize a mix of paid staff and volunteers in order to operate. The author presents the notion that individuals working in a non-profit organization obtain utility from the actual activities they perform at work on top of the monetary reward. They find an intrinsic value by being productive in a project that they believe and support increasing their job satisfaction. The results of this empirical study showed that non-profit workers were generally more satisfied with their jobs than for-profit workers. The author suggests that Non-profit firms should select intrinsically motivated individuals and continuously direct and support their motivation.

Much of the knowledge that volunteers acquire is not codified in any meaningful way and is often held tacitly by them for reuse when the occasion demands; this is particularly the case when, for example, the knowledge relates to a particular specialism such as event management (Ragsdell et al., 2017, p. 352) The research concluded that for KM to be effective in NPOs, it is important for organizations to "commit to engaging staff/volunteers on either professional or organizational levels or a combination to build trust, personal relevance, and satisfaction to support and drive knowledge". (Gillian Ragsdell, Rathi, Given, & Forcier, 2016)

Knowledge sharing and Public Amenities

Appel-Meulenbroek, Vries, and Weggeman (2017) explores how spatial design impacts knowledge sharing. They analyze how some spatial variables relate to behavior in meetings (joint activities, location, intentionality, and issues addressed). They collected data from 138 employees from one organization. They studied collocation, indivisibility, same floor, overhearing, and proximity. They found that indivisibility and proximity are more strongly associated with the sharing of knowledge. They also explain the importance of supporting unplanned meetings with physical location as coffee machines, hallway, etc. to increase knowledge sharing among employees. Serendipity is another factor that influences knowledge sharing.

The model Knowledge Commons (KC) developed by Shuhuai, R., Xingjun, S., Lin, H., & Jialin, C. (2009) combines physical and virtual elements to develop a collaborative knowledge sharing environment for the innovative community. The authors propose the following five parts: user, knowledge fields, physical layer, virtual layer, and support layer. In the case of the user, they refer to all the people involved in the creative process except the staff of the location. The second element refers to the processes of conversion of knowledge. How knowledge is

generated, regenerated, and moves along the knowledge spiral. This element adds the energy, quality and place the process of knowledge conversion. Physical layer consists of the physical space. This element provides rooms for collaboration such as seminar rooms, discussion rooms, video conference, training rooms, laboratories, halls, open areas, coffee room, lounge, etc. The physical layer combines centralized and disperse spaces. The fourth element is the virtual layer. This element connects several physical layers and builds bridges to other internal and external areas. It is comprised of digital areas, digital resources, and networking tools. The last element is the supportive layer. It refers to the environment that provides support to the operation and development of the system. It has three main forces: Information technology, organization and management, and culture and spirit.

Weijs-Perrée et al.(2018) collected data from individuals working at business centers. They found that studied a lounge area is the most significant factor for knowledge sharing between organizations. Also, meeting spaces and flexible use workspaces nurture knowledge sharing within organizations. The study evaluated variables such as: organizational size, meeting spaces, reception, restaurant, kitchen, lounge and coffee area, open space, and type of use.

Using observations and interviews, Bouncken, R., & Aslam, M. M. (2019) performed a study at several German Coworking spaces. The authors found that co-location is about physical proximity and collaboration opportunities. Colocation facilitates the exchange of tacit knowledge, discussion of ideas, sharing of domain-related knowledge and inter-domain learning. Their findings suggest that spatial co-location nurture social interactions and diminish organizational boundaries.

Knowledge sharing and entrepreneurial motivations

The work of Shane, S., Locke, E. A., & Collins, C. J. (2003) argues that people differ in their willingness and abilities to act on entrepreneurial opportunities because they are different from each other. Variations across people influence how they see risk and opportunity and entrepreneurial decision. Their model used several controls variables to isolate the effects of entrepreneurial motivation. The study identifies several human motivations that influence the entrepreneurial process. They found the following factors of entrepreneurial motivations: need for achievement, locus of control, vision, desire for independence, passion, drive, goal setting and self-efficacy.

The meta-analysis of Stewart, W. H., & Roth, P. L. (2007) contrast the achievement motivation of entrepreneurs and managers. The most important finding is that entrepreneur's exhibit higher achievement motivation than managers and that these differences are influenced by the entrepreneur's venture goals. The authors present the point of McClelland (1961) that a high need for achievement, characterized predisposes someone to seek out an entrepreneurial position Alternatively, managers tend to be higher in need for power and lower in need for achievement (McClelland and Winter 1969).

Turner, T., & Pennington III, W. W. (2015) develops a framework using motivation, opportunity, and ability to explore knowledge sharing and organizational learning. Using data from 200 franchise operators present the importance of Corporate Entrepreneurship (CE) and how CE offers an alternative to cope with high-velocity change. They mention that organizational innovation and transformation depends on information generated and shared. The decentralization of knowledge means that most of the entrepreneurial opportunities occur at the individual unit and as a result, organizations need to harvest ideas across the organization.

The work of Liñán, F., & Chen, Y. (2009) develops a measurement instrument to evaluate the perceptions and intentions of entrepreneurs. They explain that the cognitive variables are called motivational antecedents that would lead to the start-up intentions. They use Hoftede's cultural dimensions to validate the scale in different nations. They used samples of 519 students at universities from Spain and Taiwan.

Chapter Summary

This chapter presents the relevant literature from the following disciplines: Makerspaces, knowledge sharing, third sector organizations, and entrepreneurial motivation. The literature that explores makerspace states that makerspaces draw makers to the makerspace because of access to social, knowledge and technology (Aldrich, Bradley et al., 2019). Makers use that knowledge to create artifacts during their visits to makerspaces. The knowledge sharing in makerspaces occurs with the contributions of knowledge from novice or experts.

Makerspaces have technical areas with tools such as 3D printers, routers, soldering equipment, saws, etc. In those areas, makers share technical knowledge on how to use tools, how to develop an artifact, what materials are appropriate. Makerspaces also have areas for socializing such as lounges, kitchens, break rooms, coffee lounge, etc.

This difference of technical and non-technical areas of makerspaces presents an important and interesting are to study and contribute to the field of knowledge sharing and makerspaces.

CHAPTER III

RESEARCH MODEL AND HYPHOTHESES DEVELOPMENT

The purpose of this chapter is to detail the theory and hypotheses of this dissertation. The first section presents the theoretical frameworks used to guide this study. The following frameworks are presented and used in this section: The sharing economy, sense of community and membership. The next section presents the research model and the hypotheses. The first two hypotheses are centered on the role of personal investment, the following two hypotheses explain the role of trust in membership. The rest of the hypotheses use membership type, makerspace layout and entrepreneurial motivation as moderation variables.

Theoretical Framework

Sharing Economy and knowledge sharing

The following paragraphs will present important academic work related to the sharing economy. The sharing economy will help the reader understand important changes in the behavior of users of community or civic organizations. To better understand the sharing economy, let's explore the core elements of this phenomenon. The first element is the role of access to goods (Acquier, Daudigeos, & Pinkse, 2017; Puschmann & Alt, 2016; Schor, Fitzmaurice, Carfagna, Attwood-Charles, & Poteat, 2016). The traditional economy is based in the ownership of goods. For example, owning your own vehicle. In the sharing economy, individuals incline having temporary access to goods instead of owning the good. This element is evident in makerspaces where individuals that attend these civic spaces share "making"

equipment with other members. The second element is a community-based environment (Böcker & Meelen, 2017; Puschmann & Alt, 2016). Traditional community-based organizations tend to form around a strong-ties membership. In the case of the shared economy, it seems that members develop trust and connection even when individuals have a weak-ties. Makerspaces are community-based organizations where members search for the assistance, help and support from other members, even if they have a weak-tie. The third element are digital platforms (Frenken & Schor, 2017; Guttentag, Smith, Potwarka, & Havitz, 2017; Sutherland & Jarrahi, 2018). Digital platforms allow participants of the sharing economy to engage in the sharing economy by mitigating the potential risk of doing activities with individuals that you are not familiar.

The work of Acquier et al. (2017) based on a review of the sharing economy literature explain that the sharing economy has three core foundations. First, the access economy explains the trend of promoting access instead of ownership of goods. Some of these assets are underutilized allowing to increase their utilization by allowing others to "share" the good. The access economy could occur in a variety of governance configurations, from centralization to individual configurations and it can either be for profit, non-profit, a public-private partnership or a cooperative mode. The second foundation is platform economy that uses digital platforms to decentralize exchanges among individuals using digital technology. Platforms also allow the coordination and management tasks remotely and to secure and control transactions. The third core foundation is the community-based economy that empower communities and triggers social change, emancipation and solidarity among weakly connected individuals. Theses interactions are through non-contractual, non-hierarchical or non-monetized relationships.

Puschmann and Alt (2016) identify the following drivers as explanations to explain the adoption of the sharing economy. First, the shift from ownership of goods to temporary use of

goods. Some examples are car2go or Nextbike were individuals use the goods for a period allowing others to use the good. Some of the reasons that explain this behavior are convenience, lower prices, and ecologic sustainability. The second driver are social networks. Social networks link many users and consumers willing to share their goods with other members of the community. These platforms connect individuals while reducing the search and transaction costs for connecting with others. The platforms can generate trust and reputation in anonymous markets. Another driver are mobile devices that allow companies to use a combination of an electronic service with physical goods to offer a wider variety of services.

Frenken and Schor (2017) developed a conceptual framework in terms of the economic, social and environmental impacts. They explore current regulations and future alternatives, and present future research questions. They explain that historically individuals have tended not to share with strangers or people outside their social networks. Normally, the sharing occurred between trusted individuals such as family, friends and neighbors. The sharing economy facilitate people who do not know each other to share. This is called "stranger sharing" that entails a higher risk, and in intimate situations. Digital platforms make stranger sharing less risky and more appealing because individuals are able to verify the identity of the individuals via the use of ratings and reputations.

The work of Böcker and Meelen (2017) studies the motivations of individuals to participate in the sharing economy. Using a survey with 1330 respondents from the Netherlands the authors investigate the relative importance of (1) economic, (2) social and (3) environmental motivations to participate in peer-to-peer sharing. They evaluated different sectors, different socio-demographic groups, and users and providers. They observed a significant difference

between sectors and to a lesser extent between sociodemographic groups. Users were more motivated by economic factors than providers.

The work of Schor et al. (2016) uses relational analysis to study how individuals deploy, convert, and use their capital in the sharing economy. They explain that in the sharing economy, individuals trade food with each other, provide or receive services, or share skills, information, and social contacts. The authors using interviews and participant observation, studied a time bank, a food swap, a makerspace and an open-access education. They found that when an individual has mastered a practice, the exchange becomes more difficult to complete.

Ert, Fleischer, and Magen (2016) studied the impact of seller's photos of 'sharing economy' service platforms. They evaluate the role the images play in the decision of future guests when reserving a room using Airbnb, using an empirical analysis they found photos of hosts perceived as trustworthy were able to rent their property at a higher price and also had a higher occupancy rate. The authors explain that the photos help the consumers verify the identity of the service provider and generate a sense of personal contact. They also found that the reputation expressed at the reviews of the cite had no effect price or booking potential.

The study also presents the characteristic of the sharing economy where individuals are seeking low-cost accommodations and direct interactions with the local community. They explain that profiles of service providers in a sharing-economy market contain more personal information that you would see in a more traditional market. Individuals that decide to use AirBnb evaluate the attributes of the product and the attributes of the host. In a traditional market, individuals take a decision evaluating the characteristics of the product, in the case of the shared economy, individuals evaluate both profiles before taking a decision.

Makerspaces

From the sharing economy literature, it is possible to establish that makerspaces are part of this social behavior. Table 5 presents a summary of the characteristics of the sharing economy and the characteristics of a makerspace. First, one of the drivers of the sharing economy is the social change from intention of ownership of goods to temporary use of goods (Puschmann & Alt, 2016). Members of makerspaces become members of a spaces to gain access to tools, equipment and a location to develop their projects. The second driver of the sharing economy is a community-based environment. Social networks link many users and consumers willing to share their goods with other members of the community (Puschmann & Alt, 2016). Members of makerspaces are individuals with a desire to learn skills from each other and cooperate with other individuals (Han, Yoo, Zo, & Ciganek, 2017, p. 186). The last driver of the sharing economy are digital platforms. The function of the platforms is to integrate all the required elements of the environment and allow users to execute transactions or activities with a minimal effort. In the case of a makerspace, they allow maker to develop their artifacts or new ideas with agility. Makerspaces provide a supportive environment to support members of the space in the transformation of their ideas to products or artifacts (van Holm, 2017, p. 166).

Table 4 Summary of Characteristics of the Sharing Economy and Makerspaces

Drivers of the Sharing Economy	Makerspace
Access to goods • Shift from ownership of goods to temporary use of goods. Puschmann and Alt (2016)	**Access to common space, and equipment** • The fees that members paid at makerspaces give access to the tools, equipment and use of the space (Kostakis, Niaros, & Giotitsas, 2015, p. 566).
Community-based environment	**Community-based environment**

• Social networks link many users and consumers willing to share their goods with other members of the community. Puschmann and Alt (2016)	• Participants share in a community-driven physical space. (Kostakis et al., 2015, p. 556) • People with a desire to learn useful skills from each other and cooperate with other likeminded individuals (Han et al., 2017, p. 186) • Trust allows everybody to feel the 'space as their home'. (Kostakis et al., 2015, p. 565)
Digital platform • The use of digital platform de connect with other user becomes an instrumental aspect of the sharing economy Puschmann and Alt (2016)	**Platform for making artifacts** • Makerspaces provide a flexible, creative, and supportive environment to aid innovation as members transform products from ideas to reality (van Holm, 2017, p. 166)

In table 6, the principal investigator presents a summary comparing the main differences of makerspaces and regular organizations. Considering membership relationships, makerspaces have a loose membership or users. It is up to individual to decide their affiliation to a certain makerspace. The individual may choose to cancel the affiliation and attend another makerspace or maybe continue being a member but is active. The structure of makerspaces is quite flat. Normally, members volunteer for committees, mentor or help with administrative task. The structure is quite informal and with not many levels of management roles. The primary motivation for members at makerspaces is to support the organization with their personal time, knowledge and funds. In relationship to funds, members in makerspaces normally pay fees to gain access to the space. The focus of makerspaces is a social innovation or product development environment. It is a culture that invites members to share tools, knowledge and time. Members at makerspaces cooperate sharing ideas, mentorship, and feedback to advance their projects. It is a cooperation environment. The emphasis is sharing and learning.

Table 5: Comparison of Regular Organizations and Makerspaces

	Regular organizations	**Makerspaces**
Member relationship	Tight	Loose
Organizational Structure	Hierarchical	Flat
Member Motivation	Responsibility	Volunteerism
Financial Transaction	Getting paid	Paying for membership
Primary Focus	Economic	Social
Driving force	Competition	Cooperation
Member goals	Earning/Promotion	Learning/sharing
Underlying Mechanism	Structure/power	Community

Makerspaces are community workshops where individuals pay membership fees to gain access to tools and the workspace (van Holm, 2015a, p. 25). These spaces are equipped with a large variety of tools that many makers could not afford on their own. (Aldrich, 2014). The fees that members paid at makerspaces give access to the tools, equipment and use of the space (Kostakis et al., 2015, p. 566). Users have gained access a wide variety of tools such as such as laser cutters, CNC machines, and 3-D printers diversifying the possibilities of resources that members can use (Aldrich, 2014).

Members of makerspaces form an open community that has an emphasis on technology and experimentation and where sharing of knowledge, ideas, and space are expected (Kostakis et al., 2015, p. 556). Makers share the idea that collaborating and sharing is crucial for the success of the makerspace (Foster, 2014). Makerspaces are built around the use of tools and the diverse knowledge that members bring to the space (van Holm, 2015a, p. 29). Makerspaces could fit the characteristic of what Oldenburg (1997) define as a third place. The first place the home; the

second is work and the third place is a civic place where the individual feel comfortable (Moilanen, 2012, p. 107). Makerspaces are civic organizations that draw members from local geographies (Holman, 2015). Trust in other members nurture the feeling that the "space is a home" (Kostakis et al., 2015, p. 565).

Makerspaces function as an innovation platform where individuals develop and create objects or artifacts (van Holm, 2017, p. 164). The spaces enables different types of users such as hobbyists, engineers, hackers, artists, and students, to develop their ideas by using the makerspace (Papavlasopoulou et al., 2017, p. 58). The resources available at the spaces, from equipment to individuals and knowledge allows experimentation and the development of ideas. The equipment and tools allows makers to request immediate feedback and potentially creating a better design of their ideas (Sheridan et al., 2014). Makers can minimalize costs from the development of imperfect ideas by them early in the development process (Barrett t et al., 2015). Members also find in the makerspace the on-the-spot assistance to pursue the projects.

Sense of Community

The Sense of Community theory provides an avenue to explain the behavior of members of makerspaces. McMillan and Chavis (1986) propose the following Sense of Community definition (SOC): "Sense of community is a feeling that members have of belonging, a feeling that members matter to one another and to the group, and a shared faith that members' needs will be met through their commitment to be together". The authors identified four elements of SOC. The first element is membership or feeling a personal relatedness. They explain that there are boundaries that establishes who belong to a certain community and who do not. The second element is influence or if members influence or impact the group. The third factor is integration and fulfillment of needs. The authors explain that this element focuses on the idea that some of

the needs of the individuals will be met as a result of the participation in the group. The fourth factor is shared emotional connection or the belief that members of the community share some common ground. They mentioned that robust groups provide positive ways for members to interact, events to connect and members recognition.

The work of Yoo, Suh, and Lee (2002) explores the factors that enhance members participation in virtual communities. It concentrates in managing strategies and information system quality. The authors targeted eight different communities (four non-profits and four for profit). They measured the following six managing factors: purpose, rule, role, event, ritual, and subgroup. For system quality and information quality, they measured the following, for system quality: speed, reliability, ease of use, functionality, and recovery. For information quality they used: timeliness, accuracy, abundance, customized information presentation, and useful information presentation. They also, used to concept of visits to measure the use of the system by measuring frequency and time of each visit. For participation, they measured the following types: participation in community operations, participation in subgroups or events, participation in regular messages boards, and participation in chatting or email with other members. In the case of sense of community, emotional connection didn't show discriminant validity ending in three measurements: fulfillment, membership and influence. They collected 2094 questionnaires and eliminated 207 for low reliability. They found that participation could not be enhanced directly, but sense of community can be enhanced by an appropriate managing strategy, and the number of visits could be increased by the quality of information.

Cantillon, Davidson, and Schweitzer (2003) study assess the validity of sense of community as a measure of community social organization and if it mediates the impact on several youth outcomes. This study conceptualized sense of community in the following

components: a sense of physical safety; emotional connections and attachment; and an empowering or action-oriented component. A total of 103 tenth-grade males participated in the study. They interviewed the student, one parent of the student and a neighbor of the student for a total of 309. The findings show that sense of community mediated the effect of neighborhood advantage on conventional activity. More specifically, the action component of SOC mediated the effect of block stability. The results also indicate that sense of community did not significantly mediate the relationship between neighborhood advantage and self-reported delinquency.

The work of Nowell and Boyd (2010) explore the second-order assumptions of psychological sense of community. They present two different models related to psychological sense of community. The first one is based on the human needs theory with an emphasizes humans as social creatures with desires for affiliation, power, and achievement. The second model explores the expectations of sense of community as an expectation of personal benefit.

The study by Peterson et al. (2008) purpose is to provide evidence of the validity of an instrument designed to measure sense of community for community organizations. The study begins by reviewing the Community Organization Sense of Community Scale proposed by Hughey et al. (1999) that measured sense of community in community. The scale used the following four components: (1) relationship to the organization, (2) organization as mediator, (3) influence of the organization, and (4) bond to the community. The study used two studies and two samples (Sample 1= 724, and sample 2= 508). The authors presented a revised version of the Community Organization Sense of Community Scale that included only positive worded statements and confirming the following factors: relationship to the organization, organization as mediator, influence of the organization, and bond to the community.

The work of Garrett, Spreitzer, and Bacevice (2017) focuses on how members of a coworking space collaborate and create a sense of community. Using a single case qualitative study, they identified identify three types of collective interaction that nurture a sense of community: endorsing, encountering, and engaging. They also explain that communities normally have a purpose that go beyond the social interaction or value created by that interaction.

Rosenbaum, Ostrom, and Kuntze(2005) compared the loyalty of members part of a communal versus non-communal loyalty program. They evaluated the following the following questions: “Can loyalty programs be differentiated based on whether or not members perceive a sense of community?”; and “Does a perception of a sense of community impact member loyalty to sponsoring organizations?”. The authors defined "Communal loyalty programs as organizational sponsored loyalty programs that transfer support from organizations to members by providing them with a sense of community". The authors studied 153 loyalty program participants establishing that consumers are more loyal to communal programs in comparison to programs that only use financial incentives.

Wang and Ki (2018) examined the attitude towards professional associations and the engagements of members as a result of their fulfillment and perceived organizational support. The study surveyed 13,299 members from 18 professional associations. Authors found that members’ perceived need fulfillment and organizational support influenced their attitudes toward, and in turn inspired their engagement with, their associations. They also documented the role of career status in the relationship between members’ attitude and their volunteering behavior towards the organization.

The work of Zhang(2010) integrated constructs from the sense of community framework with the information systems usage and success framework. They got 181 valid responses from 240 that were send out. They found that user satisfaction is the most important significant factor for determinant system usage. They also found that sense of community has a significant role in the explanation of the on-line social interaction process and indirectly influence usage passing through user satisfaction. They found all the four dimensions of the Sense of Community construct were significant.

The work of Legg, Wells, Newland, and Tanner(2017) explores the experience of participants in an adult recreational tennis league. Using semi-structured interviews, the authors interviewed 21 players part of a adult recreational leagues to understand their social benefits of being involved with the tennis's organization. Authors found that sense of community was important and it was found in through social spaces, perceptions of fairness, competition, and commitment. Authors found that individuals divided the issues in the following groups: administrative and individual issue. Participants mentioned that league rules and administrative decisions that supported generated situations that diminished the social experience.

Nistor et al.(2015) investigated the relationships between the following communities of practice variables: time spent in the community, centrality and socio-emotional interpersonal knowledge, the socio-emotional component of sense of community and participants' acceptance of knowledge sharing in face-to-face academic communities of practice. The study used a sample of 136 German and Romanian scholars. The results show that the socio-emotional interpersonal knowledge is the strongest predictor for socio-emotional sense of community and knowledge sharing acceptance. They also found that sense of community socio-emotional mediates the effect of centrality on the organization and time spent in the organization.

Membership

Makerspaces are organizations that are centered on their membership. For this reason, it is critical to explore some literature that explains the behavior of members from the perspective of the Sense of community theory. For The work of Bhattacharya (1998) focuses in the relationship between how and whether members join, affiliate and help influence the lapsing behavior in full-choice membership. They classify paid membership schemes in two types: (1) access. - membership is required to obtain access to the organization's resources, and (2) full-choice.- the recourse are available to the customer regardless of whether the individual is a member. They evaluated the following factors: Received membership as a gift, Professional association, change in membership level, interest group participation, length of membership, inter-renewal time, and helping behaviors. The empirical study was performed in a museum with a membership base of 18,000. The final dataset was comprising of 7,798 members episodes. Some of the findings suggest that hazard of lapsing the membership is diminish with increasing duration of membership, participation of interest groups, gift frequency and increasing inter-renewal times.

Knoke (1981) examines the relationship centralization of decision making, pattern of communication, and total amount of influence on commitment and detachment in voluntary organization. They explain that commitment depends on how the members of the organization support and are loyal to the organization. In the case of detachment, they explain as the feeling of personal remoteness from group and the feeling of inability to influence the organizational policies and activities. They comment that the total amount of influence could be expanded by 1) structural conditions or 2) motivational conditions (See Tannenbaum, 1968) make an interesting point related to the total amount of influence. with data of 32 voluntary organizations, the

researcher was able to find that communication and participation increased the commitment and reduce detachment. Communication and decision participation interact suggesting that communication can compensate for low involvement in making decisions.

Slater (2004) refined the membership scheme developed by Hayes and Slater. They classify 90 membership schemes affiliated to museums and galleries. They mention that there are two key areas of research: the behavior of members, and the nature of the organization. Hayes and Slater used the following seven typologies: the nature of the membership base; the purpose of the scheme; the type of benefits that were being offered; 'openness' of recruitment; governance; approaches to fundraising and marketing; and evaluation. This study used the following 11 characteristics: degree of autonomy/integration; number and stratification of membership categories; extent of differentiated brand identities and values attached to stratified categories; channels of entry to membership; fundraising approaches; focus on longitudinal relationship; extent of professionalism; an organization's strategic dependence on a membership scheme; level of business planning underpinning membership schemes; promotional methods; and application of audience research and evaluation. From the study, the author development four typologies or sub-groups: Emerging Public Members, Established Public Members, Stagnated Public Members, and Aspirant Integrated Membership. These typologies establish four types of stages that members of organizations go thru.

Cress et al. (1997) explored the relationship between membership duration or persistence and the level of activity of members or participation. They explain that the commitment thesis states that persistence and participation are the consequences of commitment. They also explain the competition thesis that argues that individuals with higher levels of participation will have to sacrifice other involvements. The study uses a sample of 1587 voluntary memberships across a

fifteen-year period. They found that participation and persistence are negatively correlated with one another.

The work of Paswan and Troy (2004) explores the motivational dimensions of membership to a non-profit organization. They explore the dimensions, the impact at different membership levels, and the relationship of demographic variables on membership motivation and levels. They mention that the membership fee for non-profit is normally considered a form of charitable donation. To conduce the exploratory study, they identified the following motivations: philanthropy, preservation, social recognition, children's benefits, tangible benefits, and hedonistic. For this exploratory study they used current members of a museum. They got 524 questionnaires back. They found that specific factors are related the different levels of membership. They could not find support for the hypothesis that members with a stronger preservation motivation will join at higher levels.

The work of Bennett (2012) explores how the selection criteria of members of a major gift fundraising effort determine the perception of performance of the fundraising activity. The study evaluates diversity within the team, team membership, selection of team members, commitment to major gift fundraising, ability to nurture relationships, personal status of the team member, extent and quality of intra-organizational relationships, communication ability, and experience of major gift fundraising. The study used an empirical approach and investigated a sample of 151 charities. They found that the diversity of its composition, and the motivation and commitment of the members of the team impacts performance, not the number of members in the group. They also found that the abilities and commitment of team members regardless of their status led to better performance.

Olsson (2012) explores members' returning, participating and co-creating behaviors related to distance. They explain that retention is when members are returning and renewing their memberships; participation refers to the use of members services; and co-production or co-creation when members get involve in a voluntary fashion to the production or creation of value. They explain that member renewal could be influenced by the member's feeling of meaningfulness and recognition. Some of the interactions that members perform with supported organization are financial contributions, volunteer work or advocates. They received a total of 755 completed surveys. The study found that members behaviors show significant differences depending on how distant the member lives from the location.

McMillan & Chavis (1986) explain that one of the critical components of membership are the boundaries of the organizations. The boundaries help to establish who belong to the organization and who do not. They explained that social psychology research has demonstrated that people have boundaries protecting their personal space. Groups create social distance between members and not-members by using language, rituals, and dress to create identity and separation. Such barriers separate "us" from "them" and allay anxiety by delimiting who can be trusted. Other authors have study boundary from different angles. Some of those studies have focused on boundary spanning activities (Tushman & Scanlan, 1981); the role of boundary and knowledge dispersion (Carlile, 2002); how knowledge crosses the boundary of the organization; (Carlile, 2004).

The work of Tushman and Scanlan(1981) explores individuals with intense boundary spanning activity. The author explores three different categories of spanning activities: external, internal and both. The external category refers to individuals that have characteristics that allow them to effectively connect with external areas. The author mentions that organizational

boundaries exists between subunits of the organization and with areas outside the organization. They explain that an individual need to understand the coding scheme on both sides of the boundary to be able to obtain information from the outside and transmit that information to the internal user. The empirical research found that boundary spanning would occur by individuals who were strongly linked internally and externally.

Carlile (2002) explores the boundaries that knowledge dispersion has. The study uses an ethnographic research focusing on four areas of an organization that depend on each other to develop new products. The article explains two approaches and proposes a third one. The first one is the syntactical approach that is based on a common and sufficient understanding of a syntax at the boundary; the second approach is the semantic approach that differences on interpretation or words or events will emerge overtime; and the author proposes a pragmatic approach that empathizes that knowledge as localized, embedded, and invested within an area. The study presents the difficulty of communication across boundaries and proposes how organizations may support individuals that need to work across boundaries.

The work of Carlile(2004) explores innovation settings where knowledge crosses organizational boundaries. The author develops a framework with the following three boundaries: syntactic, semantic, and pragmatic. It also uses three progressive processes: transfer, translation, and transformation. The author mentions the following three relational properties of knowledge: 1) difference in knowledge refers to a difference in accumulated knowledge from one party to the other; 2) dependence refers to a condition where two entities need to work together in order to meet their goals; and 3) the last one is novel when the knowledge that the individual shares has a novel characteristics.

McMillan and Chavis (1986) explain that *sense of belonging and identification* explain involvement with the feeling, belief, and expectation that the individual has a good fit in the group. The individual feels part of the group and is willing to scarify for the group. Other authors have explored the role of different levels and units of analysis generate the sense of community (Freeman, Anderman, & Jensen, 2007); the role of trust and social usefulness (Lin, 2008, how); the importance of relational capital and culture (Capello & Faggian, 2005); and the role of mattering and the perception of justice in the interpersonal dimension and procedural (Armstrong-Stassen & Schlosser, 2011).

Freeman et al. (Freeman et al., 2007) explore how academic motivation of students is explained by the students' sense of class belonging. They studied the following three different sense of belonging: 1) The sense of belonging to cause by the instructor, 2) the sense of belonging connected to the class, and the sense of belonging caused at the campus level. They empirical study was executed using questionnaires to college students. They authors found association between the sense of belong of students and their self-efficacy, intrinsic motivation, and task value; 2) they found association between sense of belonging at the class-level with instructors' warmth and openness, encouragement of student participation, and organization; 3) sense of social acceptance was associated with university-level sense of belonging.

The work of Lin (2008, p. 522) explores virtual communities by integrating a technical and social perceptive. The empirical study uses data collected from 198 community members regarding their experience in virtual communities. To measure sense of belonging, the author two constructs: 1) trust or the willingness of an individual to be vulnerable to activities or actions done by another; and 2) social usefulness or the perceived support in the form of recognition, approval, respect, etc. from other members of the community. The results of the

study explain that satisfaction and sense of belonging were determinants of member loyalty. The construct of trust was significant in explain sense of belonging, social usefulness was not significant.

Capello and Faggian (2005) explore knowledge spillovers and the role of relational capital on innovation activity. They define relation capital as "the set of all relationships – market relationships, power relationships and cooperation – established between firms, institutions and people that stem from a strong sense of belonging and a highly developed capacity of cooperation typical of culturally similar people and institutions". From the definition, it is possible to see that a strong sense of belonging is established when similar people and institution with culturally similarity develop a highly capacity of cooperation.

Armstrong-Stassen and Schlosser Armstrong-Stassen and Schlosser (2011, p. 319) developed and tested a model predicting the intentions of older workers to continue working in an organization. They used two studies to test their model. In study one, 236 participants from diverse groups of older workers participated. In study two 420 nurses were the participants. One of the constructs that they used was sense of belonging or perceived insider status. They linked to perceived insider status to a perception of contribution or a sense of mattering that indicates that one makes a difference to the organization and that the organization has signaled that individuals matter. They also linked insider status to the perception of justice in the interpersonal dimension and procedural.

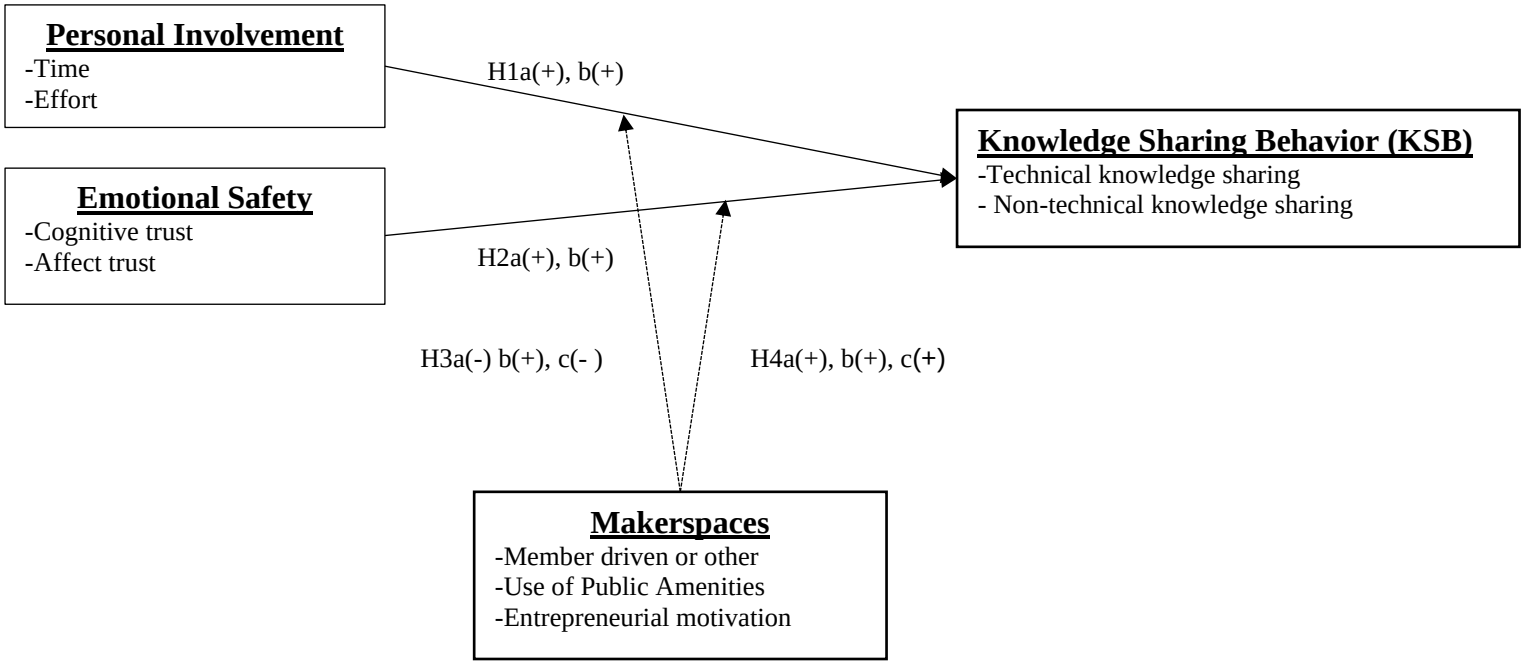
To summarize, membership has the following five attributes: boundaries, emotional safety, a sense of belonging and identification, personal investment, and a common symbol system. They contribute to the establishment of sense of community that describe who is part of the community and who is not (McMillan & Chavis, 1986). After reviewing the literature on

Sense of Community, I decided to only focus the dissertation on personal investment and emotional safety (trust). I want to concentrate my effort in increasing the understating of the internal motivation of the individual to share knowledge. I did not selected boundaries because most of makerspaces have a clear boundary. You need to join the space to become a member. Makerspaces have common symbols, but I don't expect variation in the dimension. They share a culture, tools and the following section will establish the importance of these dimensions for knowledge sharing in the context of makerspaces.

Research model and Hypotheses

The research model employed for this dissertation is presented in Figure 1. The study uses the Sense of Community theory as presented by Chavis, Hogge, McMillan, and Wandersman (1986) to explain how membership motivates members of makerspaces to share knowledge among them. According to these authors, Sense of Community can be measured using the following items: Membership, influence, integration and fulfillment of needs, and shared emotional connection. The principal investigator concentrated the research efforts in two elements of the membership dimension: personal investment and emotional safety or trust. The expected dependent variable is knowledge sharing behavior. To measure this dimension, this study used and adapted two elements of the scale developed by Yi (2009). The last part of the model are the following moderating variables: makerspace type, makerspace layout, and member entrepreneurial motivation.

Figure 2: Research model



Personal Investment and Knowledge Sharing Behavior

The Sense of Community Theory contents that members of an organization that invest their time, money, knowledge, etc. by serving the organization increases the meaningful and value of their membership or connection with that organization (McMillan & Chavis, 1986). The authors also explain that personal investment in the organization generates meaningfulness and value for the individual. The investment of members is crucial for member driven organizations since they depend heavily on members' resources such as funds, effort, participation, materials, time (Knoke, 1981), advocacy, and a legitimacy (Olsson, 2012). Some members will be quite active and invest their time and efforts frequently, or/and take leadership roles, while others will only pay their membership fees (Gazley, Tschirhart, & Teckchandani, 2014, p. 89).

Organizations that offer membership tend to obtain important revenues from the fees paid by supporters (Paswan & Troy, 2004). Member driven organizations have a tendency to offer different levels of participation or memberships and each membership will offer different benefits (Gruen, Summers, & Acito, 2018). The benefits will vary accordingly to the level of membership and normally, they will increase with increases of membership level (Paswan & Troy, 2004). Members decide the level of personal investment or participation they want to offer to the organization. According to the commitment thesis, individuals with high commitment demonstrate a higher level of persistent (Cress et al., 1997). Members of professional association tent to volunteer time with their association if the tasks relates to their rationale for joining the association (Hager, 2013).

To share knowledge, a member is required to exchange information and know-how to others (Connelly & Kevin Kelloway, 2003). In makerspaces, members access the knowledge and expertise of others members in formal teams around projects or by asking other members to

share their experience (Hagel, Brown, & Kulasooriya, 2013, p. 6). If a member of a makerspace feels that is a member of that community, it will be inclined to invest their personal time to support other members of the community. Depending on the level of time invested in the makerspace, the individual will be willing to share different types of knowledge. In the case of makerspaces, members require technical knowledge to learn how to operate different equipment and tools to develop their projects. If they invest time, they will feel an increase in the belonging to the organizations or makerspace. This would translate on sharing not only technical knowledge but also nontechnical knowledge. Therefore, I propose:

> ***Hypothesis1a:*** *Higher levels of personal investment of time in a makerspace will be positively related to both technical and non-technical knowledge sharing of members of a makerspace.*

Members not only invest time in a makerspace, they need to invest their personal efforts to become part of the makerspace. The expectation is that members invest their efforts to support the makerspace or other members. Some of the ways that members invest their effort are mentoring other members, teaching classes, giving feedback to other members, etc. Members are generally willing to teach each other skills or the operation of the equipment they have experience (van Holm, 2017, p. 165) If a members of a makerspace feels that they have "invested" their personal effort, they will increase their feeling of sense of community and membership (McMillan & Chavis, 1986) and be more incline to share technical and non-technical knowledge. Therefore, I propose:

> ***Hypothesis1b:*** *Higher levels of personal investment of efforts at a makerspace will be positively related to both technical and non-technical knowledge sharing of members of a makerspace.*

Emotional Safety and Knowledge Sharing Behavior

Membership establishes the boundaries of the organization and provides members the emotional safety to develop a connection and expose their needs and feelings to other members (McMillan & Chavis, 1986). The structure and security offered by the organizational boundary allows and protects group intimacy (McMillan & Chavis, 1986) and creates opportunities for members to build trusting relationships with others (Gazley et al., 2014, p. 85). This feeling is constructed by the self-investment of the members of the community increasing their own perception of the value of their own membership to the group. Members build trust among them, trusting each other in a personal way and in relation to their skills and competences. McAllister (1995) explains that interpersonal trust has an affective and a cognitive dimension. The emotional safety increases when its members experience membership of a group and trust increases between their members (McMillan & Chavis, 1986).

Knowledge sharing requires the exchange of information from one individual to one or more individuals (Connelly & Kevin Kelloway, 2003). Individuals will share knowledge based on the level of the cognition-based trust they have on the others person's perceived competence and reliability (McAllister, 1995). Aldrich (2014) explains that experienced members at a makerspace volunteer their time to help novices. They share their knowledge with other members solving design and fabrication problems (Aldrich, 2014). The level of competence and reliability in the technical area will increase the cognition-based trust the ember recognize in the member. Therefore, I propose:

> ***Hypothesis 2a:*** *Members' cognitive trust is positively related to technical knowledge sharing in a makerspace setting.*

The second type of trust is related to affect-based trust. This type of trust is built on the relationship that is established by members of a groups that care for each other, value the relationships, and believe that the they are reciprocated (McAllister, 1995). Wang, Dunn, and Coulton (2015) explain that makerspaces should be seeing as social hubs should were members bond around a technology rather than subservient to the technology itself. Members of a makerspace experience peer learning through interaction and cooperation among users leading to an increase of social capital (Han et al., 2017, p. 186). Makerspaces contributes to the feeling of like a "family or a group of friends" (González-González & Arias, 2018). The mindset of people organizing and visiting such makerspaces and its workshops is described as open, friendly, supporting and creative (Schön et al., 2014, p. 17). Members will share non-technical knowledge with individuals that they feel trust in an affect way. Therefore, I propose:

> ***Hypothesis 2b:*** *A members' affective trust is positively related to non-technical knowledge sharing in a makerspace setting.*

Personal Investment, Knowledge Sharing, Makerspace type, Makerspace layout, and Entrepreneurial motivation

Makerspaces are civil spaces sponsored or run in several ways. Member-driven makerspaces are established when a group of individuals get together and create the space using their own resources. Practically half of all makerspaces are member-driven spaces suggesting the importance of self-organized spaces in the popularity of this type of civic space (Holman, 2015). This type of 'member-driven' spaces form a legal entity to operate the space and establishes the membership operating rules. A second type are makerspaces sponsored by a public entity. For example, Makerspaces in libraries provide access to citizens to material and equipment not normally available in their homes providing a space for practical and creative activities (Fourie & Meyer, 2015). Other makerspaces are sponsored by Universities such as the Georgia Institute

of Technology where students volunteer to manage the civic space (Forest, 2014). Sponsoring institutions need to consider liability and training issues when establishing makerspaces. (Crumpton, 2015). For example, if the sponsoring agent is a library, the staff of the library must learn skills and abilities to guide users (Crumpton, 2015).

Makerspaces that have sponsoring organizations will need to align the operation of the makerspace with the operation of the sponsoring organizations. Crumpton (2015) explain how libraries have addressed the policy and sustainability issues of makerspaces at libraries. For example, library staff must learn and develop the skills required at a makerspace in order to help and guide users (Crumpton, 2015). In the case of makerspaces sponsored by a university, the space needs to align to the needs, policies and paths of the university. Forest (2014) enlist some of the aspects of university sponsored makerspaces. For example: primary student-run, no cost to use, related to the curriculum, and located in campus. From the previous paragraphs, it is evident that member-driven and sponsored makerspaces provide access to similar equipment and tools. But the membership and sense of community that members experience might be different.

Members of member-driven makerspaces increase their perception of the benefits of the organization as a result of co-creating the services and benefits of a makerspace (Gruen et al., 2018). Russell E. Browder et al. (2017) explain that members of makerspaces obtain knowledge and expertise on the use of equipment and product development through formal or informal activities. Therefore, I propose:

> ***Hypothesis3a:*** *The effort a member invest is positively related to both technical and non-technical knowledge sharing in a makerspace setting and will be stronger in member-driven makerspaces.*

The work of Hua et al.(2010) explores the impact of workspace on the collaboration and interactions of individuals at work. Using a multiple-site field study, the authors study the typology of formal and informal collaborative spaces. The authors used the following typologies for the study: team-work-related, service-related, and amenity-related spaces. They also explain that interactions could occur at circulations areas. The following three hypotheses were tested: The first hypothesis was supported showing clear differences between workplace layouts on the basis of distances between workstations and various collaborative spaces; the second hypothesis supported that the layout of collaboration spaces at the workspace impacts directly the perception of workers on how well the work environment supports collaboration; and hypothesis three supported the idea that public spaces are better predictor than individual work stations on collaborative work.

The work of Inalhan and Appel-Meulenbroek (2010) explores the role of a building in the knowledge sharing behavior of employees. The author collected data from 138 workers of a research institution to show the impact of co-presence in knowledge sharing and the way knowledge is shared. Co-presence or the proximity between workers impacts knowledge sharing because workers have higher interactions with other works just by moving around in the workplace. They used the following three measures for co-presence: visual accessibility; proximity; and meeting areas. The findings of the study show that co-presence explains the variability in knowledge-sharing meetings and that knowledge sharing is different between workers in co-presence and workers that work in different rooms or areas.

Appel-Meulenbroek et al.(2016) studied how spatial design of office space influence knowledge sharing behavior of employees. The study uses the following variables: collocation or sharing of the same room, inter-visibility, overhearing, close proximity, and location on the same

floor. The authors collected the interactions via diaries of 138 employees and a network analysis of the layout of the building. The results present that inter-visibility and proximity are stronger where knowledge is shared and sharing the same room and overhearing are more significant on how knowledge is shared.

The work of Weijs-Perrée et al.(2018) explore the direct and indirect effects of business centers types and use on knowledge sharing behavior within and between organizations. They collected date of 268 individuals of 53 business centers and performed a path analysis. Some of the variables that the authors used are: organizational size, facilities such as meeting spaces, reception, restaurant, kitchen, lounge and coffee area, Work-area type such as alone in a closed space, together with others in a closed space or in an open space, and type of use such as personal office, shared office and the flexible used office. They found that a lounge room is the most significant factor for knowledge sharing between organizations. They also found that meeting spaces and flexible use workspaces are important for knowledge sharing within organizations (Weijs-Perrée et al., 2018).

Makerspaces have areas for members to advance their projects and areas for members to socialize, such as a kitchen, coffee shop, game area, or lounge. This social areas nurture the social networking, information transfer, and the creative development of ideas (Hua et al., 2010). Members of a makerspace that invest their personal effort will use the amenities of the makerspace. I expect that they will use the social areas to balance their activities at the space. Members that use the social areas will share non-technical knowledge such as travel advice, cooking advice, lifestyle, etc. Based on the previous, I propose the following:

Hypothesis3b: *The effort a member invest is positively related to non-technical knowledge sharing in a makerspace setting and will be stronger for members that use intensively the social amenities of the space.*

Makers tend to get involved in a makerspace to learn skills and to have access to the means of productions (Hagel et al., 2013, p. 6). These spaces allow individuals with ideas to mature and produce artefact at a low risk and with a small scale (Jackson, 2014, p. 312). Makerspaces provide an opportunity to study how entrepreneurs develop new ideas and gain access to the tools and skills required to innovate and develop their ideas (Russell E. Browder et al., 2017). Van Holm(2017) explains that makerspaces generate new entrepreneurs. The author mentions that lead users or accidental entrepreneurs tend to use these spaces to develop products or artifacts to solve their needs before ahead of the market.

Makerspaces provide a supportive environment for members of makerspace to transform products from ideas to reality (van Holm, 2017, p. 166). Makers can develop their ideas and find design issues in the initial stages of development with the possibility of adjusting the idea at a lower cost. Makers also get access to other members to obtain feedback of the products they are developing. Makers with a strong entrepreneurial motivation will have a limited desire to support in an extraordinary form the efforts of the makerspace. Their main driver is the production of products that could lead to business benefit. Therefore, I propose the following:

Hypothesis3c: *The effort a member invest is negatively related to both technical and non-technical knowledge sharing in a makerspace setting and will be stronger for members with strong entrepreneurial motivations.*

Emotional Safety, Knowledge Sharing, Makerspace type, Makerspace layout, and Entrepreneurial motivation

Member-driven makerspaces generate a stronger sense of community. The work of McMillan and Chavis (1986) explains that strong communities offer members opportunities to interact, events, and opportunities to create bonds among members. One of the dimensions of the sense of community theory is emotional safety where members experience group intimacy, membership structure and security (McMillan & Chavis, 1986). Makers recognize the importance of collaborating and sharing with other makers (Foster, 2014). Members of makerspaces collaborate with others forming teams or asking others to share their knowledge and experience (Hagel et al., 2013, p. 6). Members need to develop an emotional trust based on their relationship. Members share an emotional investment in each other and show care and concern (Rutten, Blaas-Franken, & Martin, 2016, p. 4). Their relationship will expend from the technical arena to the non-technical arena. I expect that the knowledge sharing in member-driven makerspaces will have more non-technical knowledge sharing opportunities. Therefore, I propose:

> ***Hypothesis4a:*** *A members' affective trust is positively related to non-technical knowledge sharing in a makerspace setting and will be stronger in member-driven spaces.*

Van Holm (2017) explains that the main services of a makerspace is access to an inventory of tools, such as 3-D printers, milling machines, computers and graphic design software, laser cutters, etc. Besides the project related areas, makerspaces offer social areas (e.g. kitchen, lounge, coffee shop, etc.) for members to balance activities. Affective trust relates to the emotional safety an individual feel as a result of an emotional connection (McAllister, 1995). I expect that members of makerspaces that use intensively the social areas of the makerspace will

develop a strong affective trust that will lead to non-technical knowledge sharing. Based on the previous arguments, I propose the following:

> ***Hypothesis4b:*** *A members' affective trust is positively related to non-technical knowledge sharing in a makerspace setting and will be stronger for members that use more time social spaces.*

Russell E. Browder et al.(2017) list the following different types of members of a makerspace: hobbyists, lifestyle entrepreneurs, growth entrepreneurs, corporate innovators. This typology differentiates the entrepreneurial motivation of members. Members with a strong entrepreneurial motivation will focus on the development of their projects. To develop their projects, they need to exchange technological knowledge. By interacting with other members while working on projects, they will nurture their cognitive trust. Based on the previous, I propose the following:

> ***Hypothesis4c:*** *A members' cognitive trust is positively related to technical knowledge sharing in a makerspace setting and will be stronger for members with a strong entrepreneurial motivation.*

Chapter Summary

This chapter initiates with key aspects of the sharing economy. Then, builds the connection of makerspaces as part of the sharing economy. The next section presents sense of community as the main theory to help explain knowledge sharing in makerspaces. The research model with nine hypotheses are explained.

CHAPTER IV

DATA COLLECTION AND RESULTS

This chapter begins presetting the development and logic of the data collection instrument. The next section explains the population and sample. The following section presents the results of the confirmatory factor analysis (CFA). The third sections report the results of hypotheses tests. I end the chapter with a summary of the chapter and some conclusions.

Instrumentation

This empirical study is designed using a survey strategy to collect information from participants. The following paragraphs describe the measures and variables used in this study. In Appendix C, the reader may find the instrument. After the proposal and instrument was approved by the dissertation committee, a human subject's request for clearance was submitted and approved by the Institutional Review Board (IRB).

Dependent and Independent Variables.

To measure *knowledge sharing behavior*, I adapted the Knowledge sharing behavior scale developed by Yi (2009). The scale is appropriate to measure knowledge sharing in a makerspace because the scale was developed to measure knowledge sharing in communities of practice. I only going to use one item of the dimension of personal interaction. Personal interactions: This aspect of KSB refers to knowledge shared in informal interactions among individuals in a person-to-person channel. Some examples are when individuals have conversation and share knowledge

during lunch. (Yi, 2009, p. 5). It occurs in a non-routine fashion. Individual shares knowledge expecting reciprocity from the group (Yi, 2009, pp. 5–6). Table 7 presents the original item from the scale and the modified item to utilize on the survey. This item will be collected through self-report on survey items by asking respondents to indicate if they strongly agree or disagree in a seven-point Likert scale.

Table 6: Knowledge Sharing Behavior

Author(s)	**Factor**	**Population**	**Authors' Item**	**Authors' Item Adapted Item (final question items in bold)**
Technical Knowledge Sharing				
Yi, 2009	Personal interactions	Employees working in a US high technology company	Share passion and excitement on some specific subjects with others through personal conversation.	I share knowledge with other members about the use of materials
				I share knowledge with other members about how to work with tools
				I share knowledge with other members about fundraising
				I share knowledge with other members about business management
				I share knowledge with other members about commercialization
				I share knowledge with other members about Patents and intellectual protection
Non-Technical Knowledge Sharing				
Yi, 2009	Personal interactions	Employees working in a US	Share passion and excitement on some specific subjects with	I share knowledge with other members

		high technology company	others through personal conversation.	about projects I am working on
				I share knowledge with other members about family
				I share knowledge with other members about partner/spouse
				I share knowledge with other members about politics
				I share knowledge with other members about travel
				I share knowledge with other members about entertainment
				I share knowledge with other members about religion

To measure personal investment, I measured time and effort at the makerspace. Wang and Ki (2018) explains that members of professional associations tend to volunteer time at their associations if the task relates to the motivation for joining the association. Being a member is the feeling of being a part of something, in this case a makerspace (McMillan & Chavis, 1986). I will collect the number of hours per week the members uses the makerspace. I also will collect the number of hours the member volunteers and the type of activities the individual volunteers. To capture the feeling of effort invested by the member of the makerspace, I will use the Discretionary Effort scale developed by Lloyd (2008) (table 8). The Discretionary Effort scale and measures the voluntary effort that is over and above what is required and expected (Lloyd, 2008). To measure discretionary effort, I will use a seven-point Likert scale, ranging from 1 (very unfavorable) to 7 (very favorable).

Table 7: Personal Investment

Author(s)	Factor	Population	Authors' Item	Authors' Item Adapted Item (final question items in bold)
Nation of Makers 2018 - Member Survey	Time	Survey of makers	How many hours a week do you spend at your makerspace?	How many hours a week do you spend at your makerspace?
Nation of Makers 2018 - Member Survey	Time	Survey of makers	How many hours a week do you volunteer at your makerspace?	Do you volunteer at your makerspace? Yes. No. [P3] How many hours a week do you volunteer? o 1 to 3 hours o 4 to 6 hours o 7 to 12 hours o 12 to 19 hours o 20 or more hours
Nation of Makers 2018 - Member Survey	Time	Survey of makers	If you do volunteer, what do you do? (Please mark all that apply) o I don't volunteer o Clean o Teach o Mentor o Staff open hours o Help plan events o Plan workshops o Manage makerspace finances o Administrative work o Human Resources o Serve on the board o Serve on a committee	If you volunteer, what do you do (check all than apply)? o Teaching/Mentoring o Staff o Social media and marketing o Management (finance, human resources, etc.) o Governance (Board, Committee, etc.) o Other (please specify) _____

			○ Marketing ○ Design ○ IT/Systems administration ○ IT/Web development ○ Other (please specify) ○ No ○ No - Have work ○ experience ○ though	
(Lloyd, 2008)	Discretionary Effort	university students	When I work, I really exert myself to the fullest, beyond that what is expected.	When I volunteer at the makerspace, I really exert myself to the fullest, beyond that what is expected.
(Lloyd, 2008)	Discretionary Effort	university students	I persist in overcoming obstacles to complete an important task.	I persist in overcoming obstacles to complete an important task at the makerspace
(Lloyd, 2008)	Discretionary Effort	university students	I put in extra effort whenever I find it necessary.	I put in extra effort whenever I find it necessary when supporting my makerspace
(Lloyd, 2008)	Discretionary Effort	university students	I work harder than expected to help my organization to be successful.	I work harder than expected to help my makerspace to be successful.

To measure trust, I adapted the scale to measure *affect-based* and *cognition-based* trust created by McAllister (McAllister, 1995). The author defines interpersonal trust "as the extent to which a person is confident in, and willing to act on the basis of, the words, actions, and decisions of another" (McAllister, 1995). The author mentions that interpersonal trust is founded in affect-based trust or the emotional connection that an individua. The second foundation is cognitive trust that is the trust developed when individuals evaluate he track record of peers, or how they have been in the past in relationship with the duties and responsibilities at the organization McAllister (1995). Table 9 presents the original items and the modifications that were needed to develop the instrument.

Table 8: Trust

Author(s)	Factor	Population	Authors' Item	Authors' Item Adapted Item (final question items in bold)
McAllister 1995	Affect-based trust	Students or Alumni of an MBA program	We have a sharing relationship. We can both freely share our ideas, feelings, and hopes. I can talk freely to this individual about difficulties I am having at work and know that (s)he will want to listen.	I can freely share my ideas, feelings, and hopes at the makerspace. I can talk freely to other members about difficulties I am having and know that they will want to listen.
McAllister 1995	Affect-based trust	Students or Alumni of an MBA program	If I shared my problems with this person, I know (s)he would respond constructively and caringly.	If I shared my problems with a member of the makerspace, I know they would respond constructively and caringly.
McAllister 1995	Affect-based trust	Students or Alumni of an MBA program	I would have to say that we have both made considerable emotional investments in our working relationship.	I would have to say I have made considerable emotional investments in relationships at the makerspace.
McAllister 1995	Cognition-based trust	Students or Alumni of an MBA program	This person approaches his/her job with professionalism and dedication.	I only share my knowledge and skills with members that approach their job with professionalism and dedication.
McAllister 1995	Cognition-based trust	Students or Alumni of an MBA program	Given this person's track record, I see no reason to doubt his/her competence and preparation for the job.	Given the member's track record, I see no reason to doubt their competence and preparation for the job they are doing.
McAllister 1995	Cognition-based trust	Students or Alumni of an MBA program	I can rely on this person not to make my job more difficult by careless work. Most people, even those who aren't close friends of this individual, trust and respect him/her as a coworker.	I can rely on members not to make my job more difficult by careless work at the makerspace.

McAllister 1995	Cognition-based trust	Students or Alumni of an MBA program	Other work associates of mine who must interact with this individual consider him/her to be trustworthy. If people knew more about this individual and his/her background, they would be more concerned and monitor his/her performance more closely?	If people know more about several members and their background, they would be more concerned and monitor their performance more closely.

Moderation variables

To collect data on the type of makerspace (member driven or other), the principal investigator used the question 'name of the makerspace'. Each name of a makerspace was searched over the internet. After locating the official website of the makerspace, the principal investigator located the "about" section or the section that explained the structure of the makerspace. If the makerspace operated by a board of directors of their own members, the makerspace was included in the category of member driven makerspaces. All other makerspaces were included in the "other category". The literature indicates that almost half of all makerspaces are member-driven makerspace (Holman, 2015), other makerspaces have sponsoring organizations such as libraries and universities. (Papavlasopoulou et al., 2017, p. 58).

To evaluate the effects of facilities and workspace layout, I adopted and modified a question developed by Weijs-Perrée et al.(2018). The work of the author presents the influence of formal and informal organizational spaces in knowledge sharing behavior. Table 10 presents the original question and the adapted question.

Table 9: Makerspace layout

Author(s)	Factor	Population	Authors' Item	Authors' Item Adapted Item (final question items in bold)
Weijs-Perrée et al. 2018	Use of offered facilities	Tenants of business centers	Frequency of using offered facilities in a business center: (1) never to (7) multiple times a day • Kitchen • Print/copy area • Elevator • Coffee corner • Meeting space/conference room • Restaurant/canteen • Informal-/social meeting space • Concentration room • Common terrace • Lounge room • Event space • Project-, creative- or classroom • Atelier space	[L1] What is the numbers of hours (on average) that you use the following facilities in the makerspace? • Individual workspace (alone in a closed space) • Together with others in a closed space • An open space without partitions • An open space with partitions • Shared equipment and tools • Kitchen • Meeting space/conference room • Lounge room • Events space

To collect data to evaluate the entrepreneurial motivation of members of a makerspace, I adapted the two questions from the Nation of Makers survey (2018). The questions identify if the member of the makerspace goes to the space with entrepreneurial motivations or not. The work of Browder et al.(2017) identified the following types of members of makerspaces: hobbyists, lifestyle entrepreneurs, growth entrepreneurs, and corporate innovators. The intention of this questions is to identify if the primary reason to go to the makerspace are entrepreneurial or not. Table 11 presents the original questions and the adapted ones.

Table 10: Entrepreneurial motivation

Author(s)	Factor	Population	Authors' Item	Authors' Item Adapted Item (final question items in bold)
Nation of Makers 2018 - Member Survey	Entrepreneurial motivation	Survey of makers	• What do you use your makerspace for? • Volunteering • Socialization • Tool use • Learning new things • Sharing my knowledge • Working for the makerspace • Running my own business • Other (please specify	[E1] What was the primary reason for your decision to join your makerspace? • Volunteering • Socialization • Tool use • Learning new things • Sharing my knowledge • Working for the makerspace • Running my own business • Other (please specify) _____ [E2] **Now**, what do you use your makerspace for (check all than apply)? • Volunteering • Socialization • Tool use • Learning new things • Sharing my knowledge • Working for the makerspace • Running my own business • Other (please specify) _____
Nation of Makers 2018 - Member Survey	Entrepreneurial motivation	Survey of makers	Do you earn income of the work you do in the makerspace? • No. • Yes. I make my own products at the space and sell them. • Yes. I do custom project work for clients. • Yes. My company pays for my membership	[E3] Do you earn income of the work you do in the makerspace? • Yes. • No. [E4] If you earn income, what do you do? • I make my own products at the space and sell them. • I do custom project work for clients.

			and I use it for that business. • Yes. I consult or provide services through the space. • Yes. I teach. • Yes. I am staff at the makerspace. • Other (please specify)	• My company pays for my membership and I use it for that business. • I consult or provide services through the space. • I teach. • I am staff at the makerspace. • Other (please specify)

Control variables

To better understand the relationship between the dependent variables, independent variable and control variables, I will use the variables on table 12.

Table 11: Control variables

Author(s)	Factor	Population	Authors' Item	Authors' Item Adapted Item (final question items in bold)
Nation of Makers 2018 - Member Survey	Control	Survey of makers	Your age range	[C4] What is your age? o 18-24 o 25-34 o 35-44 o 45-54 o 55-64 o 65+
			Your gender	[C5] Your gender? o Male o Female o Choose not to disclose
			Highest level of education you have completed	[C6] Highest level of education you have completed? o No degree o High School or GED o Some College or professional certification o College o Graduate studies

			What is your employment status?	[C7] What is your employment status? ○ Full-time ○ Part-time ○ Student ○ Retired ○ Unemployed

To pilot the instrument, a database of makerspaces with information available from the internet was created. Using 319 records from the Makerspace Directory[5] from makerspaces around the world, the data was filtered the information to the Texas, Missouri, Minnesota and New York to concentrate my efforts and have a more manageable sample (See Appendix D for a list of the makerspaces by state). The following characteristics were recorded when available: location, contact email, website, telephone and type. There is a total of 67 potential organizations that were contacted to obtain their support in the validation process of the instrument. Two eligibility criterions were asked to determine if the individual should be included in the pilot study: 1) If the individual is a member of the makerspace, and 2) if the member has 18 years or age or more. Eighteen participants supported the piloting of the instrument. The instrument was improved with the feedback from the pilot study.

The questionnaire was developed considering the importance of avoiding boredoms and fatigue. Lindell and Whitney (2001, p. 118) suggest avoiding transient moods of participants by developing a short questionnaire. The author explains that if respondents perceive a questionnaire as long, irrelevant, or repetitive; the participant might reduce their cognitive effort and increase the speed of responses as they progress through the questionnaire.

[5] https://makerspaces.make.co/

To reduce the common method bias or common method variance (CMV) I provided general information on the purpose of the study. Additionally, I offered anonymity and confidentiality to the participants to minimize the social desirability of the participant (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003, p. 888). I also added attentional checks to increase the attention of participants when respooling to the instrument (Howard & Melloy, 2016, p. 181). The first item consisted of the following question "Please, verify that you are present in the survey by selecting number 3"; I expect the participant to answer 3. The second question was "Do you believe that your answers should be used for the analysis?" to which participants could respond "yes" or "No". the last attention check was "As a validation check, please answer 'strongly disagree' for this question". If participants failed two out of the three attention checks, their observation will be removed from the analysis.

Additionally, the marker variable test suggested by Lindell and Whitney(2001) was conducted. As explained by Williams & McGonagle, 2016, p. 342) any shared covariance of the marker with the variables of the model will be attributed to CMV. I selected Web use as my marker variable following the logic explained by Simmering, Fuller, Richardson, Ocal, & Atinc, 2015, p. 16). The marker variable consisted of the following items: 1) When searching for technical information in general, I use the web; 2) When searching for technical information relating to specific information, I use the web; 3) When searching for information that compares technical information, I use the web. The Marker variable scale was placed immediately after predictors and before the dependent variable as suggested by Lindell & Whitney, 2001, p. 118).

Population and Sample

Sample Size

There is some variation of the ideal number of cases needed for a confirmatory factor analysis (CFA). For example, Rummel (1970) recommends a ratio of 4:1 of items to responses. In the case of Schwab (1980), a ratio of 10:1 item to response ratio is a more conservative number. In a study elaborated by Costello & Osborne (2003), found that almost 40% of studies utilize a ratio of less than 5:1. Based on the previous recommendations, I decided to use a 4:1 ratio of respondents to items as my minimum sample. My target sample for the CFA is 152 given a 38-items scale. The second phase of the study uses regression analysis. Hair et al. (2014) suggests a minimum of five responses for each variable in a regression. Since my study has 9 variables, the minimum sample size needed for the analysis would be 45. I also used G*Power Software to estimate the sample size for the hierarchical multiple regression. The parameters that I used were a medium effect size of .15, an α of .05, a power of .95, the number of tested predictors of 4 and the total number of predictors of 7. The required sample was 129 (Output of G*Power at Appendix E). The minimum sample size needed for each analysis differs for each section of the process. For the CFA, a minimum of 152 is needed and a sample of 129 is needed for the regression analysis. Since, I will perform regression analysis on the same data, I will collect a sample of 152 based on CFA ratio.

Data Collection

The study uses Amazon Mechanical Turk as the mechanism to recruit participants. MTurk was selected because it offered the following benefits: First, MTurk's pool of potential participants was large and diverse. Makers and makerspace are dispersed around the United States and MTurk had the potential to reach out to this population and increase the response rate of the study. The second benefit was the flexibility and adaptability of MTurk to connect with

other platforms. The official deployment platform for the study was Qualtrics. This survey deployment platform has a higher level of protection of data integrity, security and is approved by the institutional IRB agent; MTurk had the capacity to connect and Qualtrics with minimal problems or modifications. The third benefit that Qualtrics offered was the cost. MTurk pricing allows pricing flexibility with a reasonable service fee. Each responded was paid $2.50 plus MTurk fee. The last benefit was the speed of the collection process, it took seven days to collect the data. The benefits observed are consistent with the benefits identified in the study of (Aguinis, Villamor, & Ramani, 2021, p. 824) of the use of MTurk for management studies.

The mitigate the challenges of using MTurk as a recruitment mechanistic, this study followed the suggestions presented by Aguinis et al., 2021). The first challenge was inattention. This challenge occurs as a result of the intention of participants to maximize profits and engage in rapid responding. To increase the attention, this study included the three attentional checks points in the study (Howard & Melloy, 2016). The second challenge is self-misrepresentation. Some respondents may force their eligibility to become eligible and obtain the monetary reward. To mitigate this challenge, I incorporate two questions in the study that questioned their identity. The first one asks them if they were a member of the makerspace and the second question requested the name of the makerspace. Another challenge are the high attrition rates in MTurk studies (range: 31.9%–51%) (Aguinis et al., 2021). The recommendation to mitigate higher levels of attrition is to have clear rules from the beginning. This study had one page explaining the expected time to complete the survey, the required qualifications, and the compensation. Other challenges that were evaluated were: vulnerability to webrobots, social desirability, researcher unfairness, self-selection, language fluency, and MTurk's community.

There was a total of 359 responders to the survey that agreed to the consent statement. The next inclusion check was the requirement of being a member of a makerspace. Sixty-two respondents did not mention a name for a makerspace reducing the sample to 296 observation. To increase the validity of the study, the principal investigator searched the name of the makerspace over the internet. If the makerspace existed, the observation was kept, if the name didn't appear on the search result, the observation was deleted. The sample was reduced to 197 after deleting 99 that could not be verified. The attentional checks were used to increase the validity of the study (Howard & Melloy, 2016). The first attentional check requested the participant to select option number 3 if they were present and paying attention on the study. The deletion was necessary as a result of this check. The next attentional check requested to answer "strongly disagree" to a question. Eight participants did not follow the instruction and were excluded from the study. The final attentional check questioned if their answers should be used as part of the study. Five participants answered "no" and were not used for the study. The final stage was the elimination of 22 observations with missing variables. The final sample consisted of 162 valid responses. Table 13 shows the final sample

Table 12: Final sample

	Total	Sample
Pilot Instrument	**18**	
Consent (Q1)		
Yes	359	**359**
No	0	
Member of a Makerspace (Q2)		
Yes	296	**296**
No	56	
Missing	6	
Valid Makerspace? (Q4)		
Valid	197	**197**

Invalid	99	
Present at survey? Select 3 (Q31)	197	**197**
3	0	
Other		
Answer 'Strongly disagree'		
Strongly disagree	189	**189**
Other	8	
Answers used for analysis. (Q32)		
Yes	184	**184**
No	5	
Dropping of missing variables	**22**	**162**

The demographic characteristic of the participants was as follows (see table 12): Most participants (56.17%) spend between four and six hours at the makerspace. Only 23.46% of the sample spend seven hours of more at the makerspace. The majority (64.81%) of the participants in the study obtained income from their work or activities at the makerspace. The majority (72.82%) of participants volunteered at the makerspaces; 70.9% of them volunteered less than six hours or less a week. The gender distribution followed the following variance: 65.75% for males and 34.25% for females. In the case of age, 84.24% of the sample were between 18 and 44 years of age, and age group between 25-34 had the highest proportion (52.17%) of participants. Almost all the participants (82.51%) had a college or graduate degree. Also, 89.27% of the sample were fully employed. The results are presented in table 14.

Table 13: Demographic Statistics

	Frequency	**Percentages**	**Cumulative Percentages**
Hours a week at makerspace			
1 to 3 hours	33	20.37	20.37
4 to 6 hours	91	56.17	76.54
7 to more	38	23.46	100.00
Total	162	100.00	

Income from work at makerspace			
Yes	105	64.81	64.81
No	57	35.19	100.00
Total	162	100.00	
Hours a week as volunteer			
1 to 3 hours	34	27.87	27.87
4 to 6 hours	52	42.62	70.49
7 to 12 hours	24	19.67	90.16
12 to 19 hours	9	7.38	97.54
20 or more hours	3	2.46	100
Total	134	100	
Gender			
Male	105	64.81	64.81
Female	57	35.19	100
Total	162	100	
Age			
18-24	8	4.94	4.94
25-34	87	53.70	58.64
35-44	44	27.16	85.80
45-54	17	10.49	96.30
55 +	6	3.70	100.00
Total	162	100.00	
Education attained			
High School or some college	26	16.05	16.05
College +	136	83.95	100
Total	162	100.00	
Employment status			
Full-time	147	90.74	90.74
Part-time	15	9.26	100
Total	162	100	

Principal Component Analysis

To initiate the statistical analysis of the data obtained from the surveys, the principal investigator imported the data collected from the surveys into the statistical Software (STATA

17). The first statistical procedure used was a CFA to identify the items that explain the covariation among the independent variables. Factor Analysis was selected over components analysis as suggested by (Costello & Osborne, 2005). The authors explain that the popularity of component analysis decades ago was the result of being a quicker and cheaper alternative to factor analysis. They continue explaining that Factor Analysis is a stronger process because the factors scores are dependent upon the data varying across cases exposing underlying factor structures (Costello & Osborne, 2005). The initial factors analysis of 31 factors only retained 18 factors. The Eigenvalues indicated five factors below the 1.000 the threshold (Factor 5 = 1.10546; Factor = 6 0.955721) providing evidence against a common method bias. Additionally, a one factor model was attempted that demonstrated a poor fit indicating minimal concerns for common method bias (Korsguard & Roberson, 1995). The scale reliability of the initial model was 0.9261and the Kaiser-Meyer-Olkin measure of sampling adequacy was .835. The Bartlett's test of sphericity was significant ($p<.01$).

Extraction and Rotation

The next step was to evaluate the reduction of the items of the model. The data reduction procedure evaluates the variables in a model and determines which variables can be removed from the model to have a parsimonious model. The most common method of extracting factors is called principal component analysis (PCA) (Hotelling, 1933). The procedure identifies the linear combination of variables that account for the greatest amount of common variance. Variables that are not associated to at least some other variable will not contribute to the analysis and should be removed. Cross-loading variables increase the difficulty in determining the true relationship between variables, factors, and the underlying dimensions. There was a total of 18 items across the set of six factors (table 15) . Personal investment of effort accounted for three

items, affective emotional safety accounted for three items, cognitive emotional safety accounted for two, entrepreneurial motivation with 3 items, technical knowledge sharing accounted for three items and non-technical knowledge sharing with four items. The resulting model accounted for 0.8803 of the variances of the model with a Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy of .823 (Kaiser 1974) and significant (p<.01) Bartlett's test of sphericity. Scale reliability coefficient of each factor were the following: Technical knowledge sharing .8260, Non-technical knowledge sharing .7467, Effort .7893, Affective .06500, cognitive .0634, entrepreneurial motivation .7108, social amenities .7900. indicates that each component meets or exceeds the 0.6 threshold of acceptable level of reliability (Bagozzi & Yi, 1988; Ursachi, Horodnic, & Zait, 2015) indicating a good inter-item reliability.

Table 14: Six Factor model

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
Entrepreneurial motivation 1		*0.6762*				
Entrepreneurial motivation 2		*0.5759*				
Entrepreneurial motivation 3		*0.6584*				
Effort at Makerspace 1			*0.6462*			
Effort at Makerspace 3			*0.6288*			
Effort at Makerspace 4			*0.6708*			
Affective trust 2				*0.6719*		
Affective trust 3				*0.5434*		
Affective trust 4				*0.5705*		
Cognitive trust 1						*0.5052*
Cognitive trust 3						*0.5131*
Technical Knowledge Sharing 3					*0.5800*	
Technical Knowledge Sharing 4					*0.6209*	
Technical Knowledge Sharing 5					*0.6276*	
Non-Technical Knowledge Sharing 2	*0.5985*					
Non-Technical Knowledge Sharing 3	*0.6783*					
Non-Technical Knowledge Sharing 4	*0.7053*					
Non-Technical Knowledge Sharing 5	*0.5816*					

(blanks represent abs(loading)<.5)

Results of Hypotheses Tests

To test the ten hypotheses of the study, the principal investigator used a statistics application called Stata (version 17). The first step was to create six new variables from the seven factors identified from the PCA. The new variables were created by adding the items of a factor and dividing the number of items in the factor. To test the research model, the principal investigator used a hierarchical multiple regression analysis. Table 16 presents the descriptive statistics and the correlations of all the variables needed to conduct the hypotheses testing. The following assumptions were tested: normality, linearity and homoscedasticity as suggested by (Hair et al., 1998). The correlations table presents the following interesting results. First, technical knowledge sharing holds significant correlation with seven of the main variables of the analysis. In the case of non-technical knowledge sharing, the variable has six significant correlations with the main variables of the study. Most of the predicting variables do not have a significant correlation. The following are the exceptions: Effort at makerspace have a significant correlation with hours at makerspace; Affective trust has a significant correlation with effort at makerspace; cognitive trust has a significant correlation with education, affective trust and effort at makerspace; use of social amenities is the predictor with five significant predictors (education, hours at makerspace, effort at makerspace, affective trust, and cognitive trust); in the case of entrepreneurial motivation the variable correlates significantly with fours predictors (effort at makerspace, affective trust, cognitive trust, and use of social amenities). All the significant correlations are positive. The Variance Inflation Factor (VIF) from ranges from 1.03 to 1.78 indicating a moderated multicollinearity. The sencibility analysis did not presented changes to the results (Appendix F, Appendix G)

Table 15: Descriptive Statistics and Correlations

Variables	N	Mean	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Technical Knowledge Sharing	162	4.272	1.000												
(2) Non-Technical Knowledge Sharing	162	4.208	0.504*	1.000											
(3) Gender	162	1.352	-0.005	0.089	1.000										
(4) Age	162	2.543	0.040	0.023	0.015	1.000									
(5) Education attained	162	1.84	0.207*	0.268*	0.076	-0.017	1.000								
(6) Employment status	162	1.093	-0.120	-0.010	-0.012	-0.100	-0.150	1.000							
(7) Hours a week at makerspace	162	2.031	0.228*	0.072	-0.054	0.119	-0.056	0.017	1.000						
(8) Effort at the makerspace	162	5.49	0.358*	0.358*	0.052	0.052	0.177	0.035	0.225*	1.000					
(9) Affective trust	162	5.565	0.308*	0.324*	0.053	0.152	-0.006	0.115	0.201	0.425*	1.000				
(10) Cognitive trust	162	5.028	0.431*	0.322*	0.069	-0.035	0.296*	0.001	0.003	0.241*	0.212*	1.000			
(11) Member driven makerspace	162	1.494	0.072	0.121	0.022	-0.006	0.028	-0.060	0.122	0.079	0.090	0.127	1.000		
(12) Use of Social Amenities	162	4.414	0.468*	0.435*	0.039	-0.021	0.217*	-0.161	0.336*	0.406*	0.278*	0.277*	0.179	1.000	
(13) Entrepreneurial motivation	162	5.633	0.332*	0.239*	0.075	0.036	0.138	-0.041	0.116	0.350*	0.344*	0.302*	0.119	0.208*	1.000

**** p<0.01, ** p<0.05, * p<0.1*

Hypotheses testing for Personal Involvement and Emotional Safety

The principal investigator used an ordinary least square regression (OLS) analysis for testing the hypotheses. Table 17 and 18 present the results of hypothesis 1a, 1b, 2a, 2b. Personal investment was tested in hypotheses 1a and 1b and emotional safety is tested on 2a and 2b. Model 1 contains all the control variable. The adjusted R^2 from model 1 is 0.039 for technical knowledge sharing and .040 for non-technical knowledge sharing providing evidence that the model has limited prediction power when only the control variables are introduced. The only variable that is significant for technical and non-technical knowledge sharing is education. Hypothesis 1a predicted a positive significant relationship between the hours a week spend at the makerspace and TKS and NTKS. The relationship was tested in model 2 and it was supported for technical knowledge sharing (*β=.439, p<01*) but not supported for non-technical knowledge sharing. Model 3 tests the effect of effort of makers at a makerspace on knowledge sharing behaviors. Hypothesis 1b was tested and it was supported for technical knowledge sharing (*β=.332, p<01*) and non-technical knowledge sharing (*β=.305, p<01*). In model 4, the principal investigator tested the role of cognitive trust on knowledge sharing behavior. Hypothesis 2a was supported (*β=.353, p<01*) for technical knowledge sharing and it was significant for non-technical knowledge sharing (*β=.130, p<01, not tested*). Model 5 tests the role of affective trust on makers non-technical sharing knowledge. H2b was supported (*β=.220, p<05*). Overall, the full model is presented on model 5 (table 16 and 17). The adjusted R^2 of .300 for technical knowledge sharing has a stronger prediction power that the non-technical knowledge sharing full model with an adjusted R^2 of .190.

Table 16: Predictors of Technical Knowledge Sharing

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Gender	-.064	-.032	-.067	-.108	-.118
	(.195)	(.19)	(.183)	(.169)	(.168)
Age					

25-34	.202	.106	.067	-.137	-.095
	(.44)	(.428)	(.412)	(.382)	(.379)
35-44	.46	.289	.222	.006	.011
	(.458)	(.448)	(.431)	(.4)	(.396)
45-54	-.169	-.355	-.332	-.526	-.549
	(.508)	(.497)	(.477)	(.442)	(.438)
55 or more	.728	.626	.441	.557	.494
	(.645)	(.628)	(.605)	(.559)	(.555)
Education	.676***	.719***	.528**	.219	.267
	(.257)	(.251)	(.246)	(.235)	(.234)
Employment	-.277	-.303	-.391	-.451	-.507*
	(.328)	(.319)	(.307)	(.283)	(.282)
Hours at makerspace		.439***	.318**	.345***	.318**
(H1a)					
		(.138)	(.137)	(.126)	(.126)
Effort at makerspace			.332***	.24***	.177*
(H1b)					
			(.09)	(.084)	(.09)
Cognitive trust				.353***	.33***
(H2a)					
				(.067)	(.068)
Affective trust					.188*
					(.098)
_cons	3.51***	2.694***	1.343**	.481	-.098
	(.493)	(.544)	(.637)	(.61)	(.676)
Observations	162	162	162	162	162
R-squared	.081	.138	.209	.331	.347
Adj R^2	.039	.093	.162	.287	.300

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Table 17: Predictors of Non-Technical Knowledge Sharing

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Gender	.144	.153	.121	.103	.091
	(.161)	(.161)	(.154)	(.151)	(.149)
Age					
25-34	.213	.185	.149	.059	.108
	(.362)	(.363)	(.346)	(.341)	(.336)
35-44	.285	.236	.174	.079	.085
	(.377)	(.38)	(.362)	(.357)	(.351)
45-54	.221	.167	.189	.103	.077
	(.418)	(.421)	(.401)	(.395)	(.388)
55 or more	.21	.181	.011	.062	-.012
	(.531)	(.532)	(.509)	(.5)	(.492)
Education	.722***	.735***	.56***	.423**	.48**
	(.212)	(.212)	(.207)	(.21)	(.207)
Employment	.137	.13	.049	.022	-.043
	(.27)	(.27)	(.258)	(.253)	(.25)
Hours at makerspace		.127	.015	.027	-.004
(H1a)					
		(.117)	(.115)	(.113)	(.112)
Effort at makerspace			.305***	.265***	.19**
(H1b)					
			(.075)	(.075)	(.08)
Cognitive trust				.156**	.130**
				(.06)	(.06)
Affective trust					.220**
(H2b)					
					(.087)
_cons	3.316***	3.08***	1.837***	1.457***	.777
	(.406)	(.461)	(.535)	(.545)	(.599)

Observations	162	162	162	162	162
R-squared	.081	.088	.177	.212	.245
Adj R^2	.040	.041	.129	.160	.190

Standard errors are in parentheses
*** p<.01, ** p<.05, * p<.1*

Hypotheses testing for Interaction with member drive, use of social amenities, entrepreneurial motivations

Following the testing of personal involvement and emotional safety, this study explores the moderating role of member-driven makerspaces, the use of social amenities by members and the entrepreneurial motivation of members. Table 19 presents the results of technical knowledge sharing and table 20 presents the results of non-technical knowledge sharing. Model 1 present the regression results of a model with the control variables. Model 2 presents the results of the regression with the control variables and the main variables. Model 3 presents the control variables and the moderating variables. The results of model 3 shows that the variable member driven is not significant in both cases: technology and non-technology knowledge sharing. The variable use of social amenities was significant in both types of knowledge sharing behavior (Technical and non-technical) and in the case of entrepreneurial motivations it was only significant for technical knowledge sharing.

Model 4,5 and 6 are used to test hypotheses 3a, 3b, and 3c. Model 4 tests if the effort of a member of a member-driven makerspace and a non-member-driven makerspace is significantly different when sharing knowledge. In both cases (technical and non-technical knowledge sharing) the hypothesis was not supported. Hypothesis 3b was tested in model 5 not finding support for the relationship of non-technical knowledge sharing and the effort of a member that use intensively the social amenities of the makerspace. Hypothesis 3c was supported for non-technical knowledge sharing with a positive relationship ($\beta=.193, p<01$) but not supported for the technical knowledge sharing.

Models 7, 8 and 9 were used to test hypotheses 4a, 4b, and 4c. Hypothesis 4a (model 7) tested the relationship of members' affective trust with their non-technical knowledge sharing in member-driven spaces. It was not supported. Model 8 presents supporting results for hypothesis 4b ($\beta=.091$, $p<.05$). The result indicates that affective trust relates positively to non-technical knowledge sharing and is stronger when the member uses more public amenities of the makerspace. Hypothesis 4c is presented in model 9. The relationship between members' cognitive trust and technical knowledge sharing was stronger for members with a stronger entrepreneurial motivation ($\beta=-.121$, $p<05$) but it was a negative relationship.

Table 18: Moderating predictors of Technical Knowledge Sharing

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**	**Model 10**
Gender	-.064	-.118	-.135	-.122	-.135	-.12	-.119	-.147	-.143	-.145
	(.195)	(.168)	(.171)	(.168)	(.163)	(.167)	(.168)	(.162)	(.16)	(.16)
Age										
25-34	.202	-.095	-.129	-.133	-.226	-.102	-.089	-.283	-.283	-.315
	(.44)	(.379)	(.389)	(.38)	(.376)	(.378)	(.381)	(.371)	(.365)	(.375)
35-44	.46	.011	.152	-.017	-.008	.001	0	-.074	-.068	-.105
	(.458)	(.396)	(.402)	(.397)	(.39)	(.394)	(.398)	(.385)	(.378)	(.385)
45-54	-.169	-.549	-.395	-.549	-.54	-.613	-.556	-.554	-.533	-.522
	(.508)	(.438)	(.444)	(.44)	(.433)	(.442)	(.441)	(.424)	(.419)	(.442)
55 or more	.728	.494	.505	.46	.438	.606	.494	.339	.449	.504
	(.645)	(.555)	(.566)	(.556)	(.548)	(.555)	(.557)	(.54)	(.531)	(.54)
Education	.676***	.267	.312	.263	.174	.269	.25	.112	.125	.113
	(.257)	(.234)	(.23)	(.234)	(.233)	(.233)	(.236)	(.232)	(.225)	(.229)
Employment	-.277	-.507*	-.073	-.424	-.295	-.482*	-.552*	-.351	-.284	-.237
	(.328)	(.282)	(.288)	(.295)	(.286)	(.282)	(.288)	(.28)	(.276)	(.289)
Hours at makerspace		.318**		.328**	.194	.326**	.316**	.178	.208	.232*
		(.126)		(.127)	(.13)	(.126)	(.128)	(.128)	(.127)	(.129)
Effort at makerspace		.177*		.307**	-.01	-.336	.184**	.125	.064	-.658
		(.09)		(.144)	(.261)	(.467)	(.091)	(.092)	(.09)	(.484)
Cognitive trust		.33***		.332***	.288***	.308***	.334***	.303***	1.004***	1.054***
		(.068)		(.068)	(.068)	(.068)	(.068)	(.067)	(.366)	(.377)
Affective trust		.188*		.168*	.134	.148	.118	.363*	.139	.172
		(.098)		(.1)	(.098)	(.099)	(.136)	(.215)	(.097)	(.311)
Member driven			.102	1.183			-.661		.211	.238
			(.165)	(.948)			(.998)		(.156)	(1.214)
Use social amenities			.36***		.074			.555*	.256***	.242
			(.065)		(.346)			(.292)	(.07)	(.433)
Entrepreneurial motivation			.278***			-.281			.688**	.122
			(.082)			(.408)			(.281)	(.5)
*Effort at makerspace * Member driven* ***(H3a)***				-.199						-.23
				(.171)						(.191)
*Effort at makerspace * Use social amenities*					.028					.053
					(.061)					(.07)
*Effort at makerspace * Entrepreneurial motivation* ***(H3c)***						.082				.118
						(.077)				(.081)

*Affective trust * Member driven*							.135			.228
							(.176)			(.211)
*Affective trust * Use social amenities*								-.057		-.052
								(.05)		(.061)
*Cognitive trust * Entrepreneurial motivations* ***(H4c)***									-.121**	-.13**
									(.06)	(.062)
_cons	3.51***	-.098	.909	-.761	.807	2.068	.212	-1.137	-3.789**	-.461
	(.493)	(.676)	(.631)	(.85)	(1.526)	(2.475)	(.873)	(1.317)	(1.847)	(3.133)
Observations	162	162	162	162	162	162	162	162	162	162
R-squared	.081	.347	.314	.355	.393	.363	.352	.397	.424	.448
Adj R^2	.039	.3	.269	.298	.339	.308	.295	.344	.365	.369

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Table 19: Moderating predictors of Non-Technical Knowledge Sharing

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**	**Model 10**
Gender	.144	.091	.098	.086	.076	.105	.091	.084	.069	.093
	(.161)	(.149)	(.147)	(.149)	(.143)	(.146)	(.149)	(.141)	(.144)	(.14)
Age										
25-34	.213	.108	-.045	.099	-.004	.033	.111	-.004	-.045	-.133
	(.362)	(.336)	(.334)	(.338)	(.33)	(.33)	(.338)	(.322)	(.329)	(.328)
35-44	.285	.085	.064	.076	.083	.057	.093	.095	.037	-.002
	(.377)	(.351)	(.346)	(.353)	(.342)	(.344)	(.353)	(.335)	(.34)	(.337)
45-54	.221	.077	.069	.106	.108	-.105	.093	.011	.071	-.225
	(.418)	(.388)	(.382)	(.39)	(.379)	(.386)	(.391)	(.369)	(.378)	(.387)
55 or more	.21	-.012	.012	-.024	-.04	.084	-.009	-.022	-.096	.008
	(.531)	(.492)	(.487)	(.493)	(.48)	(.484)	(.494)	(.469)	(.479)	(.473)
Education	.722***	.48**	.469**	.48**	.398*	.506**	.489**	.437**	.367*	.42**
	(.212)	(.207)	(.198)	(.208)	(.204)	(.203)	(.209)	(.202)	(.203)	(.201)
Employment	.137	-.043	.303	.026	.184	-.064	-.013	.184	.153	.096
	(.27)	(.25)	(.248)	(.261)	(.251)	(.246)	(.255)	(.243)	(.248)	(.253)
Hours at makerspace		-.004		-.014	-.122	.026	-.009	-.126	-.138	-.117
		(.112)		(.113)	(.114)	(.11)	(.113)	(.112)	(.114)	(.113)
Effort at makerspace		.19**		.265**	-.066	-.96**	.186**	.085	.113	-.895**
		(.08)		(.128)	(.229)	(.407)	(.081)	(.08)	(.081)	(.424)
Cognitive trust		.13**		.122**	.084	.122**	.124**	.081	.208	.415
		(.06)		(.06)	(.06)	(.06)	(.061)	(.058)	(.33)	(.331)
Affective trust		.22**		.204**	.161*	.2**	.25**	-.173	.173**	-.389
		(.087)		(.088)	(.086)	(.087)	(.12)	(.187)	(.087)	(.273)
Member driven			-.071	.506			.231		-.058	-.884
			(.142)	(.841)			(.884)		(.141)	(1.064)
Use social amenities			.279***		-.025			-.282	.23***	-.121
			(.056)		(.303)			(.254)	(.063)	(.38)
Entrepreneurial motivation			.12*			-.975***			.113	-.815*
			(.071)			(.357)			(.253)	(.438)
*Effort at makerspace * Member driven* ***(H3a)***				-.115						-.051
				(.152)						(.168)
*Effort at makerspace * Use social amenities* ***(H3b)***					.046					-.057
					(.053)					(.062)
*Effort at makerspace * Entrepreneurial motivation* ***(H3c)***						.193***				.209***
						(.067)				(.071)
*Affective trust *							-.063			.209

Member driven ***(H4a)***										
							(.156)			(.185)
*Affective trust * Use social amenities* ***(H4b)***								.091**		.12**
								(.044)		(.054)
*Cognitive trust * Entrepreneurial motivations*									-.02	-.056
									(.054)	(.055)
_cons	3.316***	.777	1.88***	.568	2.073	6.657***	.708	3.098***	.473	7.751***
	(.406)	(.599)	(.543)	(.754)	(1.338)	(2.161)	(.774)	(1.144)	(1.664)	(2.746)
Observations	162	162	162	162	162	162	162	162	162	162
R-squared	.081	.245	.252	.252	.313	.285	.249	.329	.312	.375
Adj R^2	.04	.190	.203	.186	.252	.222	.184	.270	.241	.286

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Chapter summary

This chapter presents the data collection strategy and the results of the empirical analysis. The research instrument is described and explained. Each question was presented, and the changes made to the original scales were mentioned. The target sample size of 152 was established, explained and defended. The use of MTurk as the platform to recruit participants is explained and defended. Several strategies to improve the data collection process are explained. The final sample obtained from the data collection effort was 162 observations. Several of the hypotheses were significant. A summary of the results of the hypotheses testing is presented in table 20. From the results, it is evident that personal involvement and emotional safety are important predictors of knowledge sharing behaviors. This study could not find support for different knowledges sharing behaviors as result of the type of makerspace, positive support for the use of social amenities and partial support for entrepreneurial motivation.

Table 20: Summary of Results for Technical and Non-technical Knowledge Sharing

	Technical knowledge sharing	**Non-Technical knowledge sharing**	
Hypothesis	**Coefficient**	**Coefficient**	**Result**
Hypothesis 1a: Higher levels of personal investment of time in a makerspace will be positively related to both technical and non-technical knowledge sharing of members of a makerspace.	.439***	.015	Supported for Technical knowledge sharing
Hypothesis 1b: Higher levels of personal investment of efforts at a makerspace will be positively related to both technical and non-technical knowledge sharing of members of a makerspace	.332***	.305***	Supported
Hypothesis 2a: Members' cognitive trust is positively related to technical knowledge sharing in a makerspace setting.	.353***	Not tested .130***	Supported
Hypothesis 2b: A members' affective trust is positively related to non-technical knowledge sharing in a makerspace setting.	Not tested .188*	.220***	Supported
Hypothesis 3a: The effort a member invest is positively related to both technical and non-technical knowledge sharing in a makerspace setting and will be stronger in member-driven makerspaces.	-.199	-.115	Not supported
Hypothesis3b: The effort a member invest is positively related to non-technical knowledge sharing in a makerspace setting and will be stronger for members that use intensively the social amenities of the space.	Not tested .028	.046	Not supported
Hypothesis 3c: The effort a member invest is negatively related to both technical and non-technical knowledge sharing in a makerspace setting and will be stronger for members with strong entrepreneurial motivations.	.082	.193***	Partially Supported for Non-technical sharing
Hypothesis 4a: A members' affective trust is positively related to non-technical knowledge sharing in a makerspace setting and will be stronger in member-driven spaces.	Not tested .135	-.063	Not supported
Hypothesis 4b: A members' affective trust is positively related to non-technical knowledge sharing in- a makerspace setting and will be stronger for members that use more time social spaces.	Not tested -.057	.091**	Supported
Hypothesis 4c: A members' cognitive trust is positively related to technical knowledge sharing in a makerspace setting and will be stronger for members with a strong entrepreneurial motivation.	-.121 **	Not tested -.082	Not supported

CHAPTER V

DISCUSSION AND CONCLUSION

In this section, the research questions are reviewed and the corresponding findings. The following sub-sections will discuss the research questions of the study here presented: 1) What is the role of trust and personal investment of members of a makerspace in their sharing behavior of technical or non-technical knowledge at a makerspace?; 2) What is the effect of members' use of social amenities (characteristic of the physical layout of the makerspace) on their knowledge sharing behavior?; 3) What is the role of the member's entrepreneurial motivation in their knowledge sharing behavior?4) What is the role of makerspace type (member driven versus other) on members' knowledge sharing behavior?

Discussion

Trust and personal investment

The empirical analysis presented in the previous chapter shows that the personal investment of time in an organization is a strong and positive predictor of the sharing of technical knowledge but not for the sharing of non-technical knowledge (Hypothesis 1a). This finding shows that different types of knowledge need different conditions for individuals to share knowledge. The Sense of Community Theory establishes that members of an organization increase their perceived value of the organization as they invest their resources (time, money, knowledge) (Knoke, 1981; McMillan & Chavis, 1986). More specifically, the effort a member

invest in an organization is a strong and positive predictor of the sharing of both types of knowledge (technical and non-technical knowledge) (Hypothesis 1b). Members of makerspaces are expected to support other members with their efforts by mentoring other members, teaching classes, giving feedback to other members, etc. (van Holm, 2017, p. 165) From the two previous factors (personal investment of time and effort), and in alignment with the Sense of Community Theory, it is possible to conclude that members of makerspaces will share different types of knowledge depending on their self-perception of their investment on their makerspace. For these types of organizations, the flow of knowledge is an instrumental part of the value creation for their members (Hagel et al., 2013, p. 6).

The second dimension of the Sense of Community theory was emotional safety. Members of makerspaces elect being part of a makerspaces; that membership provides a boundary and creates connections and trust with other members and the organization (McMillan & Chavis, 1986). Interpersonal trust has two factors: affective and cognitive (McAllister, 1995). this study predicted and found significant evidence that members' cognitive trust had a positive and meaningful effect on technical knowledge sharing (hypothesis 2a). This finding is consistent with the literature that explains that members of makerspaces share their expertise in product development with novice members (Aldrich, 2014). As a supplementary analysis, cognitive trust was evaluated as a predictor of non-technical knowledge sharing resulting on a positive and meaningful predictor. Affective trust was the second factor evaluated from the emotional safety dimension. As explained by McAllister (1995), affective trust is built on the reciprocal feeling of care between members. Makerspaces are communal spaces where individuals develop trust and connection with other members while using technology (Wang et al., 2015). Hypothesis 2b provides significant support for the argument that members of the makerspace that feel affective

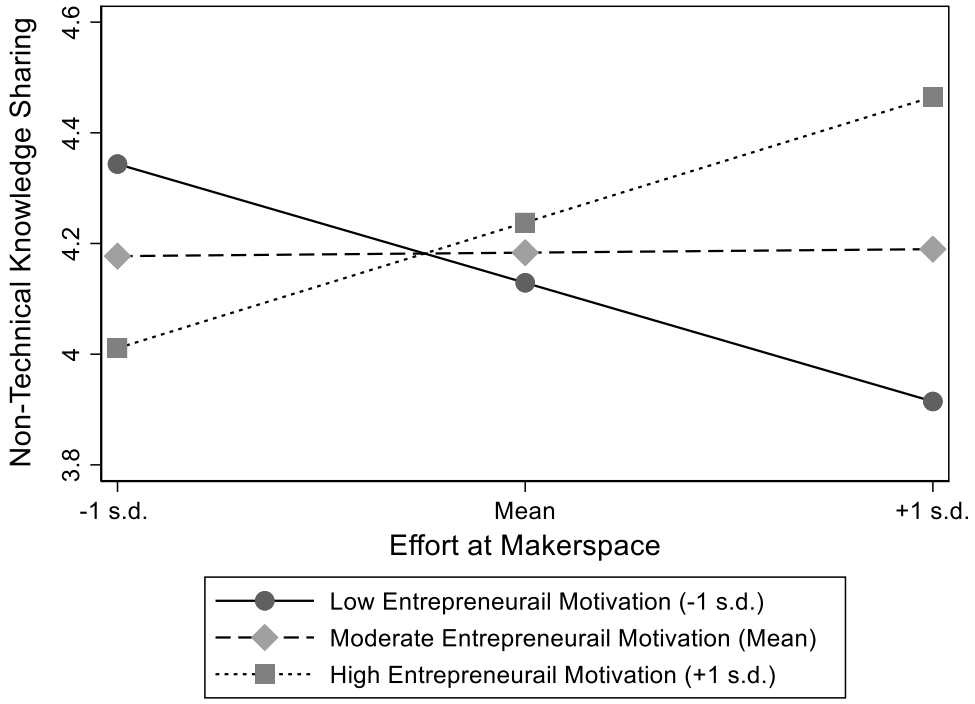
trust will share non-technical knowledge. As a supplementary analysis, this study found that affective trust also had a strong and significant relationship with technical knowledge sharing.

Moderation of makerspace type, social amenities, and entrepreneurial motivation,

More than half of the makerspaces of the sample of this study (51.63%) were established by individuals' members that by organizing created a makerspace using only the resources of the group. This proportion of member-driven makerspaces is consistent with previous studies of this type of organizations (Holman, 2015). Other types of makerspaces are sponsored by public or private entities. This study proposed that member-driven spaces moderate the role of efforts made by members and their knowledge sharing behavior. Contrary to what this study suggested in hypothesis 3a, there was not support for the argument that individuals in a member-driven makerspace were more incline to share knowledge as a reflection of their efforts than members of other types of (non-member-driven) makerspaces. The second interaction relates to the use of social amenities of makerspaces such as lounges, kitchens, game rooms, etc. Gathering spaces nurture social interaction, knowledge transfer, and creativity (Hua et al., 2010). The results of this study could not find support for the argument that the efforts of members that use more the social amenities areas will be stronger and significant in the knowledge sharing of non-technical knowledge (hypothesis 3b). As a supplementary analysis, technical knowledge sharing was tested and found no meaningful impact of the interaction of efforts and social amenities on knowledge sharing. The last interaction relates to entrepreneurial motivations. Members of makerspaces gain access to skills and means of productions at makerspaces (Hagel et al., 2013, p. 6; Jackson, 2014, p. 312; Russell E. Browder et al., 2017). Hypothesis 3c argues that members of a makerspace with high (strong) entrepreneurial motivations will accentuates the effect of efforts at makerspace on technical and nontechnical knowledge sharing. For members with high

entrepreneurial motivation (one s.d. above the mean) the effect of effort at makerspace on nontechnical knowledge sharing increases in a positive direction. In the case of members with a low entrepreneurial motivation, the effect of effort on non-technical sharing increases in a negative direction (see figure 3). These results provide partial support for hypothesis 3c.

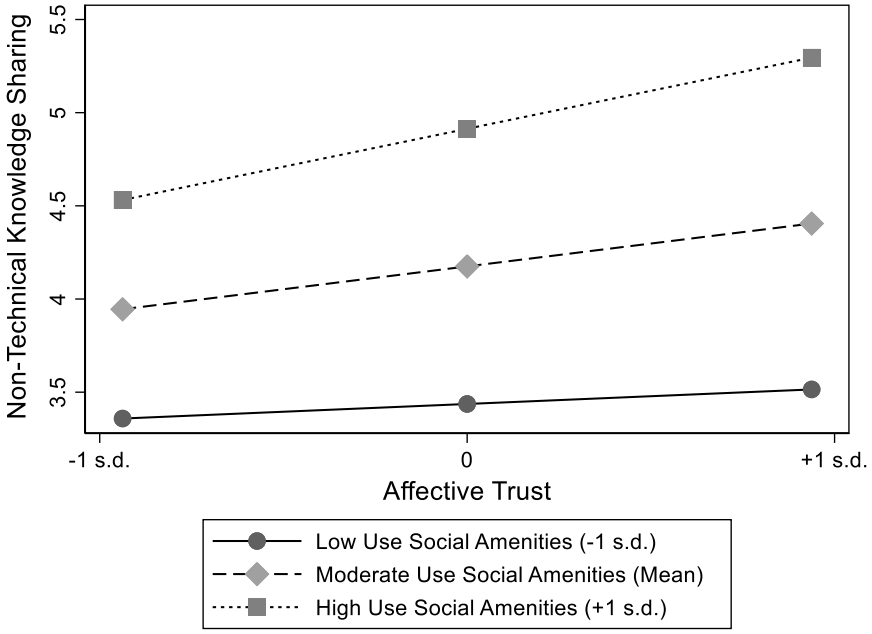
Figure 3: Interaction effect of Entrepreneurial Motivations on the relationship between Effort at Makerspace and Non-Technical Knowledge Sharing (H3c)



The last portion of the discussion centers on affective and cognitive trust with the interaction variables (Member-driven, use of social amenities, and entrepreneurial motivations). This study proposed the relationship between affective trust and non-technical knowledge sharing will be stronger in member-driven makerspaces. McMillan and Chavis (1986) mentions that communities spaces offer opportunities for members to interact and develop bonds among members leading the intimacy, membership structure and security. Members of makerspaces collaborate joining teams with other members and sharing their knowledge and experience

(Hagel et al., 2013, p. 6). The results of this study didn't find any support for the interacting effect of member-driven makerspaces (Hypothesis 4a). The use of social amenities was expected to mediate the interaction of affective trust and non-technical knowledge sharing. Affective trust develops as a result of an emotional connection with other members of the community (McAllister, 1995). In the case of members that scored high in the use of social amenities, this study expected that individuals that use more intensely social amenities, accentuate the effect of affective trust on nontechnical knowledge sharing. Members with a high score on use of social amenities accentuates the effect of affective trust on nontechnical knowledge sharing (see figure 4). This relationship was strong and supported by the empirical analysis.

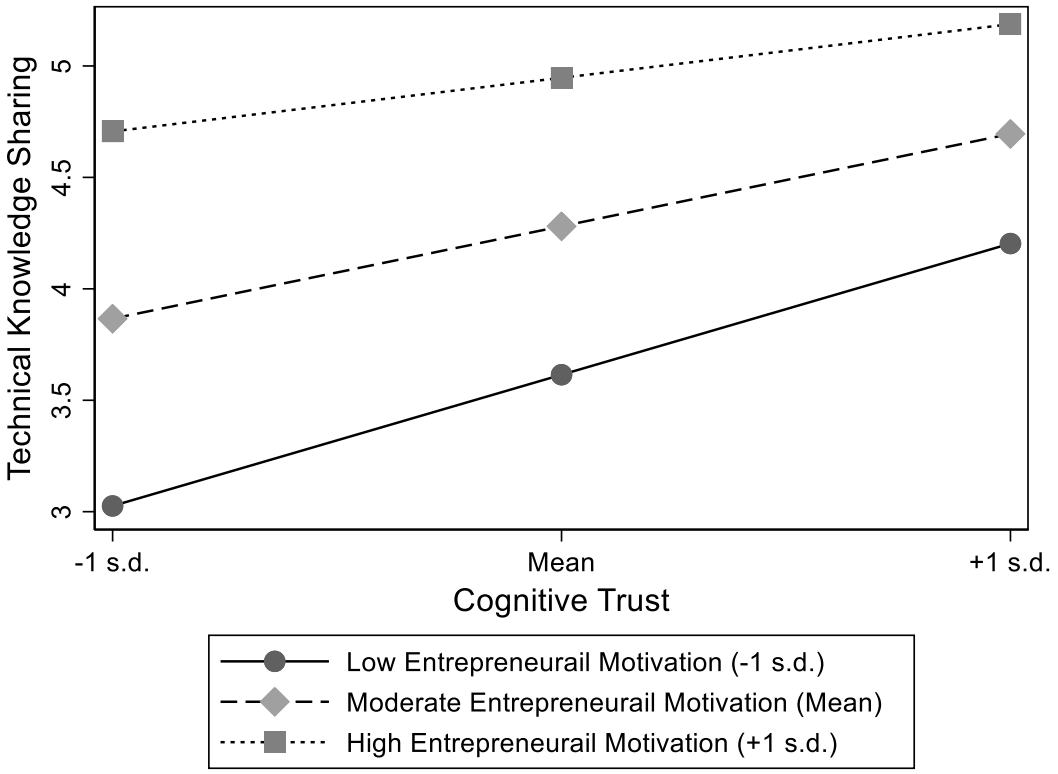
Figure 4: Interaction effect of Use of Social Amenities on the relationship between Affective trust and Non-Technical Knowledge Sharing



The final analysis evaluates the role of entrepreneurial motivation on cognitive trust. Members of makerspaces vary on the entrepreneurial motivation (Russell E. Browder et al., 2017). Members with stronger entrepreneurial motivation will concentrate on developing their

project. This study proposed that higher entrepreneurial motivation will accentuate the effect of cognitive trust on technical knowledge sharing (hypothesis 4c). As figure 5 present, at higher scores of entrepreneurial motivations, the effect of cognitive trust on technical knowledge sharing becomes weaker.

Figure 5: Interaction effect of Entrepreneurial Motivations on the relationship between Cognitive trust and Technical Knowledge Sharing



Limitations and Future Research Directions

One of the limitations of the study relates recall bias and the following filtering question: Were you a member of a makerspace for at least one month between Sep 1, 2019 to Feb 28, 2020 (before the COVID Pandemic)? This filtering question was needed because at the time of the application of the data collection instrument, all the makerspaces that were invited to support this study were closed to the members and public due to public health regulations. The nature of a

makerspace is community collaboration, sharing and cocreation. Due to the mandate of social distancing because of COVID, this study used AmazonMTurk to locate members of makerspaces and invite them to participate. Due to the limited access to makerspace, it was necessary to ask them to recall their experiences at their makerspace before the social distance limitations. Future efforts could benefit from deploying the data collection instrument when members of makerspaces are able to return to regular visit to their makerspace.

Using AmazonMTurk also presents limitations. As explained on chapter three, the design of the survey followed the following strategies to increase the validity of the data collection effort: inattention, self-misrepresentation, attrition, vulnerability to webrobots, social desirability, researcher unfairness, self-selection, language fluency, and MTurk's community. Future researchers should collect data requesting the support from makerspaces. The first option is to request access to their location and collect the data using a paper copy of the survey. The second options could be to prepare a digital version of the survey and request makerspaces to send their members an invitation with a link to the digital instrument.

The third limitation is the reduced information of the makerspace. The data collection effort didn't gathered information directly from the makerspace. Variables such as governing structure (member-drive or other), amounts of public amenities, types of events or trainings, etc. could enrich the information provided by respondents. Future studies could explore the group-level properties of sense of community. Using the elements of the Sense of Community Theory defined by McMillan and Chavis (1986), future studies could explore at the group level the roles of the following elements: 1) membership; 2) influence; 3) integration and fulfillment; and 4) shared emotional connection .

Makerspaces provide an opportunity to study and contribute to the social exchange literature. The metanalysis of Mazur, K. (2014) presents several studies that explore the following relationships: Team-Member Exchange (TMX) , Leader-Member Exchange (LMX). The author mentions the limited number of studies exploring the Member-Member Exchange (MMX) indicting the potential for future studies. More specifically, the study could explore the MMX of individuals in a third sector organization. The study could explore the exchange between members, volunteers, staff, or customers.

Conclusion

This dissertation explores personal investment (time and effort) and emotional safety (affective and cognitive) as predictors of technical and non-technical knowledge sharing at makerspaces. Furthermore, the moderation effects of type of makerspace (member-driven versus other), use of public amenities, and entrepreneurial motivation were analyzed. From the literature, it has been established that members of makerspaces value the sharing of tools, connecting with others and the knowledge shared at these spaces (Aldrich, 2014; Bowden, April/2016).

The first contributions relates to the sense of community theory (McMillan, 1976; McMillan & Chavis, 1986). This theory explores the feeling of individuals when they are part of a community. This study presents the importance of the efforts of members of a makerspace and their technical and non-technical knowledge sharing behavior. The second contribution establishes that cognitive and affective trust is a significant predictor of knowledge sharing behavior in makerspaces for technical and non-technical knowledge. These results expand the understanding of the Sense of Community theory providing evidence that personal efforts, affective and cognitive trust are significant predictors of technical and non-technical knowledge

sharing in makerspaces. Knowledge sharing is instrumental for the success of makerspaces (Aldrich, 2014; Bowden, April/2016), the previous contributions provides guidance for the management team of makerspaces that are searching alternative way to increase the knowledge sharing at their makerspaces.

This study explores the impact of some organizational and physical characteristics of a makerspace on knowledge sharing behavior. No significant difference was found between the knowledge sharing behavior of members of member-driven makerspace and members of non-member driven spaces was found. The previous result contradicts what the proposed hypothesis had anticipated. Additional studies could expand the knowledge of knowledge sharing behavior on member-driven makerspaces. Another contribution is the interacting effect of the use of public amenities and affective trust on non-technical knowledge sharing. Makerspaces have spaces such as lounges, kitchens, game-rooms (Hua et al., 2010). These spaces allow members to have conversations from technical or non-technical nature. This study showed that members that use them increased their affective trust on the organizations leading to a higher non-technical knowledge sharing. Several limitations and future directions were presented to aid and ignite future studies and expand the topics presented in this document.

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APPENDIX A

APPENDIX A

ARTICLES WITH THE HIGHER NUMBER OF CITATIONS

Paper	Total Citations
The Status, Challenges, And Future of Additive Manufacturing In Engineering	423
The Promise of The Maker Movement for Education	102
Open Labware: 3-D Printing Your Own Lab Equipment	90
Click Here for a Data Scientist: Big Data, Predictive Analytics, and Theory Development in The Era of a Maker Movement Supply Chain	66
Maker Movement Spreads Innovation One Project at a Time	60
Paradoxes of Openness and Distinction in the Sharing Economy	51
Learning Through Stem-Rich Tinkering: Findings from a Jointly Negotiated Research Project Taken up in Practice	49
The Invention Studio: A University Maker Space and Culture	36
Learning Spaces in Academic Libraries - A Review of the Evolving Trends	31
Empirical Studies on the Maker Movement, a Promising Approach to Learning: A Literature Review	30
Hands On, Hands Off: Gendered Access in Crafting and Electronics Practices	29
Makers in the Library: Case Studies of 3d Printers and Maker Spaces in Library Settings	26
Hacking with Chinese Characteristics: The Promises of the Maker Movement Against China's Manufacturing Culture	24
Designing Digital Fabrication Learning Environments for Bildung: Implications from Ten Years of Physical Computing Workshops	22
The Makerspace Movement: Sites of Possibilities for Equitable Opportunities to Engage Underrepresented Youth in Stem	18
Change in the Making: Makerspaces and the Ever-Changing Landscape of Libraries	16
Collaborative Futuring with and by Makers	15
The Rise of the User-Manufacturer	14
An Assessment Instrument of Technological Literacies in Makerspaces and Fablabs	13
Make-Her-Spaces As Hybrid Places: Designing And Resisting Self Constructions In Urban Classrooms	12
Nurturing Creativity and Innovation Through Fabkids: A Case Study	12

APPENDIX B

APPENDIX B

SUMMARY OF THE SOME OF THE MOST IMPORTANT LITERATURE DISCUSSING MAKERSPACES

Author, editor or organization	Year	Method	Key findings	Focus
Browder, R.; Aldrich, Howard E.; Bradley, S.	January, 2017	Literature review, observations	Three components: technology, space, and community. Spectrum of entrepreneurial intent and scope	Describe common patterns and features of the maker movement in order to guide future research.
Wang, D.; Dunn, N.; Coulton, P.	April, 2015	Ethnographic	The value of makerspaces as social hubs should be bonded around a technology rather than subservient to the technology itself.	Explain the function of makerspaces as community space and space for communities
Curry, Rober	2017	Literature review	The three overarching learning themes found were: experiential learning (Dewey, 1909; Kolb, 1984), communities of practice (Lave and Wenger, 1991) and self-efficacy through social learning (Bandura, 1997).	exploring the possibilities for makerspaces to function as a new learning space within academic library services in higher education

Forest, Craig R.		Empirical, Survey qualitative and quantitative (50)	The report presents best practices to be replicated in other spaces.	Overview of the operation of a Invention Studio. Sections: Space, equipment and resources, management structure, safety, intellectual property, funding and expenses, outreach, impact on students
Heimans, Jeremy; Timms, Henry	2014	Conceptual	"The Participation Scale," include sharing, shaping, producing, and co-owning.	Difference of Old Power and New Power
Papavlasopoulou, Sofia; Giannakos, Michail N.; Jaccheri, Letizia	2017	Literature review	The Maker Movement has begun to play a role both inside and outside the classroom, showing that it could be part of the classroom in offering a pattern of simulation; making approach to learning is being taken most notably in programming, as well as in STEM curricular areas; All the studies used some type of digital material	Provide a review of the Maker Movement approach in order to summarize the current findings and guide future studies
van Holm, Eric Joseph	2015	Content analysis; sample of 581, self-definitional statement from the web.	The greatest area of differentiation between the three terms is with regard to education, where fab labs are highly concentrated in education institutions	Disentangle the concepts of makerspaces, hackerspaces, and fab labs

Dougherty, Dale	2012	Viewpoint	The Faires bring a community together around figuring out how to solve a range of problems. Discovery keeps us young because it's always fresh.	Explains that we are we all are makers.
Barrett t; Pizzico, M.; Levy, B.; Nagel, R.	June, 2015	Web search	The benefit of prototypes and informal learning.	Review of the characteristics of university makerspaces.
Blikstein, Paulo; Kabayadondo, Zaza; Martin, Andrew; Fields, Deborah	2017	Survey,	Student's exposure to general computing and Information and communication technologies tools differs from exposure to exploration and fabrication technologies tools.	Process of developing an assessment instrument for this new technological literacy, the Exploration and Fabrication Technologies
Bowler, Leanne; Champagne, Ryan	2016	Focus groups with 29; Observations	Revealing the perspectives of youth makers and adult mentors about their own critical technical practices, and secondly, by presenting a set of eight core questions to a critical orientation to technical practice.	Question prompts as a means to scaffold reflection and reflexivity in the design, development, and use of technological artifacts in maker spaces for youth at public libraries, museums, and community-based organizations.
Mortara, Letizia; Parisot, Nicolas Gontran	2016	Semi-structured interviews (12)	provides a starting point to understand how Fab-spaces evolve, and how this type of service industry is emerging and diversifying; The analysis shows that whilst Fab-spaces currently facilitate the distribution of	Fab-spaces as providers of knowledge and production competencies

			innovation across society (open innovation) and (partly) across geographies, they are still weaker in the provision of opportunities for distributed manufacturing.	
Schön, Sandra; Ebner, Martin; Kumar, Swapna	2014	Opinion paper	Presents the potential of the makerspaces and different learning models.	Provides a broad introduction to the trend forum the perspective of learning
Sheridan, Kimberly; Halverson, Erica Rosenfeld; Litts, Breanne; Brahms, Lisa; Jacobs-Priebe, Lynette; Owens, Trevor	2014	Comparative case study; Field observation; archival data; interviews	makerspaces support making in disciplines that are separate ; Makerspaces seem to break down disciplinary boundaries in ways that facilitate process- and product-oriented practices, leading to innovative work with a range of tools, materials, and processes.; marked diversity of learning arrangements we see occurring within each of the studied spaces; Learning in each of these spaces is deeply embedded in the experience of making.	to understand how the selected makerspaces function as learning environments.

van Holm, Eric Joseph	2017	Snowball sampling; 34 interviews	Makerspaces support are in existing fields, and managers have struggled to transform members into entrepreneurs, partially because members lack confidence in their own ideas and have even shown resistance to the idea of commercializing their hobbies.	On makerspace contributions to metropolitan statistical areas (MSAs) with less than 1.5 million residents because those regions have fewer resources to support economic development.
Crumpton, Michael A.	2015	Viewpoint	Makerspaces add a unique and fresh element to libraries and should be provided a sustainable model up front.	discuss operational components associated with creating a makerspace unit or department within a library.
Doussard, Marc; Schrock, Greg; Wolf-Powers, Laura; Eisenburger, Max; Marotta, Stephen	2017	137 interviews	Makers and their small start-up businesses access external, market-based manufacturing infrastructure with clear disadvantages; makers respond to these limitations by duplicating resources and products, rather than lengthening individual product runs; makers' production process choices add to their long-term challenges in scaling; organizational limitations collectively push makers towards competitive strategies based on low-volume, high-margin production.	Evaluates makers' strategies for accessing capital, production networks and mass markets without the infrastructure of the manufacturing firm.

Hartmann, Frank; Mietzner, Dana	June, 2017	Media content analysis, 199 articles	Maker movement is a niche innovation, social innovation. The Maker movement is formed by the interaction of innovation, organization and human resources.	Whether and in which way the Maker Movement will influence the prevailing production system,
Kostakis, Vasilis; Niaros, Vasilis; Giotitsas, Christos	2015	Observation; 23 semi-structured interviews;	Hackerspaces, at least those examined here, could be considered a manifestation of online CBPP in the physical realm but not a direct or a precise transfer due to the scarcity and the subsequent allocation problems of the material world;	Whether hackerspaces do in fact, and to what extent, replicate governance structures and principles we already observe in online Commons-based peer production.
Fourie, Ina; Meyer, Anika	2015	Literature Review	Explore an interconnection between makerspaces and an expanded information-related involvement of libraries, e.g. in information literacy training, guided inquiry, bridging the digital divide, research (embedded librarianship) and community support.	Comment on such publications within the library and information science (LIS) literature and to warn libraries to not only focus on providing physical spaces and tools

Zhong, X.; Fan, K.	2016	Conceptual	Establish a "creative production manufacturing" process based on "The Maker Movement" context along with the relationship between "media-as-tools" and "creative production-manufacturing"	The aim is to establish a "creative production manufacturing" process based on "The Maker Movement" context along with the relationship between "media-as-tools" and "creative production-manufacturing".
Toombs, Austin; Bardzell, Shaowen; Bardzell, Jeffrey	2014	Ethnographic study, 15-month, 7 expert interviews	Drivers of the maker identity: 1) the tool and material sensibility; 2) adhocist attitude; 3) sense of community	The development of the maker identity shared by members of a small-town hackerspace
Moorefield-Lang, Heather Michele	2015	Content analysis to investigate 24 different user agreements	Consistencies found across makerspace user agreements include liability waivers, permissions for minors, safety, copyright and technology replacement costs.	Analyze the user agreements of makerspaces in public and academic libraries
Aldrich, Howard E.	April, 2014	Conceptual	Characteristics of the space: 1) User generated innovation; 2) Expensive shared tools for prototyping; 3) cooperation and sharing; 4) Use of internet for sharing, marketing and distribution; 5) Access to crowdfunding	Implications for technology innovation, entrepreneurship, and the emergence of new industries

Bean, Vanessa; Farmer, Nicole M.; Kerr, Barbara A.	2015	Qualitative focus group, 8 women,	1)Women participate for the tools and workspace it provides ; 2) Mentorship also is rated highly; 3) motivation and encouragement to complete projects, 4) safe getaway to express their creativity; 5) Women denied the existence of gender barriers	Explores participation of women in a maker space.
van Holm, Eric Joseph	2015	Observations to Maker Spaces in the USA	1) The maker movement attracts more individuals into product design; 2) generates dense but diverse networks; 3) lowers the costs for prototyping.	Identifying ways it expands opportunities for entrepreneurship, both accidental and intentional.
Svensson, Peter O.; Hartmann, Rasmus Koss	2018	Archival data, semi-structured interviews.	1) Innovations developed by the clinical staff were intended primarily to make their own jobs more efficient, safer or better and were a response to a problem that the innovator faced on a daily basis her work; 2) Makerspaces support the development of valuable innovations; 3) this potential is not realized because innovations do not diffuse very widely.	Supporting users' innovation activities may have the effect of heightening social welfare by encouraging more users to innovate.

Author, editor or organization	Year	Method	Independent Variable	Dependent Variable	Key findings
Lin, Chieh-Peng	2007	Questionnaires, 212 students	Distribute justice, procedural justice, Cooperativeness, Instrumental ties, expressive ties. mediators: organizational commitment and trust in co-workers	Tacit knowledge sharing	Tacit knowledge sharing is affected by distributive justice, procedural justice, and cooperativeness indirectly via organizational commitment. Additionally, tacit knowledge sharing is also affected by distributive justice, instrumental ties, and expressive ties via trust in co-workers. The paths from procedural justice and cooperativeness to trust in coworkers are shown to be insignificant.
Nakano, Davi; Muniz, Jr. Jorge; Batista, Jr. Edgard Dias	2013	The study is based on a qualitative approach, and it draws data from a four-month field study at a blown-molded glass factory. Data collection techniques included interviews, informal conversations and on-site	N/A	N/A	Sharing of tacit knowledge is facilitated by an engaging environment. An engaging environment is supported by shared language and knowledge, which are developed through intense communication and a strong sense of collegiality and a

Author, editor or organization	Year	Method	Independent Variable	Dependent Variable	Key findings
		observations, and data were interpreted using content analysis.			social climate that is dominated by openness and trust. Other factors that contribute to the creation of an engaging environment include managerial efforts to provide appropriate work conditions and to communicate company goals, and HRM practices such as the provision of formal training, on-the-job training and incentives.
Borges, Renata	2013	Sample of 143 respondents and employed a partial least squares (PLS) analysis to assess the structural and confirmatory models.	Team oriented, Supportive, Social network, Conscientiousness, Emotional stability, Extraversion	Tacit Knowledge Sharing	The results indicate that hardworking, responsible, and introverted employees tend to share their tacit knowledge when they feel they are in a supportive and team-oriented environment, are not overly threatened by competitiveness, and experience good social interactions in the workplace.

Author, editor or organization	Year	Method	Independent Variable	Dependent Variable	Key findings
Holste, J. Scott; Fields, Dail	2010	The relationships were examined through data provided by a sample of 202 professionals and managers in world headquarters of an international organization.	Willingness to use tacit knowledge, affect-based trust, cognition-based trust, Gender, age, tenure	Willingness to share tacit knowledge	The levels of affect-based and cognition-based trust influence the extent to which staff members are willing to share and use tacit knowledge. Affect-based trust has a significantly greater effect on the willingness to share tacit knowledge, while cognition-based trust plays a greater role in willingness to use tacit knowledge.
Yang, Shu-Chen; Farn, Cheng-Kiang	2009	Multi-informant questionnaire.	Affect-based trust, shared value, external control, internal control, tacit sharing intentions	Tacit knowledge sharing behavior	Tacit knowledge sharing intention can be induced by affect-based trust. Internal control has a positive effect on tacit knowledge sharing intention. External control moderates positively the interaction between tacit knowledge sharing intention and behavior.

Author, editor or organization	Year	Method	Independent Variable	Dependent Variable	Key findings
Wu, Li-Wei; Lin, Jwu-Rong	2013	Structural equation model. 212 completed surveys returned	Knowledge sharing, co-production, learning orientation, tacit knowledge	Knowledge effectiveness	Knowledge sharing increasingly affects knowledge effectiveness under the condition of explicit knowledge. The mediating roles of learning orientation and co-production in the process of tacit knowledge sharing become apparent.
Zhang, Lianying; He, Jing; Zhou, Shuguo	2013	Case study	N/A	N/A	it was found that tacit knowledge sharing leads to the integrated project team flexibility through building connections between team members and increasing team dynamic capabilities. The primary contribution of this study is finding the linkage from tacit knowledge sharing to the integrated project team flexibility, which can provide a theoretical guide for the integrated project team to improve its

Author, editor or organization	Year	Method	Independent Variable	Dependent Variable	Key findings
					ability to survive in the dynamic environment of construction projects.
Wang, Zhining; Wang, Nianxin	2012	Structural model. Data collected from 89 high technology firms in Chine.	Explicit knowledge sharing, tacit knowledge sharing, innovation speed, innovation quality	Operational performance, financial performance	It is found that both explicit and tacit knowledge sharing practices facilitate innovation and performance. Explicit knowledge sharing has more significant effects on innovation speed and financial performance while tacit knowledge sharing has more significant effects on innovation quality and operational performance.
Jones, Mary C.	2005	Exploratory. Semi-structured interviews. 3 firms.	N/A	N/A	Firms were tacit knowledge was shared had atmospheres that encouraged ideas, regardless of whether they were fully formed or could be immediately supported with

Author, editor or organization	Year	Method	Independent Variable	Dependent Variable	Key findings
					hard data. An atmosphere conductive to tacit knowledge sharing not necessary carry over to the team's interactions. An atmosphere that is not conducive to tacit knowledge sharing does appear to carry over interactions with others.
Suppiah, Visvalingam; Sandhu, Manjit Singh	2011	Survey data was collected from 362 participants from seven	Competing Values Framework (CVF): clan; adhocracy; market, hierarchy	Tacit knowledge sharing behavior: organizational communications, personal Interactions, mentoring/tutoring, willingness to share knowledge freely	Clan culture have a positive influence on tacit knowledge sharing behavior; Market and hierarchy have a negative effect in tacit knowledge sharing behavior.

APPENDIX C

APPENDIX C

INSTRUMENT USED FOR DATA COLLECTION

Invitation to participate:

- o I consent to participate in this survey.
- o I do not wish to participate

Were you a member of a makerspace for at least one month between Sep 1, 2019 to Feb 28, 2020 (before the COVID Pandemic) ?

- o Yes
- o No

Your primary makerspace's name:

_____

Your primary makerspace zip code:

_____

On average, how many hours a week you use to spend at your makerspace?

0 to 3 hours

4 to 6 hours

7 to 15 hours

More than 15 hours per week

On what frequency you used the following makerspace facilities:
Scale: Not available (1); Never (2); Less than once a month (3); Once a month (4); Once a week (5); Multiple times a week (6); Almost Daily (7); Multiple times a day (8)

- Shared equipment and tools (1)
- Kitchen (2)
- Meeting space/conference room (3)
- Lounge room (4)
- Events space (5)

Do you earn income of the work you did at the makerspace?

- Yes
- No

If you earn income, what you did?

- I make my own products at the space and sell them. (1)
- I do custom project work for clients. (2)
- My company pays for my membership and I use it for that business. (3)
- I consult or provide services through the space. (4)
- I teach. (5)
- I am staff at the makerspace. (6)
- Other (please specify) (7) _____

How much do you agree that the following statements describe you?
Scale: Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

- I want to be a business owner.
- I want to profit from my endeavors
- I like to be told how to do my job
- I enjoy having authority at work.
- I like to control my own time at work.
- I think that having a business can improve my financial status
- I see a good future for myself if I start a business
- I like to make business decisions

Indicate your level of agreement with the following statements:
Scale: Strongly disagree, Disagree, Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

- I am determined to create a business in the future
- I am ready to do anything to be an entrepreneur
- I have seriously thought of starting business

Did you volunteer at your makerspace?

- Yes
- No

On average, how many hours a week did you volunteer? (hours per week)

- 1 to 3 hours
- 4 to 6 hours
- 7 to 12 hours
- 12 to 19 hours
- 20 or more hours

If you volunteer, what did you did (check all than apply)?

- Teaching/ Mentoring
- Staff
- Social media and marketing
- Management (finance, human resources, etc.)
- Governance (Board, Committee, etc.)
- Other (please specify) _____

Indicate your level of agreement with the following statements:
Scale: Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

- When I volunteer at the makerspace, I really exert myself to the fullest, beyond that what is expected.
- I persist in overcoming obstacles to complete an important task at the makerspace
- I put in extra effort whenever I find it necessary when supporting my makerspace
- I work harder than expected to help my makerspace to be successful.

Please, verify that you are present in the survey by selecting number 3

- 1
- 2
- 3
- 4

Indicate your level of agreement with the following statements:
Scale: Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

- I can freely share my ideas, feelings, and hopes at the makerspace.
- I can talk freely to other members about difficulties I am having and know that they will want to listen.
- If I shared my problems with a member of the makerspace, I know they would respond constructively and caringly.
- I would have to say I have made considerable emotional investments in relationships at the makerspace.

Indicate your level of agreement with the following statements from the following options:
Scale: Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

- I only share my knowledge and skills with members that approach their projects with professionalism and dedication.
- I can rely on members not to make my job more difficult by careless work at the makerspace
- If people knew more about several members and their background, they would be more concerned and monitor their performance more closely.
- As a validation check, please answer ‘strongly disagree’ for this question”

Indicate your level of agreement with the following statements:
Scale: Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree

- When searching for technical information in general, I use the web
- When searching for technical information relating to specific information, I use the web
- When searching for information that compares technical information, I use the web

Indicate your level of agreement with the following statements:
Scale: Never; Very Rarely; Rarely; Occasionally; Frequently; Very Frequently

- I share knowledge with other members about the use of materials
- I share knowledge with other members about how to work with tools
- I share knowledge with other members about fundraising
- I share knowledge with other members about business management
- I share knowledge with other members about commercialization

- I share knowledge with other members about Patents and intellectual protection

Indicate your level of agreement with the following statements:
Scale: Never; Very Rarely; Rarely; Occasionally; Frequently; Very Frequently

- I share knowledge with other members about projects I am working on
- I share knowledge with other members about family
- I share knowledge with other members about partner/spouse
- I share knowledge with other members about politics
- I share knowledge with other members about travel
- I share knowledge with other members about entertainment
- I share knowledge with other members about religion

Do you believe that your answers should be used for the analysis?

- Yes
- No

What is your age?

- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65+

Your gender?

- Male
- Female
- Choose not to disclose

Highest level of education you have completed?

- No degree
- High School or GED
- Some College or professional certification
- College
- Graduate studies

Q27 What is your employment status?

- Full-time
- Part-time
- Student
- Retired
- Unemployed

APPENDIX D

APPENDIX D

LIST OF MAKERSPACE BY STATE

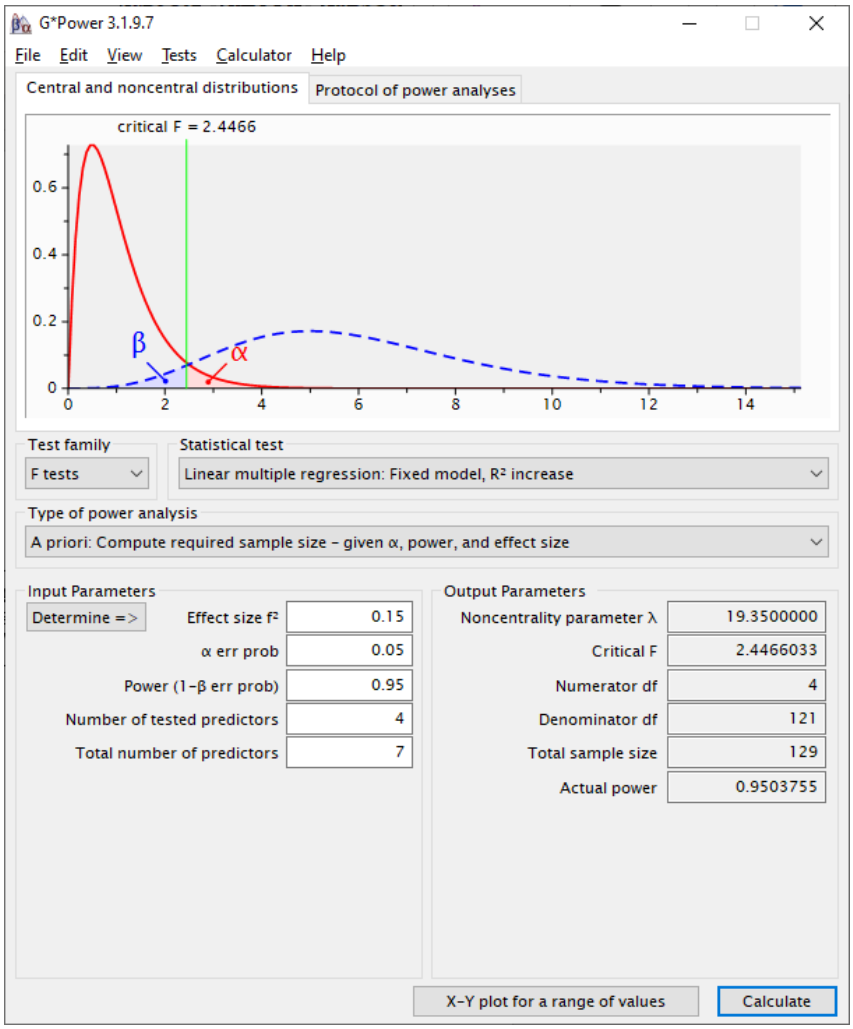
Name	Location
Maker Lab	Abilene, TX
DaVinci Maker Labs	Alvin, TX
Space 8	Austin, TX
Austin Children's Museum	Austin, TX
ATX Hackerspace	Austin, TX
d.lab for Making	Austin, TX
co.lab // Community Makers	Austin, TX
Creative Side Jewelry Academy	Austin, TX
BinarySpace	Bryan, TX
Dallas Makerspace	Dallas, TX
WorkChops	Dallas, TX
H3 Labs	El Paso, TX
Fort Worth Makerspace	Fort Worth, TX
Fort Works	Fort Worth, TX
Pottery in the Park	Fort Worth, TX
Panther Lab	Fort Worth, TX
Frisco Public Library	Frisco, TX
Makerspace Greenville	Greenville, TX
Tx/Rx Labs	Houston, TX
Houston Makerspace	Houston, TX
Innovation Lab	Houston, TX
Katy Makerspace	Katy, TX
The MakerBarn	Magnolia, TX
thelab.ms	Plano, TX
Red Oak Makerspace	Red Oak, TX
UTDallas Makerspace	Richardson, TX
Lake Jackson Public Libaray	Richwood, TX
STEAM Central	San Angelo, TX
10BitWorks	San Antonio, TX
Techno Chaos	Sugar Land, TX
Innovation Pipeline	Tyler, TX
Tyler Innovation Pipeline	Tyler, TX

Maker's Edge	Waco, TX
Name	**Location**
Alpha One Labs	Brooklyn, NY
Buffalo Lab	Buffalo, NY
Marymount Fab Lab	New York, NY
Ithaca Generator	Ithaca, NY
Maker Space @NYSCI	Queens, NY
Tech Valley Center of Gravity	Troy, NY
Staten Island MakerSpace	Staten Island, NY
3rd Ward	Brooklyn, NY
SALT Makerspace	Syracuse, NY
Interlock Rochester	Rochester, NY
Fayetteville Free Library Fab Lab, Digital Creation Lab and Little Makers Lab	Fayetteville, NY
Fox Meadow Makerspace	Scarsdale, NY
Mirrorball Photo & Design	Brooklyn, NY
CILK119	Nanuet, NY
µMake Labs	Massapequa, NY
Innovation Station	Levittown, NY
Syracuse Innovators Guild (SIG)	Syracuse, NY
Triple Cites Makerspace, Inc.	Johnson City, NY
Jefferson County RAC	Watertown, NY
THINQubator	Troy, NY
Omega Hub	Ossining, NY
Idaho Art Lab	St. Anthony, ID
Squidwrench	Highland, NY
Hack Manhattan	New York, NY
SVA Visible Futures Lab	New York, NY
Fat Cat Fab Lab	New York, NY
IONYC Makerspace	Astoria, NY
CCLD Makerspace	Elmira, NY
The Foundry	Buffalo, NY
OCC Library Makerspace	Syracuse, NY
Mouse Makerspace	New York, NY
Rochester Makerspace	Rochester, NY
Colleg of the Canyons MakerSpace	Santa Clarita, CA
SPark Workshop Brooklyn	Brooklyn, NY
Island Labs Makerspace	Greenlawn, NY
Maker Nexus	Sunnyvale, CA
Long Island Makerspace	Plainview, NY
Carmel High School MakerSpace	Carmel, NY
CoSewing Studio @ Esaie Couture	New York, NY
Phelps Library STEAM Lab Makerspace	Phelps, NY

APPENDIX E

APPENDIX E

OUTPUT OF G*POWER



APPENDIX F

APPENDIX F

SENSITIVIY ANALYSIS

Technical Knowledge Sharing

	(1) **Model-1**	(2) **Model-2**	(3) **Model-2**	(4) **Model-3**	(5) **Model-3**
Gender	-.064	-.118		-.145	
	(.195)	(.168)		(.16)	
Age					
25-34	.202	-.095		-.315	
	(.44)	(.379)		(.375)	
35-44	.46	.011		-.105	
	(.458)	(.396)		(.385)	
45-54	-.169	-.549		-.522	
	(.508)	(.438)		(.442)	
55 or more	.728	.494		.504	
	(.645)	(.555)		(.54)	
Education	.676***	.267		.113	
	(.257)	(.234)		(.229)	
Employment	-.277	-.507*		-.237	
	(.328)	(.282)		(.289)	
Hours at makerspace		.318**	.294**	.232*	.221*
(H1a)					
		(.126)	(.126)	(.129)	(.127)
Effort at makerspace		.177*	.215**	-.658	-.39
(H1b)					
		(.09)	(.089)	(.484)	(.471)
Cognitive trust		.33***	.335***	1.054***	1.072***
(H2a)					
		(.068)	(.065)	(.377)	(.372)
Affective trust		.188*	.155	.172	.237
		(.098)	(.096)	(.311)	(.308)
Member driven				.238	.524
				(1.214)	(1.177)
Use social amenities				.242	.172
				(.433)	(.415)
Entrepreneurial motivation				.122	.434
				(.5)	(.475)
*Effort at makerspace * Member driven*				-.23	-.29
(H3a)					
				(.191)	(.187)
*Effort at makerspace * Use social amenities*				.053	.084
				(.07)	(.066)
*Effort at makerspace * Entrepreneurial motivation*				.118	.062
(H3c)					
				(.081)	(.078)

*Affective trust * Member driven*				.228	.23
				(.211)	(.209)
*Affective trust * Use social amenities*				-.052	-.071
				(.061)	(.06)
*Cognitive trust * Entrepreneurial motivations* ***(H4c)***				-.13**	-.137**
				(.062)	(.061)
_cons	3.51***	-.098	-.049	-.461	-2.401
	(.493)	(.676)	(.588)	(3.133)	(3)
Observations	162	162	162	162	162
R-squared	.081	.347	.295	.448	.417
Adj R^2	.039	.3	.277	.369	.366

Standard errors are in parentheses
*** p<.01, ** p<.05, * p<.1*

APPENDIX G

APPENDIX G

SENSITIVITY ANALYSIS

Non-Technical Knowledge Sharing

	(1) **Model-1**	(2) **Model-2**	(3) **Model-2**	(4) **Model-3**	(5) **Model-3**
Gender	.144	.091		.093	
	(.161)	(.149)		(.14)	
Age					
25-34	.213	.108		-.133	
	(.362)	(.336)		(.328)	
35-44	.285	.085		-.002	
	(.377)	(.351)		(.337)	
45-54	.221	.077		-.225	
	(.418)	(.388)		(.387)	
55 or more	.21	-.012		.008	
	(.531)	(.492)		(.473)	
Education	.722***	.48**		.42**	
	(.212)	(.207)		(.201)	
Employment	.137	-.043		.096	
	(.27)	(.25)		(.253)	
Hours at makerspace		-.004	-.025	-.117	-.153
(H1a)					
		(.112)	(.109)	(.113)	(.111)
Effort at makerspace		.19**	.222***	-.895**	-.74*
(H1b)					
		(.08)	(.078)	(.424)	(.411)
Cognitive trust		.13**	.174***	.415	.427
		(.06)	(.056)	(.331)	(.325)
Affective trust		.22**	.191**	-.389	-.365
(H2b)					
		(.087)	(.084)	(.273)	(.269)
Member driven				-.884	-.952
				(1.064)	(1.026)
Use social amenities				-.121	-.009
				(.38)	(.362)
Entrepreneurial motivation				-.815*	-.738*
				(.438)	(.414)
*Effort at makerspace * Member driven*				-.051	-.076
(H3a)					
				(.168)	(.163)
*Effort at makerspace * Use social amenities*				-.057	-.061
(H3b)					
				(.062)	(.058)
*Effort at makerspace * Entrepreneurial motivation*				.209***	.194***
(H3c)					
				(.071)	(.068)
*Affective trust * Member*				.209	.244

driven					
(H4a)					
				(.185)	(.182)
*Affective trust * Use social amenities*				.12**	.105**
(H4b)					
				(.054)	(.052)
*Cognitive trust * Entrepreneurial motivations*				-.056	-.053
				(.055)	(.054)
_cons	3.316***	.777	1.099**	7.751***	7.015***
	(.406)	(.599)	(.512)	(2.746)	(2.616)
Observations	162	162	162	162	162
R-squared	.081	.245	.213	.375	.347
Adj R^2	.04	.19	.193	.286	.29

Standard errors are in parentheses
*** p<.01, ** p<.05, * p<.1*

BIOGRAPHICAL SKETCH

Eduardo Jose Millet is a Lecturer of Management at State University of New York New Paltz. He specializes in Strategy, New Venture Creation, Entrepreneurship, Social Entrepreneurship, and Innovation. He joined SUNY in 2020 and earned his PhD from the University of Texas Rio Grande Valley. He holds a Masters Degree in Urban and Regional Planning and a B.A in Economics from the University of Minnesota. He received his Ph.D. in Business Administration from the University of Texas – Rio Grande Valley in August 2021.

His primary research interests are in the areas of knowledge sharing, innovation types, and new product development by independent inventors. Eduardo has presented his research at the, Academy of Management Annual Meetings, Decision Science Institute, and a variety of seminars, research symposia, and colloquia. Eduardo

Eduardo has a balanced background of both industry and academic experience. He worked at the McAllen Chamber of Commerce where he developed an innovative approach to entrepreneurial development. The approach uses several components that promote entrepreneurial learning, networking, and action. The core programs were the Inventors and Entrepreneurs Network, the GoodPitch Competition, The Crowdfunding Catapult, the McAllen Innovation Grant Awards, the McAllen Business Plan Competition, the Idea Lab, and the Collaboration Space.

Originally from Mexico, Millet moved to McAllen from Mexico where he worked as the Director of Institutional Development for the State Government of Yucatan for five years, and as Director of Business Intelligence for a nationwide telecommunications company for three years. He is passionate about public speaking and has been an active member of Toastmasters for the past two years. Millet is married to Susana Lam and has one child, Jesus Millet. He can be reached at millete@newpaltz.edu.