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**The role of responsible innovation
in increasing firm performance in small and medium-
sized enterprises and increasing their sustainability**

Carla Tattiana Gonzales Gemio



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PhD in Business | Carla Tattiana Gonzales Gemio

2020



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Thesis title:

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sustainability

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Date:

November 2020



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To Him the cornerstone of my life

And

To my mother Juana

For always being a source of love

AGRADECIMIENTOS

Han pasado cuatro años desde que postulé al doctorado en Empresa de la Universidad de Barcelona (UB). Era joven en ese momento, y desde siempre muy curiosa con la vida, más allá de mi profesión. Mis trabajos en un par de organizaciones de desarrollo social y en Universidades en mi país, Bolivia, me abrieron una serie de posibilidades, además de amigos que pensaron que mi licenciatura en Ingeniería de Sistemas, un Máster en ICT4D de la Universidad de Salamanca-España, y los ocho años de experiencia laboral podrían hacerme una candidata viable a un doctorado en el extranjero. Entonces, entré en campaña y comencé a hablar con personas relacionadas a la ciencia. La verdad, y según quien fuera, obtenía versiones muy diversas de la misma pregunta. *¿qué esperas obtener de un doctorado?* En respuesta, escepticismo, pero con todo, de algo si estaba segura, había que vivir el proceso para contarlo. Y aquí estoy, con el gozo de llegar a la meta.

Indudablemente, durante ese tiempo conoces personas que van formando parte de esta apasionante aventura, llamada investigación, y a los que no podría dejar de agradecer por el soporte, apoyo y cariño. En principio me gustaría agradecer al *Programa de Soberanía Científica Tecnológica del Ministerio de Educación de Bolivia*, quien fue mi fuente de financiamiento desde 2016 a 2020, muchas gracias por su voto de confianza. También agradezco al *Departamento de Empresa de la UB* por acogerme en la Escuela de Empresa. Un agradecimiento muy especial a mis supervisores de tesis, Claudio Cruz Cázares de la UB y Mary Jane Parmentier de la Universidad Estatal de Arizona (ASU) de los Estados Unidos. Muchas gracias Claudio por tu guía, consejos y paciencia, han sido invaluable a lo largo de estos años. De igual manera, muchas gracias Mary Jane por confiar en mí, por el soporte y apoyo con mi estancia durante tres meses (en principio) en la *Escuela para el Futuro de la Innovación en la Sociedad (SFIS)* en ASU. Me sentí tan bien aceptada y recibida en la Universidad Estatal de Arizona, que de tres meses pasé a un año, de febrero 2018 a marzo 2019, tiempo que ha sido inmejorable por la cantidad de recuerdos, aprendizajes, ayuda, oportunidades, formación, experiencias, consejos, contactos y amigos que gané y, sobre todo, porque me permitió dar sentido y un giro completo a mi investigación. Gracias ASU siempre con las puertas abiertas, que gran Universidad.

Dentro de los trabajos de campo, también tuve la oportunidad de conocer algunas personas y asociaciones a las que no quisiera dejar pasar sin agradecer su apoyo. A Bill Parmentier, a Hector Cordoba, al profesor

Frederic Marimon, a María Teresa Lupiañez de la UB, a la Asociación de Mujeres en 3D printing, con sede en San Francisco de los Estados Unidos, a tantas personas quienes me apoyaron en la recopilación de datos. Me gustaría también mencionar a mis colegas y amigos del doctorado, con los que he compartido tan buenos momentos (Ryan, Sucet, Liz, Agustin, Keivan...)

Finalmente, mi eterna gratitud a las personas que de alguna forma han contribuido también directa o indirectamente a la realización de este trabajo, mi familia y amigos. A mi mamá Juana que Dios la bendiga siempre por todo su cariño, a mis queridos hermanos Gaby, Marco, Ramiro, y Manuel. A mis entrañables amigos Paola, Montserrat, Pep, Juliana, Laura, Nancy, Kevin D., Cristina, Sisy, Iván, Medelis, Guillem... Y ¡a mi querida Universidad de Barcelona!

¡Gracias, esta ha sido una experiencia de vida en todos los sentidos!

SUMMARY

It is difficult to imagine life without changes influenced by technology and innovation, which are characteristic of the era in which we live, with changes that, albeit always present throughout the history of mankind, are today presented as challenges for companies, organisations and governments, which pursue sustainable development, that is, prudent use of resources for the benefit of humans and the ecosystem around us, in a way that makes available such resources today and into the future.

Unfortunately, the outcome of business innovation practices that are at the centre of these processes have resulted in the exclusion of four billion segment of the population comprising low-income groups in developing countries, also in degradation of natural resources, climate change, social inequality and excessive consumption of resources, because perhaps what was once good and innovative is now no longer so. In this context, debates have emerged and caught the attention of researchers and practitioners about how companies could innovate in a way that promotes sustainable development, which comes from "innovation", but also it to be "responsible".

Responsible innovation (RI) deepens the relationship between science and society, which seeks for innovation under a democratic governance framework to be better integrated into society to ensure its contribution and benefits are effective. But *how does responsible innovation in industry happen?* In other words, in terms of one of the most widely used definitions in the academic context, “responsible innovation means taking care of the future through collective stewardship of science and innovation in the present” (Stilgoe et al., 2013, p. 1570). Although this last definition acknowledged responsible innovation as a practice closely related to sustainability, the way in which its integration happen into industry is still in its infancy, and even more so when it comes from small and medium-sized enterprises (SMEs). This discussion remains one of the major research gaps analysed in this thesis.

Moreover, in order to survive in a global and highly competitive environment, SMEs seek to achieve sustainable development through technological innovations. 3D printing (3DP) holds substantial promise for

sustainability and the creation of a circular economy¹. Although 3D printing does not have a real sense of poverty alleviation in developing countries, has the potential to be a transformative alternative to the local production and consumption system. Manufacturing requires an understanding of local cultural issues that affect the management and organizational practices on which the competitiveness of enterprises is based. In that sense, once the decision is made to use a technology, it must be adopted and implemented. However, 3D printing, in that sense, is currently in the early stages of adoption especially from the perspective of small and medium enterprises. Therefore, in order to strengthen this area of research, this dissertation presents a comprehensive analysis of the factors influencing the adoption of 3D printing by different types of SMEs. This analysis is therefore another of the main topics analysed in this thesis.

Regarding the main topics of this thesis, unawareness of the potential value of responsible innovation for SMEs with the common objective of reaching sustainability, that generates economic benefits, but also generate social value connected to the global challenges of society. Even more so in a developing country, such as Bolivia, means once again being left out of an important socio-economic development, in a society that is marginal to what is going to happen. Bolivia has been undergoing a major boom period in recent years due to the price of natural gas and its derivatives, which has led to one of the best GDP per capita indices in Latin America, but despite these indicators, it is one of the poorest countries in the region with one of the highest indices of inequality, which could increase levels of poverty and extreme poverty, which in 2019 were 37.2% and 12.9% respectively (INE, 2019). These are part of the greatest challenges that Bolivia still faces. Thus, the third analysis for understanding the spread of responsible innovation is through corporate social responsibility (CSR) practices. This understanding is crucial for SMEs because, CSR seems to have a relevant capability of promoting responsible innovation, in particular resulting from collaboration with other stakeholders.

Based on the existing literature, this dissertation proposes three different analyses. The first empirical study explores the key factors that determine the

¹ The circular economy (CE) aims to radically improve resource efficiency by eliminating the concept of waste and leading to a shift away from the linear take-make-waste model (Despeisse et al., 2017).

adoption of 3DP technology by SMEs in Arizona in the United States. Their results suggest that factors such as relative advantage, integration, readiness, managerial obstacles, and in turn, external collaboration foster the adoption of 3DP. The second study deals with a systematic literature review to develop a conceptual model for responsible innovation and its relationship with business performance through corporate social responsibility and sustainable innovation practices. The last one empirical study focuses on explore whether CSR practices towards stakeholders promotes RI and financial performance, findings suggest that the relationship between CSR and financial performance mediated by responsible innovation was positive but weak.

Finally, the results of this dissertation join the emerging debate on responsible innovation and its application in SMEs. The focus is on SMEs because they represent 98% of the companies in the world. Their achievements have the potential to generate a major impact on the country's economy and society. Furthermore, this dissertation could also help researchers and practitioners to new insights to address responsible innovation for society, with society and for sustainable development.

LIST OF ABBREVIATIONS

SMEs	Small and medium-sized enterprises
RI	Responsible Innovation
RRI	Responsible Research and Innovation
3DP	3D Printing
3D4D	3D Printing for Development
CSR	Corporate Social Responsibility
SI	Sustainable innovation
SDG	The United Nations' Sustainable Development Goals
UN	United Nations
TOE	Technology – Organization – Environment framework
TRA	Technology Relative Advantage
TI	Technology Integration
OR	Organisational Readiness
MO	Managerial Obstacles
ECR	Environmental Customer Requirements
EEC	Environmental External Collaboration
ECP	Environmental Competitive Pressure
FP	Financial Performance
ASFI	Financial System Supervisory Authority

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Chapter 1. Introduction

...the problem is not so much the technology itself but the challenge of adopting and applying it responsibly.

1.1. Sustainability and firm performance

SMEs, which represent 95% of the workforce, are considered responsible for approximately 60% of all greenhouse gas emissions and approximately 70% of global pollution (Aragón-Correa et al., 2008; Bartolacci et al., 2020; Miller et al., 2011). Thus, the concern for the care of the environment and sustainability has promoted a scientific debate, which has resulted in an important social attention, but also in the attention of practitioners and researchers (Bartolacci et al., 2020). In light of the current business situation, special attention has been given to studying the relationship between performance and sustainability. The former is related to the multidimensional construction which uses both financial (e.g. ROA, productivity, sales growth, market share, etc.) and non-financial measures (e.g. customer satisfaction, brand image and corporate reputation, employee motivation, etc.). The latter is related to investigate the influence of sustainability practices. However, we can start with their definition. Sustainability has its origins in the 1987 Brundtland Report as a political concept and refers to “development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs”. To this end, sustainability can be studied from a macro and micro approach. The first refers to the general economic system, and the second to a specific analysis of individuals, companies, and governments. On the one hand, at the macro level, sustainability focuses on reconciling the aspirations of nations to live better with Well-being. Because while to live better nature is seen as something that must be conquered and exploited at a competitive level, Well-being is life in its fullness, it is about knowing how-to live-in balance and harmony with nature. Along these lines, there have almost always been two opposing

visions of the relationship between man and nature, one aligned with Well-being and the other with living better (Kuhlman and Farrington, 2010). However, living better has perhaps been the dominant phenomenon in the last two decades, with repercussions that are presented today as one of the most profound challenges that humanity has faced, i.e. climate change and its effects (floods, ecological change, extreme heat, loss of species, scarcity of resources, and droughts). At the same time, the counterpart has always been present, i.e. the concern for the care of the environment, but the important argument is "welfare" seen from an intergenerational "equity" approach (Kuhlman and Farrington, 2010). Equity is understood as the study of *who gets what, when, and how* (Lasswell, 2018), which means distribution - whether of goods and services, wealth and income, opportunity and disadvantage. Although equality is the goal, distributions contain both equality and inequality considered to be fair. Thus, in 1992, the United Nations made a statement on this subject and held that to care for the environment all levels of society, governments, organizations, businesses, and individuals must share the same vision of care. That same year the United Nations Framework Convention on Climate Change was established to organize negotiations with the world's states. In 1997, the first negotiation with many countries was established, the so-called Kyoto Protocol, which aimed to reduce the level of greenhouse gases. However, in five years the Kyoto Protocol did not achieve much because the signatory states did not meet the commitments they had made. Moreover, the two largest emitters of greenhouse gases in the world, the United States and China, were not covered by the Protocol.

On the other hand, concerning the micro-level at the business level, sustainability is called corporate sustainability (Bos-Brouwers, 2010) and is defined as meeting the needs of a company's direct and indirect stakeholders, not including its ability to also meet the needs of future stakeholders (Porter and Kramer, 2006). One strategy for building sustainable industry practices has been the triple-bottom-line (TBL) approach, with indicators that look at social, economic, and environmental dimensions that are interrelated (Elkington, 1998). Consequently, corporate sustainability is also related to other ways of stating it such as corporate social responsibility (CSR) (Castka et al., 2004). According to the authors, CSR should advocate for companies to improve the impact of their actions through the protection of social and

environmental dimensions, directly connected to their business strategy (Porter and Kramer, 2006). Also, business sustainability has been addressed as a sustainable *Bioeconomy* in the European Union that aims to strengthen the connection between the economy, society, and the environment (European Commission, 2018). Consequently, in business terms, we have two perspectives sustainability from the point of view of corporate sustainability and financial performance both to ensure business viability in the medium and long term and to continue operating in the interest of stakeholders (Bartolacci et al., 2018). In light of the above, although there is a gap in the relatively new literature regarding the relationship between sustainability and performance in SMEs (Bartolacci et al., 2020; Prashar and others, 2020), the integration of responsible innovation strategies allows companies to be simultaneously coherent to add value to society, thus satisfying sustainability demands, and at the same time obtain benefits from the very beginning of innovation activities (de Poel et al., 2017). This last argument has led to the recognition of responsible innovation as a strategy to seek, on the one hand, added value for society, and on the other, to obtain a competitive advantage. However, how performance and sustainability relate to responsible innovation remains a major research gap, which will be explored in this dissertation.

Thus, the aim of this dissertation is to understand the adoption of a technology -3D printing- and responsible innovation in order to pursue sustainability among SMEs.

1.2. RRI and RI

Although several authors have identified that responsible research and innovation (RRI) shares common characteristics with the responsible innovation (RI) discourse and vice versa (Bessant, 2013; Von Schomberg, 2013, 2012) and have even used them interchangeably because of the flexibility of their interpretation (Rip and Voß, 2013), in recent years these discourses seem to have moved along divergent paths (Owen and Pansera, 2019). In other words, the RRI and RI are analogous but different (Owen and Pansera, 2019). It is not the purpose of this research to make an in-depth analysis of the distinction between these two discourses, but we do believe it is important to briefly summarise this relationship to position ourselves in the discourse. RRI, which derives from the concept of "anticipated governance",

a term first used by Guston and Sarewitz (2002), provided a public policy sense in their discourse and was appropriated mainly by the European Commission, which was struggling at the time to overcome its economic crisis and, saw innovation as a possible future scenario of sustainable growth (Burget et al., 2017). Thus, in 2011 the European Commission committed itself to the RRI because it thought that it could be beneficial for people if it met the needs of society, i.e. providing economic, social, and environmental sustainability. Although in practice, the complexity was greater because its definition was not clear until then (Owen et al., 2012) and, it was not until 2011 that Hilary Sutcliffe first attempted to summarise the characteristics of RRI but, it was Von Schomberg (2012, p. 9) who defined RRI most clearly and today it is one of the most widely used administrative (Burget et al., 2017) definitions, which is "A transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)." (see Table 1). It is in this process that RRI, which from the beginning was a public policy discourse, has remained necessary not only for a future sustainable growth scenario but also for meeting the needs of the different stakeholders, and society.

In the same way, RI (the term used in this research²) refers to a new approach to innovation governance that emphasizes the common and recurrent logic of sustainable development, adjusted to the needs of society (Owen et al., 2012) with, a strong sense of individual and collective responsibility in the actors of the innovation system and which is inherent to democratic life - democracy understood in terms of participation and representativeness -, i.e. innovation governance in line with moral, democratic principles, standards, and the political function directed towards concrete results (Van Oudheusden, 2014). This is in line with the definition of RI proposed by Stilgoe et al. (2013) which refers to "taking care of the future through the collective management of science and innovation in the present" (see Table 1 for more definitions). Based on this argument, the question arises as what is innovation governance? The governance of innovation refers to changes in policies,

² The term RI is used in this dissertation and RRI is used explicitly when the authors quote it in this way.

laws, and regulations; the development of business and organizational strategies by the main companies involved in the development of innovations; the development of negotiation mechanisms and other decisions, i.e. a response to the results of innovative activity, while mitigating the worst social and environmental outcomes so that research and creative entrepreneurship can be encouraged with the best results (Foster and Heeks, 2013; Valdivia and Guston, 2015; Van Oudheusden, 2014). This argument has led to the recognition of RI as a relevant approach to innovation governance (Guston, 2014; Owen et al., 2012; Stilgoe et al., 2013). However, to take responsibility for the future to which RI invites us, some kind of action is required in the present that responds to the duality of innovation outcomes. While in the fundamental theory and central motivations there is an important development of literature (Bessant, 2013; Owen et al., 2012; Stilgoe et al., 2013; Von Schomberg, 2013, 2012). In practice, RI is still in its infancy (de Poel et al., 2017; Gonzales-Gemio et al., 2020; Ribeiro et al., 2018) because most academic and also business actors are not fully aware of what RI specifically refers to or whether it is just "old wine in a new bottle" (as quoted in Marschalek et al., 2017, p. 308). The truth is that responsibility is not a new concept in companies because, while many have been adopting for example practices related to CSR, sustainable innovation, social responsibility, responsible business practice, among other 56 different alternative terms to CSR (CSR is an umbrella term used in this research) in SMEs (Ortiz-Avram et al., 2018). RI goes further, is more specific, and refers to the early stages of technology development, to the early inclusion of stakeholders in the innovation process. However, who and what drives business change and legitimizes RI? According to the authors, although the latter is a real challenge, there are some indications that RI could be promoted by CSR which is part of the language in companies (a relationship that we will deal with in the following section). Consequently, it seems that CSR, in addition to being adopted due to its sustainability-oriented framework, reinforces the potential to promote responsible innovation within companies. Aspects that are developed throughout this research.

1.3. The relationship between CSR and RI

The authors have shown, with a plethora of studies related to CSR activities and the multitude of similar terms to refer to it, that companies engage in CSR activities mainly because they are associated with internal or external

benefits or both, also, because of their capacity to promote innovation. In the same vein, the European Union Competitiveness Report 2008 (ECR, 2008) argues that there are three main ways in which CSR can contribute to innovation capacity and performance, which are: (a) innovation resulting from collaboration with other stakeholders; (b) identification of business opportunities through the solution of social problems; and (c) creation of more innovation-friendly workplaces. Then, it seems that CSR could not only promote innovation but also encourage stakeholder engagement, which is essential for responsible innovation. Because, consideration of individual stakeholders alone is not sufficient to explain the environment in which a company operates, but rather "jointly" with other stakeholders (Tang and Tang, 2018). Therefore, CSR practices seem to act as drivers of responsible innovation through stakeholder engagement. This previous assumption, which will be investigated in this thesis, is in line with previous research suggesting that RI encompasses aspirations and processes related to corporate responsibility (Van Oudheusden, 2014) and, both economic incentives and corporate culture change are the mechanisms to promote RI in industry and, CSR combines both (Valdivia and Guston, 2015). Then, let's review the concepts, on the one hand, according the European Commission's Green Paper, CSR is a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with stakeholders voluntarily (European Commission, 2001). From this definition we learn that: 1) there are some concerns with society (social and environmental) identified by companies and related to their operations and; 2) the need to involve listening to stakeholders is also identified, but; 3) their treatment is voluntary. Thus, while the concept of CSR explicitly or implicitly defines a problem and a moral need, its clear recommendation of voluntary treatment has made CSR informal, philanthropic (de Poel et al., 2017), with a scope that varies (Perrini et al., 2007) from company to company, from country to country, or from the term related to CSR that is used (e.g. Social Responsibility, Responsible Business Practice, Responsible Entrepreneurship among other different terms alternative to CSR in SMEs) and, in many cases, although they are ideas with great potential in favor of the environment, they are small in terms of the totality of what innovation represents. Therefore, CSR does not emerge as a deliberate policy (Preuss and Perschke, 2010). While RI, as explained in previous sections, emerges as a new approach to innovation governance that emphasizes the common

and recurrent logic of sustainable development, adjusted to the needs of society (Owen et al., 2012) with, a strong sense of individual and collective responsibility in the actors of the innovation system. From the definitions of RI (see Table 1) we can also find in common that a problem, a moral need, and a treatment recommendation, which are identified according to Van Oudheusden (2014) as: 1) Problem definition: Science and technology fail when they are not in line with society's values; 2) Moral assessment: Society's needs and values need to be heard and; 3) Recommendation for treatment: The scientific, political and industrial communities should seek society's opinion by listening to what it has to say about scientific and technological innovations. In that sense, RI refers to the early stages of technology development, in the context of enterprise, this means a design space that allows the early inclusion of stakeholders in the innovation process in order to ensure responsible results (Silva et al., 2019). Whereas in CSR stakeholders are included at a late stage of the innovation process, i.e. at the final innovation stage, when the product or service is already on the market, which allows for some adaptation of solutions, but of a limited nature. On the other hand, we can see what happens in terms of results. Despite indications that CSR practices seem to act as drivers of responsible innovation, empirical evidence is still scarce and leaves little to be desired in terms of implementation, which means how? and who? Therefore, and as described in previous sections of this thesis, we will investigate "how" CSR practices relate to "responsible innovation" (rather than innovation in general) and its effect on performance-sustainability in SMEs. Furthermore, we will explore "who" are the stakeholders collaborating in innovation because, in the RI discussion, it is stressed that the selection of stakeholders refers to who will contribute, but also who will be affected.

1.4. Theoretical framework

In this section, firstly 3D printing adoption is analysed in the context of SMEs and its potential relationship with sustainable development. Then, the relationship between CSR and RI for a conceptual model; and the relationship between CSR toward stakeholders and RI and financial performance in SMEs are also analysed.

1.4.1. Potential value of 3D printing

3D printing has gained ground in many industries around the world (Arvanitis and Hollenstein, 2001; Rayna and Striukova, 2016). In light of the current potential advantage, from the simple manufacturing of toys and gifts, to more complex high value-added manufacturing applications in the biomedical, automotive and aerospace sectors, among others. SMEs have adopted 3DP to achieve competitiveness (Rahardjo and Yahya, 2010). However, companies are still struggling to adopt it (Yeh and Chen, 2018), owing to the strategic, operational and organizational challenges (Martinsuo et al., 2018) that are often complex for large firms, but appear to be greater for SMEs with fewer resources (Rahardjo and Yahya, 2010), one of which is the limited/lack of knowledge and skills that are crucial for successful implementation (Saber et al., 2010). Additive manufacturing (AM) also known as 3D printing (the term used in this research) is defined as the process of joining materials to manufacture objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methods (ASTM, 2012, p. 2).

3D printing was invented more than 50 years ago. However, at that time it was far from the technology it is today, with such potential for innovation that it has been described as "the elephant in the room" (Hornick, 2015). The fruit of human creativity, it changes the way a company can produce almost anything, and the only limit is one's own imagination. Today, 3D printing is present in anything from the simplest to the most complex applications, and in the biomedical, automotive, aerospace, fashion, jewellery, food, toys, and many other sectors. It has undergone enormous growth in the last five years. This increase is in line with the research firm Gartner's prediction that by 2023 households will have fully adopted 3D printing. However, while in 2020 the compound annual growth rate represented around 98.5% (Basiliere, 2016), and experts now estimate a growth of 50% until 2027. In fact, several studies have shown that 3DP will be one of the most revolutionary technologies of the near future, with it expected to have a significant, profound effect on the industrial world (Pretorius, Steenhuis, and Pretorius 2016; Khorram Niaki & Nonino 2017; Rayna and Striukova 2016; Rifkin 2015). In addition to having an effect on industry, including micro, small and medium sized enterprises, 3D printing could contribute to their long-term sustainability. *But why would 3D printing have such a capability?* Because

it primarily has the potential to democratize manufacturing and could contribute to the United Nations' Sustainable Development Goals (SDGs), which will be explored below.

Democratization of manufacturing, 3D printing breaking the barriers on entry to the market niches (Hornick, 2015) because, it has the potential to enable that small and medium sized enterprises and anyone can make almost anything that is the result of human creativity and, getting more for less (Prabhu & Jain, 2015). 3D printing could become akin to a "Swiss Army Knife" (Birtchnell and Hoyle, 2014) because of its capabilities for remote printing of products and on multi-plastic materials or sintering/fusing metals by laser/electronic radiation that enables the construction of truly innovative products. Lighter weight products that retain their quality are a unique feature in the aerospace, medical, automotive and other sectors for their ease of use and energy savings. 3D printing offers personal control, which implies customization (Birtchnell and Hoyle, 2014), also the integration of customers into the manufacturer's supply chain, which could be a solution for disconnected supply chains or product lead time. It could help to build a bridge between the production process and the person, which means the digital reunification of the workforce (Birtchnell and Hoyle, 2014). Furthermore, it could reach collapsed markets and/or poverty groups neglected by globalization (Birtchnell and Hoyle, 2014). Customers may become competitors, manufacturing the products they previously bought. 3D printing is still far from being controlled, which is controversial because of intellectual property issues. It is an example of what industries could achieve in this century with such frequent radical and qualitative changes. *The Economist* predicts that this new approach to manufacturing will lead to a third industrial revolution (The Economist, 2012).

The dynamic evolution of 3D printing is evident in many industrial sectors. At first, product designers only used this technology for rapid prototyping³ to create functional and conceptual models. The second evolutionary phase included its capacity to produce end-usable products, while the third phase now involves end-consumers using 3D printers in a similar way to desktop

³ Rapid Prototyping means the production of prototypes, visual design aids, touch, feel, fit and assembly test parts, etc., that are used in the product development phase and are not meant to be equivalent to real production parts at all levels (Kruth et al., 2007).

printers. Thus, **3D printing adoption by SMEs, which will be studied in the second chapter, seems to be closely related to such benefits as a high level of customization, flexibility, logistic management possibilities and cost saving potential** (Mellor et al., 2014) **with the ultimate objective of reaching corporate sustainability.**

3D Printing and its relationship to the UN SDGs, whereby innovation and technology together have changed and are changing the lives of many people and businesses around the world. The results of these practices have also been the exclusion of four billion of the world's population, which includes low income groups (Agola and Hunter, 2016), and those at the Base of the Pyramid (BoP) (Papaioannou, 2018). The term BoP, which was first used by Franklin Roosevelt in 1932, refers to the inclusion of underserved low-income groups in economic development, and who can become BoP innovators with opportunities to survive through the drive not only of technology, but of the ways in which they can harness it⁴, which in the case of Bolivia⁵ involves micro and small enterprises being formed in small local communities with natural resources managed on a shared basis for their use, care, and sustainability (Ostrom, 2000). In that line, 3D printing could become a useful tool for boosting sustainable socioeconomic development (3D4D), in the same way that information and communication technologies do for development⁶ (ICT4D), which means qualitative contributions from the bottom up to the development of the SDGs from 2016 onwards, taking into account the fact that Bolivia only achieved 3 out of 23 targets of the Millennium Development Goals (MDGs) (2000-2015) described in eight key areas such as 1) eradicate extreme poverty and hunger, 2) achieve universal primary education, 3) promote gender equality and empower women, 4)

⁴ In 2016, the Inter-American Commission on Human Rights adopted its American Declaration on the Rights of Indigenous Peoples which, in addition to expressing its adherence to the fundamental documents of the United Nations in this area, includes Article 26 to guarantee the right of indigenous peoples in isolation and in initial contact to remain in that condition and to live freely and according to their cultures.

⁵ Bolivia legitimately recognizes 34 indigenous native peasant peoples of the East, Chaco and Bolivian Amazon, 12.9% of whom live in extreme poverty and 37.2% in poverty (National Institute of Statistics [INE], 2019). Furthermore, it is a developing country where the informal sector is the most predominant in the region at approximately 80%, i.e. 7 out of 10 employees are in the informal sector, (INE, 2017).

⁶ ICT4D is defined as combining ICT Scope and Development Scope "the application of any entity that processes or communicates digital data in order to deliver some part of the international development agenda in a developing country" (Heeks, 2017).

reduce child mortality, 5) improve maternal health, 6) combat HIV/AIDS, malaria and other major diseases, 7) ensure environmental sustainability, and 8) develop a global partnership for development (United Nations for Bolivia).

From the adoption standpoint, once the decision is made to use a technology - in this case 3D printing - it must be adopted and implemented. According to Tornatzky et al. (1990) implementation is an action and synonymous with utilisation (Scheirer, 1983). Voss (1988) states that an adoption and implementation process must be reinvented with each new technology. In the case of 3D printing, the application is currently in the early stages. Since most studies have focused on large companies or a combination of large and small companies (Deradjat and Minshall, 2017; Schniederjans, 2017; Yeh and Chen, 2018), especially from the adoption and implementation perspective, it is not surprising that only a handful of researchers have studied the adoption of 3D printing in a small and medium sized enterprises context. Thus, to identify the factors that influence the adoption and implementation process, the first specific objective is as follows:

Strategic objective 1: To analyse empirically the factors affecting the adoption of 3D printing in small and medium-sized enterprises.

1.4.2. Responsible innovation for a Conceptual Model

RRI which first appeared in the Sixth Framework Programme (EU Regulation No 1291/2013) arose in discourses on emerging technologies⁷ and research ethics in controversial and innovative fields, such as nanotechnologies or geo-engineering (Owen et al., 2012). RRI has been a topical issue since the beginning of the last decade, but it was not until 2011 that it began to become significantly relevant and visible thanks to framework programmes such as "Horizon 2020" and "FP7" promoted and encouraged by the European Commission. However, the integration of responsible

⁷ Rotolo et al. (2015) defined emerging technologies as: a relatively fast growing and radically new technology characterized by a certain degree of coherence that persists over time and that can have a considerable impact on the socio-economic field(s) observed in terms of the composition of actors, institutions and patterns of interaction between them, together with the associated knowledge production processes. However, its most prominent impact is in the future and, therefore, in the emergence phase it is still somewhat uncertain and ambiguous. Five attributes of emerging technologies were identified: (i) radical novelty, (ii) relatively rapid growth, (iii) coherence, (iv) salient impact and (v) uncertainty and ambiguity.

innovation –the term to be used in this dissertation- in companies is still in its infancy *and is greater when it comes to small and medium-sized enterprises*. In fact, the theoretical concept of responsible research and innovation is questioned by its rapidly evolving concept, with not enough translation into practice (Owen et al., 2012).

Also, very little research has been done, the vast majority of which is articles focused on political issues. In fact, there are still gaps in the literature regarding a practical understanding of the influence of responsible innovation on social values and organisational capacities (Pandza and Ellwood, 2013). Such an understanding is crucial because, with awareness growing among businesses, researchers and governments of recurrent activities to “innovate with and for society”, the concept of "responsible innovation" together with its dimensions as essential parts of that goal, have been included in the literature.

Based on the above, we then start from the term “innovation”. Innovation is change, a new or improved product, service or business model (OECD, 2005), a process of creating ideas ,or a simple improvement, doing what we do, but better and which can be disruptive or incremental (Halme and Korpela, 2014). Thus, the role of innovation is defined as the successful exploitation of new ideas (DIT, 1998), with a spectrum of increasing novelty that brings various benefits as well as risks. The study by Ribeiro et al. (2017) highlights how innovation could fail when ethical and social issues inherent in the process itself are not considered. In this regard, a key dimension when exploring innovation is the concept of "responsibility". The most relevant definitions found in literature review, which have been classified as administrative and academic following the study by Burget et al. (2017) are summarised in Table 1. The term responsible innovation will be used in this research.

Table 1: Responsible innovation literature reviews

Reference	Findings related to responsible innovation
<i>Administrative definitions</i>	
(Von Schomberg, 2012, p. 9)	“A transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow

	a proper embedding of scientific and technological advances in our society).”
(European Commission, 2003)	Responsible research and innovation refers to the comprehensive approach of proceeding in research and innovation in ways that allow all stakeholders that are involved in the processes of research and innovation at an early stage (A) to obtain relevant knowledge on the consequences of the outcomes of their actions and on the range of options open to them and (B) to effectively evaluate both outcomes and options in terms of societal needs and moral values and (C) to use these considerations (under A and B) as functional requirements for design and development of new research, products and services.
<i>Academic definitions</i>	
(Stilgoe et al., 2013, p. 1570)	“Responsible innovation means taking care of the future through collective stewardship of science and innovation in the present.”
(Halme and Korpela, 2014, p. 548)	Responsible innovation refers to a new or significantly improved product, service or business model whose implementation at the market solves or alleviates an environmental or a social problem.
(Stahl, 2013, p. 712)	“RRI is a higher level responsibility or meta-responsibility that aims to shape, maintain, develop, coordinate and align existing and novel research and innovation-related processes, actors and responsibilities with a view to ensuring desirable and acceptable research outcomes.”
(Spruit et al., 2016, p. 2)	“by a shift from assessing the desirability of the outcome of innovation processes, such as evaluating harmful product outcomes in court under liability law, to assessing the qualities of the innovation process.”
(Wilford, 2016, p. 348)	“RRI creates a step-change in the way that those who are engaged in research and innovation should consider the impact of what they do.”
(Pandza and Ellwood, 2013, p. 1112)	“Responsible innovation becomes what Hoffman (1999) calls an issue around which members of technological fields (Carlsson et al., 2002) coalesce, because of its importance to the interests and objectives of specific organizations.”

Source: Own elaboration.

The definitions of responsible innovation emphasize a common recurrent rationale of "sustainable development"⁸, adjusted to the "needs of society", i.e. close collaboration and active involvement with various and different stakeholders (Owen et al., 2012). The Von Schomberg (2012) definition, which is one of the most widely used, shows that innovation is a process of

⁸ The United Nations World Commission on Environment and Development conference described sustainable development as "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs." (World Commission on Environment and Development, 1987, p. 6).

co-responsibility for ethical acceptability, social coexistence, and the construction of holistic sustainability. However, very similar approaches can be found in companies' "corporate social responsibility" or "sustainable innovation" strategies. In this regard, the study by Valdivia and Guston (2015) stated that there is an important relationship between corporate social responsibility and its potential to promote responsible innovation in industry, which refers to two main routes: economic benefits and change of culture in the company, both of which are to a greater or lesser extent reflected and combined in these corporate social responsibility strategies. However, while these CSR and SI strategies are drivers of responsible innovation, according to the study by de Poel et al. (2017) they must shift from a conservative, philanthropic, and defensive way of addressing social, environmental and ethical issues towards a progressive way of "doing good". Then, the question arises as to how this specificity of "doing good" is to be achieved in SMEs.

On the other hand, the term CSR is used alternatively in the literature, which makes it difficult to consolidate e.g. Social Responsibility (Lepoutre and Heene, 2006), Responsible Business Practice (Jenkins, 2006), Responsible Entrepreneurship (Fuller and Tian, 2006) among others 56 different terms alternatives to "CSR" in SMEs (Ortiz-Avram et al., 2018). Therefore, although the term CSR cannot be said to have a unified meaning across literature, CSR is an umbrella term encompassing those sub-terms. Consequently, the dissertation supports Ortiz-Avram et al. (2018) argument and CSR term is used.

Moreover, the study by Ortiz-Avram et al. (2018) grouped the terms used for CSR in the literature into four topics: 1) ethical values and social connections/relationships of the entrepreneur or owner-manager, 2) relevance of business context and long-term performance, 3) importance of formal processes for CSR integration, and 4) political issues of relevance to CSR. Additionally, we identify a discretionary and silent approach by SMEs to CSR. For example, the study by Baumann-Pauly et al (2013) found that SMEs involved in CSR activities limit external communication and reporting, unlike large companies. Furthermore, according to the study by Lee et al (2016), such a limitation would be related to a lack of resources and managerial capacity among SMEs. On the other hand, the study by Bansal and Roth (2000) found that factors that motivate companies to respond

ecologically are influenced by conditions such as individual concern, which responds to values and principles proposed gradually and inspired by a mix of personal and cultural motivations of founders and senior managers of SMEs, meaning that according to Jenkins (2004) "unknowingly they are responsible". This can also be illustrated by the informal, altruistic and philanthropic nature of these discretionary personal values (Perrini et al., 2007; Jamali et al., 2009; Preuss and Perschke, 2010; Jamali et al., 2009; Lee et al., 2016). Based on this argument, which is a fragmented field of CSR that is difficult to consolidate, we found common points in SMEs such as: the objective they pursue, which is none other than to ensure business responsibility based on the interests and needs of stakeholders. Therefore, CSR could foster responsible behaviour towards stakeholders (Perrini et al., 2007), and can be defined as "actions that appear to promote some social good, beyond the interests of the company and what is required by law" (McWilliams and Siegel, 2000, pag. 117). Thus, as we explained earlier CSR is a strategy that seems to foster "responsible innovation" as well if (and only if) SMEs act proactively rather than reactively. Similarly, sustainable innovations, which are additional strategies that seek ethical business behaviour, can be defined as innovations in which the renewal or improvement of products, services, technologies or organisational processes not only lead to better economic performance, but also generate better environmental and social performance, both in the short and in the long term (Bos-Brouwers, 2010), thus boosting responsible innovation.

Thus, following Porter and Kramer' s statement that "corporate social responsibility can be much more than a cost, a constraint or an act of charity: it can be a source of opportunity, innovation and competitive advantage" (Porter and Kramer, 2006, p. 3), we formulate our next strategic objective:

Specific Objective 2: To develop a conceptual model of responsible innovation, considering the relationship between CSR/SI practices and firm performance.

1.4.3. Responsible innovation and firm performance in SMEs

The efficiency of responsible innovation in a company depends on it having a strategy that seeks both value to society and economic benefits; the former is related to the debate over stakeholder engagement, which emphasizes who

will contribute, but also who will be affected because when stakeholders understand the objectives for observing RI principles they can commit to achieving them (Chatfield et al., 2017). The latter is related to strategies linked to responsible innovation, such as corporate social responsibility practices, which lead to the creation of economic value when they address the most important stakeholders (Hammann et al., 2009). For example, some authors measured performance by looking at indicators ranging from quantitative performance indicators (e.g. ROA, productivity, sales growth, market share, etc.) to qualitative indicators (e.g. customer satisfaction, brand image and corporate reputation, employee motivation, etc.) and from different fields of innovation, such as from empirical work and literature reviews. Authors who measured the relationship between CSR and firm performance revealed both a positive causal relationship and a positive but weak relationship. For example, the study by Reverte et al (2016) revealed that practices have a direct, positive and significant effect on both innovation and organisational performance, covering financial and non-financial indicators. Similarly, Torugsa et al (2012) found that specified capabilities (such as shared vision, stakeholder management and proactivity) share a positive association with proactive CSR, which in turn improves financial performance. Aragón-Correa et al. (2008) found a significantly positive relationship between proactive social responsibility related to environmental and financial performance by SMEs. The study by Hammann et al (2009) found that social responsibility practices towards employees, customers and, to a lesser extent, society, have a positive impact on the company and its performance.

Previous research also showed a positive but weak relationship between social responsibility activities and financial performance. For example, the study by Jain et al. (2016) found a significant but weak positive relationship between social responsibility and financial performance through the stakeholder approach in SMEs, which is similar to the findings by Orlitzky et al (2003).

Besides fostering firm performance, RI should also pursue environmental sustainability, social sustainability, diversity and inclusion, anticipation and reflection as RI performance indicators, which are less frequent, but which previous research has also considered (see Table 2). For example, diversity

and inclusion positively improve employee performance, satisfaction and commitment, as well as contributing to firm performance (Sancho et al., 2018). The study by Khan et al (2020) revealed that managing the relationship with key stakeholders (employees, environment, community, suppliers, and customers) has a significant positive influence on sustainable competition and business performance. Similarly, the study by Choongo (2017) found that while social and environmental dimensions have a significant impact on financial performance, performance measures related to corporate reputation and employee engagement were partially significant because employee engagement can be negatively affected when there is no investment in their training and development. Moreover, the study by Ratnawati et al. (2018) revealed that social responsibility activities have a significant effect on learning orientation, innovation and performance in SMEs. In the same vein, the study by Burlea-Schiopoiu and Mihai (2019) found that employee training, innovation and social responsibility practices are significant and correlated factors in promoting competitive advantage in SMEs.

To summarise, Table 2 shows performance indicators identified in the literature that promote RI in SMEs.

Table 2. Performance Indicators in SMEs

Reference	Reference to performance
Reverte et al. (2016)	CSR -> FP* ++
Torugsa et al. (2012)	CSR -> FP*** +
Aragón-Correa et al. (2008)	CSR -> FP*** ++
Hammann et al. (2009)	CSR -> FP* +
Jain et al. (2016)	CSR -> FP** +-
Orlitzky et al. (2003)	CSR -> FP +-
Sancho et al. (2018)	CSR -> FP* +
Khan et al. (2020)	CSR -> FP*** ++
Choongo (2017)	CSR -> FP** ++
Ratnawati et al. (2018)	CSR -> FP*** ++
Burlea-Schiopoiu and Mihai (2019)	CSR -> FP* ++

CSR: Corporate social responsibility; FP: Financial Performance
*** $p \leq 0.001$; ** $p \leq 0.05$; * $p < 0.01$
+ Positive effect; ++ Positive and significant effect; +- Positive but not significant
Source: Own elaboration.

Responsible innovation appears to moderate the relationship between CSR and SME performance. Furthermore, responsible innovation plays an interesting role in the relationship between corporate social responsibility practices and performance by SMEs. Valdivia and Guston (2015) consider the main drivers for promoting responsible innovation in industry to be economic incentives and change in business culture, both of which are included to a greater or lesser extent in the corporate social responsibility strategy and which are connected in a causal and long-term way with performance (Freeman, 2010). However, there is very little empirical evidence on this issue (de Poel et al., 2017; Hadj, 2020). Thus, the third specific objective is formulated as follows:

Strategic objective 3: To understand empirically the relationship between corporate social responsibility towards stakeholders, responsible innovation and financial performance in SMEs in Bolivia.

1.5. Research overview

The aim of this dissertation is to understand the adoption of a technology - 3D printing- and responsible innovation in order to pursue sustainability among SMEs. Therefore, this dissertation proposes three different analyses. The first empirical study explores the key factors that determine the adoption of 3DP technology by different types of SMEs. Based on the Technology – Organization – Environment framework. The second study deals with a systematic literature review to develop a conceptual model for RI and its relationship with firm performance. The last one empirical study focuses on explore whether CSR practices towards stakeholders - customers, employees, community, and environment - promote RI and financial performance (FP).

For clarifying the dissertation approach, Figure 1 shows the linkage of the three studies to pursue sustainable development in SMEs. The authors attributed such sustainable development, also known as corporate sustainability (Johnson and Schaltegger, 2016), to the need to operate in a responsible manner to take care the resources that companies use and the resulting footprint they leave behind (Prashar and others, 2020).

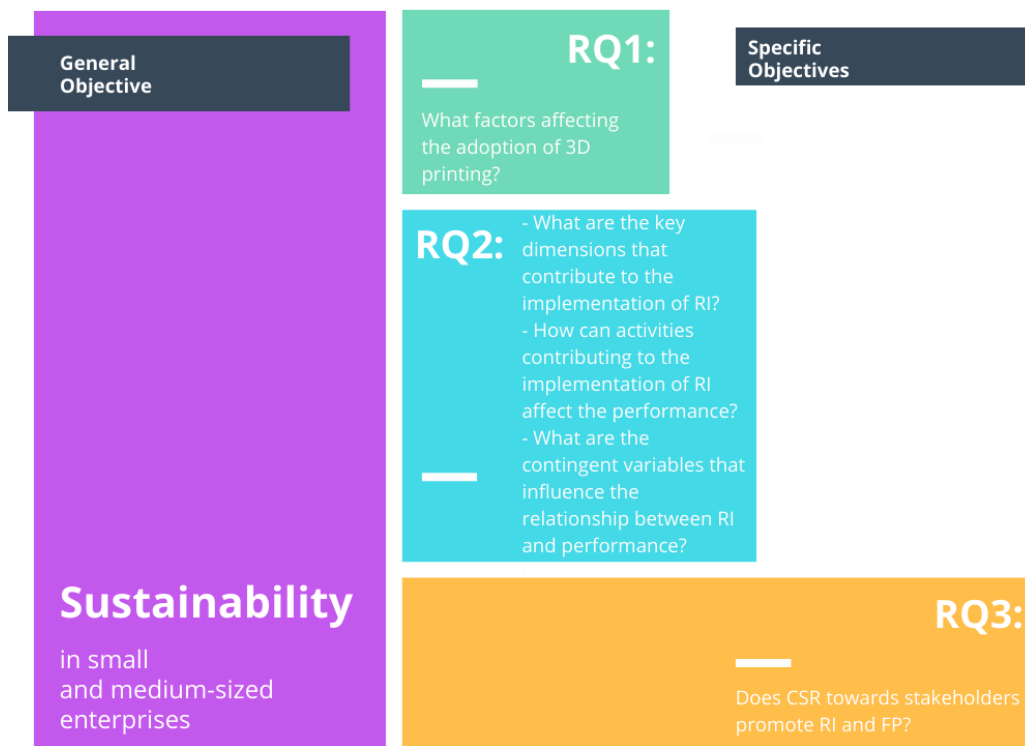


Figure 1. Dissertation research sequential design

Source: Own elaboration.

1.6. Original articles

This thesis is based on the following articles presented to peer-reviewed journals, as part of the contributions derived from it:

1. 'An empirical analysis of factors affecting the adoption of 3D printing in Small and medium-sized enterprises (SMEs)', (under review).
2. 'Responsible innovation in SMEs: A systematic literature review for a conceptual model', (Sustainability, 2020. This article belongs to the Special Issue Responsible Innovation for a Sustainable Future).
3. 'Corporate social responsibility practices associated with the spread of responsible innovation among SMEs', (under review).



Chapter 2. An empirical analysis of factors affecting the adoption of 3DP in SMEs

The adoption of 3D printing technology fosters sustainable competitive innovation.

The adoption of 3D printing technology in SMEs helps them to compete and survive in the business world.

The adoption of 3D printing technology in SMEs occurs in a sphere where the state of maturity to adopt or not adopt is decisive for moving from functional prototyping to end-products.

Abstract

In order to survive in a global and highly competitive environment, SMEs seek to achieve corporate sustainability through technological innovations. In this sense, 3D printing seems to be a suitable technology for achieving a sustainable competitive advantage all along the production chain due to its variety of applications offering customization and intimacy between production and consumer. The aim of this chapter is to explore the key factors that determine the adoption of such technology by different types of SMEs. Based on the Technology – Organization – Environment framework, the findings of this research suggest that factors such as relative advantage, integration, readiness, managerial obstacles, and in turn, external collaboration foster the adoption of 3D printing in SMEs. This research contributes to the literature on the adoption of 3D printing technology in SMEs, by filling an important gap left by previous research.

Keywords: 3D printing; Additive Manufacturing; Technology adoption; Small and medium-sized enterprises

2.1. Introduction

3D printing (3DP) is gaining territory in many industries worldwide (Arvanitis and Hollenstein, 2001; Rayna and Striukova, 2016). In light of the potential competitive advantage, SMEs have adopted 3DP to improve efficiency and achieve competitive success (Rahardjo and Yahya, 2010). However, companies are still struggling to adopt 3DP (Yeh and Chen, 2018) due to the existence of so many strategic, operational and organizational challenges (Martinsuo et al., 2018). Indeed, 3DP also runs into other issues when adopted by SMEs, and which are addressed in the remainder of this paper by focusing on the adoption process. To this end, SMEs are required to understand how they should move from not having the innovation to having it, which means overcoming barriers in the adoption process, and hence implementing 3D printing more effectively (Mellor, et al., 2014; Tornatzky et al., 1990).

Once a decision is made to innovate, it must be adopted and implemented. As Tornatzky et al. (1990) discussed, that adoption of an innovation refers to the point when a firm defines a problem to be solved, searches for solutions and makes a choice. Voss (1988) identified that the process of adopting innovations is their implementation, and that the implementation process should be reinvented with each new technology. In that sense, 3D printing is currently at the early stages of its adoption (Schniederjans, 2017; Yeh and Chen, 2018). Since most studies have focused on large enterprises (Deradjat & Minshall, 2017; Mellor et al., 2014; Schniederjans, 2017; Yeh & Chen, 2018), especially from the perspective of adoption and implementation, it is thus not surprising that only a handful of researchers have investigated SMEs. Therefore, in order to strengthen this area of research, this paper presents a comprehensive analysis of the factors that influence the adoption and implementation of 3D printing by different types of SMEs, considering that both the adoption of a new technology and the size of a company require different considerations that embrace different ideas. The former is related to a complex process that presents significant challenges for companies (Yeh and Chen, 2018). The latter is related to company size, and the many differences between small and large firms.

The disparities between SMEs and large companies are wide and varied. Marri, Gunasekaran and Sohag (2007) argued that since SMEs have less

complex organizational structures, this could facilitate the implementation process. They also have a greater ability to produce change, which is positively associated with the level of confidence (Voss et al., 1998). However, SMEs have fewer resources (Rahardjo and Yahya, 2010), with one of these being the limited/lack of knowledge and skills that are crucial for successful implementation (Sabeti et al., 2010). Also, SMEs still struggle to integrate 3D printing into their production lines (Yeh and Chen, 2018). As a result, more effort is often required to implement 3DP within current management practices. Consequently, the ways in which 3D printing is adopted by SMEs — rather than adopted in general — remains a major research gap (Deradjat and Minshall, 2017; Despeisse et al., 2017; Mellor et al., 2014; Schniederjans, 2017) that will be explored in this study.

While 3D printing technology is still not widely used by manufacturing industries (Yeh and Chen, 2018), its understanding is particularly poor with regard to SMEs (Martinsuo et al., 2018). Despite the substantial literature on the adoption process, the empirical evidence has focused on large enterprises or a combination of large and small enterprises (Deradjat & Minshall, 2017; Schniederjans, 2017; Yeh & Chen, 2018). For example, Mellor et al. (2014) found that six factors should be considered regarding the implementation of 3DP; although this study considers that framework should be tested further in different industries. Deradjat and Minshall (2017) observed a positive impact of 3DP implementation on the maturity stage of technology but the effects varied significantly across theories valid for large companies to smaller ones. Khorram Niaki and Nonino (2017a) also found positive and direct effects of 3DP implementation on competitiveness when time and company size are considered. The most recent study by Martinsuo et al. (2018), for example, shows that SMEs face different challenges when adopting 3D printing depending on supply chain positions, which can be summarized with socio-technical factors using Mellor et al.'s (2014) study on implementation of additive manufacturing (AM). Studies showed that most determining factors of the adoption of 3D printing factors from past research can be summarized as three: technological, organizational, and environmental factors (Darbanhosseiniamirkhiz and Wan Ismail, 2012). These are consistent with the Technology – Organization – Environment (TOE) framework proposed by Tornatzky et al. (1990). TOE has been acknowledged as a relevant theoretical framework as well as a powerful tool

(Yeh and Chen, 2018) for accomplishing adoption in broader conditions and for exploring factors of new technology from the perspective of organizations.

Moreover, TOE is positively related to many studies of the adoption of various technologies, and which have proposed different factors that might affect the adoption of technology by SMEs based on past research, such as technological (e.g. relative advantage, integration), organizational (e.g. readiness, managerial obstacles) and environmental (e.g. competitive pressure, external collaboration, customer requirements) factors. Under this TOE framework, this research empirically examines the factors that affect the adoption of 3D printing by SMEs using a sample of companies from diverse sector backgrounds.

The research is organized as follows. Section 2 reviews and discusses the related literature. Section 3 describes the research methodology, presents the conceptual model and the experimental hypothesis on which it is based, and provides the empirical findings. Section 4 analyses the data to validate the model and Section 5 concludes with the results.

2.2. Theoretical background and hypotheses

2.2.1. 3D printing

3D printing, also known as additive manufacturing, is defined as the process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methods (ASTM, 2012, p. 2). For terminological accuracy, the term 3D printing is used in this study. It was invented more than 50 years ago. 3DP consists of various technologies and processes, the most widely used including stereolithography, fused deposition modelling, and selective laser sintering (Mellor et al., 2014). This study considers those 3D printing technologies in various categories of use, such as prototyping, finished goods, mix of prototyping and finished goods, and so on. However, it could not have been originally foreseen that it would have so many applications today: from the simple manufacturing of toys and gifts, to more complex high value-added manufacturing applications in the biomedical, automotive and aerospace sectors, among others. 3DP has undergone huge growth in the last five years (Figure 2). While in 2012 the compound annual growth rate (CAGR) represented around 27.3% (Wohlers

and Caffrey, 2015), experts now estimate a growth of up to 40% for 2020, so its use has doubled in less than 10 years and it is now extensively used worldwide.

3D printing can produce almost anything, the implications of which could cause major disruption to the manufacturing industry (Berman et al., 2012) due to the unprecedented access to such a powerful manufacturing tool with such potential for innovation (Wohlers and Caffrey, 2015). In fact, several studies have shown that 3DP will be one of the most revolutionary technologies of the near future, with it expected to have a significant, profound effect on the industrial world (Pretorius, Steenhuis, and Pretorius 2016; Khorram Niaki & Nonino 2017; Rayna and Striukova 2016; Rifkin 2015). More specifically, the adoption of 3DP by SMEs seems to be closely related to such benefits as a high level of customization, flexibility, possibilities for logistics management and potential for cost savings (Mellor et al., 2014). Although these claims may be exaggerated, 3DP does affect all parts of the production chain, including design, product development and manufacturing. Meanwhile, the dynamic evolution of 3DP is evident in many industrial sectors — Figure 2 shows the three main phases of this (Khorram Niaki and Nonino, 2017b). At first, product designers only used 3DP technologies for rapid prototyping⁹ to create functional and conceptual models. The second evolutionary phase of 3DP included its capacity to produce end-usable products, while the third phase now involves end consumers using 3D printers in a similar way to desktop printers. To summarize, 3D printing offers personal control, which involves customization and intimacy between production and consumer (Birtchnell and Hoyle, 2014).

⁹ Rapid Prototyping means the production of prototypes, visual design aids, touch, feel, fit and assembly test parts, etc., that are used in the product development phase and are not meant to be equivalent to real production parts at all levels (Kruth et al., 2007).

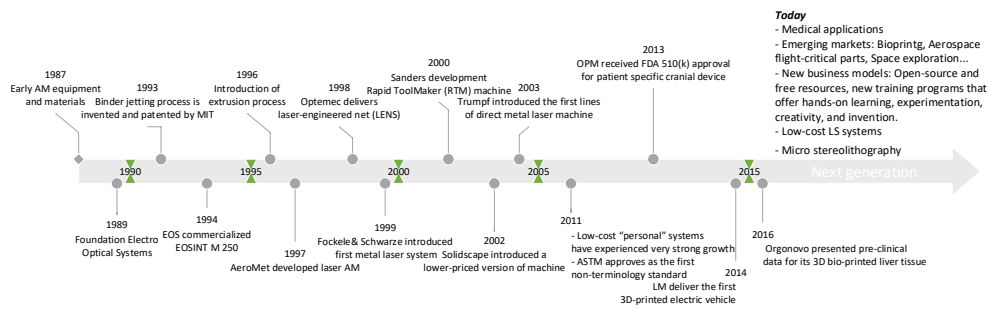


Figure 2. The evolution of 3D printing technology
Source: Own elaboration.

2.2.2. Theoretical framework

Given the strategic importance of 3D printing, its adoption has not been as expected (Yeh and Chen, 2018), but it seems to be greatest when SMEs are involved. Most recent studies have shown that critical factors that influence the adoption of advanced manufacturing technology in SMEs can be categorized under three main dimensions: organizational, technological and environmental context (Darbanhosseiniamirkhiz and Wan Ismail, 2012). This last argument synthesizes the integrated theoretical framework of Technology – Organization – Environment (TOE) proposed by Tornatzky et al. (1990).

The TOE framework emphasizes three aspects: 1) characteristics of the *technological context* referring to features of the technological innovations currently implemented by firms; 2) characteristics of the *organizational context* referring to managerial structures and resources available; and 3) characteristics of the *environmental context* referring to the external pressures in which a firm conducts its business. On this basis, some empirical studies have successfully used the TOE framework to explain the adoption of different technologies; for example, the adoption of advanced manufacturing¹⁰ (Raymond and Uwizeyemungu, 2007; Yeh and Chen, 2018), adoption of IS innovation (Xu et al. 2005), enterprise resource planning (Zhu et al., 2010), Internet adoption and use (Xu et al. 2004), and open systems (Chau and Tam, 1997). The latest study by Yeh & Chen, (2018) which uses a TOE framework to identify factors for the adoption of 3D

¹⁰ Advanced Manufacturing Technologies (AMT) can be described as a group of computer-based technologies (Saber et al., 2010), including, among others, additive manufacturing (AM). AM, also known as 3D printing, is an AMT (Arvanitis and Hollenstein, 2001).

printing, from the production, marketing and R&D division perspectives, suggested that four factors should be considered: technological, organizational, environmental and costs. Consequently, under this TOE framework, this research empirically examines the factors that affect the adoption of 3D printing in SMEs.

2.2.2.1. Technological context

In the age of global competition, SMEs are continually challenged to increase their competitive advantage and boost their potential for survival through innovation. To this end, they implement Advanced Manufacturing Technologies such as 3D printing in order to improve their efficiency and achieve competitive success (Rahardjo and Yahya, 2010). However, SMEs have been slow to adopt new technology, although the problem is not so much the technology itself (Hayes et al., 1991) as the challenge of applying it. Along these lines, according to the authors, two factors are considered highly important within the technological context: both *relative advantage* and *technology integration* seem to influence the use of 3D printing in SMEs.

Mellor et al. (2014) recognized that the relative advantage, i.e. the capacity that adopters have to recognize the benefits of such a technology over their current practices, is a crucial factor for moving towards a competitive business when this is linked to the business strategy. Moreover, previous authors noted that such potential benefits derived from the use of 3D printing also seem to be a factor that can affect its adoption by SMEs (Chan et al., 2012; Mellor et al., 2014; Thomas, 2016; Yeh & Chen, 2018). However, the relative advantage might also be intrinsically attributed to technology integration and future applications, which is an argument that requires further investigation (Gibson et al., 2010). Thus, this indirect relationship may be a contributory factor to SMEs adopting 3D printing to enhance their traditional businesses.

According to the authors, the relative benefits derived from the application of 3D printing could be attributed to efficiency in terms of cost reduction over traditional manufacturing/prototyping. Research by Atzeni and Salmi (2012) suggests that 3DP avoids the delays caused by other methods, which can reduce the time and costs of manufacturing products, and even perform tasks that are not even possible using traditional methods. 3DP also makes

production — design, analysis, testing, and manufacturing — more efficient, offering companies considerable benefits in terms of the end-product and avoiding the need to invest in other tools. Similarly, 3DP allows a high level of customization, which not only increases customer satisfaction but also on-time delivery with the potential to save costs in production (Mellor et al., 2014). It also has the potential to transform the supply chain to produce different products (H. Steenhuis and Pretorius, 2017). The latter must be considered beyond the lower inventories, but also in terms of the manufacture of functional products that can reduce waste and unplanned downtime.

SMEs need to make a greater effort to integrate 3D printing in their existing systems (Oettmeier and Hofmann, 2016), as it usually leads to improved profits. This last argument refers to technological integration, i.e. the degree of interrelation between back-end information systems and their databases (Zhu et al. 2006). In fact, empirical studies have argued that SMEs are more likely to adopt new technology given that they are more flexible and have less complex structures (Belassi and Fadlalla, 1998; Saberi *et al.*, 2010), and thus have a greater capacity to absorb new knowledge (Voss, 1988). In a recent study of the critical factors that influence the adoption of 3D printing, Yeh & Chen (2018) conclude that companies that have integrated 3D printing in their information systems will be more prone to reap the benefits on a large scale, particularly if it is integrated with the supply chain (Martinsuo et al., 2018).

This discussion leads to the following hypotheses:

H1: The relative advantages of technology positively affect the adoption of 3D printing.

H2: Technological integration positively affects the adoption of 3D printing.

H3: Relative advantage has a positive effect on technology integration

2.2.2.2. Organizational Context

Organizational structures with formal and informal processes are a core factor for implementing 3D printing (Mellor et al., 2014). The previous empirical research shows that both organizational readiness and managerial obstacles play a role in facilitating or constraining conditions to utilize new

technology. The former is related with sufficient human resources or infrastructure and the latter is related to challenges concerning organizational adaptations. To this end, SMEs face the challenge of installing new technology and receiving benefits from it (Sabeti et al., 2010) while avoiding the problems associated with the management of that technology. Organizational factors, therefore, seem to influence the intention to adopt new technology.

During the technology adoption process, SMEs must assess their organizational readiness i.e. whether or not they have enough technological resources (Chan et al., 2012). Moreover, previous studies on technology implementation recognized that companies without the necessary organizational readiness find it hard to integrate technology (Yeh and Chen, 2018; Zhu et al., 2006). In this line, SMEs that have no or limited expertise and technical skills (Deradjat and Minshall, 2017; Martinsuo et al., 2018; Mellor et al., 2014; Thomas et al., 2008) are not aware of the benefits of advanced technology (as cited in S Sabeti et al., 2010 p. 1229) and may need to collaborate with their external peers (Deradjat and Minshall, 2017). As a result, only a minority of them can adopt 3D printing, although the implementation process should not pose a barrier (Martinsuo et al., 2018). Indeed, according to the authors, it seems that the acquisition of new knowledge through learning by doing increases the motivational effects in employees, and may lead to new capabilities related to 3D printing technology (Fulton and Hon, 2010; Mellor et al., 2014).

Moreover, in order to pursue the adoption of 3D printing, companies should first change their work practices by re-designing their organizational structures (Mellor et al., 2014), even though this involves a great deal of effort, challenges and managerial obstacles. According to a recent study, managerial obstacles are the most important factor affecting the adoption of 3D printing, even more so than organizational readiness from the production standpoint (Yeh and Chen 2018). Hence, SMEs with fewer structures have greater potential to improve attitudes, supervise more effectively, and generate greater individual responsibility among employees, which supports the adoption of new technology (Belassi and Fadlalla, 1998; Sabeti et al., 2010). Other managerial obstacles that SMEs have to face include the cost of investment in 3D printing technology (Hopkinson et al., 2003; Ruffo and

Hague, 2007), the changes to organizational structures and work practices that it entails (Mellor et al., 2014; Saberi et al., 2010), and the need for leadership to support its successful implementation (Rahardjo and Yahya, 2010), and these factors seem to be a barrier to the successful adoption of 3D printing by SMEs.

This discussion leads to the following hypotheses:

H4: Organizational readiness positively affects the adoption of 3D printing.

H5: Managerial obstacles negatively affect the adoption of 3D printing.

H6: Organizational readiness has a positive effect on technology integration

H7: Managerial obstacles have a negative effect on organizational readiness

2.2.2.3. Environmental context

The environmental context exerts an internal influence on the company that can encourage the use of new technologies and seems to affect their adoption. This dimension is analyzed in terms of customer requirements, external collaboration, and competitive pressure. Nowadays, customers have greater expectations in terms of high quality products, lower costs, reliable production, and more flexible services (Rahardjo and Yahya, 2010). There is also a greater requirement for customization, i.e. creation and delivery of products according to customer requirements, which seems to positively influence customers satisfaction (Deradjat and Minshall, 2017). This means that companies — including SMEs — need to improve their current manufacturing technology, and one such choice has been to adopt 3D printing (Rahardjo and Yahya, 2010) because its allows them to improve their manufacturing process (Khorram Niaki and Nonino, 2017b; Mellor et al., 2014). Thus, it seems that customer requirements influence the adoption of technology.

From the external collaboration standpoint, Tobiassen and Pettersen (2018) suggested that, in order to improve the innovation process and reduce the risk when new technology is adopted, SMEs should consider collaborating with external partners, such as business partners, customers, suppliers and academic research institutions, because these seem to have the potential to create new ways to do so (Martinsuo et al., 2018). On this basis, SMEs with

few resources might expand their technological opportunities and may benefit greatly if they collaborate with their peers during the early stages (Deradjat and Minshall, 2017), since recommendations from other parties involved in the same business has been found to play a significant role in the way companies adopt 3D printing technology (Martinsuo et al., 2018). Although SMEs can benefit from increased collaboration with their external partners, most of them tend to be somewhat reluctant to do so, because such partnerships can be challenging for SMEs with limited resources (as cited in Tobiassen & Pettersen, 2018, p. 67).

Competitive pressure refers to the positive influence of competition, and has been identified as a motivating factor behind the adoption of new technologies (Thong and Yap, 1995) in order to penetrate the market earlier or maintain a competitive advantage (Fulton and Hon, 2010; Rahardjo and Yahya, 2010; Yeh and Chen, 2018). Therefore, in order to retain competitiveness, companies have adopted 3D printing technology to improve their operational efficiency and performance (Rahardjo and Yahya, 2010). They can also boost competitiveness by providing better quality, fast delivery, and flexible and reliable products. Therefore, external factors can be expected to influence the adoption of 3D printing by SMEs, as stated in the following hypotheses:

H8: Customer requirements positively affect the adoption of 3D printing.

H9: External collaboration positively affects the adoption of 3D printing.

H10: Competitive pressure positively affects the adoption of 3D printing.

To summarize, Figure 3 shows the studied relationships.

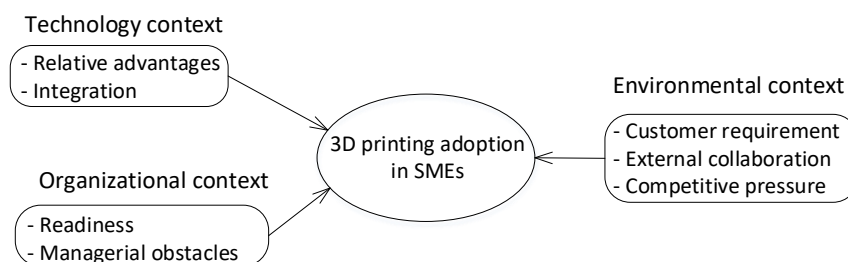


Figure 3. Research model 3D printing adoption

2.3. Research methodology

2.3.1. Sample selection

This research focuses on different types of SMEs that use 3D printing to enhance their traditional businesses. These SMEs are using 3D printing in a variety of industries and categories (see Table 3). 300 of the top manufacturing firms were randomly selected in Arizona, United States. The first contact was made in different ways, such as company directories, word-of-mouth methods to collect business cards, and via LinkedIn. Firstly, a summarized list of factors was drawn from the review of the literature that was later used to construct the questionnaire. Secondly, the Chief Executive Officers (CEOs) of four SMEs were interviewed in order to test and validate the factors that were included in the final questionnaire, and no further changes had to be made. Firms have been defined as Medium and Small depending on the number of employees, following this, medium as <250 employees and small as <50 employees. Finally, a version was prepared using Survey Monkey and was sent via email in three rounds from April to August 2018 to stakeholders in these different industries and different positions, because owners or senior management might not necessary be the stakeholders who are the most familiar with 3D printing technology. We received 81 valid answers. The response rate was 27%. The questionnaire was answered anonymously and confidentially in observance of the research protocol approved by Arizona State University's Institutional Review Board. Table 3 summarizes the detailed demographic characteristics of the responses, and includes further clarifications related to the descriptive statistics of the sample. As a result, there is no concern about the representativeness of this sample.

Table 3. Sample characteristics (N=81)

Characteristic	Percentage
<i>Number of employees</i>	
10 - 49	56.58
50 - 250	43.42
Total	100
<i>Number of years using 3D Printing</i>	
2 years or less	37
3 to 5 years	63
Total	100
<i>Respondent position</i>	

Owner	13.6
Management	18.5
Engineering	51.9
Operator	8.6
Designer	7.4
Total	100
<i>Gender</i>	
Male	74.1
Female	25.9
Total	100
<i>3D printing use</i>	
Prototyping	24.7
Finished goods	11.1
Mix of prototyping finished goods	56.8
Research and development	6.2
Jigs and fixtures	1.2
Total	100

2.3.2. Data analysis

Structural Equation Modeling (SEM) is a statistical technique for analysis of data and relationships between independent and dependent constructs. One of the two types of SEM is PLS-SEM, also called PLS path modeling, which focuses on explaining the variance in the dependent variables in the model. Research supports that method variance is a potential threat to research. This study was carried out to identify the key factors that influence the adoption of 3D printing by SMEs from the literature and from the stakeholders' perceptions. By examining relationships between each factor, and then validating the model and testing the hypotheses, the research used the Partial Least Square technique (PLS), because its object is relatively new, and the theory is not consolidated (Chin, 1998, p333). Likewise, the study takes an exploratory approach (Hair et al., 2011 p.144), and the sample size is minimal (Hair et al., 2011; Chin 1998). In turn, the PLS-SEM path model consists of two elements. First, there is a structural model (inner model) that displays the relationships between the latent variables, and second, the measurement model (outer model) displays the relationships between the latent variables and the indicators (Hair Jr et al., 2016). Thus, SmartPLS software was used to run all the PLS-SEM analyses in this study. SmartPLS, which is commonly

encountered in social science research, combines aspects of factor analysis and regression, enabling the examination of relationships between measured variables and latent variables.

2.3.3. Measurement of the variables

Measures in this research were adopted from the existing literature. Items were modified to fit the 3D printing context. Items for the technological context, which are relative advantage and integration variables, were adapted from Yeh and Chen (2018) and Schniederjans (2017). Five items pertaining to the organizational dimension support readiness and managerial obstacles, which were adapted from Chan et al. (2012) and Yeh and Chen (2018). Items for customer requirements, external collaboration, and competitive pressure were adapted from Mellor et al. (2014) and Darbanhosseiniamirkhiz and Wan Ismail (2012). For all items, we used a five-point Likert scale ranging from “Strongly Disagree” to “Strongly Agree”. Table 4 summarizes the measurement items of the independent variables.

Table 4. Measurement items of the independent variables.

Variables	Measurement items
Relative Advantage	TRA1. 3D printing allows quick design changes with software TRA2. 3D printing increases our organization's efficiency TRA3. Using 3D printing improves on-time delivery TRA4. Using 3D printing reduces unplanned downtime
Integration	TI1. 3D Printing is integrated with our information systems TI2. 3D Printing is integrated with all our company's databases TI3. The use of 3D printing fits into our company supply chain
Readiness	OR1. We have the necessary knowledge and skills to use 3D printing OR2. A specific person (or group) is available for assistance with 3D Printing difficulties
Managerial Obstacles	Do you agree that the following obstacles were encountered when 3D Printing was adopted? MO1. Cost MO2. Change MO3. Leadership
Customer requirements	ECR. The company works with customer requirements
External collaboration	EEC. The company has other collaborations or support (e.g. other business networks, academic institutions, local-level authorities)
Competitive pressure	ECP. The company is influenced by competitive pressure

The dependent variable and its measurement were also adopted from previous literature. Adoption refers to decisions based on intuition and vision that occur over time (Kirton, 1976). So, the gradual processes of adopting 3D printing that occur in companies specify the type of adopters that first evaluate the compatibility of technology through use and considering its practicality (Schniederjans, 2017). To this end, four items were considered to be related to motives for the adoption and use of 3D printing: “Improved product development is possible in our company via 3D printing” (ADOPT1); “higher flexibility is possible in our company and via 3D printing” (ADOPT2); “better product quality is achieved in our company and via 3D printing” (ADOPT3); “best practices are achieved in our company and via 3D printing” (ADOPT4). The construct was also measured on a 5-point Likert scale ranging from “Strongly Disagree” to “Strongly Agree”.

Control variables

This research was conducted in six different industries. Table 5 provides the descriptive statistics, because different industries may achieve different innovation results (Lanjouw and Schankerman, 2004). Thus, the industry was a control variable coded as a dummy variable.

Table 5. Descriptive statistics

Dummy variable	Codification	Frequency	%
<i>Industry</i>			
Biomedical	0	10	12.3
Medical devices	1	36	44.4
Metal products	2	17	21.0
Machinery	3	5	7.4
Rubber	4	8	8.6
Furniture	5	5	6.2

2.4. Results

2.4.1. Reliability and convergent validity

The reliability and validity of the measurement model were evaluated before testing the proposed model. Table 6 presents the composite reliability (CR) score of the endogenous constructs, which was above the minimum recommended value of 0.7, which is considered adequate (Nunnally, 1978). The average variance extracted (AVE) was greater than 0.5 (Hair et al., 2016), which suggests discriminant validity. However, the same

measurement scales were not applied to measure formative indicators - environmental context- , because these indicators mostly represent independent causes and thus do not correlate highly (Hair Jr et al., 2016). According to the authors, independent causes or single items have the advantage of being able to adjust to meet the research objective; they also allow questions to stand out for respondents and reduce cognitive constraints that increase the likelihood, for example, of missing answers or identical responses to all items (as cited in Cheah et al., 2018). To this end, the same (high) importance for assessing convergent and discriminant validity among the exogenous construct has been evaluated according to the variance inflation factor (VIF), which was lower than the conservative threshold of 5, thus suggesting that there are no correlations between indicators that evidence any potential collinearity problem (Hair et al., 2011). In summary, the measurement model is considered reliable as shown in Table 6. Consequently, the postulated hypotheses can be tested.

Table 6. Reliability and convergent validity

Construct	Indicator	λ^a	<i>t</i> -Value	VIF	Cronbach's Alpha	Composite Reliability	AVE
Relative advantage	TRA1	0.722	6.823* *		0.725	0.827	0.545
	TRA2	0.791	9.757* *				
	TRA3	0.708	7.147* *				
	TRA4	0.693	8.821* *				
Technology integration	TI1	0.698	6.807* *		0.728	0.847	0.651
	TI2	0.872	18.508 **				
	TI3	0.852	17.988 **				
Organizational readiness	OR1	0.886	6.375* *		0.531	0.750	0.602
	OR2	0.692	2.873* *				
Managerial obstacles ^b	MO1	0.784	0.692	2.02 5	na	na	na
	MO2	0.155	0.096	2.12 3			

	MO3	0.869	1.947	1.21			
				7			
Customer requirements ^b	ECR	0.552	1.021	1.10	na	na	na
				5			
External collaboration ^b	EEC	0.843	1.525	1.10			
				6			
Competitive pressure ^b	ECP	-0.698	1.102	1.20			
				8			
3D printing	ADOPT	0.934	50.194		0.819	0.882	0.655
	1		**				
Adoption	ADOPT	0.786	12.067				
	2		**				
	ADOPT	0.748	9.100*				
	3		*				
	ADOPT	0.708	14.184				
	4		**				

Notes: ^a $p < 0.01$; ^bformative construct; na: CA, CR and AVE are not applicable to formative constructs.

2.4.2. Discriminant validity

Table 7 shows the results for the assessment of discriminant validity. In the partial least squares context, the criterion for discriminant validity is that the square root of the AVE of each construct should be higher than the construct's highest correlation with any other construct in the model (as cited in Hair Jr et al., 2016). Discriminant validity was therefore examined by testing the correlation between constructs. Next, as shown in Table 7, the Heterotrait-Monotrait Ratio (HTMT) values for all constructs are smaller than the more conservative threshold value of 0.85 (Hair Jr et al., 2016). Finally, one can check the cross-loading discriminant validity for each indicator, which is above 0.70 as required (Hair Jr et al., 2016). These tests suggest that discriminant validity is satisfactory for the measurement model.

Table 7. Discriminant validity

	1	2	3	4	5	6
Fornell-Larcker criterion						
1. 3DPA	0.790					
2. OR	0.425	0.776				
3. TI	0.563	0.194	0.807			
4. TRA	0.471	0.116	0.376	0.739		
5. Industry	-0.257	-0.112	-	-	0.447	
6. Time	0.174	0.063	0.165	0.286	-0.074	0.552
HTMT ratio of correlations						
1. 3DPA	-					

2. OR	0.786					
3. TI	0.784	0.486				
4. TRA	0.580	0.590	0.520			
5. Industry	0.332	0.558	-			
6. Time	0.261	0.386	0.275	-		
Cross Loadings						
ADOPT1	0.934	0.322	0.586	0.255	-0.244	0.180
ADOPT2	0.795	0.246	0.485	0.295	-0.146	0.123
ADOPT3	0.750	0.255	0.458	0.298	-0.221	0.106
ADOPT4	0.703	0.449	0.350	0.234	-0.201	0.136
OR1	0.373	0.872	0.219	0.373	-0.179	0.122
OR2	0.279	0.700	0.053	-0.074	0.049	-0.060
TI1	0.418	0.092	0.698	0.324	-0.286	-0.051
TI2	0.503	0.175	0.872	0.218	-0.297	0.190
TI3	0.543	0.198	0.849	0.404	-0.384	0.209
TRA1	0.259	0.276	0.282	0.722	0.050	0.234
TRA2	0.279	0.054	0.246	0.791	-0.224	0.192
TRA3	0.120	0.136	0.249	0.708	-0.177	0.206
TRA4	0.231	0.162	0.271	0.601	-0.095	0.143
Industry_0	-0.032	0.022	0.134	-0.223	-0.159	-0.150
Industry_1	0.101	0.037	0.140	0.116	-0.459	0.175
Industry_2	-0.072	0.209	-0.193	-0.028	0.492	-0.048
Industry_3	-0.076	-0.019	-0.123	0.042	0.291	-0.065
Industry_4	0.176	-0.075	0.202	0.177	-0.480	0.006
Industry_5	-0.185	-0.348	-0.274	-0.147	0.638	-0.018

2.4.3 Assessment and results of the structural model

Through the TOE framework, this study was performed to examine ten research hypotheses to explain the adoption of 3D printing by SMEs. Table 8 summarizes the results of our analyses. Moreover, as shown in Table 9, the square root of the AVE of each construct is larger than all the cross-correlations between the construct and inter-construct (Fornell Claes, 1981). Therefore based on support from (Garson, 2016; Hair Jr et al., 2016) the model in this study presents no multi-collinearity issues.

Table 8. Results of bootstrapping with 5000 sub-samplings

	Coefficient/p Value	T Statistics	Conclusion
Direct effects			
TRA->3DPA	0.253(0.005)	1.844*	H1 not supported
TI->3DPA	0.500(0.000)	6.706*	H2 supported
OR->3DPA	0.268(0.011)	2.534*	H4 supported
MO->3DPA	-0.245(0.021)	2.398	H5 supported
ECR->3DPA	0.034(0.640)	0.467	H8 not supported
EEC->3DPA	0.172(0.050)	1.967	H9 supported
ECP->3DPA	-0.188(0.060)	1.882	H10 not supported

Indirect effects			
TRA->TI	0.358(0.000)	4.877	H3 supported
OR->TI	0.254(0.010)	1.917	H6 supported
MO->OR	-0.326(0.021)	2.308	H7 supported
Control variables direct and indirect effects			
Industry->3DPA	-0.098(0.554)	0.591	

**p < 0.050*

Integration is found to be significant, while relative advantage is not significant at the adoption stage. Therefore, H2 is supported and H1 is not supported. In fact, these results are in line with previous research investigating the adoption of technology, which was supported by similar findings (Chan et al., 2012; Mellor et al., 2014). Although the study by Yeh & Chen (2018) recognized that relative advantage is one of the most important factors of the adoption of 3D printing by large companies, it was not significant at the adoption stage in SMEs. However, this does not imply that SMEs do not recognize the relative advantage of 3D printing to increase their potential benefits before adopting it. In fact, the relationship between relative advantage and technology integration was found to be significant. Therefore, H3 is supported. These last results will be discussed later. On the other hand, however, technology integration was found to have a significantly positive effect at the adoption stage in SMEs. This finding is consistent with the studies by Martinsuo et al. (2018) and Yeh & Chen (2018), which found that the adoption of 3D printing requires a higher level of integration with existing practices and process flows such as the supply chain. In that case, 3D printing should be consistent with current systems in order to make its adoption more favourable. Readiness and managerial obstacles were also supported as facilitators of the adoption of 3D printing. Therefore, H4 and H5 are supported. Based on the previous measurement of readiness, a positive and significant relationship is evidenced between lack of highly skilled personnel (Mellor et al., 2014) and the adoption of 3D printing technology. Moreover, we also found that the relationship between organizational readiness and technology integration is significant. Therefore, hypothesis H6 is supported. Like many studies, we found that managerial obstacles remain negative, which is supported by hypothesis H5 because they inhibit the adoption of 3D printing, also indicating the extra challenge faced by smaller companies. Moreover, managerial obstacles are found to have a significant relationship with organizational readiness. Thus, H7 is supported. External collaboration is also perceived as significant. That is, SMEs that

lack resources generally choose the most appropriate solution to satisfy their requirements through reactive mechanisms such as sales representatives rather than expert advice; the former is related to representatives with extensive specification details and based on their own interests. The latter is related to impartial expert advice, but may increase the considerable capital expenditure, something smaller companies do not want to do (Fulton and Hon, 2010). Thus, as reported by Deradjat & Minshall (2017)'s study, SMEs need to rely on collaboration with external parties such as academic research institutions or industrial partners to adopt 3D printing, a conclusion that agrees with the results of hypothesis 9. Thus, H9 is supported. On the other hand, it was evidenced that customer requirements and competitive pressure do not have a significant effect on the adoption of 3D printing and thus H8 and H10 are not supported.

Table 9. Descriptive statistics and discriminant validity.

Constructs	Mean	SD	Correlation matrix								
			3DPA	ECC	ECP	ECR	MO	OR	TI	TRA	
3DPA	4.438	0.605	0.809								
ECC	3.642	0.795	0.099	na							
ECP	3.864	0.720	0.133	0.308	na						
ECR	4.493	0.760	0.051	0.309	0.106	na					
MO	2.967	1.044	-0.230	-0.158	-0.101	0.059	na				
OR	4.018	0.696	0.425	-0.093	0.136	-0.080	-0.335	0.776			
TI	3.938	0.854	0.609	0.014	0.018	0.053	0.153	0.262	0.807		
TRA	3.685	0.790	0.473	-0.029	0.004	-0.087	0.043	0.232	0.391	0.738	

Note: Value on the diagonal is the square root of AVE.

Finally, Figure 4 illustrates the endogenous variable ‘the adoption of 3D printing’, where t-statistics and path coefficients with significance levels are presented, as well as $R^2=0.523$ such that the variables described above explained 56% of the variance of 3DP adoption, which can be considered moderate (Hair Jr et al., 2016). The path associated with all TOE determinants — relative advantage, integration, readiness, customer requirements, external collaboration, competitive pressure — have positive significant paths. The path associated with managerial obstacles is significant and negative, as we expected. According to the results, seven hypotheses are supported: H2, H3, H4, H5, H6, H7, and H9; in contrast H1, H8, and H10 were not supported. The discussion of these results, as well as the academic and managerial implications, are presented in the following section.

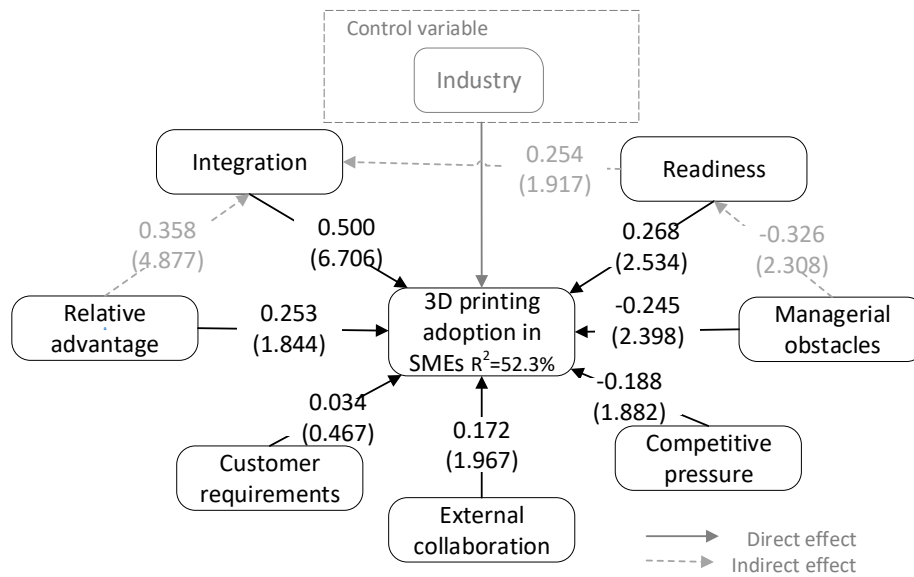


Figure 4. Results of the empirical model

Note: *t*-statistics values (in parentheses) are significant at $p < 0.05$

2.5. Discussion

Based on SMEs, this study examines the effects of factors derived from the TOE framework for the adoption of 3D printing. Although research into the adoption process in SMEs, that is, the stage in where SMEs have committed resources to the use of 3D printing in their manufacturing is still inconclusive and, in its infancy, this research provides a useful reference.

Technology integration is the most important factor and has a stronger influence on adoption by SMEs. Past studies have found that large companies might find it harder to integrate between their processes, while SMEs might have less integration issues, as they have less complex organizational structures and are thus able to build a single integrated system. Technology integration is often viewed as a key factor as it offers more benefits than individual processes, as supported by studies such as Saberi et al. (2010). Therefore, when companies adopt 3D printing to enhance their manufacturability over more traditional methods, it might be integrated with their other systems. Only then will SMEs have a real possibility to move towards becoming a competitive firm. This is supported by Mellor et al. (2014).

Relative advantage, however, was not found to be significant in this study, although it was in the study by Yeh and Chen (2018) for large companies.

This result does not mean that SMEs view relative advantage as unimportant. In fact, unlike in the adoption stage, relative advantage was found to be a significant factor during the intention to adopt 3D printing (Schniederjans, 2017) since smaller companies might experiment with 3D printing technology at that stage in order to judge the benefits and prevent unfamiliarity from generating barriers at the adoption stage. This is also supported by Martinsuo et al. (2018), who suggests that SMEs that have adopted 3D printing as shown in Table 3 are concerned about the integration with their other systems and need to be sure that it will be better than their current practices. Therefore, regardless of whether decision makers adopt 3D printing or have the intention to do so, relative advantage is an important factor for generating attitudes towards the use or not of this technology.

The results also show that both organizational readiness and managerial obstacles are significant factors in the adoption stage. Readiness is the second most important factor when SMEs adopt 3D printing. There have been diverse findings about the effects of this criterion in previous studies. Martinsuo et al. (2018) found that the lack of knowledge of 3D printing is the challenge that interviewees mention most and is hence a barrier to adopting it. In other words, although SMEs may have conducted some technical evaluations, they will first need to ensure that they have the necessary technical or financial resources to truly take advantage of it. However, our result also shows that SMEs that had been using 3D printing for less than 2 years (37%) and were perhaps not ready to adopt it, did do so regardless. Thus, SMEs with less complex organizational structures also learn by doing, and this is especially true for younger companies (63%), through active experimentation or external collaboration. This is supported by studies such as Martinsuo et al. (2018) on AM adoption.

Our results also show that Managerial obstacles are still an important factor in the adoption stage. This suggests that SMEs are concerned about identifying threats in order to support the implementation of 3D printing. However, they are less aware of the implications and future applications in which the technology could be helpful, which is supported by Saberi et al. (2010). Nevertheless, it is important to highlight that SMEs are more sophisticated nowadays (Chan et al., 2012) when it comes to solving technological issues that could hinder their adoption of 3D printing. As stated

in Deradjat and Minshall (2017), some SMEs are forced to collaborate in order to create successful processes. Although this last argument was not empirically tested, the authors also found that this network support from external partners encourages new models for the adoption of 3D printing among smaller companies (Martinsuo et al., 2018). Therefore, external collaboration is a significant factor during the adoption stage. This suggests that SMEs are more influenced by the potential benefits of external cooperation such as other business networks or academic institutions, which is in line with earlier studies by Deradjat and Minshall (2017) and Martinsuo et al., (2018).

In the environment dimension, however, competitive pressure and customer requirements were not significant, which suggests that companies that have adopted 3D printing will be more concerned about its effectiveness in terms of their own capabilities or collaboration with other companies than they are about the competition. This result is consistent with previous adoption studies (Chan et al., 2012). This outcome suggests that if there is too much competitive pressure, companies might face unwanted distractions, which hinders their adoption process at this stage. Our result also shows that even if external collaboration can foster the adoption of 3D printing (Deradjat and Minshall, 2017; Martinsuo et al., 2018), greater effort, beyond the adoption of 3D printing, is required to achieve a competitive business.

2.6. Conclusion

The aim of this study was to explore the core factors affecting the adoption of 3D printing by SMEs, within the TOE framework. To this end, the relationships between technological, organizational, and environmental context in smaller companies were analyzed. The findings suggest that relative advantage, integration, readiness, managerial obstacles, and in turn, external collaboration factors, might foster the adoption of 3D printing in smaller companies, which also seems to be related to competitive business. However, the findings also show that the adoption of 3D printing is not strategically beneficial to small companies when they are not ready to truly take advantage of its innovations. Based on this, SMEs might adopt 3D printing when it is integrated with other technologies in their current system, something that seems to be critical in order to promote the development of new abilities in accordance with the relative advantages of using this

technology. This, in turn, might provide managerial contributions to make reasonable decisions in order to encourage users, potential users or non-users who might want to use 3D printing in their enterprise in spite of the limited resources.

The main implication for academia is that this study is only one of a handful of empirical studies that focuses on SMEs within the TOE framework. This study also clarifies the core factors that influence the adoption of 3D printing by SMEs, which fills an important gap left by previous research.

The main implications for practitioners are that the relevant factors identified relative to the advantages of the technology, its integration in their current systems, and managerial obstacles will allow them to make the right decisions and progress from adoption to use of 3D printing in less time, which in terms of competitiveness leads to financial savings. At the same time, an understanding of the core issues that affect the adoption of 3D printing by SMEs may be increasingly important for its successful implementation.

Despite its contributions, this exploratory study does have some limitations. First, in terms of cost, it was conducted with a sample of SMEs in the United States, which consider that the cost of the technology is justified ahead of the risks of making the wrong decision in the marketplace. This therefore implies that the cost factor should be taken into further consideration in the future. Second, this study is limited to certain sectors in the United States, and future research should validate its findings with a larger sample and in other countries. Finally, this study uses a limited set of variables according to the TOE framework, and future research should investigate other factors by using other perspectives.

Acknowledgements

We would like to thank Mr. Parmentier, Ms. Healey, Ms. Hazzard and Mr. Ferrell, Padtinc, Women in 3D printing Association for their assistance with data collection and all stakeholders who answered the survey used in this research. We are also grateful to three anonymous reviewers for their feedback and comments.

Chapter 3. Responsible innovation in SMEs: A systematic literature review for a conceptual model

Abstract

Responsible innovation has been an important issue in discourses addressing the major challenges faced by mankind in terms of natural resource degradation, climate change, economic progress and societal well-being. However, its integration into industry is still in its infancy, and even more so when it comes to small and medium-sized enterprises (SMEs). The aim of this research is to use a systematic literature review to develop a conceptual model for responsible innovation and its relationship with SME performance, in connection with sustainable innovation and corporate social responsibility practices. A bibliometric analysis of 102 articles collected between 2000 and April 2020 from the Web of Science database was used, in addition to the systematic literature review using the Gephi and NVivo software. The study presents an overview of the articles, authors, most influential journals and research clusters identified, and provides a solid conceptual framework to be applied in this field and in the context of SMEs.

Keywords: Responsible innovation in industry; responsible research and innovation; CSR; corporate social responsibility; sustainable innovation; SMEs

3.1. Introduction

Growing global concern about environmental degradation, social inequality and over-consumption of resources has attracted increasing attention in the academic literature (Jones and de Zubielqui, 2017; Kraus et al., 2017). In

light of the current situation, one of the means for working towards the United Nations 17 proposed Sustainable Development Goals (SDGs) for 2030 regarding the major challenges being faced in terms of natural resource degradation, climate change, economic progress and society's welfare is "innovation" (Porter, 1985) and the need for it to be "responsible" (Auer and Jarmai, 2018; Martinuzzi et al., 2018; Ribeiro et al., 2018; Von Schomberg, 2013).

Responsible innovation has been a topic of discussion because it connects the basic concerns of business with the global challenges of society, i.e., the challenge for companies in this increasingly competitive world to innovate in order to generate economic benefits, but also to generate sustainable social value, meaning that "responsibility" is now deeply rooted in the conscience of entrepreneurs, and consequently in companies' DNA (Visser, 2010). However, the integration of responsible innovation in business is still in its infancy (de Poel et al., 2017; Ribeiro et al., 2018). In other words, there is not yet a clear understanding of what should be "done" (Ribeiro et al., 2017), especially in small and medium-sized enterprises (SMEs), which are largely unaware of what the concept of responsible innovation implies (Auer and Jarmai, 2018) because, as it is an emerging topic, very little practical research has been done to understand its influence on sustainable development and organisational capacities (Pandza and Ellwood, 2013).

On the other hand, understanding the implications of responsible innovation in industry, especially regarding SMEs, which constitute 95% of all enterprises in the world (Khan et al., 2020), and their impact represents approximately 64% of pollution and waste in Europe (European Commission, 2002), is still novel, and it remains to be understood how RI can be applied by companies (Lubberink et al., 2017) and how it relates to business performance (de Poel et al., 2017). The authors therefore suggest that more attention needs to be paid to SME activities (Hammann et al., 2009; Klewitz and Hansen, 2014) because their propensity to adopt responsible innovations could have an equally positive and significant impact (Aragón-Correa et al., 2008; Bos-Brouwers, 2010; Cassells and Lewis, 2011). Although this last argument is in line with corporate social responsibility (CSR), sustainable innovation (SI), and similar terms to CSR in SMEs (Ortiz-Avram et al., 2018), it also demands companies to take a step further with a

responsible innovation approach that is a transparent and interactive process (Ribeiro, Barbara E and Smith, Robert DJ and Millar, 2017). Moreover, RI is more specific and refers to mutual responsibility and the early inclusion of different actors in the innovation process. Therefore, it seems that CSR, besides being adopted due to its sustainability-oriented framework, reinforces the potential to promote responsible innovation within firms (de Poel et al., 2017; Valdivia and Guston, 2015). Therefore, this research aims, based on literature review and bibliometric analysis, to develop a conceptual model that could allow us to explain the drivers of RI in SMEs, its effect on firm performance, and the contingent variables which moderate this relationship.

Section 2 presents the background to the study. This is followed in Section 3 by the methodological approach of a systematic review of the literature. Section 4 presents the results of the research, followed by the theoretical framework in Section 5.

3.2. Background

Innovation is change. It is a new or improved product, service or business model (OECD, 2005), i.e. a simple improvement to what we already do, but which makes it better or radically different. However, although such changes have been happening throughout the history of mankind, what they are today are changes in the process of development. That is, despite the fact that innovation is a spectrum of growing novelty, a "Darwinian dynamic phenomenon" that brings many benefits as well as risks, as the study by Ribeiro et al. (2017) highlights, it could end up failing when ethical and social issues inherent to the innovation process have not been considered. In this line, a key dimension when exploring innovation is the concept of "responsibility". Responsible innovation" (RI) or "responsible research and innovation" (RRI), which first appeared in the Sixth Framework Programme (EU Regulation No 1291/2013), is a term which, in order to deepen the relationship between science and society, seeks to ensure that innovation under a framework of democratic governance is better integrated into society to guarantee its contribution and benefits. In this regard, the most relevant definitions of "responsible research and innovation" are:

- a) "A transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)." (Von Schomberg, 2012, p. 9).
- b) Responsible research and innovation refers to the comprehensive approach of proceeding in research and innovation in ways that allow all stakeholders that are involved in the processes of research and innovation at an early stage (A) to obtain relevant knowledge on the consequences of the outcomes of their actions and on the range of options open to them and (B) to effectively evaluate both outcomes and options in terms of societal needs and moral values and (C) to use these considerations (under A and B) as functional requirements for design and development of new research, products and services (European Commission, 2003).
- c) "Responsible innovation means taking care of the future through collective stewardship of science and innovation in the present" (Stilgoe et al., 2013, p. 1570).
- d) Responsible innovation refers to a new or significantly improved product, service or business model whose implementation at the market solves or alleviates an environmental or a social problem (Halme and Korpela, 2014, p. 548).

Although the precise interdisciplinary nature of RRI is a work in progress (Chatfield et al., 2017), the above definitions show common recurrent themes such as "sustainable development¹¹" adjusted to "societal needs", and early involvement with "participation of different stakeholders" (Owen et al., 2012). For example, the definition by Von Schomberg (2012), which is one of the most widely used, shows that innovation is a process of co-responsibility for ethical acceptability, social coexistence, and the construction of a holistic sustainability. Nevertheless, very similar approaches can also be found in industry but using different terms like "sustainable innovation¹²" (Stahl et al., 2019) and in activities that lead to

¹¹ The United Nations World Commission on Environment and Development conference described sustainable development as "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs".

¹² Sustainable innovations are defined as innovations in which the renewal or improvement of products, services, technological or organizational processes not only provides better economic

RRI results, such as "corporate social responsibility¹³" policies (de Poel et al., 2017). So, with the growing awareness of companies regarding recurring activities to *innovate with and for society*, the concept of "responsible innovation" is incorporated in the previous literature along with its dimensions as essential components of this objective, i.e. "innovating with and for society". On this basis, the research by Stilgoe et al. (2013) developed a framework for responsible innovation, which is now a benchmark in the academic literature. It consists of four dimensions - anticipation, reflexiveness, inclusion, responsiveness - each of which indicates a reflection on the purpose(s) of innovation. There is also the knowledge management dimension proposed by Lubberink et al. (2017). The latter refers to the fact that SMEs lack human resources, and hence are constantly on the lookout for opportunities to expand and build knowledge as well as to be able to extend it to their employees (Aragón-Correa et al., 2008). Therefore, further research might explore these five dimensions - anticipation, reflexiveness, inclusion, responsiveness, and knowledge management - in greater depth in the SME context.

Anticipation involves systematic thinking, whereby organisations consider uncertainty, the possibility of something happening or not happening, and what is possible, risk (Stilgoe et al., 2013). Meanwhile, *reflexivity* refers to the process of self-awareness, like holding up a mirror in order to scrutinise oneself (Stilgoe et al., 2013). *Inclusion* refers to the participation of stakeholders (Lubberink et al., 2017; Owen et al., 2012; Stilgoe et al., 2013). Responsiveness involves responding to newly emerging knowledge, perspectives, users' views (Stilgoe et al., 2013) and stakeholders regarding the innovation process in order to gather information from them and thereby adapt innovation to changes and new requirements (de Poel et al., 2017). Finally, previous research refers to the knowledge management dimension, especially in SMEs that lack resources. For that reason, an owner-manager may wish to invest in developing the capacity of his employees, but is often forced to prioritize investment in more immediate and urgent needs of his

performance, but also greater environmental and social performance, both in the short and long term (Bos-Brouwers, 2010). Similar terms include eco-innovation, environmental innovation and ecological innovation, according to the study by (Franceschini et al., 2016).

¹³ The European Commission's Green Paper of July 2001 defined corporate social responsibility as a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis.

company (Lepoutre and Heene, 2006) than employee development, as concluded in Suriyankietkaew and Avery (2016). Activities that are implemented to develop knowledge, share it, transfer it and apply it through members therefore help to fill some of the knowledge gaps needed to develop innovation (Lubberink et al., 2017).

Section 5 below develops each of the proposed RI dimensions – RI is the term that will be used in this study - and their relationship with SMEs and business performance according to the existing literature.

3.3. Methodology

We performed a systematic review (Tranfield et al., 2003) of the extant literature on practices such as CSR and SI that promote responsible innovation and performance in SMEs. Systematic review has become an essential activity with regard to the literature because of the analysis and synthesis of articles that underpin it. In this study, content analysis and bibliometrics were thus applied to learn about the evolution of publications and journals, their impact on the field, and the relationship between articles and their references. Following Denyer and Tranfield (2009), the study involved four stages. *Stage 1*, the questions to be addressed in the systematic literature review were formulated. *Stage 2*, relevant articles were located and selected from the extant literature and according to evaluation criteria. *Stage 3*, data were analysed and synthesised using various methods appropriate to the research. *Stage 4*, significant results and consequences of the proposed conceptual framework were described.

3.3.1. Question formulation

Based on the extant literature on RI, a relationship is evident between CSR, SI and RI that supports the evolution of the concept and the potential impact on business performance. However, although research in this field of "responsible innovation" is at an early stage (Ribeiro et al., 2017), it seems to be particularly less developed with regard to small and medium-sized enterprises. Therefore, the systematic literature review is based on underlying practices and activities that come from empirical studies on responsible innovation, sustainable innovation, and corporate social responsibility practices, which, in addition, are related to the performance of small and medium-sized enterprises. More specifically, these are practices with a

broader perspective than the social, economic and/or environmental one, which promote arguments of anticipation, reflexiveness, inclusion, responsiveness, and knowledge management as a basis for putting responsible innovation into practice (Lubberink et al., 2017). In order to achieve the purpose of this study, the following research questions are posed, which this study seeks to answer:

- What are the key dimensions that contribute to the implementation of responsible innovation in SMEs?
- How can activities contributing to the implementation of responsible innovation affect the performance of SMEs?
- What are the contingent variables that influence the relationship between responsible innovation and performance in SMEs?

3.3.2. Locating and selection studies

The second step followed a strategy to locate articles in the existing literature (Figure 5). The ISI Web of Science (WoS) database was chosen to perform the keyword search. This database is recognized by academics and professionals as one of the most comprehensive and highest-level databases of scientific information in the world (Aboelmaged, 2010). The search was then performed to bring together articles published in the period from 2000 to April 2020 with such keywords as "*small and medium sized enterprises*" OR "*SMEs*" AND "*responsible innovation*" OR "*sustainability*" OR "*sustainable development*" OR "*corporate social responsibility*" OR "*corporate social innovation*" AND *firm performance*. The 20-year period was determined because it includes the first article related to responsible research and innovation that appeared in the early 2000s. This resulted in 293 articles (some articles from the Journal of Responsible Innovation were included because of their relevance to the topic). The titles and abstracts of all articles were analysed (see the search sequence in Figure 6). After obtaining that initial sample, the "snowball" technique was applied to the most relevant papers in the initial search to retrieve articles related to the keywords but not identified in the first search. This expansion allowed the identification of papers related to the evolutionary process of corporate responsibility that precedes the concept of RI itself by adding 25 articles. A database was then created in Microsoft Excel with the bibliometric

information from WoS noting the title, abstract, authors, keywords, journal, references and number of citations.

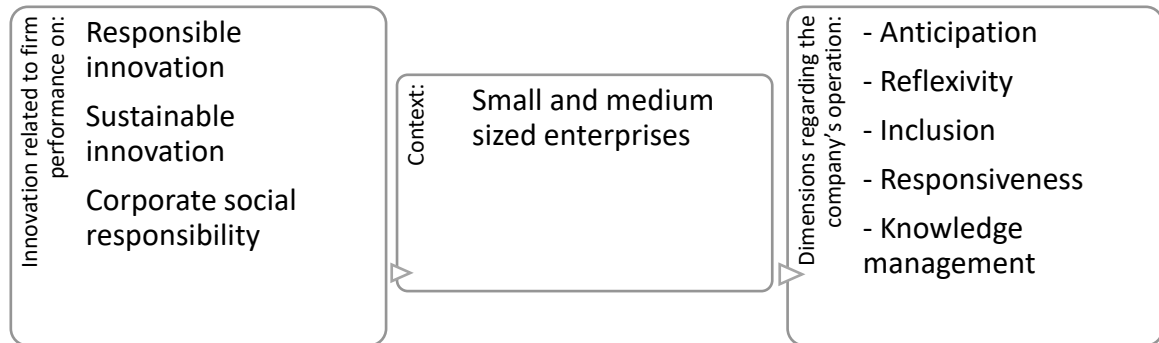


Figure 5. Adapted framework of Lubberink et al. (2017) to categorize the indicators.

As a result, 195 articles were analysed manually and more precisely. Of these, 80 articles did not meet the criteria for inclusion and were therefore excluded. Subsequently, the full texts of the remaining 115 relevant articles were downloaded for full evaluation. In the above process, 13 articles could not be accessed through the above-mentioned database and were instead requested directly from their authors. As a result, and in line with the seven evaluation criteria proposed for the selection of studies - and detailed below - the final number of **102** articles was reached.

- (1) articles based on empirical and peer-reviewed research;
- (2) that included one of the key words in the title or the abstract;
- (3) articles that consider SMEs as research centres;
- (4) available in the above-mentioned database;
- (5) published between 2000 and 2020;
- (6) articles in English; and
- (7) articles in the areas of business research or economics or social sciences or environmental sciences or technological science

The exclusion criteria were articles not related to the keywords; articles that did not contribute to an understanding of responsible innovation in SMEs and therefore did not pass the selection test (See Figure 5); and articles that could not be accessed through the database.

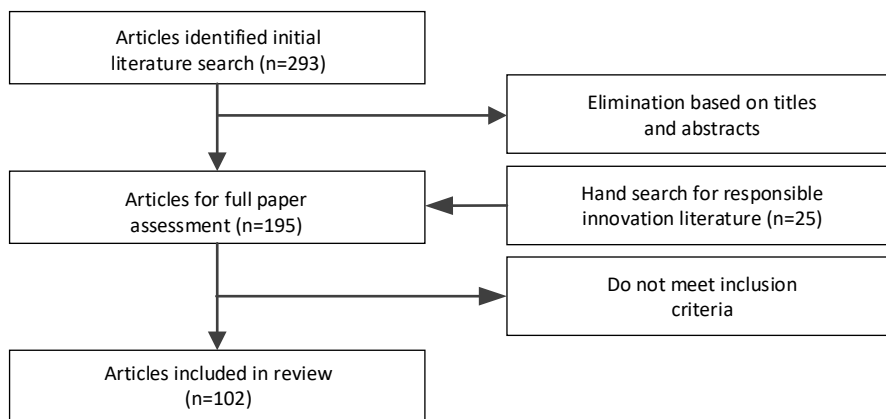


Figure 6. Flow diagram of study selection.

3.3.3. Data analysis

The database created with the **102** articles was read in its entirety and analysed using a combination of methods such as bibliometrics and content analysis, then cluster analysis, using the Gephi software¹⁴ and the BibExcel tool version 2016.

In order to explore the chronology and evolution of the identified academic literature, bibliometric analysis was applied to measure the impact of published articles, the number of citations per year, the number of publications ordered by journal and year of publication. Furthermore, bibliometrics enabled analysis of the evolution of these publications over time.

In addition, the WoS database was used to extract in .CSV format information that was first exported to the BibExcel tool version 2016 for the preparation of the information. Then, the file generated in BibExcel served as input data for the open source bibliometric tool Gephi. Clustering based on citations was chosen, so the use of the Gephi tool enabled identification of clusters with their complex shared relationships, as well as the modularity and aggregation of communities. That is, through mathematical algorithms such as the Leuven algorithm used by the Gephi software, it is possible to visualize a network node represented by a citation in our case, and each link between two nodes indicates a co-occurrence, which means that the two references appear in the same article. In this study, four clusters emerged. In addition to

¹⁴ Gephi is available for free at: <https://gephi.org/>

a full reading, each selected article was also codified following the framework proposed by Lubberink et al (2017) for which the software NVivo 1.2 2020 was used. Therefore, content analysis of each article enabled identification of the practices that contribute to the dimensions of responsible innovation in SMEs, i.e. anticipation, reflexiveness, inclusion, responsiveness, knowledge management and its relation to business performance, as well as the variables used, the models, propositions, definitions, etc. The summary of the resulting codification scheme is shown in Table 10.

Table 10. Content analysis coding scheme

Coding	
1: Dimensions	3: Contingent variables
Anticipation	Firm size
Reflexiveness	Type of industry
Inclusion	Firm age
Responsiveness	Country
Knowledge Management	Corporate strategy
	Learning orientation
2: Firm performance	Employee's commitment
Sales growth	Relational marketing
Profitability	4: Main Players
Financial indicators	Clients/Customers
Market share	Employees
Customer satisfaction	Environment
Innovation performance	Suppliers
RI performance	Community
Environmental sustainability	Owners/shareholders
Social sustainability	R&D
Diversity and inclusion	Government
Anticipation and reflection	Competitors
	Funding agencies/Investors
	Alliances

3.4. Results

3.4.1. Bibliometric analysis

Bibliometric analysis shows the evolution of published articles, where it was observed that the first publications were from the year 2000. This is justified by the fact that the term "responsible innovation" emerged in 2002 as part of the EU's Sixth Framework Programme for Research and Technological

Development. As shown in Figure 7, there were very few publications between 2000 and 2010 an average of only twenty articles was published during these ten years. In 2011, the number of publications increased slightly, but it was from 2016 onwards that the number truly started to rise. This increase may be due to RI being promoted by the European Commission through the European framework programmes for research and innovation (e.g. "Horizon 2020" and "FP7").

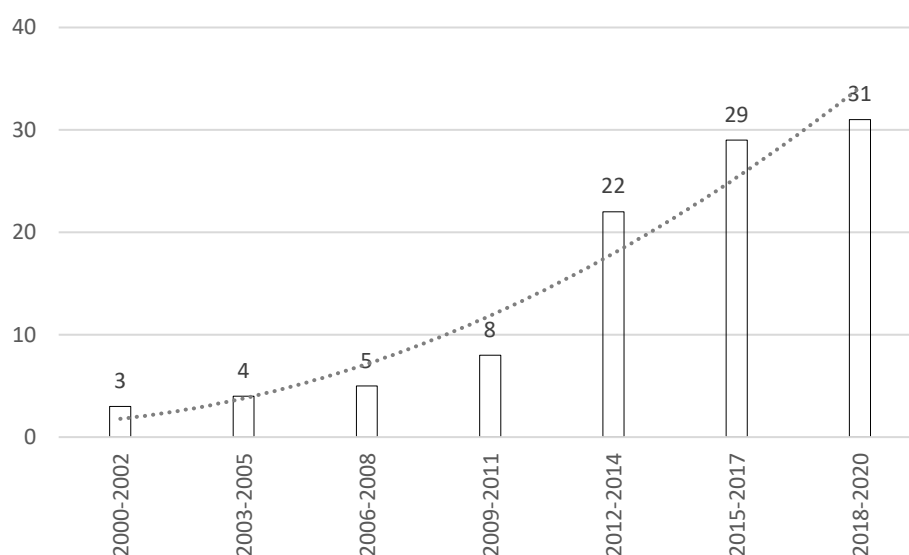


Figure 7 Number of publications per year (2000-2020)

Table 11 shows the number of publications per journal, considering the journals that published at least two articles. Most articles were published in the *Journal of Cleaner Production*, followed by *Business Ethics* and *Sustainability*.

Table 11. Publications and citations per journal

Journal	Publications	Citations
Journal of Cleaner Production	14	1608
Journal of Business Ethics	14	2095
Sustainability	14	187
Business Strategy and The Environment	9	719

Corporate Social Responsibility and Environmental Management	6	503
Journal of Responsible Innovation	4	25
Journal of Small Business Management	3	38
Strategic Management Journal	2	1764
Research Policy	2	1612
European Management Journal	2	1076
Journal of Management Studies	2	159
Science and Engineering Ethics	2	152
Industrial Management & Data Systems	2	26
Global Business Review	2	15
Technological Forecasting and Social Change	2	15
British Journal of Management	2	7

Note: Minimum of two publications. In descending order of the total number of publications.

The concentration in a few journals indicates that the topic was the subject of intense debate on specific issues such as social responsibility, corporate responsibility, environment, development, society, sustainability and performance (see Figure 8 with the Figure 8 words highlighted by size according to their frequency of use). **All journals are peer-reviewed and indexed with a high impact factor.**



Figure 8. Keywords of responsible innovation research field

3.4.2. Research trends over time

Four five-year periods were created to analyse trends over time, namely Period 1 (between 2000 and 2005), Period 2 (between 2006 and 2010), Period 3 (between 2011 and 2015), and Period 4 (between 2016 and 2020).

2000-2005: This period witnessed a broadening of the understanding of innovation practices together with corporate social responsibility adapted to the needs of SMEs. It was recognized that both the lack of commitment and the involvement of SMEs in social responsibility activities were debatable. The former has been related to how CSR has been framed from its origins in terms of large companies rather than involving SMEs or being relevant to them. The latter has been somewhat related to the fact that many SMEs participate in responsible activities without knowing it. This prompted academics to work on broadening and understanding the concept of social responsibility from the point of view of SMEs (Bansal and Roth, 2000; Besser and Miller, 2001; Jenkins, 2004; Castka et al., 2004; Salzmann et al., 2005). For example, Jenkins (2004) examined the relevance of the social responsibility programme for SMEs. Based on his analysis, the author highlighted the need to develop new terminology and interpretations of CSR that are more relevant to the characteristics of SMEs in order for it to be integrated into everyday life.

2006-2010: This period saw an increase in the academic literature on practices promoting responsible behaviour in SMEs, ranging from reactive compliance practices to proactive responsibility practices. These studies revealed that the unique characteristics of SMEs are correlated with the organizational capabilities that drive the adoption of responsible practices, e.g. closer interactions between SMEs' stakeholders, flexibility, and the founder's vision (Aragón-Correa et al., 2008). The latter is also conditional on individual discretion (Hamman et al., 2009), altruism and philanthropy (Jamali et al., 2009). Thus, the social responsibility aspect of SMEs remained largely informal (Preuss and Porschke, 2010) or unintended (Perrini et al., 2007). At this stage, academics also showed great interest in sustainable innovation practices linked to environmental strategies, such as life cycle analysis to measure environmental impact (Dangelico and Pujari, 2010; Bos-Brouwers, 2010) and the performance of SMEs (Rhee et al., 2010).

2011-2015: This period saw the emergence of a theoretical framework for responsible research and innovation (Von Schomberg, 2012; Stilgoe et al., 2013), as well as an increase, with 8 articles, in academic interest in demonstrating the impact of practices that promote responsible behaviour in SME performance. The examined studies were on the adoption of pro-

environmental practices (Cassells and Lewis, 2011; Brammer et al., 2012; Hofmann et al., 2012) and their impact on performance (Tang and Tang, 2012; Agan et al., 2013), and the relationship between CSR and performance in SMEs (Torugsa et al., 2012; Tantaló et al., 2012; Tang et al., 2012; Torugsa et al., 2013), among others. Particularly prominent among the research during this period were studies to understand the relationship between innovations and sustainability in SMEs (Boons and Lüdeke-Freund, 2013; Gaziulusoy et al., 2013)

2016-2020: This period had the highest number of publications (70 articles) and a growing academic interest in practices related to and promoting responsible innovation in SMEs. During this period, some authors recognized that although SMEs are largely unaware of the concept of responsible innovation, they may be able to identify which current practices share aspects of RI as a starting point (Auer and Jarmai, 2018). For example, the study by de Poel et al. (2017) found that there is a need for a comprehensive vision of responsible innovation, i.e. that in addition to being connected to CSR activities, its contribution in social, environmental and economic terms can be identified. Regarding the contribution of social, environmental and economic factors, many authors examined their effect on the performance of SMEs (25 articles). In addition to these studies, this period witnessed the increasing development of models and debates to apply responsible innovation to the business context (6 articles). These models enabled analysis of the dimensions of responsible innovation in the business context (Lubberink et al., 2017), as well as the involvement of stakeholders. For example, Silva et al. (2019) used a meta-synthesis to highlight how, in the business context, stakeholders should be included early in the innovation process in order to ensure responsible outcomes. During this period, there was an increase in case studies on CSR and SI to demonstrate that their application is related to SME performance. For example, Martínez-Conesa et al. (2017) presented a detailed case to examine the relationship between CSR and innovation-mediated business performance of 552 Spanish SMEs, and their results may help to understand how CSR strategy is a mechanism that drives the innovation process towards responsible results. Meanwhile, the study by Burlea-Schiopoiu and Mihai (2019) investigated the relationship between three sustainability factors (CSR, innovation and training) and their effects on the financial performance of SMEs, arguing that CSR, training and

innovation are significant and correlated factors in the promotion of competitive advantage in SMEs. Although this period saw an increase in RI research and the practices that promote it, in the context of industry it is still in its infancy, and especially when it comes to SMEs.

3.4.3. Associated communities

Figure 9 represents a network of the articles mentioned. The idea behind this analysis was to explore the clusters that share key references and to understand their relationships. We performed this reference network analysis with the help of the open source software Gephi. Each colour of the network represents a cluster and each link between two nodes indicates that the reference appears in the same article. The thickness of the link is proportional to the number of times the two references appear in the same article. The results of the Gephi display showed four clusters: the first (C1) is purple and represents 40% of all articles, the second (C2) is green with 30%, the third (C3) is orange with 20% and the fourth (C4) is light blue with 10%. Based on the result found with the Gephi software, the obtained clusters are described by referring to relevant studies that promote responsible innovation in SMEs such as: C1 responsible innovation drivers in SMEs, C2 genuine silent responsibility practices, C3 innovation framework based on a responsibility approach, and C4 social responsibility practices and performance in SMEs.

Cluster 1: Responsible innovation drivers in SMEs

Of the 102 articles, C1 are the most cited with 40%. The group with the highest number of key references includes studies on environmental responsibility activities, their impact on performance, and the motivations that promote SMEs to adopt environmentally and socially responsible environmental response practices, ranging from reactive compliance to proactive prevention of environmental pollution, associated with organizational capabilities and that in the long term are conducive to better performance, including image and competitive advantage (Agan et al, 2013; Bansal and Roth, 2000; Halme and Korpela, 2014; Aragón-Correa et al., 2008). An examination of how some stakeholders perceive corporate responsibility has attracted the attention of researchers (Pandza and Ellwood, 2013), including the focus and impact among stakeholders, the relationship

between corporate performance and stakeholders, the power differences of stakeholders able to influence corporate responsibility and consequently environmental performance in SMEs (Jain et al., 2016; Tang and Tang, 2012; Sen and Cowley, 2013; Madueno et al., 2016). Some of the associated internal strategic and operational measures include learning orientation, training, regulation, market dynamism, public concern, competitive intensity and innovation. Several studies related to CSR practices have shown a positive effect on performance and competitive advantage in SMEs (Ratnawati et al., 2018; Leonidou et al., 2017; Burlea-Schiopoiu and Mihai, 2019; Li et al., 2019). Importantly, attention has been given to issues related to environmental performance. For example, the study by Hang et al. (2019) concluded that causality between environmental and financial performance depends on the time horizon, i.e. while environmental performance has no short-term effect, it will be significant for a company's long-term financial performance, which is significant as it encourages managers to maintain a proactive environmental policy as well as not to abandon investments if financial success is not immediately visible. This can also be illustrated by Leonidou et al. (2017), who found that regulation, market dynamism, public concern and competitive intensity are all factors that help to positively moderate the effect of green business strategies on a small company's competitive advantage.

Cluster 2: Genuine silent responsibility practices

The nodes identified within this cluster include a different and discrete profile of SMEs when addressing corporate responsibility, sustainability-oriented innovation and business performance. The authors used various methods to analyse different operational dimensions in the supply chain (Dey et al., 2020; Ghadge et al., 2017) from management practices and environmental sustainability (Brammer et al., 2012; Cassells and Lewis, 2011; Dangelico and Pujari, 2010) to sustainability-oriented innovation practices (Jones and de Zubieta, 2017; Jansson et al., 2017) that explain the commitment to sustainability in SMEs. An overview of the literature associated with sustainable development in SMEs has attracted major attention from Hsu et al. (2017), who identified key performance factors (such as reducing employee turnover, increasing employee productivity, and improving manufacturing processes) that are capable of creating business efficiency.

Similarly, some authors point out that the environment, social development, and economic development factors, together with multiple stakeholders (Khan et al., 2020) create economic value in the firm (Choongo, 2017; Hammann et al., 2009; Jenkins, 2006).

Moreover, the discretionary and silent approach by SMEs to corporate social responsibility attracted the interest of several authors. For example, the study by Baumann-Pauly et al. (2013) found that SMEs involved in CSR activities limit external communication and reporting, unlike large companies. According to the study by Lee et al. (2016), this is due to the lack of resources and management capacity of SMEs. Moreover, even though many SMEs are involved in CSR activities, these actions have not been thought of in those terms, but rather, have been driven by legitimate individual concerns. For example, the study by Bansal and Roth (2000) found that the factors motivating companies to respond ecologically are influenced by conditions such as individual concern that respond to proposed values and principles in a gradual manner and inspired by a mix of personal and cultural motivations of SME founders and senior managers, who according to Jenkins (2004) "unknowingly are responsible". In fact, this can be illustrated by the informal, altruistic and philanthropic nature of these discretionary personal values (Jamali et al., 2009; Lee et al., 2016; Perrini et al., 2007; Preuss and Perschke, 2010). In contrast, Williams and Schaefer (2013) stated that although there is greater awareness and understanding among SME managers about climate change, translating that awareness into practical action is difficult, mainly because of their scepticism about how their actions "might impact on the big picture". Therefore, as the study by Stahl et al. (2019) highlighted, it is important for companies to understand that they are not separate from society but part of it. This can be achieved, according to the study by Dossa and Kaeufer (2014), through internal discussions among employees in order for them to articulate the reason for the company's existence and its role in society.

SMEs continuously seek to use simple language such as "operating the business ethically" to explain the concepts related to corporate responsibility (Sen and Cowley, 2013). In that regard, the appropriateness of the term "corporate" responsibility in the context of small and medium enterprises that differ in many aspects from large companies has been criticized, while a

focus on the practical aspects of its internal application has been suggested, whereby according to the study by Jenkins (2006) a more suitable terminology for SMEs, such as "responsible business practice", would improve understanding.

Cluster 3: Responsible innovation framework

Cluster 3 is composed of 20% of the nodes, which represents the framework for innovation based on a responsibility approach (Owen et al., 2012) with the proposal of at least four integrated dimensions - anticipation, reflexiveness, inclusion and responsiveness - (Stilgoe et al., 2013). The authors also focused on investigating both organisational and sustainable innovations (Boons and Lüdeke-Freund, 2013), rooted in deeper socio-economic contexts of sustainable products and service developments (Boons et al., 2013) that help companies of different sizes and sectors think about the challenges and societal values that lead to benefits from the outset, especially when these have been included in the early stages of product development (de Poel et al., 2017). Although there is still tension between the RI ideal and its application in the business context (Brand and Blok, 2019), identification of the main challenges (Ribeiro et al., 2018) and the drivers that could also become obstacles within the RI process (Auer and Jarmai, 2018), it has become a shared endeavour, and one that could link the innovation process with the concept of responsibility and early stakeholder engagement (Silva et al., 2019) in order to ensure responsible and sustainable results in the short, medium and long term (Gaziulusoy et al., 2013).

Cluster 4: Social responsibility practices and performance in SMEs

The final cluster with 10% of the references is characterized by studies that analysed the relationship between CSR and performance in SMEs. Previous research has empirically shown that CSR activities in SMEs are a potential driver of a company's performance (Madueno et al., 2016; Martínez-Martínez et al., 2017; Moneva-Abadía et al., 2019) and that this positive and significant relationship in micro, small and medium-sized enterprises is moderated by the size of these organizations; the larger the size, the stronger the relationship (Hernández et al., 2020). There are also studies that consider this relationship to be partial (Martinez-Conesa et al., 2017) or even positive but weak (Orlitzky et al., 2003).

An analysis of the relationship between socially responsible human resources and the competitive performance of SMEs has also attracted the interest of studies, such as Sancho et al. (2018). Related theories, such as stakeholder theory, were investigated. In the new era, a firm's responsibilities have to be extended to other stakeholders, which will help foster positive changes in profits in the long term (Canh et al., 2019). Innovation as mediation in the relationship between CSR practices and performance has been studied by Ratnawati et al. (2018), where it was found that CSR programming can be used as a means to encourage innovation in SMEs as well as having a significant effect on learning and performance orientation. This is also illustrated in the study by Zhu et al. (2019), which found that innovation is a driver of environmental performance. Similarly, the study by Chege and Wang, (2020) found that management innovation and employee involvement in environmental protection practices has a positive impact on SME performance. Other topics in this group included an analysis of stakeholders and their relationship with CSR practices, innovation and performance in SMEs.

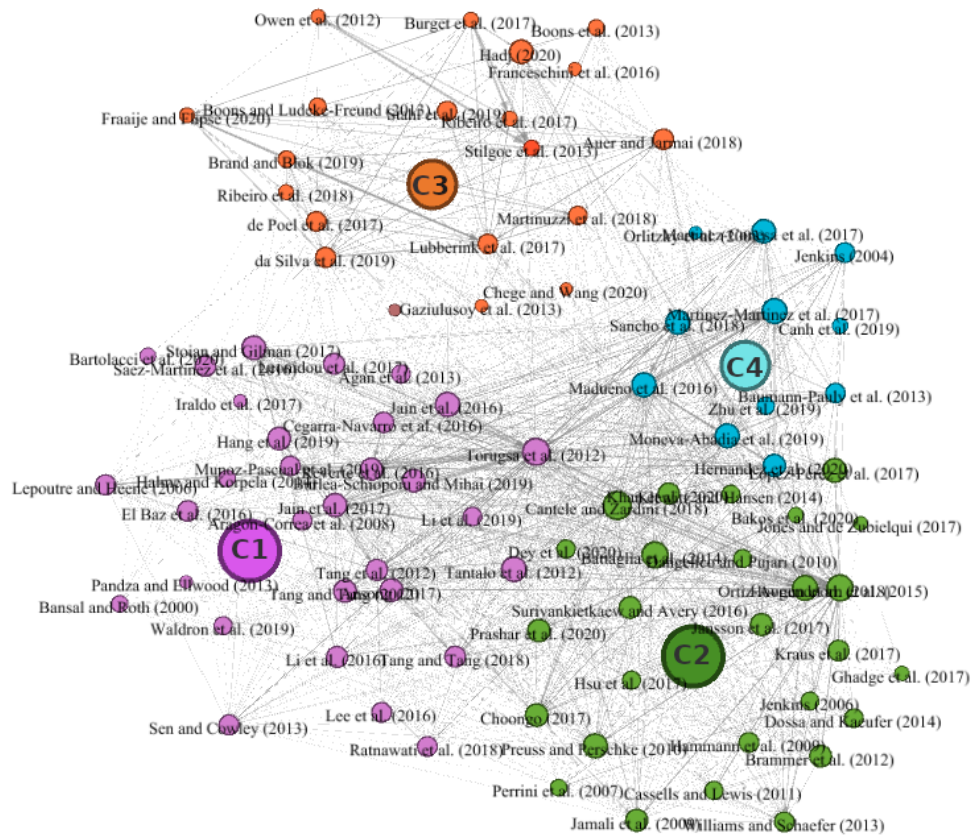


Figure 9. Network of article citations by references

3.5. Theoretical framework based on the literature

According to Stilgoe et al. (2013), a responsible innovation strategy must take into account at least four dimensions of the process, namely anticipation, reflexiveness, inclusion, and responsiveness. In addition to these, there is the knowledge management dimension, which was identified as relevant in the business context in the study by Lubberink et al. (2017) and which is included in the analysis of the literature in this study. In fact, and according to de Poel et al. (2017), a responsible innovation strategy should not only include the four dimensions but its use and priority will depend on the technology and company that applies it and could therefore be different in each case. Thus, in this section, on the one hand, we analyse the responsible innovation dimensions in the context of SMEs and, on the other hand, we analyse their relationship with the business performance in SMEs in addition to the other components of the theoretical model proposed in this study, such as the contingent variables, facilitators, and stakeholders identified in the process.

3.5.1. Dimensions of responsible innovation

3.5.1.1. Anticipation

Anticipation involves systematic thinking in order for organisations to consider uncertainty, the possibility of something happening or not happening, what is possible, risk (Stilgoe et al., 2013), and an overview of possible outcomes and alternatives (Fraaije and Flipse, 2020). Rogers-Hayden and Pidgeon argued that "anticipation processes must be timely so that they are early enough to be constructive but late enough to be meaningful" (as cited in Stilgoe et al., 2013, p. 1571). In the editorial presented by Martinuzzi et al. (2018) on RRI in industry certain challenges, perspectives and prospects illustrate how systematically anticipating problems helps companies to regain confidence and legitimacy, which drives their capacity for socially responsible impact. Under these circumstances, previous research can show whether determination of the desired impacts and outcomes of innovation is an anticipated activity in SMEs.

Determining the desired impacts and results of innovation: Responsible actions in the context of SMEs are the result of unplanned actions. The study by Cassells and Lewis (2011) found that although 80% of owner-managers stated that they were aware of the potential environmental risks arising from the work they do, only 87% agreed that regulation alone cannot protect the environment without voluntary actions by companies. Environmental practices are therefore associated with a potential financial benefit rather than being motivated by environmental protection, so processes are fortuitous rather than expected results. Then, in order to improve the impact of socially responsible activities in SMEs the study by Stoian and Gilman (2017) highlighted the need for specific strategies and policies. However, the study by Auer and Jarmai (2018), who explored the drivers of and barriers to incorporating responsible research and innovation in SMEs, found six drivers of RRI that relate to previous studies on eco-innovation and sustainable innovation. Of these, for example, laws, regulations or certifications could be drivers according to El Baz et al. (2016) and Li et al. (2016) but also possible barriers to the implementation of RRI when the regulatory approach is not clear (Dangelico and Pujari, 2010), or there is no specific regulation (Stahl et al, 2019), or there is too much legislation to comply with. For example, environmental legislation can lead to owner-manager indecision (Cassells and Lewis, 2011), so the business response appears to be largely regulatory

rather than empirical (Williams and Schaefer, 2013). Moreover, there are limitations on governance models in relation to techno-scientific developments (Stilgoe et al., 2013). Consequently, responsible innovation needs to be supported or even initiated by institutionally powerful actors (e.g. government, funding agencies) in order to change perceptions and make it possible to unambiguously articulate the theories with the practice of SMEs (Dangelico and Pujari, 2010; Ghadge et al., 2017; Halme and Korpela, 2014; Pandza and Ellwood, 2013; Perrini et al., 2007; Tang and Tang, 2012). For example, Tilley's study argued that "government was expected to take a leadership role in relation to the environment" (as cited in Lepoutre and Heene, 2006, p. 268). On the other hand, Jansson et al. (2017) argued that the implementation of policies and regulations requiring greater consideration of social and environmental sustainability issues could generate serious resistance in SMEs, as they are reluctant to adopt regulation on a voluntary basis and hence respond less proactively (Jenkins, 2004; Tang and Tang, 2012). However, according to the study by Agan et al. (2013), regulation seems to be a low-level driver because it is drafted in general terms and is often not appropriate for SMEs. Therefore, despite institutional and cultural resistance to anticipation (Stilgoe et al., 2013), previous research suggests that governments have an important role to play in developing and enforcing its regulation, in addition to the necessary support for socially and environmentally responsible SMEs (Jenkins, 2006; Ghadge et al., 2017).

3.5.1.2. Reflexiveness

Responsibility requires reflexivity on the part of actors and institutions, and refers to the process of self-awareness, rather like holding up a mirror to scrutinise oneself (Stilgoe et al., 2013), in order to understand the social aspects of an innovation (Fraaije and Flipse, 2020). The study by Lubberink et al. (2017) refers on a practical level to actions such as values and motivations, knowledge and perceived realities for responsible actions. However, past literature on SMEs refers to values and motivations as perceived realities for their responsible actions.

Values and motivations: According to the study by Auer and Jarmai (2018), SMEs' motivations for responsible innovation can be manifold, including, for example, motivations related to cost reduction practices (Cassells and Lewis, 2011), compliance with standards (Dangelico and Pujari, 2010), consumerist

or instrumental matters (Li et al., 2019), competitiveness, legitimacy and personal commitment (Williams and Schaefer, 2013). The studies by Jenkins (2006) and Dangelico and Pujari (2010) showed that awareness of the role and power of business in society, mostly based on moral and ethical arguments i.e. doing "the right thing", that "everyone has a responsibility to do what they can", is significant, because researchers have found that it leads to the recognition of the active and primary role of employees (Li et al, 2019). This moral and ethical culture encourages them to perform their tasks and responsibilities in a more committed and satisfying manner (Tantalo et al., 2012; Jain et al., 2017). Furthermore, even though some empirical studies indicate that owner-manager values can be a decisive motivation for adopting socially responsible practices (Brammer et al., 2012; Burlea-Schiopoiu and Mihai, 2019; Jain et al., 2016; Jamali et al., 2009; Jenkins, 2006; Preuss and Perschke, 2010) among others, these individuals do, after all, have the potential to significantly influence company strategies and culture (Jansson et al, 2017). However, the extent to which this positive attitude is turned into action is not clear (e.g. Cassells and Lewis, 2011). On the other hand, such moral and ethical arguments can also have an impact on social improvement in local communities (Jamali et al., 2009) and vice versa, the latter especially when the cultural influence of the local community is so strong that it is able to displace the personal values of the small business owner-manager (as quoted in Lepoutre and Heene, 2006, p. 260).

3.5.1.3. Inclusion

Inclusion refers to stakeholder participation (Stilgoe et al., 2013; Lubberink et al., 2017). Studies relate inclusion to practices that promote: (a) stakeholder engagement at different stages; (b) increased commitment and contribution.

The participation of stakeholders at different stages is considered imperative for the responsible innovation process (Silva et al., 2019). Previous studies on responsible innovation, sustainable innovation and corporate social responsibility in SMEs have well established that social interaction and strong owner-manager relations with stakeholders contribute to responsible behaviour and the integration of strategies in SMEs (Perrini et al., 2007; Sen and Cowley, 2013), which in turn means more opportunities to reap the benefits of such responsible behaviour (Lepoutre and Heene, 2006). Previous

studies also report that small firms will often depend on the responsible behaviour of their peers to generate such behaviour (Lepoutre and Heene, 2006), or on the quality of personal relationships between the owner-manager and various stakeholders (Jenkins, 2004). This is illustrated in the study by Preuss and Perschke (2010), who recognised that such behaviour mainly focuses on the values of owner-managers, thus acknowledging the wider circle of influence of decision makers than just the owner-manager, as also shown in the study by Cegarra-Navarro et al (2016) where it is stated that corporate social responsibility implies involvement of multiple internal and external stakeholders to generate favourable attitudes, as well as better supportive behaviours as reported in the study by Sen and Cowley (2013). In this line, this inevitably corroborates the relationship between the inclusion process and power issues (Stilgoe et al., 2013), i.e. the stakeholder's power over the company to engage in responsible behaviour and the power of a company to counteract that stakeholder (Tang and Tang, 2012). Stakeholders have therefore been defined as "groups that can and may be affected by an organisation's actions because they share with it certain demands or expectations," and they can be internal (owners, employees) and external (customers, government, competitors, suppliers, etc.), and they have been described and analysed in various literature studies such as (Jain et al., 2016; Jamali et al., 2009; Jansson et al., 2017; Sáez-Martínez et al., 2016; Tang and Tang, 2018), among others.

Increased commitment and contribution: SMEs within their responsibility programmes apply practices that are compatible with stakeholder expectations. For example, Hammann et al. (2009) argued that socially responsible practices, which are based on someone's personal values, lead to the creation of economic value. That study also found that executives can more easily express their values to internal stakeholders, such as employees, and closer external stakeholders, such as customers, than they can to an abstract group such as society. Previous studies have also recognised that the relationship between owners-managers and stakeholders at all levels is a strategic approach (Perrini et al., 2007; Ortiz-Avram et al., 2018) related to increased commitment, trust, a better working environment (Preuss and Perschke, 2010; Hsu et al., 2017) and, consequently, greater competitive advantage (Sancho et al., 2018; Jamali et al., 2009). However, the study by Silva et al. (2019) also showed that stakeholders are included at a late stage

of the innovation process, when the product or service is already on the market, which allows for some adaptation of solutions, but in a limited manner. Silva therefore proposes the creation of a design space that allows for early inclusion of multiple stakeholders. Likewise, Khan et al. (2020) argues for the early inclusion of stakeholders, who may have divergent opinions in the innovation process, but must be included in order to ensure responsible results in the business context. In that line, and even if participants do not undertake social activities on their own, the motivation to do so will underlie the establishment of relationships and networks with other members (Sen and Cowley, 2013) as "business champions," namely a series of people who give their time, expertise and support to other businesses (Jenkins, 2006).

3.5.1.4. Responsiveness

Responsiveness means responding to newly emerging knowledge, perspectives, users' views (Stilgoe et al., 2013) and stakeholders on the innovation process in order to make responsible decisions (Fraaije and Flipse, 2020), and thus adapt innovation to change and new requirements (de Poel et al., 2017). Responsiveness is explicitly linked to inclusion. However, and given the previous point where the anticipation dimension is an unforeseen process in SMEs, the study by de Poel et al. (2017) proposes a conceptual model that integrates responsible research and innovation into corporate social responsibility policies, highlighting that under these circumstances, responsiveness may be a more reliable strategy. Some key activities within this dimension that are likely to improve responsiveness in SMEs are: 1) ensuring that one can respond to changes in the environment, 2) real response to changes in the environment, 3) addressing major challenges, 4) mutual response.

Ensuring that one can respond to changes in the environment: Hsu et al. (2017) explained that the most important factors in priority order are environment, social development and economic development. In that regard, employees, with the criterion of reducing the incidence of health and safety problems, are a key factor for improving the performance of SMEs, as noted by Jansson et al. (2017), especially when they are involved in sustainable and responsible innovation processes (Reverte et al., 2016). Similarly, the European Commission's innovation policy recognized this link: "Innovation

must be organized in a way that not only supports the acceptance of change, but also offers opportunities in human resource management, leading to higher productivity" (European Commission, 2006). Previous studies on this subject state that some organizational and managerial characteristics of SMEs (e.g. informal, flexible communication style, fewer hierarchical levels) are favourable to their responsiveness to the changing needs of the enterprise and its stakeholders (Torugsa et al, 2012). So, as a result, these personal attitudes may affect the socially responsible behaviour of SMEs (Brammer et al., 2012), as dictated by needs, in addition to improving their capacity for innovation (Jenkins, 2006), and proactivity responding to socially responsible and environmental activities (Aragón-Correa et al., 2008; Ortiz-Avram et al., 2018; Sáez-Martínez et al., 2016; Sancho et al., 2018) among others.

Real response to changes in the environment: Boons and Lüdeke-Freund (2013) found that a sustainable business model is a mediator for innovations in SMEs, the latter being able to create "responsible innovations" despite limitations on such resources as financial capital, skills, and social capital (Halme and Korpela, 2014). For example, a company that produces and sells light bulbs will be able to switch from conventional ones to energy-saving bulbs. Similarly, Starbucks aims to have 100% recyclable or reusable cups, and new standards have come into force in China to encourage the development of sustainable packaging (Dangelico and Pujari, 2010). China is also the first country to ban the production, sale and use of plastic bags that are less than 0.025 mm thick (Tang and Tang, 2012). On the other hand, studies have also shown that the relationship between awareness, attitude and responsible adoption practices of many SME owner-managers is not determined by a positive attitude. In fact, some are inclined to shun a responsibility that they feel should be assumed by the government (Cassells and Lewis, 2011). This is worth mentioning because the study by Ghadge et al. (2017) explained that three major external drivers, namely government, competitors and customers, significantly influence and drive the need for improved responsible practices.

Addressing the big challenges faced by society promotes responsible innovation in SMEs. Previous research suggests that the driving of social, environmental and economic activities to incorporate responsible research

and innovation in SMEs implies reconsideration of the role of business in society (Auer and Jarmai, 2018; Reverte et al., 2016). Examples of how previous literature has responded to social, environmental and economic problems include: the study by Halme and Korpela (2014) which showed that despite the limited resources of SMEs, they can create "responsible innovations" by combining resources such as equity, cooperation, networks, knowledge and reputation. Likewise, Bartolacci et al. (2020) revealed that one research topic is innovation and impact on the sustainability of SMEs. The study by Li et al. (2019) found that the effect of environmentally friendly activities influences the performance of service innovation only when it is mediated by advanced dynamic capacity¹⁵. Ratnawati et al. (2018) found that a social responsibility programme, on the one hand, has a significant effect on learning orientation, innovation and performance and, on the other, promotes innovation. Bos-Brouwers (2010) revealed that sustainable innovation can be explained by different levels of sustainability embedded in innovation processes for new product development and cooperation with stakeholders. Jones and de Zubieta (2017) found that the transfer of human resources from higher education institutions to SMEs has a significant positive effect on innovation capacity, which on one hand is positively related to the company's performance, and on the other hand supports the argument for sustainability. Dangelico and Pujari (2010) revealed that the green product development process for energy minimization, materials reduction, and pollution prevention are part of different companies' motivations to develop green products. Moreover, Hofmann et al. (2012) found that the adoption of advanced technology, collaboration with customers and suppliers, innovation capacity and strategic benefits can provide SMEs with capabilities that help them to address environmental challenges. Burlea-Schiopoiu and Mihai (2019) stated that CSR, training and innovation are significant and correlated factors to promote competitive advantage in SMEs, among others.

Mutual response: Responsibility is not only found at the level of government or industrial organizations, but also implies responsibility at the level of individual small businesses (Lepoutre and Heene, 2006). In practice, previous studies such as those by Mendibil showed that SME social

¹⁵ Dynamic capacity is the "ability of the firm to integrate, build and reconfigure internal and external competencies to cope with rapidly changing environments" (Li et al., 2019).

responsibility and innovation seem to create a synergy with the strong commitment of stakeholders to contribute to innovation capacity and company competitiveness (as cited in Reverte et al., 2016, p. 2872). Thus, willingness to recalibrate responsibilities in order to maintain stakeholder relations is another example from the previous paragraph to promote a mutual response among SMEs, as they seek to cohere with other SMEs in order to promote better performance in their social practices (Tang and Tang, 2012).

3.5.1.5. Knowledge management

Previous research shows that although there is a lack of knowledge among SMEs, different activities are undertaken to create, share, transfer and apply it through their members (Jain et al., 2017). The previous literature mainly refers to two key activities in SMEs, which is knowledge creation and development as studied by Lubberink et al. (2017).

Knowledge creation and development: While corporate responsibility activities in SMEs have been recognised as drivers of knowledge creation and exchange (Li et al., 2019), it is also recognised that they have the potential to become operational and competitive benefits (Cegarra-Navarro et al., 2016). For instance, knowledge management and transfer, which together with capacity constitute an opportunity for improvement of employees' skills and knowledge (Tantalo et al., 2012; Sancho et al., 2018; Agan et al., 2013), among other studies. Due to the importance of the knowledge management dimension for SMEs, extensive information taken from the literature review is presented in the following paragraphs.

Ratnawati et al. (2018) argued that a social responsibility programme is positively related to learning orientation, which is significant for SMEs because it fosters development learning mechanisms by improving skills, processes, resources, and services aimed at their adaptation to change. Learning orientation is viewed as a process of developing employees' competences, skills and knowledge to help SMEs to boost competitiveness (Rhee et al., 2010) and according to Liu it is used as a tool for SMEs to create community and foster their relationships (as cited in Ratnawati et al., 2018, p. 23S). Likewise, the study by Burlea-Schiopoiu and Mihai (2019) argues that through socially responsible activities, SMEs can promote multidimensional relationships with a variety of external agents (e.g. other

private companies, universities, research centres, public authorities and community leaders) to voluntarily share information, ideas and knowledge in local networks with their peers as shown by Jenkins, (2006) and Ortiz-Avram et al (2018), among other studies. They trust the aforesaid agents more than advisory organizations (Williams and Schaefer, 2013) and are therefore more likely to recognize responsibility issues and ways to address them (Lepoutre and Heene, 2006), observe trends and open up markets that otherwise could not be explored (Sen and Cowley, 2013). Furthermore, collaborative networks play an important role in the innovation processes in SMEs as stated in the study on drivers and barriers to incorporating responsible research and innovation in SMEs by Auer and Jarmai (2018). SMEs are therefore urged to recognize and pay close attention to the improvement of labour resources and cooperation efforts, i.e. to emphasize strategic developmental relationships between important stakeholders (Jenkins, 2006), because the more cooperation there is, the greater the impact of sustainable innovations (Bos-Brouwers, 2010).

3.5.2. Relationship of responsible innovation with performance

Analysis of the articles that measured responsible innovation practices against the organization's performance (37 articles) uses various indicators, including quantitative (e.g. ROA, productivity, sales growth, market share, etc.) as well as qualitative (e.g. customer satisfaction, brand image and corporate reputation, employee motivation, etc.) performance indicators and from different fields of innovation, such as empirical work and literature reviews. Performance indicators related to responsible innovation practices are less frequent, but previous research has considered these and this study groups them according to the classification proposed by de Poel et al. (2017) (see Table 2).

Responsible innovation efficiency in a company depends on its strategy to seek, on one hand, added value for society, and also to make profits (de Poel et al., 2017). Moreover, according to the same article, although strategies linked to practices that drive responsible innovation, such as CSR and SI, promote potential organizational performance, these strategies must shift from their conservative, philanthropic, defensive way of addressing social, environmental and ethical issues towards a progressive way of "doing good". For example, some authors measured performance by considering financial

and non-financial indicators and revealed a positive causal link. An empirical example is the study by Reverte et al. (2016) who investigated the mediating role of innovation in the relationship between social responsibility and organizational performance in SMEs in Spain. They revealed that social responsibility practices have a direct, positive and significant effect on both innovation and organisational performance, covering both financial (such as the level of sales growth; the level of ROE; ROA; market share; level of productivity) and non-financial (the quality of products and/or services offered) indicators; technological position and coordination of internal processes; coordination and organisation of human resources; degree of customer satisfaction; degree of adaptation to changing market needs; brand image and corporate reputation; employee motivation; staff turnover; and staff absenteeism). They also reported that long-term benefits are reflected either internally, externally or both: internally by helping to develop new resources and capabilities that relate to technical knowledge and business culture, and externally by being linked to companies' reputation which in turn improves relationships, attracts better employees or increases their motivation and commitment; or both. Social responsibility hence positively influences organisational performance. Torugsa et al. (2012) revealed that specified capabilities (such as shared vision, stakeholder management and proactivity) share a positive association with proactive social responsibility, which in turn improves company's financial performance. They also reported that SMEs can maximize their financial benefits while proactively moving towards corporate social responsibility. Similarly, Aragón-Correa et al. (2008) found a significantly positive relationship between proactive social responsibility related to the environment and financial performance in SMEs. The study by Hammann et al. (2009) on the relationship between socially responsible practices in SMEs and value creation towards stakeholders found that socially responsible practices towards employees, customers and, to a lesser extent, society, have a positive impact on the company and its performance.

Previous research also showed a positive but weak relationship between social responsibility activities and financial performance. For example, the study by Jain et al. (2016) found a significant but weak positive relationship between social responsibility and financial performance, which is similar to the findings by Orlitzky et al. (2003). The indicators used were: the

company's profit margin; satisfaction with the change in profit margin; company sales and long-term consequences. The model explained 81% of the variance in customers, 78% of the variance in employees, 82% of the variance in environment and 67% of the variance in community. Although this last argument showed that corporate social responsibility contributed positively to different stakeholders, it is not designed in terms of money or personnel that can be deployed in such activities. What this means is that CSR is not considered a strategic commitment for most SMEs or a legal obligation and therefore remains philanthropic and not institutionalised.

Another way of measuring performance has been related to certain indicators of responsible innovation. Previous research has considered aspects related, for example, to diversity and inclusion, and has shown that positively improving employees' individual performance, satisfaction and commitment contributes to organizational performance (Sancho et al., 2018). The study by Khan et al. (2020) analysed the effect of sustainable social responsibility dimensions related to employees, environment, community, suppliers and customers on performance in SMEs. The results revealed that managing the relationship with a company's key stakeholders has a significant positive influence on sustainable competition and business performance. In addition, the need to take multiple stakeholders seriously, and not just owners, was highlighted. Similarly, Choongo (2017) found that while the social and environmental dimensions of socially responsible practices in SMEs have a significant impact on financial performance, performance measures related to corporate reputation and employee engagement were only partially significant because employee engagement can be negatively affected when there is no investment in employee training and development. Meanwhile, the study by Ratnawati et al. (2018) examining the effect of learning orientation and innovation in mediating social responsibility on performance and competitive advantage in SMEs revealed that social responsibility activities have a significant effect on learning orientation, innovation and performance in SMEs. In the same vein, the study by Burlea-Schiopoiu and Mihai (2019) investigated the relationship between three sustainability factors (CSR, innovation and training) and their effects on competitive advantage of SMEs in Romania. The study found that employee training, innovation and social responsibility practices are significant and correlated

factors in promoting competitive advantage in SMEs. To summarise, Table 12 shows the performance indicators identified in the literature review.

Table 12. RI Performance Indicators in SMEs

<i>Firm performance</i>
Sales growth
Profitability
Financial indicators
Market share
Customer satisfaction
Innovation performance
Benefits/utility
<i>RI performance</i>
Environmental sustainability
Social sustainability
Diversity and inclusion
Anticipation and reflection

3.5.3. Contingent variables affecting responsible innovation and performance relationship in SMEs

The main variables identified and treated in the literature as control variables and mediating variables were included in the relationship between practices that promote responsible innovation and performance in SMEs as: Size (Agan et al., 2013; Aragón-Correa et al., 2008; Besser and Miller, 2001; Brammer et al., 2012; Burlea-Schiopoiu and Mihai, 2019; Canh et al., 2019; Cantele and Zardini, 2018; Cassells and Lewis, 2011; Choongo, 2017; Hernández et al., 2020; Hofmann et al., 2012; Jain et al., 2016; Khan et al., 2020; Madueno et al., 2016; Martínez-Martínez et al., 2017; McWilliams and Siegel, 2000; Muñoz-Pascual et al., 2019; Preuss and Perschke, 2010; Reverte et al., 2016; Sáez-Martínez et al., 2016; Sancho et al., 2018; Stoian and Gilman, 2017; Tang et al., 2012; Tang and Tang, 2018, 2012; Tantalo et al., 2012; Torugsa et al., 2013, 2012); industry (Agan et al., 2013; Bansal and Roth, 2000; Besser and Miller, 2001; Burlea-Schiopoiu and Mihai, 2019; Cantele and Zardini, 2018; Hofmann et al., 2012; Hull and Rothenberg, 2008; Jain et al., 2017, 2016; Leonidou et al., 2017; McWilliams and Siegel, 2000; Muñoz-Pascual et al., 2019; Perrini et al., 2007; Reverte et al., 2016; Sáez-Martínez et al., 2016; Stoian and Gilman, 2017; Tang et al., 2012; Tantalo et

al., 2012); age (Besser and Miller, 2001; Cassells and Lewis, 2011; Choongo, 2017; Hofmann et al., 2012; Hoogendoorn et al., 2015; Jain et al., 2016; Khan et al., 2020; Muñoz-Pascual et al., 2019; Reverte et al., 2016; Stoian and Gilman, 2017; Tang and Tang, 2018, 2012); innovation (Aragón-Correa et al., 2008; Canh et al., 2019; Cegarra-Navarro et al., 2016; Hadj, 2020; Hull and Rothenberg, 2008; Jones and de Zubielqui, 2017; Kraus et al., 2017; Martínez-Conesa et al., 2017; Martínez-Martínez et al., 2017; Moneva-Abadía et al., 2019; Ratnawati et al., 2018; Reverte et al., 2016; Zhu et al., 2019); country (Bansal and Roth, 2000; Perrini et al., 2007; Sáez-Martínez et al., 2016); corporate strategy (Reverte et al., 2016; Stoian and Gilman, 2017); learning orientation (Ratnawati et al., 2018; Rhee et al., 2010); employee's commitment (Choongo, 2017; Sancho et al., 2018); and relational marketing (Martínez-Martínez et al., 2017; Sancho et al., 2018).

3.5.4. Responsible innovation antecedents and enablers

Some facilitators were identified in the literature related to the practices that promote RI in SMEs such as, organisational flexibility, shared collective vision and internal and external drivers. *Organizational flexibility* allows SMEs to respond more quickly to changing circumstances in the business environment, which is identified as favourable to the implementation of CSR practices because they are not tied to the bureaucracy of relationships in both the internal and external environment (Jenkins, 2004; Burlea-Schiopoiu and Mihai, 2019). Brammer et al (2012) found that while most medium-sized enterprises appear to be engaged in a wide range of environmental initiatives (e.g. the development of environmental policies and mission statements, recycling and waste management programmes, and the auditing of environmental impacts.), most small companies are involved in only a few initiatives, which means on the one hand that there is a significant heterogeneity in the participation of SMEs, and on the other hand that their flexibility allows them to easily adapt to local market challenges, thus, responding to changing environments and competitors' actions (Aragón-Correa et al, 2008). On the other hand, another identified facilitator is the *shared collective vision*. The same study by Aragón-Correa et al. (2008) found that environmental strategies adopted by SMEs range from reactive compliance with regulations to proactive prevention of environmental pollution, associated with organizational capacities such as: shared vision, stakeholder management and strategic proactivity. It also revealed that the

organizational capacities that drive the adoption of environmental strategies are correlated with the unique strategic characteristics of SMEs such as: shorter communication lines and closer interaction within SMEs, the presence of a founder's vision, and the flexibility. Other identified enablers are internal and external momentum. In the first *internal driver*, for example, Jenkins (2006) found that the values and principles proposed in the CSR strategy were driven gradually and according to the personal values of the business owner or manager, which means an internal drive, from an internal champion to the highest level of management. The analysis by Bakos et al. (2020) found that management and stakeholder pressure were the main influences on a company's adoption of environmentally responsible practices. Similarly, the study by Lee et al. (2018) found that the higher the position in SMEs, the greater the willingness to adopt environmentally responsible practices. The other, *external driver, which has to do with external pressure such as regulation*, which according to Sáez-Martínez et al. (2016) is an important driver of socially responsible practices, similarly, in the study by Auer and Jarmai (2018) identified regulation as an effective factor in driving the implementation of responsible research and innovation. Also, because SMEs will avoid fines if they do not adapt their practices to regulation (Bakos et al., 2020). In contrast, the study by Jenkins (2006) identified external pressure from both clients and applicable but weak legislation.

As an essential part of responsible innovation strategies, the stakeholders identified in the literature are: customers, employees, environment, suppliers, community, owners/shareholders, R&D, government, competitors, funding agencies/investors, and alliances (Agan et al., 2013; Aragón-Correa et al., 2008; Bansal and Roth, 2000; Battaglia et al., 2014; Bos-Brouwers, 2010; Brammer et al., 2012; Canh et al., 2019; Cantele and Zardini, 2018; Castka et al., 2004; Cegarra-Navarro et al., 2016; Dey et al., 2020; Ghadge et al., 2017; Hadj, 2020; Hammann et al., 2009; Hofmann et al., 2012; Hoogendoorn et al., 2015; Iraldo et al., 2017; Jain et al., 2017, 2016; Jamali et al., 2009; Jenkins, 2006; Khan et al., 2020; Lee et al., 2018; Li et al., 2016; Madueno et al., 2016; Martinez-Conesa et al., 2017; Martínez-Martínez et al., 2017; Moneva-Abadía et al., 2019; Preuss and Perschke, 2010; Reverte et al., 2016; Sen and Cowley, 2013; Tantalo et al., 2012; Torugsa et al., 2012; Zhu et al., 2019).

Based on findings of this section, a conceptual model for responsible innovation and its relationship with business performance for SMEs is presented in Figure 10. The activities appear in the model in order of priority, the highest being the ones that appeared in the most studies (see Appendix for more information).

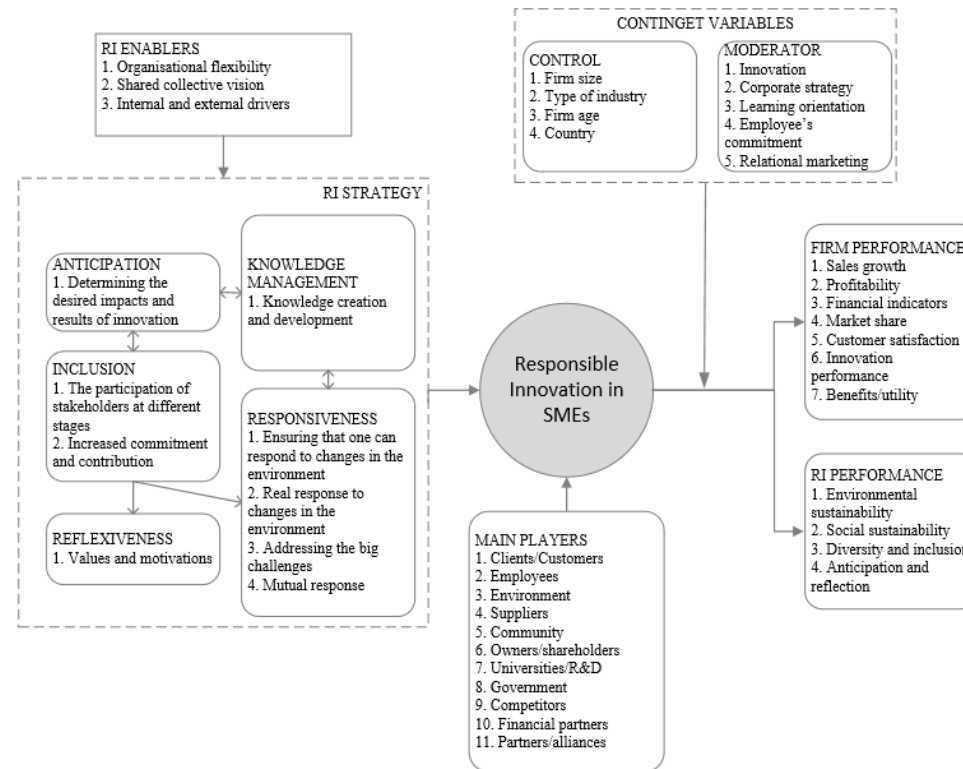


Figure 10. Integrated conceptual model of Responsible Innovation in SMEs
 Source: Own elaboration

3.6. Conclusions

This study is particularly relevant for small and medium-sized enterprises because it analysed a body of literature and its practical implications for business performance, i.e., it derived a conceptual model of responsible innovation that is based on recent practices and studies on responsible innovation, corporate social responsibility, sustainable innovation practices, and their relationship with business performance in SMEs. In addition, it forms part of the emerging debate on responsible innovation and contributes to the literature in three ways. First, it encourages SME practitioners to engage in responsible innovation activities due to the tangible and intangible benefits to the company that are: Capability to involve internal and external stakeholders; capability to generate favourable attitudes to engage in responsible behaviour; capability to determine desired impacts of innovation; capability to create and develop knowledge; capability to deal with values and motivations; capability to address challenges. Moreover, this conceptual model presents a comprehensive view of RI and past practices together with their potential benefits for the company's performance. From there, it is possible to consider integrating it systematically in the corporate strategy and not vice versa. In other words, responsible innovation becomes one further theoretical concept that is reinvented with each emerging technology. Secondly, responsible innovation changes the perception with regard to stakeholders, i.e., this study highlights the new direction promoted by RI and in response to stakeholder values (Stilgoe et al., 2013), whereby stakeholder interests can be unambiguously articulated, without leaving out those who will be affected. These are sustainable solutions that correspond to the impact on society because stakeholders drive responsible innovation strategies, not only because of their advisory role which changes the perception that company is the main driver, but also because of their contribution to the innovation process. Finally, this study could encourage and help small and medium-sized enterprises to make sense of their activities, strategies, and policies linked to sustainable innovation and corporate social responsibility because "responsible innovation" is connected to such strategies. However, this requires SMEs to think about ways to add value to their strategies in order to positively influence society, but also the performance of their organization.

There are some limitations to this study. First, it examined only 102 journal articles with some impact in the WoS Database. However, some important existing articles may have been unintentionally left out, bearing in mind that the search was restricted to articles in the areas of business research, economics, social science, environmental science, and technological science. Another limitation of this study is that the methods it adopts are not exhaustive, so researchers are encouraged to address the research questions in this study with the use of other research methods. It is also hoped that future research can test the theoretical model empirically in order to contrast its results, which are similar to the theoretical findings of previous studies. Finally, this study concludes by emphasizing directions for future research on responsible innovation. Literature in this field could be improved by researchers including areas of innovation in relation to inclusion such as inclusive innovation, social innovation, and frugal innovation, fields that have been little explored in the literature.

Appendix

Main code	Strategy	Qty	References
Inclusion	The participation of stakeholders at different stages	17	(Sáez-Martínez et al., 2016) (Burget et al., 2017) (Jansson et al., 2017) (Tang and Tang, 2018) (Jamali et al., 2009) (Jain et al., 2016) (Torugsa et al., 2012) (Sancho et al., 2018) (Jain et al., 2017) (Hammann et al., 2009) (Halme and Korpela, 2014) (Khan et al., 2020) (Silva et al., 2019) (Tantalo et al., 2012) (Stahl et al., 2019) (Battaglia et al., 2014) (Gaziulusoy et al., 2013) (Dossa and Kaeufer, 2014)
	Increased commitment and contribution	11	(Hammann et al., 2009) (Perrini et al., 2007) (Ortiz-Avram et al., 2018) (Preuss and Perschke, 2010) (Hsu et al., 2017) (Sancho et al., 2018) (Jamali et al., 2009) (Silva et al., 2019) (Khan et al., 2020) (Sen and Cowley, 2013) (Jenkins, 2006) (Dossa and Kaeufer, 2014)
Responsiveness	Ensuring that one can respond to changes in the environment	12	(de Poel et al., 2017) (Burget et al., 2017) (Hsu et al., 2017) (Jansson et al., 2017) (Reverte et al., 2016) (Torugsa et al., 2012) (Brammer et al., 2012) (Jenkins, 2006) (Ortiz-Avram et al., 2018) (Sancho et al., 2018) (Sáez-Martínez et al., 2016) (Aragón-Correa et al., 2008)
	Addressing the big challenges	12	(Auer and Jarmai, 2018) (Reverte et al., 2016) (Halme and Korpela, 2014) (Li et al., 2019) (Ratnawati et al., 2018) (Bos-Brouwers, 2010) (Silva et al., 2019) (Jones and de Zubielqui, 2017) (Dangelico and Pujari, 2010) (Hofmann et al., 2012) (Burlea-Schiopoiu and Mihai, 2019) (Hoogendoorn et al., 2015)
	Real response to changes in the environment	6	(Boons and Lüdeke-Freund, 2013) (Halme and Korpela, 2014) (Dangelico and Pujari, 2010) (Tang and Tang, 2012) (Cassells and Lewis, 2011) (Ghadge et al., 2017)
	Mutual response	3	(Lepoutre and Heene, 2006) (Reverte et al., 2016) (Tang and Tang, 2012)

Reflexiveness	Values and motivations	20	(Lubberink et al., 2017) (Burget et al., 2017) (Auer and Jarmai, 2018) (Cassells and Lewis, 2011) (Dangelico and Pujari, 2010) (Li et al., 2019) (Williams and Schaefer, 2013) (Jenkins, 2006) (Dangelico and Pujari, 2010) (Tantalo et al., 2012) (Jain et al., 2017) (Preuss and Perschke, 2010) (Brammer et al., 2012) (Jamali et al., 2009) (Jain et al., 2016) (Burlea-Schiopoiu and Mihai, 2019) (Jansson et al., 2017) (Cassells and Lewis, 2011) (Jamali et al., 2009) (Lepoutre and Heene, 2006) (Dossa and Kaeufer, 2014)
Knowledge management	Knowledge creation and development	22	(Li et al., 2019) (Cegarra-Navarro et al., 2016) (Tantalo et al., 2012) (Sancho et al., 2018) (Agan et al., 2013) (Ratnawati et al., 2018) (Orlitzky et al., 2003) (Rhee et al., 2010) (Ratnawati et al., 2018) (Burlea-Schiopoiu and Mihai, 2019) (Jenkins, 2006) (Ortiz-Avram et al., 2018) (Williams and Schaefer, 2013) (Lubberink et al., 2017) (Lepoutre and Heene, 2006) (Sen and Cowley, 2013) (Auer and Jarmai, 2018) (Jenkins, 2006) (Bos-Brouwers, 2010) (Jain et al., 2017) (Kraus et al., 2017) (López-Pérez et al., 2017)
Firm performance	Sales growth	21	(Jain et al., 2016) (Madueno et al., 2016) (Reverte et al., 2016) (Preuss and Perschke, 2010) (Sancho et al., 2018) (Choongo, 2017) (Ratnawati et al., 2018) (Cegarra-Navarro et al., 2016) (Cantele and Zardini, 2018) (Jones and de Zubielqui, 2017) (Sáez-Martínez et al., 2016) (Leonidou et al., 2017) (Dey et al., 2020) (Hang et al., 2019) (Jain et al., 2017) (Khan et al., 2020) (Preuss and Perschke, 2010) (López-Pérez et al., 2017) (Ikram et al., 2019) (Suriyankietkaew and Avery, 2016) (Hull and Rothenberg, 2008)
	Profitability	21	(Bansal and Roth, 2000) (Torugsa et al., 2012) (Torugsa et al., 2013) (Jain et al., 2016) (Madueno et al., 2016) (Sancho et al., 2018) (Agan et al., 2013) (Burlea-Schiopoiu and Mihai, 2019) (Choongo, 2017) (Cantele and Zardini, 2018) (Leonidou et al., 2017) (Martinez-Conesa et al., 2017)

			(Burlea-Schiopoiu and Mihai, 2019) (Jain et al., 2017) (Jones and de Zubielqui, 2017) (Khan et al., 2020) (Ikram et al., 2019) (Hernández et al., 2020) (Chege and Wang, 2020) (Suriyankietkaew and Avery, 2016)
	Financial indicators	15	(Tang et al., 2012) (Torugsa et al., 2012) (Torugsa et al., 2013) (Reverte et al., 2016) (Aragón-Correa et al., 2008) (Choongo, 2017) (Cegarra-Navarro et al., 2016) (Cantele and Zardini, 2018) (Leonidou et al., 2017) (Martinez-Conesa et al., 2017) (Hang et al., 2019) (López-Pérez et al., 2017) (Ikram et al., 2019) (Hernández et al., 2020) (Canh et al., 2019)
	Market share	13	(Madueno et al., 2016) (Reverte et al., 2016) (Sancho et al., 2018) (Agan et al., 2013) (Choongo, 2017) (Ratnawati et al., 2018) (Cegarra-Navarro et al., 2016) (Leonidou et al., 2017) (Hang et al., 2019) (Khan et al., 2020) (Stahl et al., 2019) (López-Pérez et al., 2017) (Ikram et al., 2019)
	Customer satisfaction	10	(Madueno et al., 2016) (Reverte et al., 2016) (Sancho et al., 2018) (Ratnawati et al., 2018) (Cantele and Zardini, 2018) (Leonidou et al., 2017) (Martinez-Conesa et al., 2017) (Khan et al., 2020) (Iraldo et al., 2017) (Moneva-Abadía et al., 2019)
	Innovation performance	7	(Li et al., 2019) (Martinez-Conesa et al., 2017) (Muñoz-Pascual et al., 2019) (Ratnawati et al., 2018) (Khan et al., 2020) (Tantalo et al., 2012) (Battaglia et al., 2014)
	Benefits/utility	6	(Madueno et al., 2016) (Sancho et al., 2018) (Aragón-Correa et al., 2008) (Ratnawati et al., 2018) (Hofmann et al., 2012) (Jenkins, 2006)
	Productivity	4	(Besser and Miller, 2001) (Jones and de Zubielqui, 2017) (Dey et al., 2020) (Hsu et al., 2017)
RI performance	Environmental sustainability	27	(Bansal and Roth, 2000) (Kraus et al., 2017) (Agan et al., 2013) (Tang and Tang, 2012) (Brammer et al., 2012) (Sáez-Martínez et al., 2016) (Bos-Brouwers, 2010) (Leonidou et al., 2017) (Dey et al., 2020) (Hsu et al., 2017) (Hang et al., 2019) (Williams and Schaefer, 2013) (Dangelico and

			Pujari, 2010) (Hofmann et al., 2012) (Muñoz-Pascual et al., 2019) (Ghadge et al., 2017) (Hadj, 2020) (Tantalo et al., 2012) (Prashar and others, 2020) (Waldron et al., 2019) (Stahl et al., 2019) (Iraldo et al., 2017) (Gaziulusoy et al., 2013) (Chege and Wang, 2020) (Hoogendoorn et al., 2015) (Lee et al., 2018) (Zhu et al., 2019)
	Social sustainability	24	(Besser and Miller, 2001) (Kraus et al., 2017) (Bos-Brouwers, 2010) (Dey et al., 2020) (Hsu et al., 2017) (Jenkins, 2006) (Burlea-Schiopoiu and Mihai, 2019) (Stoian and Gilman, 2017) (Khan et al., 2020) (Hadj, 2020) (Lepoutre and Heene, 2006) (Tantalo et al., 2012) (Prashar and others, 2020) (Pandza and Ellwood, 2013) (Waldron et al., 2019) (Burget et al., 2017) (Stahl et al., 2019) (Gaziulusoy et al., 2013) (Ribeiro et al., 2018) (Hernández et al., 2020) (Suriyankietkaew and Avery, 2016) (Zhu et al., 2019) (McWilliams and Siegel, 2000) (Hull and Rothenberg, 2008)
	Diversity and inclusion	14	(Castka et al., 2004) (Sancho et al., 2018) (Khan et al., 2020) (Madueno et al., 2016) (Hammann et al., 2009) (Cantele and Zardini, 2018) (Martinez-Conesa et al., 2017) (Jenkins, 2006) (Hadj, 2020) (Stahl et al., 2019) (El Baz et al., 2016) (Ikram et al., 2019) (Moneva-Abadía et al., 2019)
	-Engagement		
	Anticipation and reflection	12	(Agan et al., 2013) (Madueno et al., 2016) (Hammann et al., 2009) (Cantele and Zardini, 2018) (Jenkins, 2006) (Bos-Brouwers, 2010) (Hadj, 2020)
	-Legislative landscape		(Stahl et al., 2019) (López-Pérez et al., 2017) (Ikram et al., 2019) (Chege and Wang, 2020) (Moneva-Abadía et al., 2019)
	-Assessment		
	-Public and ethical issues		
	-Imagen		
Main players	Clients/Customers	32	(Agan et al., 2013) (Aragón-Correa et al., 2008) (Bansal and Roth, 2000) (Battaglia et al., 2014) (Bos-Brouwers, 2010) (Brammer et al., 2012) (Cantele and Zardini, 2018) (Castka et al., 2004) (Cegarra-Navarro et al., 2016) (Dey et al., 2020) (Ghadge et al., 2017) (Hadj, 2020) (Hammann et

		al., 2009) (Hofmann et al., 2012) (Hoogendoorn et al., 2015) (Iraldo et al., 2017) (Jain et al., 2016) (Jain et al., 2017) (Jamali et al., 2009) (Jenkins, 2006) (Khan et al., 2020) (Lee et al., 2018) (Li et al., 2016) (Madueno et al., 2016) (Martinez-Conesa et al., 2017) (Martínez-Martínez et al., 2017) (Moneva-Abadía et al., 2019) (Preuss and Perschke, 2010) (Reverte et al., 2016)(Sen and Cowley, 2013) (Tantalo et al., 2012) (Torugsa et al., 2012)
Employees	28	(Aragón-Correa et al., 2008) (Battaglia et al., 2014) (Bos-Brouwers, 2010) (Brammer et al., 2012) (Canh et al., 2019) (Cantele and Zardini, 2018) (Castka et al., 2004) (Cegarra-Navarro et al., 2016) (Dey et al., 2020) (Hadj, 2020) (Hammann et al., 2009) (Hofmann et al., 2012) (Iraldo et al., 2017) (Jain et al., 2016) (Jain et al., 2017) (Jamali et al., 2009) (Jenkins, 2006) (Khan et al., 2020) (Lee et al., 2018) (Li et al., 2016) (Madueno et al., 2016) (Martinez-Conesa et al., 2017) (Martínez-Martínez et al., 2017) (Preuss and Perschke, 2010) (Reverte et al., 2016) (Sen and Cowley, 2013) (Tantalo et al., 2012) (Zhu et al., 2019)
Environment	15	(Aragón-Correa et al., 2008) (Bansal and Roth, 2000) (Battaglia et al., 2014) (Bos-Brouwers, 2010) (Hadj, 2020) (Iraldo et al., 2017) (Jain et al., 2016) (Jain et al., 2017) (Jamali et al., 2009) (Jenkins, 2006) (Khan et al., 2020) (Madueno et al., 2016) (Martinez-Conesa et al., 2017) (Tantalo et al., 2012) (Zhu et al., 2019)
Suppliers	14	(Aragón-Correa et al., 2008) (Battaglia et al., 2014) (Brammer et al., 2012) (Canh et al., 2019) (Dey et al., 2020) (Hofmann et al., 2012) (Jamali et al., 2009) (Jenkins, 2006) (Khan et al., 2020) (Lee et al., 2018) (Martinez-Conesa et al., 2017) (Sen and Cowley, 2013) (Tantalo et al., 2012) (Torugsa et al., 2012)
Community	14	(Bansal and Roth, 2000) (Battaglia et al., 2014) (Canh et al., 2019) (Hadj, 2020) (Jain et al., 2016) (Jain et al., 2017) (Jamali et al., 2009) (Jenkins,

			2006) (Khan et al., 2020) (Lee et al., 2018) (Martinez-Conesa et al., 2017) (Tantalo et al., 2012) (Torugsa et al., 2012) (Zhu et al., 2019)
	Owners/shareholders	7	(Aragón-Correa et al., 2008) (Jamali et al., 2009) (Jenkins, 2006) (Khan et al., 2020) (Lee et al., 2018) (Li et al., 2016) (Torugsa et al., 2012)
	R&D	7	(Sáez-Martínez et al., 2016) (Torugsa et al., 2013) (Silva et al., 2019) (Bos-Brouwers, 2010) (Jones and de Zubielqui, 2017) (Dangelico and Pujari, 2010) (McWilliams and Siegel, 2000)
	Government	5	(Brammer et al., 2012) (Ghadge et al., 2017) (Lee et al., 2018) (Torugsa et al., 2012) (Zhu et al., 2019)
	Competitors	4	(Aragón-Correa et al., 2008) (Ghadge et al., 2017) (Iraldo et al., 2017) (Torugsa et al., 2012)
	Funding agencies/Investors	4	(Torugsa et al., 2012) (Ghadge et al., 2017) (Silva et al., 2019) (Sen and Cowley, 2013) (Lee et al., 2018)
	Alliances	4	(Castka et al., 2004) (Sáez-Martínez et al., 2016) (Burlea-Schiopoiu and Mihai, 2019) (Dangelico and Pujari, 2010)
Contingent variables	Size	27	(Besser and Miller, 2001) (Reverte et al., 2016) (Sáez-Martínez et al., 2016) (Cassells and Lewis, 2011) (Hofmann et al., 2012) (Torugsa et al., 2012) (Torugsa et al., 2013) (Stoian and Gilman, 2017) (Sancho et al., 2018) (Madueno et al., 2016) (Aragón-Correa et al., 2008) (Choongo, 2017) (Burlea-Schiopoiu and Mihai, 2019) (Martínez-Martínez et al., 2017) (Tang and Tang, 2018) (Tang and Tang, 2012) (Jain et al., 2016) (Tang et al., 2012) (Agan et al., 2013) (Brammer et al., 2012) (Cantele and Zardini, 2018) (Muñoz-Pascual et al., 2019) (Khan et al., 2020) (Preuss and Perschke, 2010) (Tantalo et al., 2012) (Hernández et al., 2020) (Canh et al., 2019) (McWilliams and Siegel, 2000)
	Type of industry	17	(Bansal and Roth, 2000) (Besser and Miller, 2001) (Reverte et al., 2016) (Sáez-Martínez et al., 2016) (Hofmann et al., 2012) (Stoian and Gilman,

		2017) (Burlea-Schiopoiu and Mihai, 2019) (Jain et al., 2016) (Jain et al., 2017) (Tang et al., 2012) (Agan et al., 2013) (Cantele and Zardini, 2018) (Leonidou et al., 2017) (Muñoz-Pascual et al., 2019) (Perrini et al., 2007) (Tantalo et al., 2012) (McWilliams and Siegel, 2000) (Hull and Rothenberg, 2008)
Firm age	12	(Besser and Miller, 2001) (Reverte et al., 2016) (Cassells and Lewis, 2011) (Hofmann et al., 2012) (Stoian and Gilman, 2017) (Choongo, 2017) (Tang and Tang, 2018) (Tang and Tang, 2012) (Jain et al., 2016) (Muñoz-Pascual et al., 2019) (Khan et al., 2020) (Hoogendoorn et al., 2015)
Innovation	13	(Reverte et al., 2016) (Aragón-Correa et al., 2008) (Martínez-Martínez et al., 2017) (Kraus et al., 2017) (Martinez-Conesa et al., 2017) (Cegarra-Navarro et al., 2016) (Jones and de Zubielqui, 2017) (Ratnawati et al., 2018) (Hadj, 2020) (Zhu et al., 2019) (Moneva-Abadía et al., 2019) (Canh et al., 2019) (Hull and Rothenberg, 2008)
Country	3	(Bansal and Roth, 2000) (Sáez-Martínez et al., 2016) (Perrini et al., 2007)
Corporate strategy	2	(Reverte et al., 2016) (Stoian and Gilman, 2017)
Learning orientation	2	(Ratnawati et al., 2018) (Rhee et al., 2010)
Employee's commitment	2	(Sancho et al., 2018) (Choongo, 2017)
Relational marketing	2	(Sancho et al., 2018) (Martínez-Martínez et al., 2017)

Chapter 4. CSR practices associated with the spread of responsible innovation

Case study: Microfinance intermediaries in La Paz-Bolivia

*"If you always do what you always did, you will always get what you always got."
Albert Einstein.*

Abstract

In an increasingly competitive environment, survival is a challenge for SMEs that today more than ever seek corporate sustainability through "innovation" that generates economic benefits, but also "responsibility" to generate social value connected to the global challenges of society. In this sense, responsible innovation responds to a process of co-responsibility of ethical acceptability, social coexistence, and the construction of a holistic sustainability. The aim of this research is to explore empirically whether corporate social responsibility practices towards stakeholders - customers, employees, community, and environment - promote responsible innovation and financial performance in SMEs. The findings suggest that employees, customers, and the environment are the most important stakeholders and that responsible innovation along with the dimensions of responsiveness (36%), inclusiveness (27%), reflexivity (27%), and anticipation (10%) can be promoted by CSR practices that result from stakeholder collaboration if (and only if) SMEs act proactively. Furthermore, the relationship between CSR and financial performance mediated by responsible innovation was positive but weak. This research contributes to the understanding of the concept of responsible innovation in business and its relationship to financial performance in SMEs.

4.1. Introduction

SMEs are the economic engine in terms of employment in developing countries. In Latin America, for example, it is estimated that SMEs account for 98% of all enterprises (Vives et al., 2005). It is not surprising, then, that their individual impact is not proportional to their overall size. However, growing global concern about natural resource degradation, climate change, economic progress, and societal well-being has attracted the attention of practitioners and researchers with recent evidence on the integration of ethics and corporate social responsibility aspects into actions, decisions, and as a way to achieve sustainability in SMEs (Ratnawati et al., 2018). In the light of this situation, corporate social responsibility, which was first introduced by Bowen (1953), emerged as actions that encourage ethical initiatives by companies in the course of their business activities and in a broader perspective of profitability.

From the results standpoint, authors have shown, with the plethora of studies related to CSR activities and the multitude of similar terms to refer to it (Ortiz-Avram et al., 2018) that, companies get involved in such activities because 1) they are associated with internal or external benefits or both, in addition, 2) for their capacity to promote innovation (Porter, 1985). In the first case, authors have reported positive and practical results of CSR activities in SMEs, especially as a possible driver of financial performance (e.g. Madueno et al., 2016; Martínez-Martínez et al., 2017; Moneva-Abadía et al., 2019), while other authors have revealed a partial effect relationship (Martinez-Conesa et al., 2017) or even a positive but weak relationship (Orlitzky et al., 2003). In the second case, CSR practices are capable of promoting innovation, resulting from collaboration with other stakeholders (ECR, 2008).

The European Union's 2008 Competitiveness Report (ECR, 2008) argues that one of the main ways in which CSR practices can promote innovation is through stakeholder collaboration. Consequently, it seems that CSR could not only promote innovation, but also encourage the stakeholder involvement that is essential for responsible innovation, i.e. consideration of individual stakeholders alone is not sufficient to explain the environment in which a company operates, but rather "jointly" with other stakeholders (Tang and Tang, 2018). Consequently, CSR practices seem to act as drivers to promote responsible innovation through stakeholder engagement.

Responsible Research and Innovation (RRI) or Responsible Innovation (RI) means “taking care of the future through collective stewardship of science and innovation in the present” (Stilgoe et al., 2013, p. 1570), which is a continuous process of aligning research and innovation with the values, needs and expectations of society. In other words, RI is more specific and refers to the *early stages of technology development* (de Poel et al., 2017), to the *early inclusion of stakeholders in the innovation process*. Stakeholders are therefore crucial in the RI debate (Von Schomberg, 2013) and their selection lies in who will contribute, but also in those who will be affected by the innovation process because, when these stakeholders understand the objectives to follow the RI principles, they can commit themselves to achieve them (Chatfield et al., 2017). However, how **CSR practices relate to "responsible innovation" (rather than innovation in general) remains an important research gap in SMEs** (Auer and Jarmai, 2018; Martinuzzi et al., 2018; Ribeiro et al., 2018; Von Schomberg, 2013), which will be explored in this study, i.e. to empirically analyse whether CSR practices towards stakeholders - customers, employees, community, and environment - promote responsible innovation and what the mediating effect of this is on the relationship of CSR practices and financial performance in SMEs.

The research is organized as follows. Section 2 reviews and discusses the related literature. Section 3 describes the research methodology, presents the conceptual model and the experimental hypothesis on which it is based, and provides the empirical findings. Section 4 analyses the data to validate the model and Section 5 concludes with the results.

4.2. Theoretical background and hypotheses development

The integration of responsible innovation in companies is still in its infancy and is greater when it comes to small and medium-sized enterprises (SMEs). In the study by De Poel et al. (2017) proposed a conceptual model to be able to integrate responsible research and innovation into corporate social responsibility policies. They argued that companies should think about and make decisions about which elements can add value to society in order to implement RRI activities. This study, however, is limited in its application because at the operational level it simply describes elements, so there is not yet a clear understanding of what should be "done" (Ribeiro, Barbara E and Smith, Robert DJ and Millar, 2017), especially in small and medium enterprises that are largely unaware of what the concept of RI implies (Auer

and Jarmai, 2018) because as it is an emerging issue very little research has been done to understand in a practical way its influence on social values and organisational capacities (Pandza and Ellwood, 2013). Although the latter argument was not empirically tested, a conceptual model describing the relationship between practices, including CSR, that promote RI and performance in SMEs was later found by Gonzales-Gemio et al. (2020). The authors conclude that RI is able to positively influence organisational performance, furthermore, that stakeholders who are able to articulate their interests unambiguously and are promoters of initiating strategies to drive responsible innovation in SMEs, changing the perception that the company is the only driver.

Although it is argued that CSR strategies are like instruments that SMEs apply to promote "responsible" behaviour towards external and internal stakeholders (Perrini et al., 2007), it is also a fact that such CSR strategies are recognized as promoting innovation. The European Union's 2008 Competitiveness Report (ECR, 2008) argues that there are three main ways in which CSR can contribute to innovation capacity and performance, which are: (a) innovation resulting from collaboration with other stakeholders; (b) identifying business opportunities by solving societal problems; and (c) creating more innovation-friendly workplaces. In terms of stakeholder collaboration, which is where this research focuses, innovation appears to be the result of collaboration with other stakeholders. However, analogous to stakeholder theory, where there is an inherent acceptance that all firms have stakeholders and that managing them properly can help reduce risk and enhance corporate social responsibility for all firms (European and SMEs, 2002), the RI debate emphasises that stakeholder selection is about who will contribute, but also who will be affected. In that line, stakeholders are any group or individual that can affect or be affected by the fulfilment of the objectives defined by the organisation (Freeman, 2010). Indeed, relationships with key stakeholders may determine how SMEs address CSR practices (Jenkins, 2006). Therefore, stakeholder engagement in the RI debate is crucial (Von Schomberg, 2013). In this line, when stakeholders understand the objectives for following the RI principles, they can commit to achieving those (Chatfield et al., 2017). For example, in the study by Silva et al. (2019) investigated stakeholder engagement in the context of responsible research and innovation, to try to link the innovation process with the concept of CSR.

The study found that stakeholders are included at a late stage in the innovation process, i.e. at the final innovation stage, when the product or service is already on the market, which allows for some adaptation of solutions, but of a limited nature. The study then suggests improving the development of responsible innovation by incorporating elements of innovation management, such as the early inclusion of stakeholders in the process to ensure responsible outcomes. In the case of SMEs, the main stakeholders are the *employees, clients, community, the environment, government, university*; other stakeholders are the investors, the market, the competitors (Muñoz-Pascual et al., 2019).

4.2.1. Customers

Customers are the essential stakeholders for businesses (Freeman, 1984) because they are the ones who provide the cash flow to SMEs (Tang and Tang, 2012). The study by Tang & Tang (2012) investigated the impact of the power difference between stakeholders and companies on SMEs' environmental performance and CSR orientation, and in doing so found that, customers have a positive but statistically insignificant effect on environmental performance. In contrast, the study by Preuss and Perschke (2010) emphasised that smaller companies do not pay much attention to stakeholders beyond the dominant client on whom they often depend. Similarly, the study by Hammann et al. (2009) concluded that customers are the second most important stakeholder group for SMEs after employees. CSR initiatives towards customers consist of providing high quality products, with accurate and complete information, at reasonable prices, with channels that allow for customer involvement. This latter understanding is crucial in the responsible innovation debate because, a space that allows for early inclusion of stakeholders will enhance their development and ensure responsible outcomes (Silva et al., 2019). Therefore, it seems that CSR towards customers, besides having an impact on the financial performance of the company (Cegarra-Navarro et al., 2016; Hammann et al., 2009; Jain et al., 2017; Preuss and Perschke, 2010; Reverte et al., 2016; Tang and Tang, 2012). Also, it seems to act as a support to promote the adoption of responsible innovation practices in SMEs (Hadj, 2020; Silva et al., 2019). As stated in the following hypotheses:

H1. CSR towards customers has a significant positive relationship with the FP in SMEs.

H2. CSR towards clients has a significant positive relationship with the adoption of RI practices in SMEs.

4.2.2. Employees

Employees are the main stakeholders of a company (Freeman, 2010) and their influence is related to financial performance (Hammann et al., 2009). The study by Jain et al. (2016) concluded that although the relationship between CSR and financial performance is positively weak similar to the findings of Orlitzky et al. (2003), 78% of the variance explaining their model lies with employees, which is also a challenge for SMEs which are more sensitive to the close relationships they have with their stakeholders such as employees and community (Jenkins, 2006). For example, in the study by Hammann et al. (2009) which examined what kind of socially responsible practices SME managers are employing in relationships with key stakeholders, they found that executives can express their values more easily towards internal stakeholders than towards an abstract group such as society. Similarly, the study by Choong, (2017) concluded that relationship between CSR and financial performance is significant, but that employee engagement can be negatively affected when there is no investment in employee training and development. The findings show that CSR towards employees consists of progressive initiatives such as commitment to health and safety, policies aimed at work-life balance, career development, and equal opportunities. The research also shows that such actions could have a connection with short and long term performance, the former related to improving working conditions, motivating employees accordingly less sick leave, encouraging innovation, and in the long term an increase in employee productivity (Cegarra-Navarro et al., 2016; Reverte et al., 2016; Jain et al., 2016). On the basis of the existing literature, CSR for employees seems to contribute to the adoption of responsible innovation practices which in turn improve FP in SMEs (Cantele and Zardini, 2018; Cegarra-Navarro et al., 2016; Choongo, 2017; Jones and de Zubielqui, 2017; Madueno et al., 2016; Martinez-Conesa et al., 2017; Preuss and Perschke, 2010; Ratnawati et al., 2018; Sancho et al., 2018) among others, then we formulate the following hypotheses:

H3. CSR towards employees has a significant positive relationship with the FP in SMEs.

H4. CSR towards employees has a significant positive relationship with the adoption of RI practices in SMEs.

4.2.3. Community

The community is an important stakeholder for SMEs (Jenkins, 2009). Similarly, SMEs are also important actors within their local community (Perrini et al., 2007) because, local reach influences their survival (Freeman and Reed, 1983). For example, according to the study by Stoian & Gilman (2017) (Stoian and Gilman, 2017) investigated the extent to which CSR activities aligned with the company's competitive strategy encourage their improvement and growth, SMEs that carry out community-related CSR activities improve their growth and are more likely to grow rapidly. While the study by L. Li et al. (2019) concluded that community-friendly activities are partly mediated by the dynamic capacity of the enterprise, which means that social participation improves the performance of service innovation. Through CSR activities such as hiring and purchasing policies that favour local communities, participation in specific projects, volunteer employees on behalf of the company, or grassroots activities such as sponsorships, charities, or similar. Thus, by focusing on local communities, while contributing to the social activities of the local community (Sen and Cowley, 2013). In addition, they benefit from favourable tax legislation and reduced local regulations (Stoian and Gilman, 2017) which seem to directly or indirectly influence responsible innovation and financial performance (Von Schomberg, 2012) as indicated in the following hypothesis:

H5. CSR towards community has a significant positive relationship with the FP in SMEs.

H6. CSR towards community has a significant positive relationship with the adoption of RI practices in SMEs.

4.2.4. Environment

Concern for environmental care has increasingly attracted the attention of practitioners and researchers (Hofmann et al., 2012; Reverte et al., 2016; Tang and Tang, 2018). However, despite the fact that there is greater commitment and understanding among SME managers about climate change

(Williams and Schaefer, 2013), some managers do not perceive it as a beneficial issue. For example, the study by Sáez-Martínez et al. (2016) found that only 9% of companies, out of a sample of 3.647 SMEs in 38 countries, considered environmental responsibility as one of their priority objectives. Meanwhile, the study by Tang & Tang (2018) concluded that the company may perceive that stakeholder pressure for environmental performance is only for showcase purposes. Therefore, while the company may strive to improve its strengths, to offset the additional costs associated with that effort, they could continue to engage in behaviours that lead to more concerns. Then, only when stakeholder pressure increases "jointly" with other stakeholders the company begin to seriously address its environmental concerns. This can be illustrated with the study by Tang & Tang (2012) which concluded that while power differences between governments and competitors significantly affect the environmental performance of SMEs, the influence of competitors could not be as strong as that of governments. So the inclusion of other stakeholders is a crucial understanding because, responsible innovation activities imply the reconsideration of the business role in society (Auer and Jarmai, 2018) with stakeholders (Stilgoe et al., 2013) to solve or improve environmental or social problems (Halme and Korpela, 2014).

Moreover, the above research also refers to the fact that environmentally friendly activities influence firm performance in SMEs. For example, the study by L. Li et al. (2019) found that the effect of environmentally friendly activities influences the performance of service innovation only if it is mediated by advanced dynamic capacity¹⁶. Similarly, Hang et al. (2019) concluded that causality between environmental and financial performance depends on the time horizon, which is significant as it encourages managers to maintain a proactive environmental policy as well as not to abandon investments if the financial success is not immediately visible. Thus, a company's investment in environmental activities such as programmes for the introduction of alternative energy sources, investments in energy saving programmes, recycling and waste management, in addition to ecological packaging or containers creates responsible actions in the community which could intensify performance in SMEs. Therefore, it seems that CSR towards environment, besides having an impact on financial performance of

¹⁶ Dynamic capacity is the "ability of the firm to integrate, build and reconfigurar internal and external competencies to cope with rapidly changing environments" (Li et al., 2019).

company, it seems to promote the adoption of responsible innovation practices in SMEs, as we propose in the following hypothesis:

H7. CSR towards environment has a significant positive relationship with FP in SMEs.

H8. CSR towards environment has a significant positive relationship with adoption of RI practices in SMEs.

4.2.5. Responsible Innovation and financial performance in SMEs

Responsible innovation efficiency in a company depends on its strategy to seek, on one hand, added value for society, and also to make profits (de Poel et al., 2017). Moreover, according to the same article, although strategies linked to practices that drive responsible innovation, such as CSR and SI, promote potential organizational performance, these strategies must shift from their conservative, philanthropic, defensive way of addressing social, environmental and ethical issues towards a progressive way of "doing good".

The analysis of the articles that measured the organisation's performance shows various indicators, ranging from quantitative performance indicators (e.g. ROA, productivity, sales growth, market share, etc.) to qualitative ones (e.g. customer satisfaction, brand image and corporate reputation, employee motivation, etc.) and from different fields of innovation, such as empirical work and literature reviews. As regards performance indicators related to responsible innovation practices, which are less frequent, but which previous research has considered (e.g. diversity and inclusion, anticipation and reflection, responsiveness and adaptive change, openness and transparency, environmental sustainability, social sustainability) are grouped according to the classification of De Poel et al. (2017) for small and medium enterprises.

Some authors measured performance by considering financial as well as non-financial indicators and revealed a positive causal link. An empirical example is the study by Reverte et al. (2016) who investigated the mediating role of innovation in the relationship between social responsibility and organizational performance in SMEs. They revealed that social responsibility practices have a direct, positive and significant effect on both innovation and organisational performance, covering both financial (such as the level of sales growth; the level of ROE; ROA; market share; level of productivity) and non-financial (the quality of products and/or services offered) indicators;

technological position and coordination of internal processes; coordination and organisation of human resources; degree of customer satisfaction; degree of adaptation to changing market needs; brand image and corporate reputation; employee motivation; staff turnover; and staff absenteeism). In addition, they reported that long-term benefits are reflected either internally, externally or both. Internally by helping to develop new resources and capabilities that relate to technical knowledge and business culture. Externally by being linked to the reputation of the companies which in turn improves relationships, attracts better employees or increases their motivation and commitment; or both. In this way, social responsibility positively influenced organisational performance.

According to Torugsa et al. (2012) the relationship between CSR practices of SMEs and financial performance revealed that the specified capabilities (such as shared vision, stakeholder management and proactivity) share a positive association with proactive social responsibility, which in turn improves the company's financial performance. In addition, they reported that SMEs can maximize their financial benefits while proactively moving towards corporate social responsibility. Similarly, Aragón-Correa et al. (2008) found a significantly positive relationship between proactive social responsibility related to the environment and the financial performance of SMEs. The study by Hammann et al. (2009) on the relationship between socially responsible practices in SMEs and value creation towards stakeholders found that socially responsible practices towards employees, customers and, to a lesser extent, society, have a positive impact on the company and its performance.

Previous research also showed a positive but weak relationship between social responsibility activities and financial performance. For example, in the study by Jain et al. (2016) found a significant but weak positive relationship between social responsibility and financial performance, the indicators used were: the company's profit margin; satisfaction with the change in profit margin; company sales and long-term consequences. The model explained 81% of the variance in customers, 78% of the variance in employees, 82% of the variance in environment and 67% of the variance in community. This showed that corporate social responsibility contributed positively to the different stakeholders.

Another way of measuring performance has been related to some indicators of responsible innovation. Previous research has considered aspects related, for example, to diversity and inclusion. Previous research shows that positively improving employees' individual performance, satisfaction and commitment contributes to company performance at the organisational level (Sancho et al., 2018). In the study by Khan et al. (2020) analysed the sustainable social responsibility dimensions related to employees, environment, community, suppliers and customers on performance in SMEs. The results revealed that managing the relationship with a company's key stakeholders has a significant positive influence on sustainable competition and business performance. In addition, the need to take multiple stakeholders seriously, and not just owners, was highlighted. Similarly, Choongo (2017) found that while the social and environmental dimensions of socially responsible practices in SMEs have a significant impact on financial performance, performance measures related to corporate reputation and employee engagement were only partially significant because employee engagement can be negatively affected when there is no investment in employee training and development. Meanwhile, the study by Ratnawati et al. (2018) examining the effect of learning orientation and innovation in mediating social responsibility on performance and competitive advantage in SMEs revealed that social responsibility activities have a significant effect on learning orientation, innovation and performance in SMEs. In the same vein, the study by Burlea-Schiopoiu and Mihai (2019) investigated the relationship between three sustainability factors (CSR, innovation and training) and their effects on competitive advantage of SMEs in Romania. The study found that employee training, innovation and social responsibility practices are significant and correlated factors in promoting competitive advantage in SMEs.

H9: RI practices derived from CSR have a positive effect on the financial performance of SMEs

To sum up, Figure 11 shows the studied relationships:

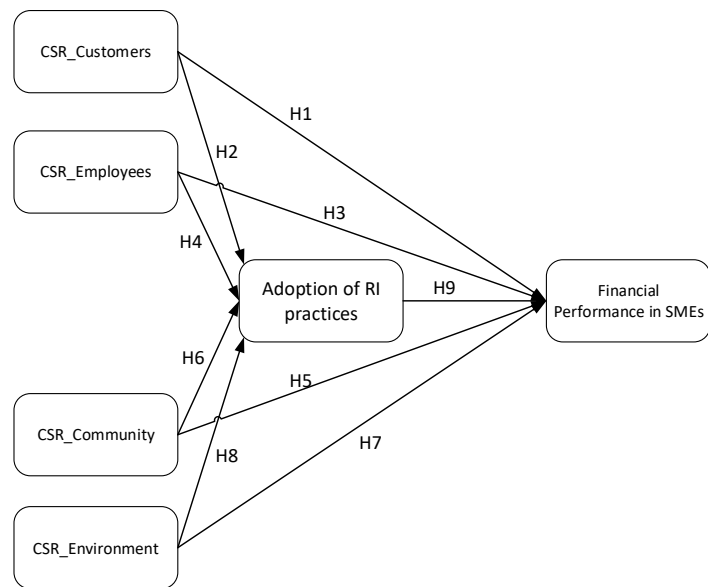


Figure 11. Research model

4.3. Methodology

4.3.1. Selection of the population and the sample

Bolivia, is a country with an economy mainly concentrated in extractive activities in mining and hydrocarbon sector, made up of 95% of micro-enterprises and 4.8% of small and medium enterprises (National Institute of Statistics of Bolivia). It also has an informal sector which is among the highest in the region at approximately 80%, i.e. 7 out of every 10 employees are in the informal sector. This is largely related to the major challenges Bolivia still faces in closing productivity gaps as well as maintaining growth rates in the coming years without causing macroeconomic imbalances (Foronda et al., 2018).

On the other hand, at the public policy level, despite the fact that Bolivia has a corporate social responsibility policy approved in August 2019, its implementation is still incipient and follows resolution No. 220/2013 on Corporate Social Responsibility issued by the Financial System Supervisory Authority (ASF¹⁷), which is mandatory for financial institutions in Bolivia.

¹⁷ The purpose of ASF¹⁷ is to regulate, control and supervise financial services within the framework of the Political Constitution in Bolivia, Law No. 393 on Financial Services and the Supreme Regulatory Decrees, as well as the activity of the securities market, intermediaries and their auxiliary entities.

It was therefore decided to choose local microfinance intermediaries, because they are the ones that at national level work with CSR programmes, aimed at showing management transparency, ethical behaviour and respect for the stakeholders and the national legislation in force since 2013. The surveys were addressed to the senior management of these entities and the unit of analysis was therefore local microfinance intermediaries in La Paz city of Bolivia. The questionnaire was constructed based on three previous interviews with national managers of financial institutions and following the guidelines of Bolivia's corporate social responsibility policy. This process resulted in 23 items which were organised into four constructions: CSR clients with four elements, CSR employees with four elements, CSR community with four elements, CSR environment with four elements, the responsible innovation construct with four elements and the financial performance construct with three elements. The data was collected initially by sending the questionnaire via email, and then by making phone calls to ensure maximum participation. Of the 579 local microfinance intermediaries and securities market participants registered and authorised by ASFI, 121 completed the survey, resulting in a response rate of 21%. The response rate is higher than average response rate of 15-20% suggested by Menon et al. (1996). Table 13 summarizes the sample demographics. The questionnaire is presented in the Appendix.

Table 13. Demographic characteristics of sample (N=121)

Characteristic	Percentage
<i>Number of employees</i>	
10 - 49	9.1
50 - 250	90.9
Total	100
<i>Annual income (UFV)</i>	
Between UFV 600,001 and UFV 3,000,000	21.5
Between UFV 3,000,001 and UFV 12,000,000	17.4
Greater or equal to UFV 12,000,001	61.1
Total	100
<i>Respondent position</i>	
Owner/Director	17.4
Manager/Sub-Manager	43.8
Executive	38.8
Total	100
<i>Gender</i>	
Male	56.2
Female	43.8
Total	100

4.3.2. Measurement

Data was collected through an online questionnaire designed for the purpose and to gather owner-manager perceptions. Responses ranged from "1: strongly disagree", "2: disagree", "3: neutral", "4: agree", and "5: strongly agree" for CSR items, to "1: not at all", "2: rarely", "3: often", "4: always" for RI items, and "1: not at all", "2: rarely", "3: often", "4: always" for financial performance items.

The approach by Jain et al. (2017) was used for the development of the questionnaire. In addition, scales from other relevant empirical studies were combined with new items that emerged from the interview to make an initial list of 23 items distributed as follows: 4 focusing on measuring customer construct, 4 focusing on measuring employees construct, 4 focusing on measuring community, 4 focusing on measuring the environmental construct, 4 focusing on measuring responsible innovation, and finally 3 items focusing on measuring financial performance (see Appendix for a list of items).

According to the study by Hadj (2020) the dimensions of responsible innovation were constructed. Then, CSR-related to customers, employees, community and the environment in line with the approach by Jain et al. (2017), among others.

Responsible innovation has been measured in various ways in previous research. In the present study, responsible innovation has been measured using a 4-item scale taken from the framework for responsible innovation developed by Stilgoe et al. (2013) and applied in the study by Hadj (2020), namely the dimension of inclusion, responsiveness, reflectiveness, and anticipation. For financial performance construct, this study used the measures of company performance commonly used in the literature such as return on assets (ROA), sales growth, and productivity level, asking owner-managers to rate the relative performance of their company over the last three years. Finally, redundant items or items outside the acceptable parameters were eliminated through an analysis of the scale items. According to the recommendation proposed by Chin (1998), indicators for reflective constructions that were equal to or higher than the acceptable threshold of 0.70 for their factor loads were maintained.

4.4. Result and Discussion

Data were analysed in two stages, on the one hand, an assessment of the reliability and validity of the measurement scales and, on the other hand, the causal relationships between CSR and FP were analysed using the structural equation model (SEM). For the analysis of our data, an exploratory factorial analysis of the variables was carried out, the Kaiser-Meyer-Olkin (KMO) test revealed a value of 0.758 (higher than the recommended value of 0.7). Bartlett's sphericity test was 1216 (df = 253) with a significance of 0.000. These results confirmed the unidimensionality between the scales. Next, a confirmatory factorial analysis of the model constructs was made, restricting each element to load it in its a priori established factor (Anderson and Gerbing, 1988). To measure the structural model, the method of maximum robust plausibility of the asymptotic variance-covariance matrix with EQS 6.4. was used, which as a result gave an acceptable fit to the data, and with each factor of the constructs assigned to the model. Some of the goodness-of-fit values were: χ^2 / d.f.=1.76, RMSEA = 0.08, y CFI=0.9 (see Table 14).

Table 14. Measurement model

Constructs	Scale items	Standardised loadings	<i>t</i> value	<i>R</i> ²	
CSR Customer	CUS1	0.61		0.46	Cronbach's alpha: 0.61 AVE: 0.50 CR: 0.70
	CUS2	0.60	3.87	0.42	
	CUS4	0.70	5.29	0.49	
CSR Employee	EMP1	0.66		0.44	Cronbach's alpha: 0.77 AVE: 0.50 CR: 0.70
	EMP2	0.81	9.33	0.66	
	EMP4	0.70	7.81	0.46	
CSR Community	COM1	0.62		0.47	Cronbach's alpha: 0.72 AVE: 0.52 CR: 0.81
	COM3	0.76	5.42	0.58	
	COM4	0.77	4.82	0.60	
CSR Environment	ENV2	0.63		0.48	Cronbach's alpha: 0.76 AVE: 0.58 CR: 0.84
	ENV3	0.90	4.91	0.81	
	ENV4	0.74	5.09	0.55	
Responsible Innovation	RI1	0.62	2.18	0.38	Cronbach's alpha: 0.75 AVE: 0.55 CR: 0.83
	RI2	0.84	2.30	0.70	
	RI3	0.63	1.18	0.40	
Financial Performance	FP1	0.75	0.55	0.56	Cronbach's alpha: 0.77 AVE: 0.70 CR: 0.86
	FP2	0.84	0.59	0.71	
	FP3	0.92	0.59	0.85	

Discriminant validity was also met and was examined through correlations between independent variables that were lower than the square root of the mean extracted variance (AVE) (Anderson and Gerbing, 1988). While the mean extracted variance for each construction was equal to or greater than the threshold level of 0.50 (Hair et al. 2011) (see Table 15). All factors had values of composite reliability higher than 0.7, which denote a reliable measurement of our constructions as components of the structural model (Bagozzi and Yi 1988).

Table 15. Correlation matrix of latent factors

	1	2	3	4	5	6
1. CSR customer	0.71					
2. CSR employee	0.64	0.71				
3. CSR community	0.61	0.70	0.72			
4. CSR environment	0.43	0.51	0.33	0.76		

5. Responsible innovation	0.62	0.58	0.28	0.37	0.74	
6. Financial performance	0.40	0.35	0.43	-0.20	0.35	0.84

Diagonal elements are the square roots of average extracted (AVE).

Correlations greater than $|\pm 0.21|$ are significant at the .01 level

The adjustment rates obtained in the estimation of this model as the Chi square proved to be statistically significant ($\chi^2_{\text{Satorra-Bentler}} = 242.04$, $p = .00$; $df = 137$), the relationship between Chi-square and degrees of freedom was satisfactory (i.e. $\chi^2/df = 1.77$) and the values of the alternative adjustment indices were within acceptable levels (NFI = 0.90, CFI = 0.87, RMSEA = 0.08). In Table 16 the normalized path coefficients obtained in the estimation of this model are presented together with the value of t .

Table 16. Results of the structural model

	Hypothesis	Coefficient	t- Value	Status
Path	H1: CSR customer → Financial performance	0.90	6.70	Accepted
	H2: CSR customer → Responsible innovation	0.87	5.73	Accepted
	H3: CSR employee → Financial performance	0.69	5.13	Accepted
	H4: CSR employee → Responsible innovation	0.90	6.97	Accepted
	H5: CSR community → Financial performance	0.21	1.19	Rejected
	H6: CSR community → Responsible innovation	0.32	2.19	Accepted
	H7: CSR environment → Financial performance	0.47	3.04	Accepted
	H8: CSR environment → Responsible innovation	0.52	4.75	Accepted
	H9: Responsible innovation → Financial performance	0.34	2.68	Accepted
Correlations	CSR customer and CSR employee	0.94	4.53	
	CSR customer and CSR community	0.71	3.53	
	CSR customer and CSR environment	0.44	2.99	
	CSR employee and CSR community	0.70	3.79	

CSR employee and CSR environment	0.52	3.27
CSR community and CSR environment	0.33	2.25

Fit statistics Chi square (χ^2 Satorra-Bentler) = 242.04, $p = .00$; $df = 137$; Ratio Chi square to d.f. (χ^2/df) = 1.77; normed fit index (NFI) = .90; comparative fit index (CFI) = .87; root mean squared error of approximation (RMSEA) = .08; 90 % confidence interval of RMSEA = (.06, .09)

According to the results, CSR towards stakeholders is positively related to financial performance, which supports H1, H3 and H7. Furthermore, CSR towards stakeholders promotes RI in SMEs, which supports H2, H4, H6, H8. In the first finding the hypotheses H1 ($\beta = 0.90$, $t = 6.70$), H3 ($\beta = 0.69$, $t = 5.13$), and H7 ($\beta = 0.47$, $t = 3.04$) confirm that employees, customers and the environment are the most important stakeholders for SMEs, and that their relationship between CSR and FP has a positive but weak relationship. The above result is fully in line with the findings of the study by Jain et al. (2016) which found a positive but also weak relationship between CSR through the stakeholder approach and FP of SMEs. This suggests that although the CSR strategy contributed positively to stakeholders (such as clients, employees and the environment), it is still conceived in philanthropic rather than strategic terms, which may also be due to the fact that in Bolivia regulations legally force companies to adopt socially responsible behaviour date from recent years, and have therefore been more of a voluntary activity. However, the CSR strategy towards the clients of small and medium sized companies and in activities such as information on their products and/or services and the value for money shown by the highest weights in the model, favours their reputation and recognition by society as socially responsible companies. Similarly, in relation to employees, our results coincide with studies by Sancho et al. (2018) because, when SMEs take care of the well-being of their employees, they improve productivity which leads to an improvement in organisational performance. In the case of the results related to the environmental factor, it is shown that the SMEs in the sample focus their efforts on savings programmes related to waste management followed by energy management, which is interesting because it suggests that companies have started to make efforts to become sustainable companies which is key to improve performance in a company, which is also supported by the findings of the study by Hsu et al. (2017). In the case of CSR activities towards community, the study by Choongo (2017) found that SMEs engage

in such activities when they perceive benefits. In our study, while H5 ($\beta = 0.21$, $t = 1.19$) has been rejected, what it suggests to us is that this could have been due to the short term vision that could have been interpreted with our instrument, being that in the context of our sample a clear influence of the communities can be perceived at company level, strong enough to influence the personal interests of owner-managers, which in Bolivia is known as "Vivir Bien"¹⁸, so SMEs cannot ignore the expectations of the community, and in the long term will favour mutual support between the company and the community (Stoian and Gilman, 2017) and, could lead to better financial performance (Choongo, 2017).

On the other hand, our study has found that RI plays a full mediating role between the relationship between CSR and FP. This is confirmed by the hypotheses H2 ($\beta = 0.87$, $t = 5.73$), H4 ($\beta = 0.90$, $t = 6.97$), H6 ($\beta = 0.32$, $t = 2.19$), and H8 ($\beta = 0.52$, $t = 4.75$). The results show that, RI reflects a partial positive indirect effect, that is, if a CSR strategy towards the stakeholders is correctly adopted, this could be a useful long-term strategy for SMEs to achieve financial performance through responsible innovation. Responsible innovation that is promoted by the effect of CSR activities towards stakeholders, and which has been identified through the dimensions of RI related to *inclusion*, *responsiveness*, *reflectivity* and *anticipation*. In the process of convergent validity of the model, it was found that the item related to *responsiveness* was the most significant (36%), followed by the item related to the *inclusion dimension* (27%) and the item related to the *reflectivity dimension* (27%). This is in line with the study by Cassells and Lewis (2011) which found that although 80% of the owner-managers declared to be aware of the possible environmental risks derived from the work they do, only 87% agreed that regulation alone cannot protect the environment without the voluntary actions of companies. Also, the

¹⁸ 'Vivir Bien' is life in its fullness, it about knowing how to live in balance and harmony with nature, in harmony with the cycles of Mother Earth, of the cosmos, of life and of history, and in balance with all forms of existence. It is not the same as living better, because that involves the need to exploit on the basis of competition. This declaration was reaffirmed in the Political Constitution of the Plurinational State of Bolivia (2009), and marked the beginning of a new stage in its history to save Mother Earth and to confront the problems of climate change, the energy crisis, water shortages, food production and other crises that beset the planet, proposing ten commandments to save the planet, humanity and life, the tenth of which is 'Living Well', the Suma Qamaña and other similar indigenous expressions, and which refers to rebuilding the Living Well of our ancestors.

environmental practices are associated with a potential financial benefit rather than an environmental protection motivation, due to this fact the processes are fortuitous rather than expected results. But it is the effect with respect to the dimension of the response capacity that is driven by CSR activities through the stakeholders, that calls our attention because it had to do with the capacity of SMEs to identify possible risks and act accordingly. This is in line with previous studies which state that some organisational and managerial characteristics of SMEs (e.g. informal, flexible communication style, with fewer hierarchical levels) are favourable to their responsiveness to the changing needs of the company and stakeholders (Torugsa et al., 2012) and, as a result, these personal attitudes may affect the socially responsible behaviour of SMEs as dictated by needs on the one hand (Brammer et al., 2012), and their capacity to innovate on the other (Jenkins, 2006). On the other hand, the item related to the inclusion of stakeholders at different stages is considered imperative for a responsible innovation process. This is supported by Cegarra-Navarro et al. (2016) which stated that the social responsibility of a company implies the participation of multiple internal and external stakeholders to generate favourable attitudes and better socially responsible behaviours. Finally, the item related to the dimension of reflexivity, which has also proved to be influential within the factor of RI which shows us that there is a willingness on the part of the owner-managers of SMEs in the sample to be able to integrate self-awareness values and beliefs in their activities. In this respect, studies such as for example Jenkins (2006) and Dangelico and Pujari (2010) showed that awareness of the role and power of business in society, mostly based on moral and ethical arguments, i.e. doing "the right thing", that "everyone has a responsibility to do what they can" is significant and can influence the strategies and culture of the company (Jansson et al., 2017) in the long term.

Finally, the empirical model validated the H9 hypothesis ($\beta = 0.34$, $t = 2.68$), which shows that RI has a weak positive effect on the financial performance in SMEs. This fact can be explained by the conservative and philanthropic way CSR strategies have on SMEs in the sample. Similarly, the study by De Poel et al. (2017) showed that responsible innovation driver strategies, such as CSR, are capable of promoting potential organizational performance, but these strategies must change their conservative, philanthropic, defensive way of addressing social, environmental and ethical issues to a progressive way

of "doing good". Nevertheless, we can state that CSR practices addressed to key stakeholders (such as customers, employees, environment, and community) are capable of generating, on the one hand, responsible innovation and, on the other hand, financial performance in SMEs, which is in line with the research by Reverte et al (2016), which found that social responsibility practices have a direct, positive and significant effect on both innovation and organisational performance covering both financial (such as level of sales growth; level of ROE; ROA; market share; level of productivity) and non-financial (the quality of products and/or services offered) indicators.

4.5. Conclusions

A central conclusion of this research is that responsible innovation has a partially mediating effect on the relationship between CSR of small and medium enterprises and financial performance. That is, on the one hand, the effect of CSR strategies contributes to financial performance in terms of increased sales, but not in terms of asset performance, suggesting that CSR activities require time to improve that change, and on the other hand, although the effect of CSR on performance stakeholders is reduced when responsible innovation is applied to the model, its effect transmitted through the dimensions of *responsiveness*, *inclusiveness* and *reflectiveness* can contribute to winning the loyalty of customers, employees and the community in the long term. *Anticipation* was not a sufficient factor in the model. Therefore, it was not taken into account in the mediation analysis. Our results also help small and medium-sized business owner-managers to appreciate the importance of adopting social responsibility strategies as a mechanism to promote the strengthening of their links with stakeholders and that this improvement, in turn, has a positive effect on long-term competitive advantage. Furthermore, with regard to responsible innovation, this study is one of the few that empirically demonstrates that small and medium-sized enterprises with a CSR strategy, thought out in economic and personnel terms, can create "responsible innovation" that results in long-term financial performance as well as adding value to society.

On theoretical and practical involvement, this study is one of the few empirical investigations that broadens the understanding of this issue and has verified the statement made by Valdivia & Guston (2015) that they consider

the main drivers for promoting responsible innovation in industry to be: economic incentives and change of corporate culture, both of which are more or less reflected in the strategy of corporate social responsibility towards stakeholders and which is causally and ultimately connected to performance (Freeman, 1984). This study investigated this relationship and in SMEs of a developing country. The focus is on SMEs, because they represent 98% of companies in Latin America, and of these, only 5% remained inactive with respect to internal CSR activities while inactivity was higher with respect to external stakeholders 39% and the environment 52% (Vives et al., 2005). Therefore, their combined achievements have the potential to generate a large impact on the global economy and society. This research can also be used for future applications regarding the correct implementation of the CSR strategy that generates responsible innovation and long-term performance in SMEs.

The main limitation of this study has been, on the one hand, the size and breadth of the sample, i.e. information was collected from only one sector, which limits the generalisation of results and could be biased towards the results of the selected sector. On the other hand, the results of this study only concern SMEs in one of Bolivia's departments, La Paz, and therefore may not be valid for the whole of Bolivia or another developing country, so a larger sample should be selected, in different sectors of industry and from different cities in the country. Finally, one could also think of other moderating factors that could be involved in the proposed model, such as Government participation, and Academy as stakeholders in the process.

Appendix

CSR

Clients.

CUS1: Accurate and complete information on our products and/or services.

CUS2: We are particularly concerned with providing high quality products and/or services to our customers.

CUS3: We are known for having the best value for money in our products and/or services.

CUS4: We have effective procedures for handling customer complaints in a timely manner.

Employees.

CUS1: Commitment to employee health and safety

CUS2: We have human resources policies aimed at balancing the work and private lives of employees.

CUS3: We encourage the training and professional development of our employees.

CUS4: Equal opportunities exist for all employees without discrimination.

Community.

COM1: Business procurement policies favouring local suppliers.

COM2: Participation in a project or projects with the local community

COM3: Voluntary employees on behalf of the company.

COM4: Sponsorship activities, charities, etc.

Environment.

ENV1: Programmes for the introduction of alternative energy sources

ENV2: Investments in energy saving programmes.

ENV3: Recycling and waste management.

ENV4: Ecological packaging/containers

Responsible Innovation

RI1: Does it involve the different stakeholders in the innovation process?

RI2: Are you able to identify potential risks and act on them?

RI3: To what extent do you integrate the values and beliefs of self-awareness of your activities into a code of conduct?

RI4: Do you take into account the current dynamics of the innovation process for the design of the future?

Financial performance

FP1: Return on assets (ROA)

FP2: Increasing sales

FP3: Level of productivity

Chapter 5. Discussion and Conclusions

...an interested hope in working toward a future that is revolutionarily, not evolutionarily, better than the present, and a commitment to bringing about that hopeful future through action (Bardzell & Bardzell 2014, p.790).

Although innovation and technology, together, have been and still are driven mainly by markets in the form of novel goods and services and they have led to competitive advantage and business success, they have also led to the exclusion of the majority of the world's population, which includes low income groups. Hence, *promoting responsible research and innovation, strengthening research ethics, enhancing research ethics education, raising science and technology personnel's awareness of scientific research ethics, and guiding enterprises to pay attention to and undertake social responsibility for protecting ecology and ensuring safety in technological innovation activities*¹⁹ (China report, p. 15) could foster the democratic development of innovation & technology; and in the short and long term sustainable development in SMEs. Therefore, this dissertation aimed to understand the adoption of a technology -3D printing- and responsible innovation to achieve sustainability among SMEs. To this end, three chapters have each addressed the specific objectives. As shown in chapter one, the first empirical study was an analysis of factors affecting the adoption of 3D printing in small and medium-sized enterprises in Arizona in the United States. The second was a systematic literature review to develop a conceptual model for responsible innovation and its relationship with business performance through corporate social responsibility and sustainable innovation practices in SMEs. The third examines the mediating role of responsible innovation between CSR practices towards stakeholders and the financial performance of SMEs in La Paz-Bolivia.

¹⁹ Chapter 7, article 24 of the 13th National Science and Technology Innovation Plan 2016–2020. Creating a social and cultural atmosphere for encouraging innovation.

The conclusions for each specific objective follow below, together with a general discussion derived from the results obtained in this thesis. Finally, the contributions and future research ideas are presented.

5.1. Summary of the conclusions of the specific objectives

1. The first specific objective of this empirical study was to explore key factors affecting the adoption of 3D printing by SMEs and under the TOE framework proposed by Tornatzky et al (1990). To this end, relationships between technological, organisational and environmental contexts in small and medium-sized enterprises in Arizona in the United States were analysed. Based on the results of Chapter 2, it can be concluded that factors such as relative advantage, integration, readiness, managerial obstacles, and in turn, external collaboration foster the adoption of 3D printing in SMEs. These factors identified in relation to the advantages of the technology will enable the right decisions to be made and to move from the adoption to the use of 3D printing in less time, which, in terms of competitiveness, translates into financial savings. On the other hand, 3D printing should be integrated with other technologies in the current system in SMEs, which seems to be essential to promote sustainability and new capacities in accordance with the relative advantages of using this technology.
2. The second systematic literature review is particularly relevant to small and medium enterprises because it analysed recent studies on sustainable innovation and social responsibility practices that could foster responsible innovation and business performance in SMEs. The study offered a comprehensive view of responsible innovation dimensions, the contingent and mediating variables involved, identification of the main stakeholders' engagement, and the effect on short and long term business performance with indicators such as sales growth, profitability, financial indicators, market share, customer satisfaction, innovation performance and benefits/utility and, with indicators related to responsible innovation performance such as environmental sustainability, social sustainability, diversity and inclusion, anticipation and reflection. Furthermore, we also found that **business responsibility strategies foster responsible innovation if (and only if) SMEs act proactively rather than reactively in line with their impact on society.**

3. The third empirical study analysed whether corporate social responsibility for stakeholders promotes responsible innovation and leads to improved financial performance in SMEs in Bolivia. A central conclusion of this research is that responsible innovation has a partially mediating effect on the relationship between CSR in SMEs and financial performance. So, the effects of CSR strategies can contribute to financial performance in terms of increased sales, but not in terms of asset performance, suggesting that CSR activities require time to improve that change, and on the other hand, although the effect of CSR towards stakeholders on performance is lower when the mediating role of responsible innovation is applied to the model, its effect transmitted through the dimensions of *responsiveness*, *inclusiveness* and *reflexivity* can help to gain the loyalty of customers, employees and the community in the long term. *Anticipation* did not present enough significant value in the model. Therefore, the latter was not considered in the mediation analysis. Our results also help small and medium-sized business owner-managers to appreciate the importance of adopting social responsibility strategies in a proactive way as a mechanism to promote stronger links with stakeholders, which in turn has a positive effect on long-term competitiveness. Furthermore, with regard to responsible innovation, this study is one of the few that empirically demonstrates that small and medium enterprises with a CSR strategy, thought out in economic and personnel terms, can create "responsible innovation" that leads to financial performance as well as adding value to society.

5.2. Discussion

In the first chapter, we outlined the main themes of this research, such as 3D printing and business responsibility strategies that could foster responsible innovation and their relationship with business performance in SMEs. So, this discussion is subdivided into three sub-sections. The first is related to 3D printing adoption by SMEs and the second part of the discussion focuses on the main objective of this thesis, which is to relate business responsibility strategies and responsible innovation to achieve sustainability in SMEs. Finally, the last part examines the relationship between CSR, RI and FP of SMEs in La Paz-Bolivia.

5.2.1. 3D adoption

3D printing technology and its adoption has barely been studied in relation to SMEs, as most empirical studies have focused on large companies or a combination of large and small companies (Deradjat and Minshall, 2017; Schniederjans, 2017; Yeh and Chen, 2018), especially in terms of the adoption and implementation of 3D printing technology. Therefore, I was not surprised to find only a couple of empirical studies related to small and medium enterprises. Mellor et al (2014) proposed a theoretical framework in which six factors should be considered in relation to various variables inherent to each factor for 3DP implementation, while a more recent theoretical study by Martinsuo et al. (2018) found that SMEs face different challenges for adopting 3DP throughout the supply chain. However, these theoretical studies, although well-established based on the existing literature, offer poor empirical proof, resulting in a significant gap in the literature on the adoption of 3D printing by SMEs, which this study aimed to fill. In order to strengthen this area of research, it analysed factors that affect the adoption of 3D printing by different types of SMEs, taking into account the fact that both the adoption of a new technology and the size of a company require different considerations because they encompass different ideas. The former is related to the decision to use a technology, whereby according to Voss (1988) the adoption process is its implementation and must be reinvented with each new technology. The latter is related to the size of the company and the many differences between small and large companies. For example, Marri et al. (2007) argued that SMEs have less complex organisational structures, which could facilitate the adoption process. However, they have fewer resources (Rahardjo and Yahya, 2010), one of which is the limited/lack of knowledge and skills that are crucial for successful implementation (Saberri et al. 2010). Additionally, this study has provided a framework based on the one proposed by Tornatzky et al. (1990), which is summarized in three dimensions: Technology - Organization - Environment. TOE has been recognized as a relevant theoretical framework, as well as a powerful tool (Yeh and Chen, 2018) to achieve adoption under wider conditions and to explore the factors of new technology from the perspective of organizations. The results obtained in this empirical study are in line with the factors proposed by Mellor et al (2014).

Regarding *technology integration*, which stems from the technology dimension of the TOE framework, the results show that it is the most important factor and has a significant positive influence on adoption by SMEs. Past studies have found that large companies might find it harder to integrate in their processes, while SMEs might have less integration issues, as they have less complex organizational structures and are thus able to build a single integrated system. Technology integration is often viewed as a key factor as it offers more benefits than individual processes, as supported by studies such as Saberi et al. (2010). Therefore, when companies adopt 3D printing to enhance their manufacturability over more traditional methods, it might be integrated with their other systems. Only then will SMEs have a real possibility to move towards becoming a competitive firm. This is supported by Mellor et al. (2014).

Relative advantage, which also corresponds to the technological dimension of the TOE framework, was also analysed, and was not found to be significant, although it was in the study by Yeh and Chen (2018) on the factors that influence the implementation of 3D printing by large companies. This result does not mean that SMEs view relative advantage as unimportant. In fact, unlike in the adoption stage, relative advantage was found to be a significant factor behind the intention to adopt 3D printing (Schniederjans, 2017) since smaller companies might experiment with 3D printing technology at that stage in order to assess the benefits and prevent unfamiliarity from generating barriers at the adoption stage, as in the study by Martinsuo et al (2018).

The relationship between 3D printing adoption and the organisational dimension of the TOE framework was also studied through factors such as readiness and managerial obstacles. *Readiness* is the second most important factor when SMEs adopt 3D printing. There have been diverse findings about the effects of this criterion in previous studies. For example, Martinsuo et al (2018) found that the lack of knowledge of 3D printing is the challenge that interviewees mention most and is hence a barrier to adopting it. In other words, even if SMEs have conducted some technical assessments, they will first need to ensure that they have the technical and financial resources to truly take advantage of it. The readiness factor therefore suggests that firms are more efficient at using a technology when they have developed certain

skills in using it. However, our result also shows that SMEs that had been using 3D printing for less than 2 years (37%) and were perhaps not ready to adopt it, did so regardless. Thus, SMEs with less complex organizational structures also learn by doing, and this is especially true for younger companies (63%), through active experimentation or external collaboration, which is supported by Martinsuo et al. (2018). The results regarding *managerial obstacles* are negative, as expected. This suggests that SMEs are concerned about identifying threats in order to support the implementation of 3D printing. Nevertheless, it is important to highlight that SMEs are more sophisticated nowadays (Chan et al., 2012) when it comes to resolving technological issues that could hinder their adoption of 3D printing.

In the environmental dimension, *competitive pressure* and *customer requirements* were not significant, which suggests that companies that have adopted 3D printing will be more concerned about its effectiveness in terms of their own capabilities or collaboration with other companies than they are about the competition. This result is consistent with previous adoption studies (Chan et al., 2012). Our result also shows that even if external collaboration can foster the adoption of 3D printing (Deradjat and Minshall, 2017; Martinsuo et al., 2018), greater effort, beyond the adoption of 3D printing, is required to achieve a competitive business. More specifically, the findings of this research suggest that factors such as relative advantage, integration, readiness, managerial obstacles, and in turn, external collaboration foster the adoption of 3D printing in SMEs.

From the sustainability standpoint, *could 3D printing contribute to the sustainability of micro, small and medium enterprises?* My main argument for considering the future adoption of 3D printing is that (see ecosystem proposal in the contribution section of this thesis) together with its capacity for innovation as "the elephant in the room" (Hornick, 2015), it **could offer an alternative to the production system, that is, democratize it**. Therefore, in the long term, on the one hand, it might promote sustainability in SMEs, and on the other hand, it might promote the United Nations proposal with the development of 17 Sustainable Development Goals (SDG) for 2030, that is, to face the great challenges of poverty; degradation of natural resources; climate change; economic progress; and the well-being of society but, as important as "**innovation**" is the need for it to be "**responsible**" (Auer and

Jarmai, 2018; Martinuzzi et al, 2018; Ribeiro et al., 2018; Von Schomberg, 2013).

5.2.2. The dimensions of responsible innovation and its relationship with business responsibility and performance

Chapter three of this dissertation sought to understand how "innovation" and "responsibility" are articulated with business performance and in a small and medium enterprise context, albeit partly driven by similar approaches with alternative terminologies such as "sustainable innovation"²⁰ or "corporate social responsibility"²¹ practices and other similar terms. Responsible innovation is incorporated in the previous literature along with its dimensions - anticipation, reflexivity, inclusion, responsiveness - (Stilgoe et al, 2013) with the aim of "**innovating with and for society**". However, according to the authors, responsible research and innovation is still at the theory-building phase, which is not surprising because the term RI (or RRI) only appeared for the first time in the Sixth Framework Programme (EU Regulation No 1291/2013), so *its integration into the industry is still in its infancy, and is greater when it comes to small and medium-sized enterprises*. Chapter three, therefore, aimed to contribute to the academic literature in the field of responsible innovation, but most importantly to offer a practical conceptual framework that shows the relationship between the practices that drive the dimensions of responsible innovation and their relationship with business performance in SMEs. In order to understand the implications of "responsible innovation", it is important to understand how it should be fostered, as well as to show its contribution in relation to short and long term business performance, and its tangible and intangible benefits and for the sustainability of SMEs.

²⁰ Sustainable innovations are defined as innovations in which the renewal or improvement of products, services, technology or organizational processes not only provide better economic performance, but also greater environmental and social performance, both in the short and long term (Bos-Brouwers, 2010). Similar terms include eco-innovation, environmental innovation and ecological innovation according to the study by (Franceschini et al., 2016).

²¹ The European Commission's Green Paper of July 2001 defined corporate social responsibility as a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis.

Based on these pre-design characteristics, in the literature review we highlighted two important initial aspects, on the one hand, that CSR strategies could drive responsible innovation through economic incentives and change in business culture, which is supported by the Valdivia and Guston (2015) study. On the other hand, systematic reviews of literature related to corporate social responsibility practices or other similar terms show that there is no clear consensus on these definitions. For example, the study by Ortiz-Avram et al. (2018) found a diverse selection of terms used by different authors to refer to CSR or other alternative terms, which undoubtedly makes it difficult for them to be consolidated. The same study grouped the terms used in the literature for CSR into four topics: 1) ethical values and social connections/relationships of the entrepreneur or owner manager, 2) relevance of business context and long-term performance, 3) importance of formal processes for CSR integration, and 4) political issues with relevance to CSR. In light of these previous conceptions, the systematic literature review was conducted.

Responsible innovation is a continuous process of aligning research and innovation with society's values, needs and expectations (European Commission, 2014). In the case of industry, RI has also been a topic of discussion, because it connects the basic concerns of business with the global challenges of society, i.e. the challenge for companies in this increasingly competitive world to innovate in order to generate economic benefits, but also to generate social value, in such a way that "responsibility" is deeply rooted in the conscience of entrepreneurs, and consequently in the DNA of companies (Visser, 2010). However, RI integration in business is still in its infancy (de Poel et al., 2017; Ribeiro et al., 2018) because there is not yet a clear understanding of what should be "done " (Ribeiro, Barbara E and Smith, Robert DJ and Millar, 2017), especially in SMEs that are largely unaware of what the concept of RI implies (Auer and Jarmai, 2018). So, as an emerging topic very little research has been done to understand its influence on social values and organisational capacities in a practical way (Pandza and Ellwood, 2013). This study therefore explored the little studied relationship between practices that promote responsible innovation and business performance in SMEs.

To do so, we started from the responsible innovation framework proposed in the research by Stilgoe et al (2013) and, which is now a benchmark in the literature. The framework consists of the proposal of four dimensions - anticipation, reflexivity, inclusion, responsiveness - each of which indicates a reflection on the purpose of innovation. In this study, I included an additional dimension of knowledge management proposed by Lubberink et al (2017). The latter, due to the fact that SMEs, which lack human and other resources, are constantly looking for opportunities to expand and build knowledge and also be able to extend it to the rest of the employees (Aragón-Correa et al., 2008). Hence, through a systematic review of the literature on corporate social responsibility and sustainable innovation practices related to innovation and business performance, we have developed a conceptual model for "responsible innovation" and its relation to performance in small and medium sized enterprises, taking into account the five dimensions proposed in the previous literature for responsible innovation, which are: *anticipation, reflexivity, inclusion, responsiveness, and knowledge management*. The results enable a comprehensive view of RI and practices that promote them, together with their potential benefits for company performance. From there, its systematic integration into their strategy can be considered. On the other hand, responsible innovation changes the perception with regard to stakeholders, i.e. this study reinforces the new direction promoted by RI and in response to stakeholders' values (Stilgoe et al., 2013), because it is capable of unambiguously articulating stakeholders' interests, without ignoring those who will be affected. In other words, these are sustainable solutions that correspond to the impact on society. Moreover, the dimensions of responsible innovation that are driven in SMEs by CSR and SI practices and that are related to organizational performance according to the conceptual model proposed in this study are described below.

Reflexiveness, which refers to the process of self-awareness, rather like holding up a mirror to scrutinise oneself. This moral and ethical culture encourages them to perform their tasks and responsibilities in a more committed and satisfying manner. *Inclusion* refers to stakeholder's participation at different stages for increasing commitment and contribution, which is considered imperative for the responsible innovation process. *Responsiveness*, which means responding to newly emerging knowledge, perspectives, users' views. This is a key activity that suggests reinventing

(innovation and organization) to align with recognized needs. For example, a company that produces and sells light bulbs will be able to switch from conventional ones to energy-saving bulbs. *Knowledge management*, SMEs are often forced to prioritize their investment in more immediate and urgent business needs. Then activities that are implemented to create knowledge, share it, transfer it and apply it through members, allow to solve some of those knowledge gaps needed to develop innovation. Social responsibility strategies have a positive relationship to learning orientation, which is viewed as a process of developing employees' competences, skills and knowledge to help SMEs to boost competitiveness. Finally, *anticipation*, which involves systematic thinking in order for organisations to consider uncertainty, the possibility of something happening or not happening, what is possible, risk. However, in the literature review the findings show that in the context of SMEs responsible actions are the result of unplanned actions. Consequently, responsible innovation needs to be supported or even initiated by institutionally powerful actors such as government.

The findings could also encourage and help small and medium-sized enterprises to make sense of their activities, strategies and policies linked to sustainable innovation and corporate social responsibility because "responsible innovation" is connected to these strategies. It can therefore be concluded that CSR and sustainable innovation practices promote "responsible innovation" and lead to better performance by SMEs as well as adding value to society in the long term. This therefore seems to promote short- and long-term sustainability in small and medium-sized enterprises.

5.2.3. CSR practices associated with the spread of responsible innovation and financial performance

To confirm whether there is a relationship between CSR practices, RI and FP, a third quantitative empirical study has been developed in this research and in the context of a developing country, namely Bolivia. In the debate on "responsible innovation", it is just as important to know who will contribute, i.e. the involvement of stakeholders; it is those who will also be affected by the innovation process. In this last study and following the literature review in the previous chapter, we therefore focused on understanding the practices and strategies that promote responsible innovation in a general way, and specifically focusing on the ultimate context of this research, Bolivia. In the

case of SMEs, the most important stakeholders identified in the previous literature are employees, clients, communities, environment, governments and universities, among others (Muñoz-Pascual et al., 2019). We therefore included four key actors in the empirical analysis and from the perspective of the owner-managers of small and medium enterprises: employees, clients, community, and the environment. In addition, we obtained qualitative information from two key actors to understand their influence and power relations: Government and Academia. In the latter case, a total of seven semi-structured interviews (3 with government officials and 4 related to academia) were conducted. This analysis has been included in the contributions section of this dissertation and its codification is shown in the Appendix.

But going back to the third and final empirical study in this research related to CSR practices associated with the diffusion of responsible innovation among SMEs in a developing country, the results confirmed on the one hand a positive relationship between the CSR towards stakeholders and financial performance, and on the other hand that the RI that is promoted by the CSR plays a full mediating role in the relationship between the CSR and the performance of SMEs. In the first finding, the hypotheses confirmed that employees, customers and the environment are the most important stakeholders for SMEs, and that their relationship with financial performance is positive but weak, a result in line with the findings of the study by Jain et al. (2016) that found a positive but also weak relationship between CSR towards stakeholder and FP in SMEs. The above shows that although the CSR strategy contributed positively to stakeholders (such as clients, employees and the environment), it is still conceived in philanthropic terms and not in strategic terms.

In the case of CSR activities towards the community, the study by Choongo (2017) found that SMEs engage in such activities when they perceive benefits. In our study this hypothesis has been rejected, which suggests to us that this could have been due to the short-term vision that our measurement instrument might have interpreted. Because, in the context of our sample a clear influence of the communities can be perceived at company level. Then, SMEs cannot ignore the expectations of the community, and that in the long term will favour the mutual support of the company and the community (Stoian and Gilman, 2017) and will lead to better financial performance

(Choongo, 2017). On the other hand, our study has found that RI reflects a partial positive spill-over effect, i.e. if a CSR strategy towards stakeholders is correctly adopted, this could be a useful long-term strategy for SMEs to achieve financial performance through responsible innovation.

In the process of convergent validation of the model, it was found that of the dimensions related to RI, *responsiveness* was the most significant (36%), followed by the item related to the *inclusion* dimension (27%) and the item related to the *reflectivity* dimension (27%). Regarding *Anticipation* dimension, CSR activities are the result of unplanned actions in the sample, which is in line with the findings of our previous study on the approach using a conceptual model (chapter 3). In addition, similar findings are reported in the study by Cassells and Lewis (2011) which found that although 80% of owner-managers declared they were aware of the possible risks to the environment derived from the work they do, only 87% agreed that regulation alone cannot protect the environment without the voluntary actions of companies. It was also found that environmental practices carried out are associated with a potential financial benefit rather than motivated by environmental protection, which is why processes are fortuitous rather than expected results.

To summarise, we can conclude that our model found that responsible innovation has a weak positive effect on the financial performance of SMEs that can be explained by the conservative and philanthropic approach to CSR strategies among SMEs in the sample. Similarly, the study by De Poel et al. (2017) showed that strategies to drive responsible innovation, such as CSR, are capable of promoting potential organizational performance, but these strategies must change their conservative, philanthropic, defensive way of addressing social, environmental and ethical issues to a progressive way of "doing good". Nevertheless, we can state, in a similar way to the study by Reverte et al. (2016), that **CSR practices addressed at key stakeholders (such as customers, employees, environment, and community) are capable of generating, on the one hand, responsible innovation and, on the other hand, financial performance in SMEs.**

5.3. Contribution of this thesis

This section presents the main theoretical contributions. Also, implications for academia, practitioners, and decision makers.

5.3.1. Theoretical contribution

This dissertation in Business has concentrated on the study of two fields, technology & innovation but responsible for firm performance and sustainability. Therefore, its contribution is directed to the field of RI in the context of SMEs. RI challenges existing epistemological approaches, therefore connecting this approach with conventional thinking that is dominated by the science-driven paradigm that delivers a product or service through innovation has been a challenge. To this end, this thesis used a three-dimensional approach to understand the potential for adoption of an emerging technology (Chapter 2), the role of responsible innovation in short- and long-term performance-sustainability respectively (Chapter 3) and the mediating role of RI in the relationship of social responsibility towards stakeholders and financial performance (Chapter 4). These studies within the context of SMEs. In the first case, we consider that what makes a technology valuable is often not the technology itself, but the experiences associated with it. In that sense, although there is a huge potential identified by academics and practitioners associated with 3D printing technology (see chapter 1), in this research it has not been our aim to focus on the final results or resulting applications whether these are pros (e.g. healthcare, clothing, automotive, architecture, sports, aerospace, robotics, furniture, consumer goods, education, food, etc.) and cons (e.g. constraints such as price, intellectual property rights or lack of knowledge), since technology can be as good as the person using it. Instead, our aim has been to explore empirically the key factors affecting its adoption and implementation with an in-depth analysis within three dimensions, i.e. in terms of technology, organisation and environment. The results of this study contribute to the literature on the adoption of this technology within a small and medium enterprise context. In addition, this study provides insights to owner-managers who currently use or intend to use this technology.

In the second case (chapter 3), the United Nations and its programme of aspirations for sustainable development requires that governments, the business sector, society and stakeholders share efforts to promote well-being

while protecting the planet (see chapter 1). From a business point of view, although performance is estimated on the basis of certain financial indicators identified in our short-term conceptual model, the conceptual model is explicit in identifying the need to develop and integrate competences for *anticipation, reflexivity, inclusion, responsiveness, and knowledge management*. This implies on the part of companies to take a step further in their social responsibility strategies as an adaptive, flexible process that is capable of learning and providing the necessary input for RI and the inclusion of stakeholders. Thus, the contribution of this study is aimed at companies to respond and give some guidelines to the who and what drives the change in companies and legitimates RI with short and long term benefits, this last one will also allow to achieve sustainability in SMEs.

In the third case (chapter 4), in order to explore the mediating effect of RI, the relationship of the CSR strategy toward stakeholders with the likelihood of their promoting RI on the one hand and financial performance on the other hand has been investigated. In contrast to the conventional study of analysing only internal stakeholders linked to the company, this research incorporates external stakeholders, which means stakeholders considered important in the innovation process, but also those who will be affected by this process. Moreover, this research has produced new knowledge that can be considered timely and important for the case study investigated because, it incorporates broader considerations of stakeholder inclusion, which is the thoughtful consideration of an employee's inclusion up to that of a citizen of the society at large. However, although microcredits may be strongly questioned because of the great scope and profits they generate today, it is important to note that before this modality it was unthinkable that a bank, as we know it, could grant a loan to an insolvent and low-income person. Therefore, the objective with which they emerged is noble because they rely on initiatives for the inclusion of low income people or groups of people to reduce poverty in which they find themselves, mostly in the informal sector in Bolivia, the so-called "base of the pyramid". That as Roosevelt (1932) rightly described in his speech "The Forgotten Man", the inclusion of neglected low-income groups in economic development has great potential to generate benefits.

5.3.2. Contribution to academia

In the light of the discussions and the results obtained in this thesis, there are three main research contributions. Firstly, researchers could consider responsible innovation as an essential strategy to respond to the challenges of innovating with and for society, and to achieve democratic development of emerging technology, allowing early inclusion of stakeholders in the innovation process and ensuring responsible outcomes. To this end, **responsible innovation must be supported by institutionally important actors** (Pandza and Ellwood, 2013), especially when it comes to achieving internalisation and implementation of its dimensions, otherwise responsibility may be perceived as a subject loaded with tensions and contradictions. Researchers might consider the latter, the institutionally powerful actors, as an additional aspect to the existing framework and dimensions of responsible innovation. Secondly, in this dissertation the mediating effect of responsible innovation on CSR/SI practices and organisational performance promotes stakeholder engagement at different stages (Torugsa et al., 2012; Sancho et al., 2018), increased stakeholder engagement and contribution (Hammann et al., 2009; Perrini et al., 2007), responsiveness (de Poel et al., 2017; Burget et al., 2017 Hsuet al, 2017), values and motivations for responsible actions (Jain et al., 2016; Burlea-Schiopoiu and Mihai, 2019), and knowledge creation and development (Ortiz-Avram et al., 2018; Williams and Schaefer, 2013). However, the results are inconclusive and could be considered in further studies, in different contexts, such as a mediating effect on R&D strategies and innovation performance (see for example Cruz-Cazares et al., 2013), RI with the relationship between proactive CSR and organizational performance (see, for example, Torugsa et al., 2012) and RI with the relationship between socially responsible human resource management and organizational performance (see, for example, Sancho et al., 2018) among others.

Finally, responsible innovation is a strategy that promotes sustainability in SMEs. Based on the results of this thesis, it can be appreciated to what extent companies were responsible in their innovation processes through the construction of the RI dimensions. For example, in the process of self-awareness of the reflective dimension, it is evident that SMEs are already participating in reflection on innovation processes and that they are inspired by a mixture of personal, cultural and even religious motivations among SME

managers (Jamali et al., 2009). Consequently, these strategies have the support of their founders and/or top managers. However, from an economic point of view, the moral persuasion of the owners may be conditioned by their financial capacity and, therefore, a regulatory framework seems to be a possible driver (El Baz et al., 2016; Li et al., 2016) but it could also be a possible obstacle to responsible innovation when the regulatory approach is not clear (Dangelico and Pujari, 2010), or there is no specific regulation (Stahl et al., 2019), or there is too much legislation to be complied with. On the other hand, the inclusion of stakeholders has been one of the most found dimensions in the literature. This concerns the involvement of stakeholders at different stages of innovation development, but results also show that stakeholders were predominantly customers, employees and suppliers, i.e. people directly related to SMEs. However, the inclusion dimension refers to stakeholder participation in a broad way (Lubberink et al., 2017; Stilgoe et al., 2013) that has been studied in the previous literature but less frequently (see conceptual model of IR for SMEs). Therefore, there is a need to seriously consider multi-stakeholders rather than just one party because their involvement promotes increased commitment and contribution, which is a key factor for business responsiveness and sustainability in the short and long term. Thus, the efficiency of **responsible innovation will lead to sustainable business performance for SMEs to the extent that the practices that promote it become part of integrated and formalized practices in strategic and proactive processes.**

5.3.3. Contribution to practitioners

According to the results obtained in this thesis, there are three main contributions to professionals. Firstly, they could consider adopting 3D printing to survive the global and highly competitive environment, thus achieving a sustainable competitive advantage along the production chain - design, development and manufacturing - and due to the variety of innovations and disruptive applications offered by customisation. 3DP consists of various technologies and processes, the most used of which include stereolithography, molten deposit modelling and selective laser sintering (Mellor et al., 2014), as well as various categories of use, such as prototyping, finished products, mixing of prototypes and finished products, with applications ranging from the simple manufacture of toys and gifts, to more complex manufacturing applications with high added value in the

biomedical, automotive and aerospace sectors, among others. 3DP has experienced tremendous growth in recent years. Its use worldwide has doubled in less than 10 years, but the adoption of 3D printing by industries is not yet widespread (Yeh and Chen, 2018), and understanding of the adoption process is particularly poor with regard to SMEs (Martinsuo et al., 2018). Indeed, Ruffo et al. (2007) argue that before considering the use of 3DP technology as a solution for manufacturing, there are many barriers that need to be considered such as: 1) manufacturing processes and materials, 2) design, and 3) management, organisation, and adoption/implementation. Additionally, other researchers state that application without prior experience is not useful. In response, professionals from micro, small and medium enterprises may see 3D printing technology as a way to exploit knowledge and creativity through innovation, because in order to adopt and implement it, key factors such as relative advantage, integration, readiness, managerial obstacles, and in turn, external collaboration, must be taken into account. In this vein, SMEs will be able to move from the functional prototype to the final product.

Secondly, practitioners may find it relevant to include their corporate social responsibility strategies within corporate strategic objectives, because these practices not only promote "responsible" behaviour towards external and internal stakeholders (Perrini et al., 2007), but are also drivers of responsible innovation. **RI in SMEs, in addition to influencing business performance, which is already important for their survival, emphasizes the importance of stakeholder participation in trying to link the innovation process with the concept of responsibility**, which is crucial within the RI debate (Von Schomberg, 2013). Then, the selection of stakeholders lies in who will contribute, but also who will be affected by the innovation process because, when these stakeholders understand the objectives to follow RI principles they can commit themselves to their achievement (Chatfield et al., 2017). So, the effect exerted by a single stakeholder in an enterprise depends on how other stakeholders work consistently with or against it. Thus, the consideration of individual stakeholders alone is not sufficient to explain the environment in which an enterprise operates, but rather "jointly" with other stakeholders (Tang and Tang, 2018). Despite their importance, stakeholders are included at a late stage of the innovation process, when the product or service is already on the market, which allows for some adaptation of

solutions, but of a limited nature. It is therefore suggested that practitioners should include stakeholders earlier in the innovation process in order to ensure responsible outcomes (Silva et al., 2019). In the case of SMEs, the main stakeholders are mainly employees, clients, community, environment, governments and universities, while others include investors, market and competitors (Muñoz-Pascual et al., 2019).

Finally, SME professionals could incorporate responsible innovation strategies because it is clear that the benefits of their implementation go beyond the purely operational. This aspect has been highlighted by the results of this thesis, that is, by connecting the challenge that companies have of innovating to generate economic benefits in this increasingly competitive world, but also to generate social value, in such a way that "responsibility" is deeply rooted in the conscience of entrepreneurs, in their DNA. The latter implies that SMEs, which constitute 95% of all companies in the world (Khan et al., 2020), and whose impact represents approximately 64% of pollution and waste in Europe (European Commission, 2002), could have an equally positive and significant impact by adopting responsible innovation policies and practices (Aragón-Correa et al., 2008; Bos-Brouwers, 2010; Cassells and Lewis, 2011).

5.3.4. Contribution to decision makers

Based on the results of this research, the process of adopting 3D printing has been examined, together with responsible innovation and its relationship with business performance, both in the context of SMEs. But these efforts in isolation are not sufficient for the sustainable development of SMEs in Bolivia, so a contribution derived from this dissertation concerns how 3D printing technology and responsible innovation can be articulated in a 3DP *responsible innovation ecosystem* for the sustainability of MYPES in Bolivia. However, a multi-level system of a complex whole requires the knowledge of "how" and "who" to relate these component parts. In other words, this means joining efforts and synergies between various key actors and dimensions of development as fundamental elements of an integrated system which, for a developing country as Bolivia, is not only compulsory but also a determining factor for the socio-economic development of micro, small and medium enterprises. However, this process is complicated because there are different frameworks, theories and models for analysing parts of a complex

multilevel set. So, in this section, and as part of the contributions aimed at decision-makers, I propose a brief outline of this ecosystem.

The responsible innovation ecosystem for 3D printing for the socio-economic²² sustainability of SMEs in Bolivia is understood to mean the set of actors and processes that, through their cooperative and competitive interactions, make innovation happen and, in doing so, co-evolve (Fransman, 2018). The conceptualization of a responsible innovation ecosystem emphasizes that the how and the who of innovation are at the centre of the conceptualization of the ecosystem and its functions. In Figure 12, I propose the how and who of the ecosystem. In addition, the appendix provides a brief summary of the obstacles/challenges identified in semi-structured surveys of government officials, academics and owner-managers of small and medium enterprises in Bolivia to understand power relations. Decision-makers may therefore consider that the findings of this research could help to create:

- Policies that promote the development of responsible innovations aimed at the sustainability of SMEs;
- Adoption of emerging technology such as 3D printing given its potential to democratize manufacturing and its relationship with the SDGs
- Promote the institutionalisation of corporate social responsibility practices that promote both IR and corporate performance in the short and long term;
- Greater understanding of the importance of collaboration with stakeholders, which is a key factor in a responsible innovation process.

²² Socio-economic development incorporates public concerns in developing social policy and economic programmes. The ultimate objective of social development is to bring about sustained improvement in the well-being of the individual, groups, family, community, and society at large. It involves sustained increase in the economic standard of living of a country's population, normally accomplished by increasing its stocks of physical and human capital and thus improving its technology (IGI Global).

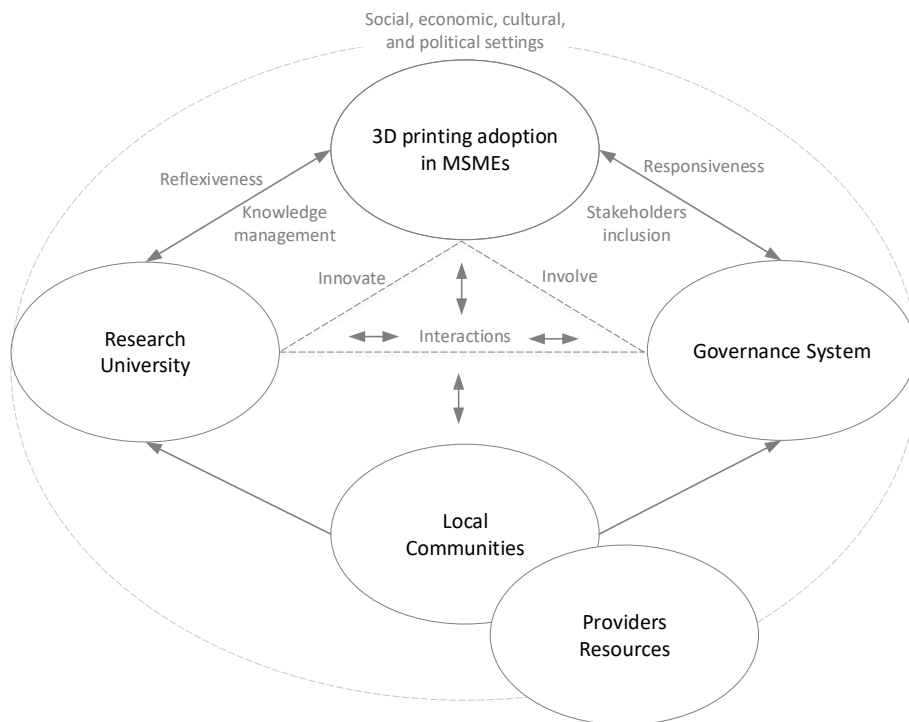


Figure 12 . Responsible innovation ecosystem for 3D4D
Source: Own elaboration.

5.4. Future research

Future research could focus on at least three aspects derived from this thesis. **Firstly**, it could link responsible innovation to inclusive innovation. As discussed above, innovation is synonymous with novelty, even though it has been, and continues to be, a driving strategy for achieving competitiveness at the enterprise level. Innovation also tends to increase inequality in terms of technological goods and services (Papaioannou, 2018). Furthermore, this characteristic of novelty when innovation occurs tends to widen the gap between rich and poor, thus excluding more poor countries like Bolivia. According to the International Monetary Fund (IMF), 85% of the world's population live in poor countries, approximately four billion people (Agola & Hunter, 2016). Inclusive innovation can therefore reduce these unfair inequalities. But what do we mean by "inclusive"? Inclusive innovation is defined as the development and implementation of new ideas that aim to create opportunities that improve the social and economic well-being of disenfranchised members of society (George et al., 2012). In fact, a significant number of researchers agree that innovation, when responsible and inclusive, "has the potential to address a number of major challenges",

such as water, food, clothing, housing, healthcare, sustainability, education, and so on. So, to be effective, this innovation must be responsible and inclusive of the needs and interests of the people at the Base of the Pyramid (Papaioannou, 2018).

Secondly, how could responsible and inclusive innovation and 'appropriate technology' offer an alternative to shape an ecosystem where the focus is on BoP innovators? This idea for future research raises some considerations for debate such as why so many projects and efforts have focused on closing the gap between developed and developing countries for over two decades, and yet the result has been a widening of the gap. For example, since Schumacher's idea of 'Appropriate Technology' was introduced in 1964, there has been an alternative to the traditional model of innovation, because appropriate technology recognises the potential of a particular community, incorporating the needs and interests of the BoP, and gradually boosts its socio-economic development (Dunn and others, 1979). In fact, and according to academic research, "Inclusive Innovation" due to affordability, cost reduction, sustainability, quality and accessibility for BoP seems to have huge potential as a development opportunity for BoP but above all as a "moral obligation " (Papaioannou, 2018).

Finally, many 3D printing entrepreneurs see this technology as part of a system of emerging technologies that are building an inclusive knowledge framework. Although a responsible innovation ecosystem for 3D4D has been outlined in the contributions section, it could be developed and analysed empirically because there is a strong belief in the 3D printing community that this technology will enable anyone, regardless of their background, to create an innovation. This is a radical change in belief because, in developing countries, it is believed that innovations can only be developed by skilled professionals. Another aspect of 3D printing in a post-structural inclusive society is that technology is being used to educate students and give them a new perspective on innovation. Technology is expected to alter the way young people approach design and, over time, a larger part of the population will be involved in creating new and inclusive responsible innovations.

REFERENCES

- Aboelmaged, M.G., 2010. Six Sigma quality: a structured review and implications for future research. *Int. J. Qual. Reliab. Manag.*
- Agan, Y., Acar, M.F., Borodin, A., 2013. Drivers of environmental processes and their impact on performance: a study of Turkish SMEs. *J. Clean. Prod.* 51, 23–33.
- Agola, N.O., Hunter, A., 2016. *Inclusive Innovation for Sustainable Development*. Springer.
- Aragón-Correa, J.A., Hurtado-Torres, N., Sharma, S., García-Morales, V.J., 2008. Environmental strategy and performance in small firms: A resource-based perspective. *J. Environ. Manage.* 86, 88–103.
- Arvanitis, S., Hollenstein, H., 2001. The Determinants Of The Adoption Of Advanced Manufacturing Technology. *Econ. Innov. New Technol.* 10, 377–414. <https://doi.org/10.1080/10438590100000015>
- Atzeni, E., Salmi, A., 2012. Economics of additive manufacturing for end-usable metal parts. *Int. J. Adv. Manuf. Technol.* <https://doi.org/10.1007/s00170-011-3878-1>
- Auer, A., Jarmai, K., 2018. Implementing responsible research and innovation practices in SMEs: Insights into drivers and barriers from the Austrian medical device sector. *Sustainability* 10, 17.
- Bakos, J., Siu, M., Orengo, A., Kasiri, N., 2020. An analysis of environmental sustainability in small & medium-sized enterprises: Patterns and trends. *Bus. Strateg. Environ.* 29, 1285–1296.
- Bansal, P., Roth, K., 2000. Why companies go green: A model of ecological responsiveness. *Acad. Manag. J.* 43, 717–736.
- Bartolacci, F., Caputo, A., Soverchia, M., 2020. Sustainability and financial performance of small and medium sized enterprises: A bibliometric and systematic literature review. *Bus. Strateg. Environ.* 29, 1297–1309.
- Bartolacci, F., Paolini, A., Quaranta, A.G., Soverchia, M., 2018. Assessing factors that influence waste management financial sustainability. *Waste Manag.* 79, 571–579.

- Basiliere, P., 2016. Enterprise 3D Printer Shipments to Grow 57.4% CAGR through 2020 [WWW Document]. Oct. 13. URL <https://blogs.gartner.com/pete-basiliere/2016/10/13/enterprise-3d-printer-shipments-to-grow-57-4-cagr-through-2020/> (accessed 10.1.18).
- Battaglia, M., Testa, F., Bianchi, L., Iraldo, F., Frey, M., 2014. Corporate social responsibility and competitiveness within SMEs of the fashion industry: Evidence from Italy and France. *Sustainability* 6, 872–893.
- Baumann-Pauly, D., Wickert, C., Spence, L.J., Scherer, A.G., 2013. Organizing corporate social responsibility in small and large firms: Size matters. *J. Bus. ethics* 115, 693–705.
- Belassi, W., Fadlalla, A., 1998. An integrative framework for FMS diffusion. *Omega* 26, 699–713.
- Berman, B., Zarb, F.G., Hall, W., 2012. 3-D printing: The new industrial revolution. *Bus. Horiz.* 55, 155–162. <https://doi.org/10.1016/j.bushor.2011.11.003>
- Bessant, J., 2013. Innovation in the twenty-first century. *Responsible Innov.* 1–25.
- Besser, T.L., Miller, N., 2001. Is the good corporation dead? The community social responsibility of small business operators. *J. Socio. Econ.* 30, 221–241.
- Birtchnell, T., Hoyle, W., 2014. 3D printing for development in the global south: The 3D4D challenge. Springer.
- Boons, F., Lüdeke-Freund, F., 2013. Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. *J. Clean. Prod.* 45, 9–19.
- Boons, F., Montalvo, C., Quist, J., Wagner, M., 2013. Sustainable innovation, business models and economic performance: an overview. *J. Clean. Prod.* 45, 1–8.
- Bos-Brouwers, H.E.J., 2010. Corporate sustainability and innovation in SMEs: evidence of themes and activities in practice. *Bus. Strateg. Environ.* 19, 417–435.
- Brammer, S., Hoejmose, S., Marchant, K., 2012. Environmental

- management in SMEs in the UK: Practices, pressures and perceived benefits. *Bus. Strateg. Environ.* 21, 423–434.
- Brand, T., Blok, V., 2019. Responsible innovation in business: A critical reflection on deliberative engagement as a central governance mechanism. *J. responsible Innov.* 6, 4–24.
- Burget, M., Bardone, E., Pedaste, M., 2017. Definitions and Conceptual Dimensions of Responsible Research and Innovation: A Literature Review. *Sci. Eng. Ethics* 23, 1–19. <https://doi.org/10.1007/s11948-016-9782-1>
- Burlea-Schiopoiu, A., Mihai, L.S., 2019. An integrated framework on the sustainability of SMEs. *Sustainability* 11, 6026.
- Canh, N.T., Liem, N.T., Thu, P.A., Khuong, N.V., 2019. The Impact of Innovation on the Firm Performance and Corporate Social Responsibility of Vietnamese Manufacturing Firms. *Sustainability* 11, 3666.
- Cantele, S., Zardini, A., 2018. Is sustainability a competitive advantage for small businesses? An empirical analysis of possible mediators in the sustainability--financial performance relationship. *J. Clean. Prod.* 182, 166–176.
- Cassells, S., Lewis, K., 2011. SMEs and environmental responsibility: do actions reflect attitudes? *Corp. Soc. Responsib. Environ. Manag.* 18, 186–199.
- Castka, P., Balzarova, M.A., Bamber, C.J., Sharp, J.M., 2004. How can SMEs effectively implement the CSR agenda? A UK case study perspective. *Corp. Soc. Responsib. Environ. Manag.* 11, 140–149.
- Cegarra-Navarro, J.-G., Reverte, C., Gómez-Melero, E., Wensley, A.K.P., 2016. Linking social and economic responsibilities with financial performance: The role of innovation. *Eur. Manag. J.* 34, 530–539.
- Chan, F.T.S., Chong, A.Y.-L., Zhou, L., 2012. An empirical investigation of factors affecting e-collaboration diffusion in SMEs. *Int. J. Prod. Econ.* 138, 329–344.
- Chatfield, K., Iatridis, K., Stahl, B.C., Paspallis, N., 2017. Innovating responsibly in ICT for ageing: Drivers, obstacles and implementation.

Sustainability 9, 971.

- Cheah, J.-H., Sarstedt, M., Ringle, C.M., Ramayah, T., Ting, H., 2018. Convergent validity assessment of formatively measured constructs in PLS-SEM: On using single-item versus multi-item measures in redundancy analyses. *Int. J. Contemp. Hosp. Manag.* 30, 3192–3210.
- Chege, S.M., Wang, D., 2020. The influence of technology innovation on SME performance through environmental sustainability practices in Kenya. *Technol. Soc.* 60, 101210.
- Choongo, P., 2017. A longitudinal study of the impact of corporate social responsibility on firm performance in SMEs in Zambia. *Sustainability* 9, 1300.
- Cruz-Cázares, C., Bayona-Sáez, C., García-Marco, T., 2013. Make, buy or both? R&D strategy selection. *J. Eng. Technol. Manag.* 30, 227–245.
- Dangelico, R.M., Pujari, D., 2010. Mainstreaming green product innovation: Why and how companies integrate environmental sustainability. *J. Bus. ethics* 95, 471–486.
- Darbanhosseiniamirkhiz, M., Wan Ismail, W.K., 2012. Advanced Manufacturing Technology Adoption in SMEs: an Integrative Model. *J. Technol. Manag. Innov.* 7, 112–120. <https://doi.org/10.4067/S0718-27242012000400009>
- de Poel, I., Asveld, L., Flipse, S., Klaassen, P., Scholten, V., Yaghmaei, E., 2017. Company strategies for responsible research and innovation (RRI): A conceptual model. *Sustainability* 9, 2045.
- Denyer, D., Tranfield, D., 2009. Producing a systematic review.
- Deradjat, D., Minshall, T., 2017. Implementation of rapid manufacturing for mass customisation. *J. Manuf. Technol. Manag.* 28, 95–121. <https://doi.org/10.1108/JMTM-01-2016-0007>
- Despeisse, M., Baumers, M., Brown, P., Charnley, F., Ford, S.J., Garmulewicz, A., Knowles, S., Minshall, T.H.W., Mortara, L., Reed-Tsochas, F.P., Rowley, J., 2017. Unlocking value for a circular economy through 3D printing: A research agenda. *Technol. Forecast. Soc. Change* 115, 75–84. <https://doi.org/10.1016/j.techfore.2016.09.021>

- Dey, P.K., Malesios, C., De, D., Chowdhury, S., Abdelaziz, F. Ben, 2020. The impact of lean management practices and sustainably-oriented innovation on sustainability performance of small and medium-sized enterprises: empirical evidence from the UK. *Br. J. Manag.* 31, 141–161.
- Dossa, Z., Kaeufer, K., 2014. Understanding sustainability innovations through positive ethical networks. *J. Bus. Ethics* 119, 543–559.
- Dunn, P.D., others, 1979. *Appropriate technology. Technology with a human face.* Schocken Books.
- El Baz, J., Laguir, I., Marais, M., Staglianò, R., 2016. Influence of national institutions on the corporate social responsibility practices of small-and medium-sized enterprises in the food-processing industry: Differences between France and Morocco. *J. Bus. Ethics* 134, 117–133.
- Elkington, J., 1998. Partnerships from cannibals with forks: The triple bottom line of 21st-century business. *Environ. Qual. Manag.* 8, 37–51.
- European Commission, 2014. *Rome declaration on responsible research and innovation in Europe.*
- European Commission, 2006. *Implementing the partnership for growth and jobs: Making Europe a pole of excellence on Corporate Social Responsibility.* COM 136.
- European Commission, 2003. *A collection of good practice cases among small and medium-sized enterprises across Europe: 1-60.* Visited 10, 2005.
- Fornell Claes, L.D.F., 1981. *Evaluating Structural Equation Models with Unobservable Variables and Measurement Error.*
- Foronda, C., Beverinotti, J., Suaznábar, C., 2018. Análisis de las características de la innovación en empresas y su efecto en la productividad en Bolivia. *Sect. Inst. para el Desarro. Div. Compet. Tecnol. e Innovación. El Dep. Países del Grup. Andin. Nota técnica, n°IDB-TN-1605.*
- Foster, C., Heeks, R., 2013. Conceptualising inclusive innovation: Modifying systems of innovation frameworks to understand diffusion of new technology to low-income consumers. *Eur. J. Dev. Res.* 25, 333–355. <https://doi.org/10.1057/ejdr.2013.7>

- Fraaije, A., Flipse, S.M., 2020. Synthesizing an implementation framework for responsible research and innovation. *J. Responsible Innov.* 7, 113–137.
- Franceschini, S., Faria, L.G.D., Jurowetzki, R., 2016. Unveiling scientific communities about sustainability and innovation. A bibliometric journey around sustainable terms. *J. Clean. Prod.* 127, 72–83.
- Fransman, M., 2018. *Innovation Ecosystems: Increasing Competitiveness.* Cambridge University Press.
- Freeman, R.E., 2010. *Strategic management: A stakeholder approach.* Cambridge university press.
- Freeman, R.E., 1984. *Strategic Management: A Stakeholder Approach* (Pitman, Boston, Mass.).
- Freeman, R.E., Reed, D.L., 1983. Stockholders and stakeholders: A new perspective on corporate governance. *Calif. Manage. Rev.* 25, 88–106.
- Fuller, T., Tian, Y., 2006. Social and symbolic capital and responsible entrepreneurship: an empirical investigation of SME narratives. *J. Bus. ethics* 67, 287–304.
- Fulton, M., Hon, B., 2010. Managing advanced manufacturing technology (AMT) implementation in manufacturing SMEs. *Int. J. Product. Perform. Manag.* 59, 351–371. <https://doi.org/10.1108/17410401011038900>
- Garson, G.D., 2016. *Partial Least Squares: Regression & Structural Equation Models,* G. David Garson and Statistical Associates Publishing.
- Gaziulusoy, A.I., Boyle, C., McDowall, R., 2013. System innovation for sustainability: a systemic double-flow scenario method for companies. *J. Clean. Prod.* 45, 104–116.
- George, G., Mcgahan, A.M., Prabhu, J., 2012. Innovation for Inclusive Growth: Towards a Theoretical Framework and a Research Agenda. *J. Manag. Stud.* 49, 661–683. <https://doi.org/10.1111/j.1467-6486.2012.01048.x>
- Ghadge, A., Kaklamanou, M., Choudhary, S., Bourlakis, M., 2017. Implementing environmental practices within the Greek dairy supply

chain. *Ind. Manag. Data Syst.*

- Gonzales-Gemio, C., Cruz-Cázares, C., Parmentier, M.J., 2020. Responsible Innovation in SMEs: A Systematic Literature Review for a Conceptual Model. *Sustainability* 12, 10232.
- Guston, D.H., 2014. Understanding ‘anticipatory governance.’ *Soc. Stud. Sci.* 44, 218–242.
- Guston, D.H., Sarewitz, D., 2002. Real-time technology assessment. *Technol. Soc.* 24, 93–109. [https://doi.org/10.1016/S0160-791X\(01\)00047-1](https://doi.org/10.1016/S0160-791X(01)00047-1)
- Hadj, T.B., 2020. Effects of corporate social responsibility towards stakeholders and environmental management on responsible innovation and competitiveness. *J. Clean. Prod.* 250, 119490.
- Hair Jr, J.F., Hult, G.T.M., Ringle, C., Sarstedt, M., 2016. A primer on partial least squares structural equation modeling (PLS-SEM). Sage Publications.
- Halme, M., Korpela, M., 2014. Responsible innovation toward sustainable development in small and medium-sized enterprises: A resource perspective. *Bus. Strateg. Environ.* 23, 547–566.
- Hammann, E.-M., Habisch, A., Pechlaner, H., 2009. Values that create value: socially responsible business practices in SMEs--empirical evidence from German companies. *Bus. Ethics A Eur. Rev.* 18, 37–51.
- Hang, M., Geyer-Klingeborg, J., Rathgeber, A.W., 2019. It is merely a matter of time: A meta-analysis of the causality between environmental performance and financial performance. *Bus. Strateg. Environ.* 28, 257–273.
- Hayes, R.H., Harding, W.B., Jaikumar, R., 1991. Requirements for successful implementation of new manufacturing technologies. *J. Eng. Technol. Manag.* 7, 169–175.
- Heeks, R., 2017. Information and communication technology for development (ICT4D). Routledge.
- Hernández, J.P.S.-I., Yañez-Araque, B., Moreno-García, J., 2020. Moderating effect of firm size on the influence of corporate social

- responsibility in the economic performance of micro-, small-and medium-sized enterprises. *Technol. Forecast. Soc. Change* 151, 119774.
- Hofmann, K.H., Theyel, G., Wood, C.H., 2012. Identifying firm capabilities as drivers of environmental management and sustainability practices--evidence from small and medium-sized manufacturers. *Bus. Strateg. Environ.* 21, 530–545.
- Hoogendoorn, B., Guerra, D., van der Zwan, P., 2015. What drives environmental practices of SMEs? *Small Bus. Econ.* 44, 759–781.
- Hopkinson, N., Dicknes, P., Dickens, P., 2003. Analysis of rapid manufacturing—using layer manufacturing processes for production. *Proc. Inst. Mech. Eng. Part C J. Mech. Eng. Sci.* 217, 31–39.
- Hornick, J., 2015. 3D Printing and IP Rights: The Elephant in the Room. *St. Cl. L. Rev.* 55, 801. <https://doi.org/10.3366/ajicl.2011.0005>
- Hsu, C.-H., Chang, A.-Y., Luo, W., 2017. Identifying key performance factors for sustainability development of SMEs--integrating QFD and fuzzy MADM methods. *J. Clean. Prod.* 161, 629–645.
- Hull, C.E., Rothenberg, S., 2008. Firm performance: The interactions of corporate social performance with innovation and industry differentiation. *Strateg. Manag. J.* 29, 781–789.
- Ikram, M., Sroufe, R., Mohsin, M., Solangi, Y.A., Shah, S.Z.A., Shahzad, F., 2019. Does CSR influence firm performance? A longitudinal study of SME sectors of Pakistan. *J. Glob. Responsib.*
- Iraldo, F., Testa, F., Lanzini, P., Battaglia, M., 2017. Greening competitiveness for hotels and restaurants. *J. Small Bus. Enterp. Dev.*
- Jain, P., Vyas, V., Chalasani, D.P.S., 2016. Corporate social responsibility and financial performance in SMEs: A structural equation modelling approach. *Glob. Bus. Rev.* 17, 630–653.
- Jain, P., Vyas, V., Roy, A., 2017. Exploring the mediating role of intellectual capital and competitive advantage on the relation between CSR and financial performance in SMEs. *Soc. Responsib. J.*
- Jamali, D., Zanhour, M., Keshishian, T., 2009. Peculiar strengths and relational attributes of SMEs in the context of CSR. *J. Bus. Ethics* 87,

355–377.

- Jansson, J., Nilsson, J., Modig, F., Hed Vall, G., 2017. Commitment to sustainability in small and medium-sized enterprises: The influence of strategic orientations and management values. *Bus. Strateg. Environ.* 26, 69–83.
- Jenkins, H., 2009. A ‘business opportunity’ model of corporate social responsibility for small-and medium-sized enterprises. *Bus. ethics A Eur. Rev.* 18, 21–36.
- Jenkins, H., 2006. Small business champions for corporate social responsibility. *J. Bus. ethics* 67, 241–256.
- Jenkins, H., 2004. A critique of conventional CSR theory: An SME perspective. *J. Gen. Manag.* 29, 37–57.
- Johnson, M.P., Schaltegger, S., 2016. Two decades of sustainability management tools for SMEs: How far have we come? *J. Small Bus. Manag.* 54, 481–505.
- Jones, J., de Zubieta, G.C., 2017. Doing well by doing good: A study of university-industry interactions, innovativeness and firm performance in sustainability-oriented Australian SMEs. *Technol. Forecast. Soc. Change* 123, 262–270.
- Khan, S.Z., Yang, Q., Khan, N.U., Kherbachi, S., Huemann, M., 2020. Sustainable social responsibility toward multiple stakeholders as a trump card for small and medium-sized enterprise performance (evidence from China). *Corp. Soc. Responsib. Environ. Manag.*
- Khorram Niaki, M., Nonino, F., 2017a. Additive manufacturing management: a review and future research agenda. *Int. J. Prod. Res.* 55, 1419–1439. <https://doi.org/10.1080/00207543.2016.1229064>
- Khorram Niaki, M., Nonino, F., 2017b. Impact of additive manufacturing on business competitiveness: a multiple case study. *J. Manuf. Technol. Manag.* 28, 56–74. <https://doi.org/10.1108/JMTM-01-2016-0001>
- Kirton, M., 1976. Adaptors and innovators: A description and measure. *J. Appl. Psychol.* 61, 622–629. <https://doi.org/10.1037/0021-9010.61.5.622>

- Klewitz, J., Hansen, E.G., 2014. Sustainability-oriented innovation of SMEs: a systematic review. *J. Clean. Prod.* 65, 57–75.
- Kraus, S., Burtscher, J., Niemand, T., Roig-Tierno, N., Syrjä, P., 2017. Configurational paths to social performance in SMEs: The interplay of innovation, sustainability, resources and achievement motivation. *Sustainability* 9, 1828.
- Kruth, J.P., Levy, G., Klocke, F., Childs, T.H.C., 2007. Consolidation phenomena in laser and powder-bed based layered manufacturing. *CIRP Ann. - Manuf. Technol.* <https://doi.org/10.1016/j.cirp.2007.10.004>
- Kuhlman, T., Farrington, J., 2010. What is sustainability? *Sustainability* 2, 3436–3448.
- Lanjouw, J.O., Schankerman, M., 2004. Patent quality and research productivity: Measuring innovation with multiple indicators. *Econ. J.* 114, 441–465.
- Lasswell, H.D., 2018. *Politics: Who gets what, when, how.* Pickle Partners Publishing.
- Lee, J.W., Kim, Y.M., Kim, Y.E., 2018. Antecedents of adopting corporate environmental responsibility and green practices. *J. Bus. Ethics* 148, 397–409.
- Lee, K.-H., Herold, D.M., Yu, A.-L., 2016. Small and medium enterprises and corporate social responsibility practice: A Swedish perspective. *Corp. Soc. Responsib. Environ. Manag.* 23, 88–99.
- Leonidou, L.C., Christodoulides, P., Kyrgidou, L.P., Palihawadana, D., 2017. Internal drivers and performance consequences of small firm green business strategy: The moderating role of external forces. *J. Bus. ethics* 140, 585–606.
- Lepoutre, J., Heene, A., 2006. Investigating the impact of firm size on small business social responsibility: A critical review. *J. Bus. ethics* 67, 257–273.
- Li, L., Li, G., Tsai, F.-S., Lee, H.-Y., Lee, C.-H., 2019. The effects of corporate social responsibility on service innovation performance: The role of dynamic capability for sustainability. *Sustainability* 11, 2739.

- Li, N., Toppinen, A., Lantta, M., 2016. Managerial perceptions of SMEs in the wood industry supply chain on corporate responsibility and competitive advantage: evidence from China and Finland. *J. Small Bus. Manag.* 54, 162–186.
- López-Pérez, M., Melero, I., Javier Sesé, F., 2017. Does specific CSR training for managers impact shareholder value? Implications for education in sustainable development. *Corp. Soc. Responsib. Environ. Manag.* 24, 435–448.
- Lubberink, R., Blok, V., Ophem, J. van, Omta, O., 2017. Lessons for responsible innovation in the business context: A systematic literature review of responsible, social and sustainable innovation practices. *Sustain.* 9. <https://doi.org/10.3390/su9050721>
- Madueno, J.H., Jorge, M.L., Conesa, I.M., Martínez-Martínez, D., 2016. Relationship between corporate social responsibility and competitive performance in Spanish SMEs: Empirical evidence from a stakeholders' perspective. *BRQ Bus. Res. Q.* 19, 55–72.
- Marri, H.B., Gunasekaran, A., Sohag, R.A., 2007. Implementation of advanced manufacturing technology in Pakistani small and medium enterprises: An empirical analysis. *J. Enterp. Inf. Manag.* 20, 726–739. <https://doi.org/10.1108/17410390710830745>
- Marschalek, I., Schrammel, M., Unterfrauner, E., Hofer, M., 2017. Interactive reflection trainings on RRI for multiple stakeholder groups. *J. Responsible Innov.* 4, 295–311. <https://doi.org/10.1080/23299460.2017.1326262>
- Martinez-Conesa, I., Soto-Acosta, P., Palacios-Manzano, M., 2017. Corporate social responsibility and its effect on innovation and firm performance: An empirical research in SMEs. *J. Clean. Prod.* 142, 2374–2383.
- Martínez-Martínez, D., Madueño, J.H., Jorge, M.L., Sancho, M.P.L., 2017. The strategic nature of corporate social responsibility in SMEs: a multiple mediator analysis. *Ind. Manag. Data Syst.*
- Martinsuo, M., Luomaranta, T., Authors, F., Martinsuo, M., Luomaranta, T., Authors, F., 2018. Adopting additive manufacturing in SMEs: exploring the challenges and solutions. *J. Manuf. Technol. Manag.* <https://doi.org/10.1108/JMTM-02-2018-0030>

- Martinuzzi, A., Blok, V., Brem, A., Stahl, B., Schönherr, N., 2018. Responsible research and innovation in industry—Challenges, insights and perspectives. *Sustain.* 10, 1–9. <https://doi.org/10.3390/su10030702>
- McWilliams, A., Siegel, D., 2000. Corporate social responsibility and financial performance: correlation or misspecification? *Strateg. Manag. J.* 21, 603–609.
- Mellor, S., Hao, L., Zhang, D., 2014. Additive manufacturing: A framework for implementation. *Intern. J. Prod. Econ.* 149, 194–201. <https://doi.org/10.1016/j.ijpe.2013.07.008>
- Miller, K., Neubauer, A., Varma, A., Williams, E., 2011. First Assessment of the Environmental Compliance Assistance Programme for SMEs (ECAP). Rep. Prep. Eur. Comm. DG Environ. Clim. Action.
- Moneva-Abadía, J.M., Gallardo-Vázquez, D., Sánchez-Hernández, M.I., 2019. Corporate social responsibility as a strategic opportunity for small firms during economic crises. *J. Small Bus. Manag.* 57, 172–199.
- Muñoz-Pascual, L., Curado, C., Galende, J., 2019. The triple bottom line on sustainable product innovation performance in SMEs: A mixed methods approach. *Sustainability* 11, 1689.
- OECD, E., 2005. Oslo manual: Guidelines for collecting and interpreting innovation data. Paris 2005, Sp 46.
- Oettmeier, K., Hofmann, E., 2016. Impact of additive manufacturing technology adoption on supply chain management processes and components. *J. Manuf. Technol. Manag.* 27. <https://doi.org/10.1108/JMTM-12-2015-0113>
- Orlitzky, M., Schmidt, F.L., Rynes, S.L., 2003. Corporate social and financial performance: A meta-analysis. *Organ. Stud.* 24, 403–441.
- Ortiz-Avram, D., Domnanovich, J., Kronenberg, C., Scholz, M., 2018. Exploring the integration of corporate social responsibility into the strategies of small-and medium-sized enterprises: A systematic literature review. *J. Clean. Prod.* 201, 254–271.
- Ostrom, E., 2000. Collective action and the evolution of social norms. *J. Econ. Perspect.* 14, 137–158.

- Owen, R., Macnaghten, P., Stilgoe, J., 2012. Responsible research and innovation: From science in society to science for society, with society. *Sci. public policy* 39, 751–760.
- Owen, R., Pansera, M., 2019. Responsible innovation and responsible research and innovation, in: *Handbook on Science and Public Policy*. Edward Elgar Publishing.
- Pandza, K., Ellwood, P., 2013. Strategic and ethical foundations for responsible innovation. *Res. Policy* 42, 1112–1125.
- Papaioannou, T., 2018. *Inclusive Innovation for Development: Meeting the Demands of Justice through Public Action*. Routledge.
- Perrini, F., Russo, A., Tencati, A., 2007. CSR strategies of SMEs and large firms. Evidence from Italy. *J. Bus. ethics* 74, 285–300.
- Porter, M., Kramer, M., 2006. Estrategia y sociedad. *Harv. Bus. Rev.* 84, 42–56.
- Porter, M.E., 1985. Technology and competitive advantage. *J. Bus. Strategy* 5, 60–78.
- Prashar, A., others, 2020. A bibliometric and content analysis of sustainable development in small and medium-sized enterprises. *J. Clean. Prod.* 245, 118665.
- Preuss, L., Perschke, J., 2010. Slipstreaming the larger boats: Social responsibility in medium-sized businesses. *J. Bus. Ethics* 92, 531–551.
- Rahardjo, J., Yahya, S., 2010. Advanced Manufacturing Technology Implementation Process in SME : Critical Success Factors. *Adv. Manuf.* 12, 101–108.
- Ratnawati, Soetjipto, B.E., Murwani, F.D., Wahyono, H., 2018. The Role of SMEs' Innovation and Learning Orientation in Mediating the Effect of CSR Programme on SMEs' Performance and Competitive Advantage. *Glob. Bus. Rev.* 19, S21--S38.
- Raymond, L., Uwizeyemungu, S., 2007. A profile of ERP adoption in manufacturing SMEs. *J. Enterp. Inf. Manag.* 20, 487–502. <https://doi.org/10.1108/17410390710772731>

- Rayna, T., Striukova, L., 2016. From rapid prototyping to home fabrication: How 3D printing is changing business model innovation. *Technol. Forecast. Soc. Change* 102, 214–224. <https://doi.org/10.1016/j.techfore.2015.07.023>
- Reverte, C., Gomez-Melero, E., Cegarra-Navarro, J.G., 2016. The influence of corporate social responsibility practices on organizational performance: evidence from Eco-Responsible Spanish firms. *J. Clean. Prod.* 112, 2870–2884.
- Rhee, J., Park, T., Lee, D.H., 2010. Drivers of innovativeness and performance for innovative SMEs in South Korea: Mediation of learning orientation. *Technovation* 30, 65–75.
- Ribeiro, Barbara E and Smith, Robert DJ and Millar, K., 2017. A Mobilising Concept? Unpacking Academic Representations of Responsible Research and Innovation. *Sci. Eng. Ethics* 23, 81–103. <https://doi.org/10.1007/s11948-016-9761-6>
- Ribeiro, B., Bengtsson, L., Benneworth, P., Bühner, S., Castro-Martínez, E., Hansen, M., Jarmai, K., Lindner, R., Olmos-Peñuela, J., Ott, C., others, 2018. Introducing the dilemma of societal alignment for inclusive and responsible research and innovation. *J. responsible Innov.* 5, 316–331.
- Rifkin, J., 2015. *The Zero Marginal Cost Society : the internet of things, the collaborative commons, and the eclipse of capitalism.* Palgrave Macmillan.
- Rip, A., Voß, J.-P., 2013. Umbrella terms as mediators in the governance of emerging science and technology.
- Rotolo, D., Hicks, D., Martin, B.R., 2015. What is an emerging technology? *Res. Policy* 44. <https://doi.org/10.1016/j.respol.2015.06.006>
- Ruffo, M., Hague, R., 2007. Cost estimation for rapid manufacturing – simultaneous production of mixed components using laser sintering. *Part B J. Eng. Manuf.* 221, 1585–1591. <https://doi.org/10.1243/09544054JEM894>
- Saberi, S., Mohd. Yusu, R., Zulkifli, N., Megat Ahmad, M.M.H., Yusuff, R.M., Zulkifli, N., Ahmad, M., Mohd. Yusu, R., Zulkifli, N., Megat Ahmad, M.M.H., 2010. Effective Factors on Advanced Manufacturing Technology Implementation Performance: A Review. *J. Appl. Sci.* 10,

1229–1242. <https://doi.org/10.3923/jas.2010.1229.1242>

- Sáez-Martínez, F.J., Díaz-García, C., González-Moreno, Á., 2016. Factors promoting environmental responsibility in European SMEs: The effect on performance. *Sustainability* 8, 898.
- Salzmann, O., Ionescu-Somers, A., Steger, U., 2005. The business case for corporate sustainability:: literature review and research options. *Eur. Manag. J.* 23, 27–36.
- Sancho, M.P.L., Martínez-Martínez, D., Jorge, M.L., Madueño, J.H., 2018. Understanding the link between socially responsible human resource management and competitive performance in SMEs. *Pers. Rev.*
- Schniederjans, D.G., 2017. Adoption of 3D-printing technologies in manufacturing: A survey analysis. *Int. J. Prod. Econ.* 183, 287–298. <https://doi.org/10.1016/j.ijpe.2016.11.008>
- Sen, S., Cowley, J., 2013. The relevance of stakeholder theory and social capital theory in the context of CSR in SMEs: An Australian perspective. *J. Bus. Ethics* 118, 413–427.
- Silva, L.M. da, Bitencourt, C.C., Faccin, K., Iakovleva, T., 2019. The Role of Stakeholders in the Context of Responsible Innovation: A Meta-Synthesis. *Sustainability* 11, 1766.
- Spruit, S.L., Hoople, G.D., Rolfe, D.A., 2016. Just a cog in the machine? The individual responsibility of researchers in nanotechnology is a duty to collectivize. *Sci. Eng. Ethics* 22, 871–887.
- Stahl, B.C., 2013. Responsible research and innovation: The role of privacy in an emerging framework. *Sci. Public Policy* 40, 708–716.
- Stahl, B.C., Chatfield, K., Ten Holter, C., Brem, A., 2019. Ethics in corporate research and development: can responsible research and innovation approaches aid sustainability? *J. Clean. Prod.* 239, 118044.
- Steenhuis, H.-J., Pretorius, L., 2016. Consumer additive manufacturing or 3D printing adoption: an exploratory study. *J. Manuf. Technol. Manag.* 27. <https://doi.org/10.1108/JMTM-01-2016-0002>
- Steenhuis, H., Pretorius, L., 2017. The additive manufacturing innovation : a range of implications. *J. Manuf. Technol. Manag.* 28, 122–143.

<https://doi.org/10.1108/JMTM-06-2016-0081>

- Stilgoe, J., Owen, R., Macnaghten, P., 2013. Developing a framework for responsible innovation. *Res. Policy* 42, 1568–1580. <https://doi.org/10.1016/j.respol.2013.05.008>
- Stoian, C., Gilman, M., 2017. Corporate social responsibility that “pays”: A strategic approach to CSR for SMEs. *J. Small Bus. Manag.* 55, 5–31.
- Suriyankietkaew, S., Avery, G., 2016. Sustainable leadership practices driving financial performance: Empirical evidence from Thai SMEs. *Sustainability* 8, 327.
- Tang, Z., Hull, C.E., Rothenberg, S., 2012. How corporate social responsibility engagement strategy moderates the CSR--financial performance relationship. *J. Manag. Stud.* 49, 1274–1303.
- Tang, Z., Tang, J., 2018. Stakeholder corporate social responsibility orientation congruence, entrepreneurial orientation and environmental performance of Chinese small and medium-sized enterprises. *Br. J. Manag.* 29, 634–651.
- Tang, Z., Tang, J., 2012. Stakeholder--firm power difference, stakeholders' CSR orientation, and SMEs' environmental performance in China. *J. Bus. Ventur.* 27, 436–455.
- Tantalo, C., Caroli, M.G., Vanevenhoven, J., 2012. Corporate social responsibility and SME's competitiveness. *Int. J. Technol. Manag.* 58, 129–151.
- Thomas, A.J., Barton, R., John, E.G., 2008. Advanced manufacturing technology implementation: a review of benefits and a model for change. *Int. J. Product. Perform. Manag.* 57, 156–176. <https://doi.org/10.1108/17410400810847410>
- Thomas, D., 2016. Costs, benefits, and adoption of additive manufacturing: a supply chain perspective. *Int. J. Adv. Manuf. Technol.* 1857–1876. <https://doi.org/10.1007/s00170-015-7973-6>
- Thong, J.Y.L., Yap, C.-S., 1995. CEO characteristics, organizational characteristics and information technology adoption in small businesses. *Omega* 23, 429–442.

- Tobiassen, A.E., Pettersen, I.B., 2018. Exploring open innovation collaboration between SMEs and larger customers. *Balt. J. Manag.* 13, 65–83. <https://doi.org/10.1108/BJM-01-2017-0018>
- Tornatzky, L.G., Fleischer, M., Chakrabarti, A.K., 1990. The processes of technological innovation. *Issues in organization and management series*, Lexington Books. Available at <http://www.amazon.com/Processes-Technological-Innovation-Organization/Management/dp/0669203483>. Accessed June.
- Torugsa, N.A., O'Donohue, W., Hecker, R., 2013. Proactive CSR: An empirical analysis of the role of its economic, social and environmental dimensions on the association between capabilities and performance. *J. Bus. Ethics* 115, 383–402.
- Torugsa, N.A., O'Donohue, W., Hecker, R., 2012. Capabilities, proactive CSR and financial performance in SMEs: Empirical evidence from an Australian manufacturing industry sector. *J. Bus. ethics* 109, 483–500.
- Tranfield, D., Denyer, D., Smart, P., 2003. Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *Br. J. Manag.* 14, 207–222.
- Valdivia, W.D., Guston, D.H., 2015. Responsible innovation: A primer for policymakers.
- Van Oudheusden, M., 2014. Where are the politics in responsible innovation? European governance, technology assessments, and beyond. *J. Responsible Innov.* 1, 67–86.
- Visser, W., 2010. The age of responsibility: CSR 2.0 and the new DNA of business. *J. Bus. Syst. Gov. ethics* 5, 7.
- Vives, A., Corral, A., Isusi, I., 2005. Responsabilidad social de la empresa en las PYMEs de Latinoamerica.
- Von Schomberg, R., 2013. A vision of responsible research and innovation. *Responsible Innov. Manag. responsible Emerg. Sci. Innov. Soc.* 51–74.
- Von Schomberg, R., 2012. Prospects for technology assessment in a framework of responsible research and innovation, in: *Technikfolgen Abschätzen Lehren*. Springer, pp. 39–61.

- Voss, C., Blackmon, K.L., Cagliano, R., Hanson, P., Wilson, F., 1998. Made in Europe: Small Companies. *Bus. Strateg. Rev.* 9, 1–19. <https://doi.org/10.1111/1467-8616.00078>
- Voss, C.A., 1988. Implementation: A key issue in manufacturing technology: The need for a field of study. *Res. Policy* 17, 55–63.
- Waldron, T.L., Navis, C., Karam, E.P., Markman, G., 2019. Toward a theory of activist-driven responsible innovation: How activists pressure firms to adopt more responsible practices. *J. Manag. Stud.* <https://doi.org/10.1111/joms.12548>
- Wilford, S.H., 2016. What is required of requirements? A first stage process towards developing guidelines for responsible research and innovation. *ACM SIGCAS Comput. Soc.* 45, 348–355.
- Williams, S., Schaefer, A., 2013. Small and medium-sized enterprises and sustainability: Managers' values and engagement with environmental and climate change issues. *Bus. Strateg. Environ.* 22, 173–186.
- Wohlers, T.T., Caffrey, T., 2015. Wohlers report 2015: 3D printing and additive manufacturing state of the industry annual worldwide progress report. Wohlers Associates.
- World Commission on Environment and Development, 1987. *Our Common Future: From One Earth to One World*. Oxford Univ. 10.
- Yeh, C.C., Chen, Y.F., 2018. Critical success factors for adoption of 3D printing. *Technol. Forecast. Soc. Change* 0–1. <https://doi.org/10.1016/j.techfore.2018.02.003>
- Zhu, K., Kraemer, K.L., Xu, S., 2006. The process of innovation assimilation by firms in different countries: a technology diffusion perspective on e-business. *Manage. Sci.* 52, 1557–1576.
- Zhu, Q., Zou, F., Zhang, P., 2019. The role of innovation for performance improvement through corporate social responsibility practices among small and medium-sized suppliers in China. *Corp. Soc. Responsib. Environ. Manag.* 26, 341–350.

