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Belgium’s receptiveness to integrate foreign frugal innovations in its healthcare

An inspection on Belgian healthcare's openness to innovation and the role of entrepreneurs in the diffusion in the context of COVID-19.

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Changes call for innovation, and innovation leads to progress.

– Li Keqiang

I. EXECUTIVE SUMMARY

The human being has continuously improved his life, according to his needs, through innovations that led to different kinds of progress. *Frugal innovation* (FI) is one of these processes – a modern paradigm, originating from the developing countries, that aims to offer more value for the many with less resources. Its promises falling within this century's crises, an increasing number of companies have understood the opportunity – or threat – this type of innovation represents. Not only its contributions bring a better answer to the needs of large segments in low-income countries, but are also a source of competitive advantage in developed countries. When they are transferred into Western markets and, they become *reverse innovation* (RI).

This research examines how receptive the Belgian healthcare is towards the integration of foreign frugal innovations. It aims to shed a light on the relevancy of these theoretical concepts by confronting them to the field reality – where the entrepreneur scrambles to diffuse innovation in the middle of complex interactions that stakeholders have.

The methods of analysis consist in a mix of quantitative and qualitative researches and the use of a set of innovations that emerged as a response to COVID-19 across the world. Once their *frugality* assessed, the potential transferability of these FIs is evaluated by panels of experts and entrepreneurs, in terms of *reversibility* and *commercial potential*. Ultimately, the objective is to explore why such innovations are likely to be integrated in Belgian healthcare.

The results display that the paradigms are relevant as 3 FIs are deemed promising. Moreover, the testing of a literature hypothesis stating that innovations from developing countries suffer from negative image and judgment, hence hindering their diffusion in western markets, has not been conclusive. Conversely, the findings suggest that Belgian healthcare is characterized by a complex institutional and regulatory structure, which increases the cost to innovate. Additionally, several results demonstrated that if an innovation brings novelty or fills a gap, there are less chances of it being feasible for entrepreneurs. It exposes the structural conservatism of the Belgian system towards innovation, with actors having no incentives to improve efficiency and living in the fear of changes, and thus progress.

To adjust this, the research suggests a reform to adopt managerial approaches to increase sensitivity to performance. Moreover, the creation of international entrepreneurs' networks appears to be a conceivable way to fasten innovation cycles, drive open innovation, and induce change to bring a better answer to the universal need – health.

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III. LIST OF ABBREVIATIONS

BoP: Bottom-of-the-Pyramid

ENT: Entrepreneurs panel

FI: Frugal innovation

FIH-ID: Frugal Innovation for Healthcare Identification

GI: Good-enough innovation

HC: Healthcare

HCW: Healthcare worker

HIC: High-income country

HQ: Headquarters

INAMI: Institut National d'Assurance Maladie Invalidité (i.e. NIHDI in English)

INT: Interviewee

IT: Information technology

LIC: Low-income country

LMIC: Low-to-middle-income country

MF: Medical-frugal panel

MFC: Medical-frugal-control panel

MNC: Multinational corporation

MR: Medical-reverse panel

NIHDI: National Institute for Health and Disability Insurance

OECD: Organization for Economic Co-operation and Development

OI: Open innovation

R.Q.: Research question

RCI: Resource-constrained innovation

RI: Reverse innovation

SI: Sustainable innovation

SME: Small and medium enterprises

T-HOPE: Toronto Health Organization Performance Evaluation

WHO: World Health Organization

WTO: World Trade Organization

IV. TABLE OF CONTENTS

V. INTRODUCTION

Nowadays, after having acted as a key driver of unprecedented economic growth, globalization has started faltering due to a great deal of factors. In fact, after having been in the Western world for the 20th century, the world's economic center of gravity is shifting towards Asia (Dobbs et al., 2012). This shift has already had an impact as Asian countries have attracted many Western companies aiming to minimize labor costs. Following its admission to the World Trade Organization (WTO) in 2001, for a longtime, China acted mainly as a manufacturing powerhouse. As the worldwide evolution of the information and communication technology has allowed connecting developed and developing countries, the different approach used by the latter in terms of innovation has become more accessible. This has, in turn, shed a light on concepts such as frugal innovation, which consists in offering more for the many, and do so with less and in a scalable way. The COVID-19 crisis has shown how intertwined the global economy is, and how universal healthcare (HC) needs are. Therefore, when a successful innovation, capable of disrupting the market occurs, the question is not if it is going to be successful, but when. In fact, more and more global actors are aware of the danger frugal innovations can represent for their businesses and start embracing both frugal and reverse innovation – embedding them in their strategy to turn the treat into an opportunity.

Innovation lies in this dilemma between the satisfaction of what is and the risk of searching for what can be. The fact that medical science has to do with the human body might be one of the reasons of the change-resisting culture that has been characterizing the medical sector. On the contrary, this specificity makes medical progresses having potentially worldwide impact. As the COVID-19 has displayed, the sector has, in some extent, the fate of humanity in its hand. Since 1995, access to the highest attainable standard of health has been established as a human right by the World Health Organization. Even though there are many reasons that make it far from being achieved, innovation constitutes one of the best ways to get attain this goal.

Innovation, but in which way? For starters, by observing the new products and services in the medical sector, one can see that innovation in healthcare is often intertwined with technological improvement. As a consequence, healthcare has become more and more expensive and worldwide, countries' expenditures in health are increasing for the honorable, yet, unachieved sake of welfare. Conversely, larger charges do not necessarily mean higher quality services as the sector is still characterized by large proportions of waste and

inefficiencies, at least in numerous of high-income countries (HICs). These challenges can be qualified as universal, as health translates into similar needs across the world. Yet, the processes of innovating to answer these needs differ from one context to another, reflecting in contrasted outcomes.

Innovation, but from where? The traditional diffusion patterns were described from a Western perspective, as trickle-down flows – from top to bottom in terms of wealth – within, and between countries. With the opening of the world and other factors such as the shift of growth to the developing world, innovation theory has been enriched thanks to the discovery and creation of new paradigms that challenge conventional theories. Among them, reverse innovation (RI) consists in the exact opposite flow, i.e. a trickle-up diffusion of resource-constrained innovations (RCI) from low- to mid- income countries (LMICs) being transferred into developed countries.

Innovation, but how? Improvement resonates with performance and the instinctive, yet garbled belief might be that technological improvements mean higher performances. Indeed, the way innovation is pursued, i.e. the process and/or the mindset, as well as the variant of innovation aimed for, depend largely on the targeted context and needs. The outcome resulting from resource-constrained settings is likely to differ from the one conceived by a R&D team holding a considerable budget. Frugal innovation (FI) is one of these modern paradigms that challenges traditional theoretical concepts. The fundamental philosophy beneath is the development of innovations which *instead of adding more bells and whistles, they strip their products down to their bare essentials* (The Economist, 2010). In other terms, to *do more with less and for the many* (Y. Bhatti, Khilji, & Basu, 2013). Overall, frugal innovation (FI) has the potential to bring an appropriate answer to both local needs and expectations of value-sensitive consumers of the incessantly increasing middle class across the world. After all, if an innovation is less costly, provides to many more, and does so more competently, then it would be adopted in any country, right?

Finally, a fundamental question has to be asked; *What is innovation*? While the emergence of contemporary schools of thought occurred over time, there is the coexistence of a myriad of ramifications of innovation theory that differ on the aim, the context, the form, the stakeholder, and so forth. From Schumpeter's conception of radical and incremental innovation to modern contributions of the evolutionary theory such as open innovation, exploring overlapping variants of innovation enables to acquire a thorough grasp of the origins and characteristics of FI and RI.

The theoretical part of this research will explore the basis of innovation and how it evolved over time with the opening of the world. Among the recent discoveries, the modern paradigms of frugal innovation (FI) and reverse innovation (RI) are examined. More precisely their origins, characteristics, drivers, barriers, and success factors. Then, the practical part of this research focuses on this critical and universal healthcare sector. The scope defined is to evaluate the transferability in Belgian HC of frugal innovations as a response to COVID-19. A mix of non-experimental descriptive and exploratory methods was chosen as research strategy, using both quantitative and qualitative data analyses. First, the *frugality* of the chosen innovations was assessed. Then, the *reversibility* and *commercial potential* of the frugal innovations were evaluated by surveying medical experts and entrepreneurs. Three aspects are investigated among a set of foreign innovations – which are the transferable FI; which factors make the rest not transferable; and what are the general dynamics around innovation in Belgian HC.

VI. PART I: LITERATURE REVIEW

1. INNOVATION

To understand what frugal innovation (FI) and reverse innovation (RI) are, it is important to understand the core of the innovation theories and how it has evolved over time into a more inclusive perspective in parallel with the opening of the world. This section aims to give an overview of this evolution, as well as defining key concepts that are the stages and the types of innovation relevant for this study on FI and RI in healthcare.

1.1. DEFINITION

According to the Encyclopaedia Universalis, the term innovation is related to the introduction of change and progress, something new that is likely to replace something initially existing. The novelty introduced can take several forms – such as innovation as a product, as a process, as a policy and so forth. The word is derived from the Latin word *innovatus* meaning renewed or altered.

In 1934, Joseph Schumpeter introduced one of the first notions of innovation describing it as the well-known term *new combinations*, referring to the introduction of a novel way to combine new or pre-existing knowledge, resources and other factors (Hagedoorn, 1996). Schumpeter also differentiated innovation from invention – describing the former one to be *carried out within the economic sphere and with a commercial purpose*, whereas an invention might be, in principle, *carried out everywhere and without any intent of commercialization* (Shah, Gao, & Mittal, 2015). It is because of this stressed differentiation that Schumpeter's definition of innovation has been largely criticized, described as being too narrow. In other words, if one sticks to Schumpeter's contributions, invention is related to the first time an idea occurs whereas innovation corresponds to the first time this idea is applied, i.e. implemented in an organizational context (Fagerberg, Mowery, & Nelson, 2005).

A few decades later, in 1985, Peter Drucker came up with a more inclusive definition, elaborating the link between innovation to entrepreneurship initially described by Schumpeter. He described innovation as a tool for entrepreneurs to find new business opportunities that are created through the so-called *new combinations* of technologies, products, etc. combined with a disciplined and systematic process (Drucker, 2014). Another definition that is more largely accepted was given by West, describing innovation being *the intentional introduction and*

application within a role, group, or organization, of ideas, processes, products or procedures, new to the relevant unit of adoption, designed to significantly benefit the individual, the group, or wider society (West, 1990). Moreover, the notion of *perception* is important, as an idea or invention might be old in terms of time passed yet its implementation can be perceived as new to an individual, which makes it an innovation (Rogers, 1962).

In the 21st century, there has been a myriad of writings on innovation done by diverse authors, from supranational actors to academics. The OECD's Oslo Manual *provides guidelines for collecting and interpreting data on innovation.* In other words, other institutions can follow its framework to carry out data collection on innovation. In 2018, the 4th edition of the OECD's Oslo Manual suggests a general definition on innovation as follows:

> *"An innovation is a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)." (OECD & Eurostat, 2019)*

This work is going to adhere to the definition given by the Oslo Manual. Indeed, the scope of the most recent definition given by the OECD – a substantial actor in the collection and treatment of data concerning innovation. Moreover, concepts such as FI and RI which are central to this research, have emerged recently and an up to date definition is judged necessary.

1.2.OVERVIEW OF INNOVATION STUDIES

The overuse of the word *innovation*, having become a buzzword, has led to confusions on what it truly represents (O'Bryan, 2013). One of the most common misunderstanding is the fact that one expects innovation to be something completely new and radical. Therefore, incremental innovations – as defined hereafter - are not taken into consideration (Kahn, 2018). Additionally, a set of incremental innovations in a given period of time can have a radical impact on a community. The immensity of the study field concerning innovation taken into account, there is a panoply of views & frameworks that are, in the end, fragmented. The academic study of innovation includes several paradigms that describe different types of innovation as well as innovation models, which sometimes overlap. It is the case for FI and RI, e.g. *open innovation*, *social innovation*, *resource-constrained innovation*, etc. (Hossain, 2018). The literature argues that such a diversity is due to the knowledge sourcing that depends directly on the specificities of the sectors, relationships or regions investigated (Prime, 2017; Tödtling & Grillitsch, 2014). The intent is not to delve into every type and application; thus,

the sections below develop the types, approaches, and theories relevant for - or linked one way or another to – research on FI and RI. In this section, we document the various attempts to categorize and define different types of innovation studies (Gregor & Hevner, 2014). For the sake of simplicity and as this study focuses on innovation in the making, this section explores the four approaches of innovation **studies** that are present among the community of researchers. These are the study of innovation as: an output – innovation is the final results; as a process – how innovation activities led to the output; as a mindset – the approach and strategy leading to the output; and as a policy – the regulatory frameworks around innovation activities.

1.2.1. INNOVATION AS OUTPUT

Innovation as an output refers to the studies that focus on innovation as the outcome of the entrepreneur or innovator's activity, like a new perceived product, service, or process introduced on the market. It is the most basic approach in the innovation literature and builds on the perceptibility of these innovative outputs since they are highly tangible, i.e. usually visible. As the reader will discover, the main legacy of this approach is the definition of *what an innovation is* and the identification of different variants of innovation that are deemed relevant by researchers (and practitioners) – such as radical versus incremental innovation.

1.2.1.1. HISTORY

Historically, Joseph Schumpeter has established the premises of innovation theories, and many maintain that the study of technical innovations has derived from his writings (Tzeng, 2009). In fact, Schumpeter's theories on how a firm looks for new opportunities and competitive advantages over its competitors have deeply influenced how one looks at innovation through a managerial or economic lens (OECD & Eurostat, 2019). He also introduced the concept of *creative destruction* – the disruption an innovation causes by creating new ways of production. In his work, he describes two levels of changes based on the *visible impact* on the firm, i.e. tangible products and services. On the one hand, there is *radical innovation* and on the other hand *incremental innovation* (O'Sullivan & Dooley, 2008). As its name suggests, the former consists in a technological advancement that creates a dramatic change and transforms existing markets. Whereas incremental innovations exploit existing technologies and tend to focus on cost or feature improvements. Although Schumpeter assumed radical innovations were more likely to bring disruptive changes than incremental ones, others have argued that when put together, several incremental innovations can have the same significance as radical innovations (**Figure 1**) (Landau & Rosenberg, 1986; Lundvall, 1992).

In 1995, Bower and Christensen introduced the *disruption theory*, to describe how new technology responds to unserved needs. According to the latter, innovations are categorized as either sustaining or disruptive (Christensen, 1997). The former relates to the incremental performance improvement by companies to achieve growth through their mainstream customers. Conversely, disruptive innovation may initially be done to deliver lower performance for mainstream customers, as customers in low-end or niche segments are targeted at the outset. Over time, as the innovation - and thus its performance – improves, more mainstream customers switch to the new technology (**Figure 2)** (Ramdorai & Herstatt, 2015). Disruption thus occurs when the innovation is gaining market share in established markets (Corsi & Di Minin, 2011). This theory partly contrasts with Schumpeter's one, as it considers the disruptive innovation as a process instead of an event occurring overnight. As shown on the figure, the evolution of technology in this case is considered linear. The broadness of the literature on innovation has led to several variants in the manner of representing graphically a product or service efficiency over time. The evolution of technology can be represented linearly – just as in this case – but other approaches such as S-curved also contribute to the research on the technological discontinuities (Ramdorai & Herstatt, 2015). This study bases itself on the following definition given by Schumpeter:

> *Radical innovations are disruptive innovations – they create a new market or consequently change the status quo in the existing one. Incremental innovations, they represent a continuous progress and consist of a series of incremental changes – not rendering a product or a process completely obsolete overnight (OECD & EC, 2005).*

1.2.1.2. VARIANTS OF INNOVATION AS AN OUTPUT

As the means of communication have proliferated, traditional and modern theories have been mingling in innovation literature. Therefore, this diversity has resulted in various fields and terminologies. Kahn (2018) non-exhaustively mentions different variants:

- *Product innovation* is quite simply the introduction of a new product, **new service** or a new program. The most common types are cost reduction, product improvements, line extensions, new markets, new uses, new category entries and new-to-the-world products. A more contemporary concept is Service Innovation – once again including different schools of thought within this field of study – which considers services as distinct from other offerings (Witell, Snyder, Gustafsson, Fombelle, & Kristensson, 2016). On the one hand, the type of benefits is either core or delivery, i.e. offer a new

benefit or a new way to deliver an existing benefit. On the other hand, the degree of separability between the service production and consumption, i.e. the time and place of service production being, or not, the same as when and where it is used (**Figure 3**);

- *Process innovation* are the changes brought to the methodology or process to reach greater efficiency such as faster processing or simply lower cost. An example is the Uganda Health Information Network which provides an online information system as well as personal digital assistants for recording health information to the health workers in its community (Bhattacharyya et al., 2017). This type concurs with *resource-constrained innovation* (RCI), which consists in innovating the process of creating and delivering the offering under – willingly or not - restrained resources settings. There are four types of *resource-constrained innovation* (RCI). Among these, *frugal innovation* (FI) brings a high market novelty with a medium technology novelty, in other terms *new for less*. *Cost innovations* is the idea to do the *same for less*. Similarly, *good-enough innovations* (GI) can be summed up by *tailored for less* – an extension of cost innovation as they achieve a low price by taking advantage of the local costs and sourcing conditions. *Reverse innovation* (RI) occurs when one of these three resource-constrained products or services are transferred in another market. Thus, the innovative aspect in RI is neither a process nor product innovation, but a market innovation, i.e. *elsewhere* (Simula, Hossain, & Halme, 2015; M. B. Zeschky, Winterhalter, & Gassmann, 2014);
- *Marketing innovation* can be understood as an endeavor to connect differently with customers. The ultimate goal is to generate greater demand by creating or endorsing brand awareness and recognition. A notable example is IKEA's *Moving Day* initiative in Montreal – the company has proven adaptation to the Quebec market with this move (Bolar, 2014);
- *Business model innovation* as its name reflects, is a brand-new business model that changes the industry. A notable example is Nespresso having revolutionized the industry with its unique selling proposition (USP) in terms of distribution (Joyce & Paquin, 2016);
- *Supply chain innovation* is a change that occurs within a company or an industry in terms of supply chain. This can be linked to the technology, network or process;
- *Organizational innovation* aims to change the organization by bringing new forms of management, work environment or organization structure. For instance, LEGO

introduced a new office concept in the same line as activity-based working (Kahn, 2018).

Additional concepts exist and are appearing with time, as the world is becoming incessantly more intertwined and new needs appear. A good example of classification based on the targeted needs is Bottom-of-the-Pyramid (BoP) innovation. This concept tackles, social and economic unsolved problems (Pervez, Maritz, & de Waal, 2013).

Overall, as these types of innovations are mostly physically tangible, innovation as an output constitutes the most perceivable variant of innovation among others. The diversity of variants within illustrates the fragmentation of innovation literature. Considering that subjectivity and diversity form gaps in the literature, thus hindering research, initiatives such as the Oslo Manual try and frame common definitions (OECD & Eurostat, 2019). To conclude, one should bear in mind the variety of innovation as an output. Distinctions can be made based on a myriad of variables, such as the novelty and the impact (**Figure 4**) (Gailly, 2020).

1.2.2. INNOVATION AS A PROCESS

This field of study considers innovation as a changing and evolving process – instead of focusing on its end result, i.e. innovation as an output, and this lens focuses on the activities behind that lead to the output. Accordingly, innovation occurs over time, goes through different steps, and results from the interactions of different factors and stakeholders. Moreover, the main legacy of *innovation as a process* is about innovation models that explain innovation emergence and diffusion.

1.2.2.1. HISTORY

A notable theory is the *evolutionary theory*, whose source is the work realized by Rahmeyer (1989) on innovation. It describes the concept of a **technological paradigm** where the innovation is developed thanks to the interactions between different actors and is, then, tested on the market. The idea is to determine the future path of economic development through testing on the market (OECD & Eurostat, 2019). For instance, artefacts, perception of opportunities but also heuristics on *how to innovate* within an industry, will have an influence on stakeholder interactions. Ultimately, it will also impact the technology that will be developed and introduced to a market (Dosi & Nelson, 1994). In other words, as its name suggest, the evolutionary theory affirms that an innovation evolves continuously as the stakeholders concerned by it have an influence on its development.

The evolutionary theory has influenced other concepts by its notion of the technology evolving throughout time. One of these concepts is *design thinking*. The emergence of the design thinking process to nurture creative problem-solving – especially for complex problems – has also been influenced by the work on decision-making and problem-solving of Herbert Simon (Verganti, 2009).

When it comes to Rothwell (1994), he describes five types of innovation models that have successively appeared through time. The *technology push* and *demand pull* are the first two traditional models following a linear logic – similarly to Bower and Christensen's disruption theory. Subsequently, a chain-linked logic underlying the third generation known as the *coupling model* was introduced, which assumes that interactions and feedback flow within the organization system. This type is alike the evolutionary theory as one assumes that the innovation evolves through different interactions. Then, the *parallel lines* model introduced the idea of downstream and upstream integration or alliances with an organization's customers and suppliers. This concept is parallel to vertical and horizontal integration, well known in strategic management. Finally, the fifth model, namely *integration and extensive networking* go further by extending these linkages, in the current context of information technology (IT), to higher levels of integration *at both intra and inter firm levels* (Le Bas, 2016).

The *systems approach* is akin to the evolutionary approach, highlighting that the innovation process should be considered holistically. In fact, it stresses the importance that innovation is not a linear and sequential process but rather involves multiple interactions in knowledge creation. The corner stone of this approach is to focus on the interdependencies of the whole system – actors, uncertainty of outcomes, other features – rather than evaluating each factor separately (Lundvall, 1992; OECD & EC, 2005; OECD & Eurostat, 2019). For instance, the decarbonization of the transportation systems is a complex system and one may consider resolving this issue with the systems approach. Another contribution from the evolutionary school of thought is the *open innovation* – which will be developed further. It is the new generation model, which could shape the future nature of the innovation production (Kotsemir, Meissner, & Abroskin, 2013; Verganti, 2009). The aforementioned theories and perspectives coexist with recent & contemporary innovation theories, such as *open innovation* or *user innovation*. An explanation could be the shifting of innovation theory from a traditionally Western perspective to a more universal one – inclusive of emerging countries specificities.

1.2.2.2. STAGES OF INNOVATION – DIFFUSION AND ADOPTION

As mentioned in the previous section, innovation as a process usually consider several stages in these interactions of actors and factors, which vary among different authors. The most common steps are the *knowledge* or *problem identification*, the *innovation*, and finally the *diffusion* and *adoption*. The purpose of this study is to get a grasp on the perspectives of entrepreneurs and to see if and how specific foreign innovations can be transferred, i.e. diffused and adopted, in the Belgian healthcare system. As a consequence, the following section focuses only on the third stage, as entrepreneurs are stakeholders who intervene mostly in it.

Rogers' (1962) ***diffusion*** *theory* is an examination of the processes through which an innovation is communicated and adopted over a period of time in a social group (OECD & Eurostat, 2019). Diffusion is a process that takes place before consumer adoption, during which an innovation is diffused through communication channels (Banytė & Salickaitė, 2008). The cornerstone of this theory is that an innovation goes through a set of changes over time instead of happening on a given date. Therefore, the diffusion of innovation process corresponds to the time between when one learns the existence of an innovation – knowledge – and when he adopts or rejects the innovation – decision. Note that this traditional theory on diffusion suggests innovation diffuse in a trickle-down way which, as developed further below, is in opposition with the RI paradigm. Four key components of innovation diffusion were identified by Rogers (1962). These are *innovation*, *communication channels*, *time,* and *social system*.

According to the glossary of the Oslo Manual (OECD & Eurostat, 2019):

> *Innovation diffusion encompasses both the process by which ideas underpinning product and business process innovations spread (innovation knowledge diffusion), and the adoption of such products, or business processes by other firms (innovation output diffusion)*

When diffusion is described as a process, often, it means that the innovation goes through a series of changes over time rather than happening on a given date. In fact, the feedback received from the social system plays a significant role (Landau & Rosenberg, 1986). That being so, one can remember the evolutionary theory – suggesting that the innovation evolves through time.

Second, **adoption** corresponds to the consumer facing the innovation and his behaviour which determines his decision. When an innovation occurs, the adopters may be sorted into five different categories, which are respectively, *innovators*, *early adopters*, *early majority*,

late majority and *laggards*. These categories approximatively follow a normal distribution (Rogers, 1962). The behaviour of the consumer depends on many variables – whether it be social or individual. The perceived characteristics of an innovation – such as relative advantage, compatibility, complexity and so forth – also have an impact on the consumer's decision (Rogers, 1962). The categorization of adopters has been widely used in literature as well as in strategic management. Moreover, according to the Oslo Manual (2018), knowledge in innovation can be exchanged through market transactions and non-market means (OECD & Eurostat, 2019). As an example of the latter, one might think of an employee switching jobs thus bringing his knowledge to a new environment. Nonetheless, these adopter categories are older than the concept of frugal innovation and one can wonder how these can apply nowadays. As aforementioned, innovation theories – at least, the ones mentioned above – can be considered as supportive of the traditional Western perspective. Concepts such as frugal innovation and reverse innovation have been shed light to recently. Therefore, some of these former innovation theories can be outdated when considering modern paradigms.

The *knowledge translation models* aim to understand drivers and barriers in the process between knowledge and practice, i.e. adoption. They are specific to the healthcare sector and help understanding the peculiarities of the sector. The latter are to bear in mind for any individual or company planning to integrate the ecosystem to do business, which is part of the practical part of the present study (Estabrooks, Thompson, Lovely, & Hofmeyer, 2006; Graham, Poole, Chainakul, & Pearson, 2006; Prime, 2017).

1.2.2.3. VARIANTS OF INNOVATION AS A PROCESS

Within an organization, innovation as a process is an aspect that cannot be disregarded. As a matter of fact, it takes part in the organization of an innovation and facilitates its implementation.

Kahn (2018) mentions a process model for innovation which goes through three phases – *discover*, *develop*, and *deliver* (**Figure 5**). The first phase implies the analysis of opportunities in the horizon. As its name proposes, the development phase is when promising opportunities are developed. The last phase is when the offering is introduced. The author stresses the importance of the last phase as innovation not only represents the introduction of something new, but also implies good execution from the firm, and acceptance from the consumer (Kahn, 2018).

The evolutionary theory has influenced several concepts by its notion of the technology as evolving throughout time. A relevant contribution is the concept of *design thinking* which is also used as a process that nurtures creative problem solving, especially for complex ones – it has also been influenced by the work on decision-making and problem-solving of Herbert Simon (Verganti, 2009). One should also bear in mind the *new product development* (NPD) process, which seeks to identify crucial process steps and checkpoints during product development. The ultimate goal is to provide a path through the different stages of development. To attain this, new product development process helps manage risk, increase efficiency, etc. (Kahn, 2018).

Finally, the concept of *open innovation* (OI), belonging to evolutionary theories, is particularly relevant to innovation in healthcare as it relies on collaboration of various stakeholders. Open innovation is in opposition to the traditional innovation models. The latter's logic is that a company should vertically integrate all activities, from R&D to manufacturing and distribution (Armour & Teece, 1980). The *parallel lines* model, mentioned above, is an example of theory belonging to the closed innovation model. Considered until the 21st century as the best approach for large firms to innovate and be the first to market, the OI model argues the use of internal and external flows of knowledge as a way to speed up the internal innovation while expanding the market potential of the innovation (Chesbrough, 2003). Sectors such as healthcare are characterized by a *high prevalence of external ideas, high labour mobility, available venture capital, numerous start-ups and a close relationship to universities*, and results show the OI model benefits to the firms (Prime, 2017). Le Bas (2016) assumes this paradigm is a determinant of the reverse innovation (RI) process. In other terms, that RI is appearing as a figure of the more general OI model. The RI is to be developed further in this research. A concept closely related to OI is the concept of user innovation, where individuals or firms other than manufacturers are inventing, prototyping and field-testing the innovation (Von Hippel, 1976). User innovators can be defined as a user with a strong individual need to fulfil, which he is likely to be the one having to solve it by exploiting products in their innovation processes (Bogers, Afuah, & Bastian, 2010; Lüthje, Herstatt, & von Hippel, 2005; Urban & Hippel, 1988). The incentive of the user is its direct involvement in the innovation activity. It has been demonstrated that this phenomenon is already successfully taking place in various industries – including healthcare. The agile method in the software product development where, based on recurrent client's requirements and feedbacks, the product is created step by step, is an example (Silva, 2017).

1.2.3. INNOVATION AS A MINDSET

While *innovation as a process* studies help experimenting with and apply various innovation methods, it might also give the impression that innovation is simple – a series of steps that, if followed correctly, will eventually turn into success. Instead, *innovation as a mindset* studies suggest that an organization is to act as a whole if innovation is to flourish from within. In fact, innovation as a mindset suggests that the organization ought to embrace the innovation with a holistic view with the internalization of innovation by the individual members of the organization who play a substantial role in innovation generation. Based on Dyer et al. (2011), Kahn (2018) mentions five skills that nourish new ways of thinking and thus induces innovation: *associating, questioning, observing, experimenting* and *networking*.

The two other mindset related considerations cited in the same article are *cross-functional thinking* and *design thinking*. While cross-functional thinking focuses on the organization-wide effort, the latter stresses the importance of considering the end user while developing the innovation (Kahn, 2018). Organizations tend to use design thinking as a process, but it appears that using it as a mindset can be much more fruitful (Kolko, 2015; Verganti, 2009). Innovation as a mindset is an emerging approach that is very promising.

A concrete example of this field of innovation literature is the concept of *sustainable innovation* (SI). Closely linked to the notion of inclusive innovation, this type corresponds to *innovations activities that contribute to the triple bottom line of sustainable development: economic, ecologic and social benefits* (Yoon & Tello, 2009). Sustainable innovation implies that environmental concerns should be considered as the topmost factor during the innovation process, as well as the needs of the Bottom-of-the-Pyramid (BoP). The latter is the segment of the world population who will suffer the most due to the climate change. A firm aiming for SI could access sustainable growth yet with potentially higher costs by aligning its strategy with this *triple bottom line*. This is what differentiates sustainable innovation from frugal innovation. The latter is a technological paradigm with the economic aspect of increasing low-income segment's purchasing power, while SI is a strategy alignment – a new mindset influencing the innovation process – for a *genuinely green growth regime*. However, the common aspect lies in the result, as FI's characteristics involve greener properties such as repairability, recycling and consistency with a circular economy model – overall contributing to a greener technical evolution (Le Bas, 2016).

1.2.4. INNOVATION AS A POLICY

Finally, *innovation as a policy* studies focus on public authorities' levers to stimulate and shape innovation. The term *innovation policy* was popularized only from mid-1990s onwards (**Figure 6**). Although the term innovation was not widely associated with policy, it did not mean that innovation policies were not undertaken until then – they were simply called differently (cf. infra). Different innovation policy instruments such as *fiscal incentives for research and development* (R&D), *entrepreneurship policy*, *cluster policy*, etc. have been used throughout the world for a long time. It seems important to take into account two different perceptions of innovation: a narrow one considering innovation only, or a broader and more holistic one which looks at the entire innovation cycle from the beginning until implementation. Three main types of innovation policy are to be distinguished:

- *Invention-oriented policies* concentrate on the R&D phase and thus have a much narrower view on innovation. These types of policies were popular post-WW2 in many countries aiming to improve society through advances in science and technology, therefore having mainly the goal to generate innovation as an output. One of its implications was the creation of public organizations such as research councils;
- *System-oriented policies* are the most recent ones that focus on system-level features. The development of these types of policies are related to the emergence of the *national innovation system* approach and its subsequent adoption by the OECD. This can be linked to the aforementioned systems approach – a holistic perspective looking at the system as a whole rather than analyzing each element separately (OECD & Eurostat, 2019). These higher-level policies resonate with the innovation as a process perspective, as they organize the generation of innovation;
- *Mission-oriented policies* aim to provide new solutions to determined challenges that are on the political agenda. These policies require a holistic approach on innovation as the innovation process is also to be considered. A notable example is global warming policies aiming to provide a solution through innovation. Similar to SI, it reminds of innovation as a mindset which influences actions having an impact on the goal;

One of the main drivers behind innovation policies can be explained by the modern state assuming a substantial role in the generation of scientific knowledge, technology and innovation (Edler & Fagerberg, 2017). Thus, it is no wonder that different types of innovation as a policy resemble to other approaches to innovation – as an output, a process or as a mindset.

1.3.CONCLUSION OF INNOVATION

Innovation goes along with novelty, and more specifically perceived newness. While Schumpeter has built the basis of innovation theory and the first, yet controverted, distinction between radical and incremental innovation, other authors developed complementary theories and approaches overtime. The evolutionary school emphasizes on the role of time, technology, and stakeholders' interactions. The subjective notion of time is a peculiar component in an innovation as it goes through a complex journey over time – it evolves from problem identification to its diffusion and adoption. This evolution depends on the type of innovation, the means and also, its reason to be. The interaction of traditional theories with other schools of thought results in either obsolescence of the first, or enriched definitions of core concepts like diffusion and adoption. Therefore, both were developed, and a conventional high-level distinction was used to structure the variants – innovation as an output, a process, a mindset, or a policy. This section has explored the origins and the evolution of innovation theories giving place to its modern ramifications. It will be useful to seize the concepts of FI and RI by mostly using the innovation concepts summarized in the table below.

Table 1.: Summary of useful concepts to study frugal and reverse innovation.

Innovation as…	**Concept**	**Definition**
an output	*Product innovation*	is the introduction of a new product, new service or a new program (Kahn, 2018)
	Process innovation	is the changes brought to the methodology or process to reach greater efficiency such as faster processing or lower cost (Kahn, 2018)
	Resource-constrained Innovation	consists of innovating the process of creating or delivering the offering under – willingly or not - restrained resources settings (M. B. Zeschky et al., 2014)
a process	*Open innovation*	is the use of internal and external flows of knowledge as a way to speed up the internal innovation while expanding the market potential (Chesbrough, 2003).
a mindset	*Sustainable innovation*	implies that environmental concerns should be considered as the topmost factor during the innovation process (Yoon & Tello, 2009).

2. FRUGAL INNOVATION

Frugal innovation (FI) is part of the modern concepts of innovation that originate from the study and analysis of unexplored contexts such as, in this case, emerging countries' economies. This leads to discovering new – at least for the Western world – ways of approaching innovation. FI by definition focuses on the price. The idea being to *do more with less and for the many*, it also has positive sustainable and social consequences (Y. Bhatti et al., 2013). The performance of emerging market firms is significantly likely to increase by implementing frugal processes and products, yet it goes beyond that. It tends to contribute to the socioeconomic development, leading to more inclusive markets and democratization within a state. In fact, as the focus is on the price, segments who rarely are targeted can then afford novelties. Multinational corporations (MNCs) can contribute to this directly, by offering products and services aimed at the BoP – yet profitable (Kahle, Dubiel, Ernst, & Prabhu, 2013). In terms of inclusiveness as well, Altamirano and Beers (2018) provide evidence that IT-induced FI are likely to improve both private sector and public services provision, while increasing on a longer term perspective, the inclusiveness of IT-based frugal solutions.

In addition to this novelty of the paradigm, some inherent characteristics such as multi-dimensionality has resulted in ambiguity of the literature. For this reason, it became difficult to define the concept without overlapping on related paradigms. As the evolutionary school stated, an innovation paradigm being brought from a different context and interactions requires different theories (Dosi & Nelson, 1994). The objective is then to reach a universal consensus on this over time. Therefore, to elaborate on what is FI, this section explores the paradigm's definitions and characteristics, which circumstances drive frugality and finally which factors influence the success or failure of a FI.

2.1. DEFINITION AND LEGACY

As mentioned above, several types of innovation are intertwined with FI. While the term first appeared in an article from an article published in The Economist in 2010, its genuine origin comes from paradigms as resource-constrained innovation and jugaad innovation. The term frugal derives from the Latin word *frugalis* and literally means *sparing* or *careful* with resources, meagre, thrifty, economical, etc. The diversity of the associated vocabulary illustrates the heterogeneity in the definition, characteristics and constraints frugal innovation comes with (Mériade, 2016). The studies on FI started in 2011 and from there, the concept has been defined in numerous different ways (Hossain, 2018). One of the most recent and holistic

definitions that takes into account most of the conceptual components is given by Rocca (2016) as:

> *"products, services, processes and business models that target underserved customers of low-mid market segments with high-quality solutions at affordable prices. They are developed in a sustainable and cost-effective manner that minimizes the use of resources, materials, and capital in the entire value chain while enhancing social value" (Cachola, 2019).*

In 2018, Pisoni et al. aimed to respond to the lack of academic consensus around frugal innovation. The study gathered the definitions available in the literature and classified them in three generations of orientation – *product-oriented*, *market-oriented* and *criteria-oriented* (Pisoni, Michelini, & Martignoni, 2018).

Product-oriented (2012-2013) generation places the attention on the product characteristics and features. According to these definitions, a frugal innovation product is accessible, robust, convivial, scalable and comes with an attractive value proposition (Tiwari & Herstatt, 2012), aiming to answer the need of the BoP (Gupta, 2011). In the same vein, characteristics like lightweight, simplified and low price has been set, as well as ease of use and use of advanced technology (Basu, Banerjee, & Sweeny, 2013). This generation is parallel to the study of innovation *as an output*, giving the *what* of FI.

The *market-oriented* (2014 - 2015) generation shifted the focus to the process and the market specificities. Y. Bhatti et al. (2013) defined FI as a *process of design innovation in which citizens' needs and the context in developing countries are at the center when developing adequate services and products, adaptable and accessible for emergent markets*. The process perspective is illustrated by the six underlying principles of frugal mindset proposed by Radjou and Prabhu (2014) which are *engage and iterate, flex your assets, create sustainable solutions, shape customer behaviour, co-create value with prosumers* and *make innovative friends*. Moreover, in the market-orientation definitions, one of the characteristics of FI is that they are targeted to large low-income segments, typically located in the resource-constrained environments – i.e. emergent markets in developing countries (M. B. Zeschky et al., 2014). However, it is argued that this determines more the origins rather than defining FI itself or criteria – seen that these innovations have also entered developed markets (Weyrauch & Herstatt, 2016). The second generation relates to open innovation and sustainable innovation

paradigms, which imply collaborations and interactions of multiple stakeholders in the innovation process. This provides the *how* and *why* of FI.

The *criteria-oriented* (2016 - 2017) generation corresponds to definitions beyond the product and market orientation, focusing on the predominant criteria and features of the FI. With the aim of a definition applicable in both developing and developed countries, Weyrauch and Herstatt (2016) provide three main criteria through a systematic literature review. These are *substantial cost reduction*, *concentration on core functionalities* and *optimized performance level*. In the same vein, Cachola (2019) contributed to the definition by extracting three additional sub-criteria (**Figure 7**) and two additional main criteria from literature – referred to as the *fundamental point of view* – which are *frugal ecosystem* (empower local social value and economy) and *market related characteristics* (scalable, untapped low- to mid-market targeted; technical novelty). While the two first generation are focusing respectively on innovation as an outcome or as a process, the criteria-oriented definitions are inclusive of both. Indeed, authors of this generation usually first analyze innovations as a product or a service defined as frugal, to identify common criteria. Then they examine the process, taken to end with this innovation – i.e. the supply chain – and again extract common criteria to be used later to identify the FI. A few empirical and practical assessment tools are being developed (Cachola, 2019), which are to be exposed further in the study. This provides the *how to identify FI*.

The evolution of definitions is a consequence of the field authors' efforts to draw a clear line between FI and the other types. Indeed, the FI concept overlaps with many others, in a disorganized and vague way, which has *hindered the development of FI as a well-established research discipline* (Hossain, 2018). Moreover, most of the literature focuses on the FI as an outcome, reason being the inherent tangibility to evaluate a product or service characteristic as compared to innovation as a process (Hossain, 2018). Therefore, there are many literature gaps to explore in order to better define and understand this phenomenon. This way, both emerging and developed economies can exploit, respectively, the beneficial impact and disruptive potential of FI. Theoretical and conceptual approaches are mostly adopted to identify criteria and evaluate the degree of frugality a product or service has. Being aware of these limitations, it is important to seize the main idea and characteristics of FI, which are summed up in the following section and **Table 2.**

2.2.CHARACTERISTICS

To understand what FI is, one needs to get familiar with what characterizes the frugality aspect of an innovation and how specific their diffusion process is. Moreover, an overview on what drives such innovation to exist, the factors that will influence on a successful or failure outcome, and the social and economic benefits of this paradigm.

2.2.1. CORE CHARACTERISTICS

In regards of the three generations of definition orientations, (Berger, 2015) proposed an acronym – F.R.U.G.A.L. – that describes the main characteristics of FI, provided by the three perspectives developed above.

Table 2: F.R.U.G.A.L. acronym for characteristics of a frugal innovation (Berger, 2015).

Functional	the design of the innovation that is focused on core functionalities, addressing the need in a brief manner so that the exclusion of unnecessary extras enables significant cost reductions (Weyrauch & Herstatt, 2016).
Robust	extended product life designed to be easily fixable with maintenance-friendly components while coping with harsh physical environment such as power cuts, dust, high temperatures (Basu et al., 2013; Rocca, 2016b; Tiwari & Herstatt, 2014).
User-friendly	consistent with the scalability criterion of a FI, i.e. *do for the many*. FI is by nature human-centric as it is targeted to low-middle market, thus it must be simple and easy of use (Rocca, 2016a).
Growing	relates to the customer base, as the scalable criterion linked with reduction of costs imply a high customers growth rate so as to make economies of scale (Tiwari & Herstatt, 2014).
Affordable	low selling price, between 50 to 97% less according to Rao (2013) as well as operating and maintenance costs to achieve it. Frugality implies costs reductions across the whole supply chain and the product life cycle (Rocca, 2016a).
Local	applies to the sourcing inputs, the technological capabilities, the production, and the output. The complete end-to-end process should be done close to the targeted market, integrating the local context and variable in the production strategy (Radjou & Prabhu, 2014; Rocca, 2016b; Tiwari & Herstatt, 2014).

2.2.2. DIFFUSION AND ADOPTION OF FRUGAL INNOVATION

Traditional diffusion models such as the one proposed by Moore (1991), *Crossing the Chasm*, have been developed for conventional innovations, often through a Western-oriented perspective. Rogers' (1962) diffusion theory, for instance, describes the innovation flow in a trickle-down manner, from the elite class to the low-income customers. Nonetheless, the reality is that the diffusion process depends on specific variables, which are different in the case of frugal innovation. As pointed out by Hossain, Simula, and Halme (2016), the *nature of the innovation, influence, the speed of diffusion, local needs, communication channels, weak institutional arrangements, lack of advanced and specific skills, time and social contexts* are different in developing countries. The diffusion of FI is rather taking the opposite path – trickle-up diffusion – with innovation being designed in low-income countries (LICs) primarily to solve local problems. Then, spreading to countries with similar socio-economic environment. Ultimately, in some cases, to be successful in Western markets. An alternative diffusion theory is needed for these innovations, that takes in account these specificities. Hossain et al. (2016) study captures four patterns of diffusions – *local, proximity, distance* and *reverse diffusion* – that are linked with 6 paths more or less likely to occur (**Figure 8**). The most common way starts with local diffusion that would usually expand to proximity diffusion. At that point, the FI can either directly turn into a reverse diffusion or go through an additional step which is the distance diffusion – in other words, diffusion to remote countries with similar economic and environmental conditions. Nevertheless, FI has inherent factors that are critical challenges to surmount as they can hinder the diffusion – which will be developed further.

To conclude, in contrast with the conventional trickle-down diffusion theories, the characteristics of FI make these innovations more likely to trickle-up. As mentioned above, this means gradually diffusing from local emerging markets to remote countries – with same socio-economic conditions or not. Whenever an innovation of this genre is diffused to developed countries in the Western world, then the innovation is said *reversed* – i.e. becomes a *reverse innovation*.

2.2.3. DRIVERS OF FRUGAL INNOVATION

As a consequence of the expansion and increase of demand for frugal products in both developing and developed markets, several major economic transformations have taken place since the beginning of the 21st century (Tiwari & Herstatt, 2014). Soni and Krishnan (2014) highlight six preconditions that generated the FI paradigm. These are *stagnating markets in the Western world*, *global economic slowdown*, *market potential of emerging economies*,

availability of local talent in emerging economies, *movement towards green and sustainability* and *diminishing returns to structured approach to conducting R&D* (Rocca, 2016a).

First, economically speaking, current proportions of the middle-class population are increasing and are predicted to keep expanding with a sharp acceleration in the upcoming years. This is due to a bidirectional evolution of the purchasing power, with developing countries' consumers raising from low to middle-class while consumers in Western countries regress from high to mid-end market segment (Kharas, 2017). This, in turn, increases the demand for frugal products in Western markets as well as the success of RI, meaning for Western firms to build frugal an reverse innovation capabilities (M. Zeschky, Widenmayer, & Gassmann, 2014).

Moreover, as global competition became fiercer over time, pushing business strategies to seek collaboration networks seems fruitful. This can remind the *distance diffusion* mentioned by Hossain et al. (2016) – diffusion to remote countries with similar economic and environmental conditions. In turn, this can partly explain the emergence of new innovation paradigms such as open innovation and user innovation.

On the demand side, the financial crisis of 2008 made many Western consumers *permanently value-sensitive*, therefore looking for simpler offerings with more value for less money (Aguirre, Hoteit, Rupp, & Sabbagh, 2012). Along the same lines, a notable trend is the new business models shifting to a *collaborative consumption* – rather than ownership by buying a product, the temporary use of a product is sold as a service (Botsman & Rogers; Rocca, 2016a). One can think of a very famous example such as AirBNB. This reminds the definition of business model innovation and service innovation in the sense that these new business models deliver existing benefits in a new way, with higher perceived value for the consumer.

Then, the sustainable drivers include a pressure on the availability of resources, both customers and companies becoming conscious if not forced to modify, respectively, their buying and production patterns towards a more efficient use of resources and lower environmental impact (Berger, 2014; Radjou, Prabhu, Ahuja, & Roberts, 2015). Corporate Social Responsibility (CSR) has become a trend more and more companies have been adopting by promoting social inclusion in their activities, controlling externalities and considering all stakeholders in the distribution of revenues and benefits (Bocken, Rana, & Short, 2015). These trends are enhanced by numerous policies that are appearing to entice, if not push, companies to adapt their business models to be compliant with sustainable considerations (Radjou et al.,

2015). One can think of the previously developed *innovation as a policy*, where governments encourage actors to innovate by redefining the rules of the game.

It seems reasonable to assume that along with the increase of ecological and societal concerns, combined with the current COVID-19 crisis, these global economic trends are also likely to increase. In other words, the aggregate production on the planet can tend to use the FI paradigm as the crisis will indubitably act as a powerful driver. As it has been well spread on social media for a long-time, the expression *we will not get back to normal because normal was the problem* seems more relevant than ever.

2.2.4. DRAWBACKS AND BARRIERS

Recent articles in the literature structure hurdles faced by companies trying to implement frugal innovation practices around 3 stages – *conception*, *production* and *marketing* issues – as well as the external environment and geographical transition (Rocca, 2016a).

2.2.4.1. CONCEPTION STAGE

Targeting value-sensitive consumers comes with the challenge of identifying their *hidden needs* during the product development phase. As described by Hossain (2018), the Western perspective is an obstacle to understand the emerging countries' contexts, value identification and market inclusiveness. This recommendation correlates with the design thinking approach that seeks to understand users and challenge assumptions in order to generate innovative solutions. Another obstacle consists in achieving a balance between a satisfying quality level – at least comparable with entry-level alternatives – while offering the price level expected from a frugal product (Tiwari & Herstatt, 2014). Finally, adapting an established traditional R&D model often characterized as rigid, costly and time-consuming, brings difficulty for Western innovators to compete against local competitors (Berger, 2015).

2.2.4.2. PRODUCTION STAGE

The instinctive way to generate frugal innovation would be to start with a high-end product that is defeatured to target low-end consumers. Yet Berger (2015) argues that the product must be redeveloped from the ground up. Indeed, the reduction of costs through removing features must be compensated with innovative features adapted to answer local needs – which is possible following a design-to-cost approach on the product, process and market application (Berger, 2015; M. B. Zeschky et al., 2014). Moreover, the operational level in the local context is challenged by poor infrastructures and deficiencies in skilled workers and reliable suppliers, hindering the production and delivery part of the intended frugal business models (Barclay, 2014; Soydan, 2012).

2.2.4.3. MARKETING STAGE

In the same vein, targeting new market segments, in the developing countries, is undermined by the reality of unreliable sales and distribution channels along with the common choice from multinational corporations (MNCs) to opt for unsuitable traditional channels (Simula et al., 2015). Soydan (2012) describes the physical infrastructures and transporting costs as a motive for a company to build its own distribution network. In addition to that, MNCs are concerned with protecting their brand image as they see a risk of self-cannibalization between frugal and already existing products (Rocca, 2016a). The risk of competing with their own products is a substantial barrier for MNCs to try and generate frugal innovation (FI).

2.2.4.4. ENVIRONMENTAL AND GEOGRAPHICAL TRANSITION

Weak policies and legislation at the institutional level is a common characteristic of the economies in which FI appears (Barclay, 2014; M. B. Zeschky et al., 2014). At the same time, this instability makes it difficult for firms to comply and adapt to the unforeseeable host government decisions, which grant permissions, licenses, intellectual property, etc. (Sako & Scho, 2009). This environment is both an opportunity and a threat as a FI often emerges thanks to, then, relies on these deficiencies (Cachola, 2019; Hoskisson, Wright, Filatotchev, & Peng, 2013; Hossain, 2018).

Moreover, as highlighted by Cachola (2019), frugal innovation involves for Western firms to adopt a well-suited, if not new, business models – consistent with the emerging market specificities. This goes along with business model innovation, that is *the design and implementation of an activity system that is new to the focal firm or new to the product market space in which the focal firm competes* (Amit & Zott, 2015). These geographical and strategical transitions are consequent hurdles for Western companies.

The challenges faced by Western companies vary in intensity from one environment to another. It displays a paradox of innovating in remote parts of the world where the paradigm initially appeared. The emerging countries' realities, i.e. poor infrastructure among many others, challenges Western companies designing, producing and delivering a frugal product. Nonetheless, it is this very specific reality that enables the generation of drivers – such as frugal mindsets – which ultimately lead to FI (Soni & Krishnan, 2014). These challenges can explain why less than a third of the firms are satisfied with the sales results of their frugal products, as described in a report of Berger Consulting Group (Berger, 2015). Conversely, both literature and companies argue that FI paradigm is a critical business opportunity. A reason for this contrast might be the belief that FI is not limited to LIC anymore, as mentioned previously. In

the end, FI is rather a universal paradigm that can be implemented in both developed and developing economies, involving different challenges depending on the context.

2.2.5. SUCCESS FACTORS AND PRACTICES

One recent concept that is consistent with the perspective of FI as a process is the *frugal mindset*, which originates from developing countries, but can be transferred and implemented in any R&D department worldwide. Indeed, the definition of innovation as a mindset suggests that the implementation of a innovation culture should be embraced with a holistic view with the internalization of innovation by the individual members. M. B. Zeschky et al. (2014) suggest that the favorable environment for this mindset is a resource-constrained context that exposes the R&D unit to the reality of the market. Furthermore, this mindset has to be cultivated through the management, similarly to concepts like *innovation champion*. Krohn and Herstatt (2018) highlighted three successive steps to implement it – *accepting the new realities of changing markets and competition*, *be willing to question the current approaches, and ultimately* and *be willing to take action and implement new approaches leading to the identified objectives*. By accepting the resource-constrained environment as a growth opportunity, these factors can help developing the frugal mindset, thus overcoming several obstacles in the whole process – developed earlier in this study.

Furthermore, Cachola (2019) gathered numerous best practices from the FI literature. As the focus of this study is on the healthcare sector, the success factors deemed relevant are briefly developed:

- *Innovative business, distribution and sales models*: a frugal approach goes beyond the product itself. It is a complete approach that must rethink the supply chain and more generally the business model, in various ways such as adaptation of distribution channels, pricing and after sales models. Innovative financing and pricing policies like micro-credits, subscriptions, lease-and-buy-back, have shown their success among price-sensitive consumers, both in emerging and developed markets. This resonates with the idea that FI has to be done beyond the consideration of the product only. Indeed, it should also consider additional product features but likewise focus on finding a dynamic and flexible business model (Berger, 2015; Rocca, 2016a).
- *Knowledge of the local context and external collaboration*: as FI strongly relies on the understanding of the specific consumer needs and overall context in varied regions. It is important to build relationship with local stakeholders – lead users, external local partners, host authorities, regional educational institutions, etc. This approach helps

reducing the risks, time-to market, and costs in case of failure, while accelerating the innovation process and the brand diffusion (Cachola, 2019; Tiwari & Herstatt, 2012, 2014).

- *Technology fusion and analogies*: Tiwari, Kalogerakis, and Herstatt (2014) described systematic analogies of existing technologies across industries as an inventive way to achieve a substantial reduction of costs in the product development. The idea is to actively seek for possible synergies and transferability of existing production processes cross-industry so that, it may be implemented into the development process, rather than created from scratch. This goes along with the creative thinking method – analogies – developed by Michalko (2006).
- *Organizational culture, Leadership discipline and Training*: FI is, indeed, a customer centric approach in a product or service development and delivery. However, the human factor is critical within the organization as the frugal mindset must be incorporated by workers, from the R&D and operational teams to the management and leadership. The frugal method is resonating with the knowledge management logic, and both require the right organizational culture (Bencsik et al., 2016).

2.3.CONCLUSION OF FRUGAL INNOVATION

In order to have a solid grasp of reverse innovation, a section developing frugal innovation was crucial. Several economic and social preconditions of emerging countries have led to the appearance of FI. The concept has been gaining in popularity over the past decade due to several global realities like the expansion of the global population and dwindling natural resources, along with a bidirectional increase of the middle-class proportion. The heterogeneity and the numerous gaps of the paradigm makes it difficult for the literature to achieve a consensus on the definition of FI. However, one can straight away assume that FI, whether it be as an output, a process or a mindset, aims to offer more value with less resources and do so for the many. The previously developed anagram is accurate to describe the FI - *Functional*, *Robust*, *User-friendly*, *Growing*, *Affordable*, and *Local*. Over time, the paradigm has seduced numerous Western companies. At first, as an opportunity to bring better solutions to satisfy the needs of the complex markets that are emerging countries. Then, to become more competitive at *home* by reversing the FI. Moreover, the characteristics of the environment FI originates from are paradoxical, as they both explain why the paradigm emerged, but also, its barrier to trickle-up effectively. Furthermore, FI is more and more considered as a mindset that, once

implemented, will affect the innovation as an output and as a process. To embrace it, success practices are recommended on various levels – innovative reconstruction of the business model, collaboration with local actors, cross-industry transfer of technologies and organizational culture internalizing FI.

3. REVERSE INNOVATION

The *reverse innovation* (RI) paradigm is originally defined as *any innovation that is adopted first in the developing world* (Govindarajan & Trimble, 2012). It follows the objective of understanding how an innovation occurs in the developing world vis-à-vis of the developed world (Barron, Ventresca, Ramaswami Basu, & Bhatti, 2018).

As this study aims to explain how a FI can be reversed, i.e. transferred, into the Belgian healthcare system, this section is crucial to understand specificities of RI. In other words, if a FI cannot be adapted to become a RI in a specific high-income country market, it is not possible for a developed country – such as Belgium – to implement it in an effective way. Following the section on FI, the next step to thoroughly seize and grasp this study is to look into RI.

First, a closer look at the definition and the origins of the paradigm is exposed after which the different characteristics of RI and its junctions with FI are developed. Finally, the paradigm's drivers, drawbacks, and barriers but also its success factors and practices are explored, followed by RI's multiple benefits and its potential.

3.1. DEFINITION AND LEGACY

Reverse innovation can be resumed by *creating far from home and winning everywhere* (Govindarajan, 2009). The phenomenon of an innovation being developed in an emerging market and subsequently taken to developed markets is called RI & is also referred as *innovation blowback* (M. Zeschky et al., 2014). In the literature, it is often defined as one of the three other resource-constrained innovations (RCI) – *cost*, *good-enough*, *frugal* – developed and sold originally in emerging markets and then adapted to be introduced, i.e. reversed, in developed countries or global markets (Basu et al., 2013; Govindarajan & Trimble, 2012; Le Bas, 2016; M. B. Zeschky et al., 2014). A more complete definition given by Le Bas (2016) is: as:

> *"reverse innovations are cost, good-enough, or frugal innovations that find a market among customer outside of the emerging market at which they were originally targeted" (Le Bas, 2016).*

In other words, the fundamental idea within lies in the development of a context specific innovation that is subsequently adapted worldwide.

The term has been popularized by Immelt et al. (2009), in order to describe a phenomenon that emerged when General Electric (GE) executives were led to question core assumptions of glocalization – a traditional international innovation approach (Barczak, 2012). However, this approach of glocalization is thought to differentiate from the concept of RI in the context of emerging-based R&D, which explains why there are confusion and no consensus in the literature regarding these interlinked concepts (Prime, 2017)

The first assumption made by GE executives was that the emerging countries would evolve just as wealthy economies did. It appeared that this did not reflect reality as the low-income segments would tend to adopt low cost innovations more easily – even if this means barely decent performance (Immelt, Govindarajan, & Trimble, 2009) . A noteworthy example is Huawei. The Chinese company is able to sell top-quality smartphones with costs reduced as much as 80% compared to Western competitors (M. B. Zeschky et al., 2014). As of May 2020, the share of Huawei in the European mobile vendor market was around 18%. Another Chinese company – Xiaomi – which has followed a similar path, had up to 8% of market share at the same time (StatCounter, 2020). In a nutshell, an innovation initially designed for a resource-constrained market – China – represents a quarter of the European mobile vendor market. One can bear this example on his mind to seize the potential of RI.

The second hypothesis was that products intended to be sold on developing countries' markets could not be good-enough to compete in developed countries. In reality, thanks to its lower price, a product intended to be sold in the developing world could also create a new market in the developed world (Immelt et al., 2009). A notable example – qualified as a good-enough innovation – is Logitech's M215 wireless mouse. Simple core functions & user-friendliness were the priorities while the costs were reduced as much as possible (M. B. Zeschky et al., 2014). The mouse is now sold worldwide therefore can be cited as another example of RI.

With the deconstruction of these assumptions, it has quickly become obvious for GE executives that if they did not come up with innovations in poor countries, competitors from the developing world would replace them (Immelt et al., 2009). From a Western perspective, with the expansion of globalization, it has become even more apparent that some products designed for wealthy customers are not affordable for the large majority in low-income emerging countries. As the latter provide new sources of innovation, new business opportunities also emerge within these countries (Le Bas, 2016). Ultimately, this is one of the

reasons that has led GE to *disrupt itself* by opening up to RI. Developing RI has been a quite difficult task for most of Western multinational corporations (MNCs) as the postulates on which their business is built comes from their experience in their home markets, i.e. developed countries.

3.2. CHARACTERISTICS

3.2.1. CORE CHARACTERISTICS

A major characteristic is that reverse innovation is associated with simple & affordable products that are good-enough to meet the requirements of mid- to low-income segments. This might be difficult for MNCs as the focus is solely on the creation of state-of-the-art products for Western markets rather than good-enough. In fact, innovation does not seem to be based upon a need but rather on technology. Throughout the research in the framework of this study, it has appeared that this problem is valid for Belgian healthcare – which will be developed further. Furthermore, a faulty logic on which MNCs are built upon is that the customer in a developing country has a Western living standard. In fact, whether it be in a developing or a developed country, the customer is supposed to have a high living standard – which does not reflect reality. Therefore, the middle class in emerging markets can be overlooked & neglected because of their meager income compared to wealthier households in the West. Moreover, the MNC is supposed to adapt its organizational culture & structure to the requirement of the RI. In other words, it is challenging to generate RI with a traditional international innovation approach. As aforementioned, RI challenges the developed country to developing country approach, i.e. the trickle-down approach previously developed.

The common belief for a long time has been that innovations flow from wealthy countries – hubs & origins of innovations – to emerging markets. Nonetheless, RI runs contrary to the traditional flow. With the globalization becoming a worldwide phenomenon, the developing countries are not only recipients of innovation. In fact, innovators with a thorough knowledge of the local context are more likely to be at the origin of innovations meeting local needs at a low cost. Thereafter, these innovations may also spread into nearby countries with a similar socio-economic level. As a matter of fact, the similarity of the needs for the concerned set of customers is one of the factors leading to the adoption (Simula et al., 2015). Today, innovation flows are not only from Western countries to low-income countries. An increasing number of firms are redeploying resource-constrained innovations to Western countries with the goal of attracting cost-minded customers (Le Bas, 2016).

It is interesting to note that whether they are developed by Western firms or by local firms in low-income emerging markets, if a RI happens, the concerned product is expected to disrupt and furthermore, create product cannibalization (M. Zeschky et al., 2014). As previously mentioned, this is also one of the factors hindering MNCs to opt for FI as they want to avoid competing with their own product lines. In fact, lower priced products generating a RI are at the expense of the Western firms having enjoyed beneficial price structures in developed markets (Simula et al., 2015).

Finally, the concept of reverse innovation is evolving, and recent studies argue that the concept goes through different generations, in the same way as innovation theories. Radojević (2016) proposes a re-interpretation of RI, articulating it around several *roles*. For instance, the actor can be any enterprise while the stimulus to innovate as such lies in any market that emerges to the actor as the new primary segment for its innovation – versus the traditional view considering exclusively developing countries. Then, the final destination of RI is not necessarily a geo-economic entity at a higher level of economic development nor the home of the actor, but rather the formerly primary market in which the actor has initially innovated. Finally, in terms of technology, the actor may draw on either or both internal and external sources. This broader and more inclusive approach seems in line with concepts like open innovation and relevant with the urgent context of healthcare.

3.2.2. JUNCTION BETWEEN FRUGAL & REVERSE INNOVATION

One of the unifying features of frugal & reverse innovation is the fact that developing countries are at the source of both. As defined above, RI matches a product that is developed in emerging markets which is then modified to be sold globally (Le Bas, 2016). However, it seems important to note that if some RIs are simply FIs flowing from developing to developed countries, not all RIs are frugal. Thus, one should bear in mind that RI is, at first, developing & selling new products in emerging markets and then, eventually, adapting these products for sale in developed countries (Nunes & Breene, 2011). Some argue that FI and RI are rooted in the same concept of innovation with similar principles – low R&D costs, limited technological sophistication, and answering peoples' basic needs (Brem & Ivens, 2013; Gupta, 2011). Moreover, Zeschky (2014) affirms that *reverse product innovations are essentially frugal product innovations which are taken to the markets of developed*. Therefore, RI is focused on a geographical region and considered as a market innovation, whereas FI is rather seen as a product and process innovation (M. B. Zeschky et al., 2014). The diffusion of FI in developed countries is only possible due to their economic constraints, thus allowing a bidirectional

product flow between developed and developing countries, and the innovation to be targeted at both (Cachola, 2019; Prime, 2017).

These differences between the two paradigms imply that, even if a large proportion of RI are frugal, it may not be always true the other way around (Hossain, 2018). Cachola (2019) summarized the difference as *frugal innovation spotlights the study of innovation under constraints, while reverse innovation focuses on managing innovation diffusion between developing and developed markets*.

3.2.3. DRIVERS OF REVERSE INNOVATION

A great deal of publications emphasizes on the potential of reverse innovation for Western companies. As aforementioned, RI is the extension of the three other types of resource-constrained innovations, i.e. low-cost, good-enough, and frugal innovation. Moreover, RI is described as a process, which means it usually includes the stages of the development and commercialization of these resource-constrained innovations. Even though there is a gap in the study of the impacts of RI, this overlap of concepts leads to similarities in the drivers and expected benefits of RI and FI.

First, going for RI is a way to exploit both mainstream markets in emerging economies and niche markets in developed countries. Then, in the context of intense competition arising from developing economies, it is a way for Western companies to defend themselves. In fact, the cost of inactivity with regard to competition is greater than opting for RI, i.e. companies better embrace the paradigm (Von Janda, 2017).

However, when considering RI in the context of small and medium enterprises (SMEs), the drivers are not the same. In fact, SMEs may be more flexible and able to adopt a global approach while incorporating RI directly in their start-up business model (Radojević, 2016). Literature has not yet exploited these suggestions to grasp better this phenomenon. This study also aims to shed a light on the phenomenon of SMEs while keeping the suggestions of Radojević (2016) in mind. The reason why researches in RI are focused on large companies is because these SMEs are likely to lack of sufficient resources to scale, along with the idea of grassroots innovators. While conducting informal interviews in the practical part of this study, the mistrust towards the SMEs has also been addressed. As a matter of fact, as SMEs cannot guarantee the same liability as MNCs, one tends to choose the latter over the former when choosing between products or services.

Besides these organizational drivers and the mainstream areas of impact vastly developed in the literature, i.e. business performance improvements, global geo-economic transformations have also been a trigger for RI. The reality is that economic power and the sources of growth have been shifting towards developing economies and RI may be considered as one of the manners through which Western companies can adapt to this (OECD, 2009). Moreover, whether it is to survive changes or a strategy to take advantage of these drivers, it is also expected that RI has beneficial social impacts to the host country (Landrum, 2007). However, Radojević (2016) study shows these impacts might be ambiguous, at times positive or at times negative. On the positive aspects, RI tends to diminish *horizontal inequality among social groups, increase access to healthcare, and create opportunities to participate in consumption*. On the negative side, local market players will lose market share and competitive capabilities. Nonetheless, while poverty and inequality are drivers that trigger RI, the paradigm does not reduces poverty (Radojević, 2016).

3.2.4. DRAWBACKS AND BARRIERS

The research conducted by Harris, Weisberger, Silver, and Macinko (2015) has shown **that low-income countries (LIC) suffer from their negative image when it comes to RI. In fact, a product innovation incoming from a LIC undergoes judgments – social and cognitive boundaries**. The judgements about the similarity of the US and the LIC are wobbly. The bias will be tested on Belgian entrepreneurs in the practical part of this study.

In order to judge the transferability of an innovation from a LIC, it goes without saying that a thorough knowledge of both the LIC's and the targeted HIC's contexts is required. Even with deep understanding, explanatory variables remain complex & cannot be simplified by national-level generalizations. Nonetheless, Harris et al. (2015) affirm through their research that generalizations are a common occurrence. In turn, these personally constructed judgments interfere with reverse innovation process. This social and cognitive bias is part of the hypothesis investigated in the practical part of this study.

Furthermore, the disruptive power of RI also has an impact. In fact, the fear of disruption within competitors & the industry can lead to political activities to create barriers in order to block RI process (Von Janda, 2017). Moreover, this disruptive power can even influence the decisions from the headquarters in case product cannibalization cannot be tolerated. Nonetheless, as aforementioned, the intense competitive climate being common in most industries, a lot of MNCs seem to understand only afterwards, that the cost of inactivity is often greater than the cost of cannibalization.

3.2.5. SUCCESS FACTORS AND PRACTICES

A major factor for RI to successfully happen is the subsidiary. In fact, as the scope of its capabilities increases, it becomes available to develop solutions that specifically tailored for the needs in its local environment. The local market & customer expertise of the subsidiary combined with the technological knowledge of the headquarters is precious (M. Zeschky et al., 2014). In the same article, during the interviews, managers have substantially stressed out the importance of local presence & native people. Indeed, the majority argued the necessity of local expertise in order to have a thorough customer understanding. This ultimately leads to addressing the correct needs as the peculiarities of the environment become known.

Nonetheless, the approach vis-à-vis of the subsidiary from HQ is not as important as one might believe. M. Zeschky et al. (2014) raise two different possible approaches. The first is *subsidiary global product mandate* where the subsidiaries are self-standing & responsible businesses within the MNC's network. They have great autonomy & leeway. Nevertheless, the subsidiary has access to the central technological know-how of the headquarters. The fundamental idea at the base of this approach is that local businesses are more likely to seize local opportunities. In other words, they are more well-suited to develop products that will serve local needs. The other approach is referred as *headquarters global product mandate*. In opposition to the last approach, this one involves strategic decisions incoming from the headquarters. Besides, the global product & sales strategies are made to ensure that products aiming emerging markets are aligned but also distinct from the firms' premium products. In a nutshell, the subsidiary's autonomy is limited & RI is sought with a determined budget. Despite the dissimilarities, both of these approaches have proven to be successful (M. Zeschky et al., 2014). Some authors argue on the importance of creating autonomous subsidiaries, with intercultural teams & management support. In fact, throughout a case study of Speres, an Italian manufacturer operating in China, Corsi, Di Minin, and Piccaluga (2014) have reported three different lessons for a successful RI. At first, the Western company must be able to identify the problem correctly. Then, through a detailed analysis of local competitors, the MNC is to determine the needs of the local customer. Finally, the HQ team should be open for the transmission of the product attributes – embracing the specific conditions of the environment is key. Along the years, several studies have tried to take a closer look to the factors & attributes of products or services that render them likely to succeed in a global market – i.e. in RI. It appears that usually, RI are low-priced, simple, come with features that lead to new functionalities and deliver performance (Govindarajan, 2009; Govindarajan & Trimble, 2012).

Others have also mentioned the modular product architecture as a common attribute of RI (Von Janda, 2017).

Through four case studies conducted on MNCs, M. Zeschky et al. (2014) have also determined three successful practices RI. First, a *from-scratch innovation* approach. In other words, MNCs should not seek to implement a predetermined innovation approach – RI is based on FI which is highly context-specific. Second, the internal *integrity* of emerging market subsidiaries. In a nutshell, coordination within the MNC is central for success. Lastly, a *low fear of product cannibalization* is also required from the HQ. As a matter of fact, as aforementioned, RI are expected to disrupt the global market. Therefore, if the MNC has apriorism & absolutely wants to keep its premium products – at a level where one can simply ignore RI – then RI becomes difficult in the *reverse* stage.

In turn, Von Janda (2017) mentions three different types of drivers of success for RI. The *structural drivers* are linked to the organizational structure of the firm. For instance, the internal embeddedness, global market screening units and problem-based market clustering are among these. As its name suggests, the *cultural drivers* are the values, norms & behaviors shared within the firm. The notable ones are low fear of product cannibalization, management diversity & an open mindset. Tangible & intangible assets form the *resource-related drivers*. In other words, these are the tools, skills & abilities of the firm.

3.3. CONCLUSION OF REVERSE INNOVATION

Reverse innovation corresponds to a market innovation and consists in the diffusion of an innovation, initially created for resource-constrained environments, outside of its initial market. The term has spread in the literature based on the success stories of various MNCs that managed to approach innovation differently. Indeed, low-income countries actually tend to adopt low-cost innovations rather than evolving the same way as developed countries did. Sometimes, these innovations are, good-enough to compete or, at least, interest a segment in HICs. Moreover, RI represents a business opportunity to answer cost-minded consumers' needs in HICs with simple and affordable offers, by reverting the traditional trickle-down to a trickle-up flow. Besides business performance improvements, it is argued that RI has a positive social impact but mitigated economic consequences on local competitors. While FI and RI are closely linked concepts, they have distinctions to be noted. The former relates to the output, the process and the mindset aspect of an innovation. Whereas the latter, RI is rooted in the

diffusion of these resource-constrained innovation (RCI) in different markets. Thus, while RI are often FI transferred into high-income countries' markets, not all FI can be reversible.

Furthermore, RI might be more than an opportunity, but a necessary solution for Western companies to survive to the shift of the economic power to newly emerging countries. Nonetheless, the literature affirms that a social bias on the country origin, as well as organizational factors, are hindering the diffusion of RI. To overcome these barriers, success factors have been identified. For instance, having a local presence and expertise through subsidiaries operating in autonomy has proven to be an effective way to develop RI with enhanced functionalities. The best practices also include a from-scratch innovation approach and a low fear of product cannibalization – as an FI can be disruptive in a HIC. Overall, the novelty of the paradigm of RI, the gaps in the literature in terms of frameworks, and its context-specificity, render it difficult to define what truly is the most efficient RI implementation. **Additionally, the role of the entrepreneurs tends to be neglected in this transfer process – as case studies focus on multinational corporations. This research intends to investigate this, by trying to identify how a frugal innovation can be reversed in healthcare through local entrepreneurs.**

4. FINAL THOUGHTS ON LITERATURE

As the nature and impact of an innovation depends on numerous factors - such as the context, stakeholders, means, targeted need – it resulted in a fragmented gapful literature where diverse perspectives and authors coexist. The first section has described various theories and how they have been evolving over times towards a more inclusive perspective, in parallel to the globalization. While Schumpeter established the premises of innovation theory, through the *innovation as an output* lens, more variants have been developed over time starting with the numerous contributions of the evolutionary theory. The latter takes into account the time perspective – innovation can be seen as a process in which actors, knowledge and technologies are interacting. In other words, an innovation evolves over time. Promising approaches like innovation as mindset and as policy show that a broader perspective could be adopted to understand how to influence the process, by identifying success factors and overcoming barriers inherent to each variant.

Frugal innovation (FI) originates from resource-constrained settings of emerging economies (Koerich & Cancellier, 2019) and is a new – from the Western perspective – way of approaching innovation. FI, by definition, focuses on the price, serving the low- to mid-income market segments with an affordable offer by, for instance, focusing on core functionalities (Weyrauch & Herstatt, 2016). The global economic, ecological and societal transformations of the 21st century are likely to translate into a push for frugality, making this paradigm relevant for both developing and developed countries (Hossain, 2018). Serving the increasing portion of value-sensitive consumers seems necessary (Kharas, 2017) but comes with hurdles such as the identification of their hidden needs or the risk for MNCs to face self-cannibalization in their offerings (Rocca, 2016a). Even though the novelty of this paradigm makes the volume of identified success factors and frameworks limited, the literature is increasingly investigating solutions to overcome these hurdles. Overall, it is argued that **frugal innovation should be seen as a mindset to be implemented in a culture of innovation (Krohn & Herstatt, 2018), as well as a cross-industry technology transfers and collaborative approach, i.e. open innovation.**

While FI is related to innovation as a product, process and mindset, reverse innovation (RI) corresponds to a market innovation (Simula et al., 2015), and more specifically when a resource-constrained innovation is transferred into another geographical market than the initial one (Radojević, 2016). This implies that these innovations are context specific and often

require an adaptation step before being implementable in the new market (Corsi et al., 2014). More than a way to fasten the innovation cycle and co-learning opportunities (Bhattacharyya et al., 2017), the fact that the growth is now in the developing world (OECD, 2009) makes is often a surviving reason for companies to pursue RI (Von Janda, 2017). However, targeting multiple markets that are fundamentally different means acquiring knowledge of these opposite contexts, which is a major barrier to RI. It is up to the MNCs as they have the financial resources to do so. While the literature gives few success practices in terms of innovations as process and mindset to overcome it, it is also reported that a social bias on the origin of a RI hinders its diffusion (Harris et al., 2015).

The literature review exposed the various traditional and modern theories and ramifications of innovation, several of them being the basis on which the paradigms of frugal and reverse innovation have been built, i.e. sustainable innovation, open innovation, resource constrained innovation among many others. However, it also revealed several gaps – frugal/reverse innovation as a process and as a mindset, positive and negative impacts on host countries (Radojević, 2016). More importantly, the fundamental role of the entrepreneurs, i.e. SMEs, in innovation diffusion (Ceci & Iubatti, 2012; Miller & Garnsey, 2000) seems to be neglected in the study of integrating foreign frugal innovation into Western countries. On the one hand, even if an innovation is theoretically reversible in a targeted HIC, it will be transferred only if it is profitable and technically implementable. And on the other hand, the entrepreneur is likely to be the stakeholder capable of overcoming most of the barriers described in the literature (Radojević, 2016).

This is what this study aims to investigate in the empirical part – exploring Belgium's receptiveness to integrate foreign frugal innovation, i.e. perform reverse innovation, while considering the critical role played by entrepreneurs in innovation diffusion and adoption. The research is articulated around the following question: ***If an innovation is assessed as being both frugal and reversible in a targeted high-income country, is it enough to be considered having a commercial potential and thus implemented by local entrepreneurs?*** Based on the results, three aspects can be explored. First, the identification of business opportunities for local entrepreneurs. Then, the highlighting of innovation and context specific reasons hindering the transfer of these innovation. And finally, establish a diagnosis of the general receptivity of the chosen sector – healthcare - in the targeted HIC – Belgium – towards foreign frugal innovation and reverse innovation.

VII. PART II: PRACTICAL PART

5. INTRODUCTION TO THE RESEARCH

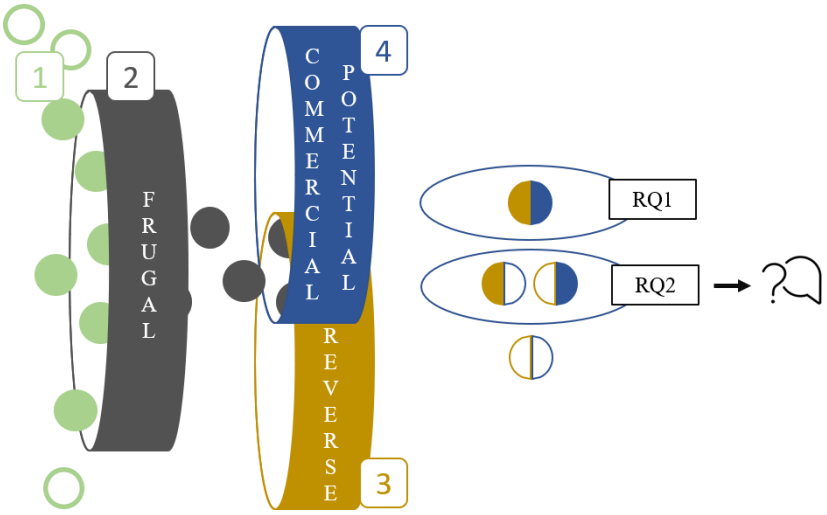
Healthcare (HC) is one of the sectors where regulatory standards are set all around the globe, especially stricter in high-income countries (HICs). This, in turn, is playing a hindering role in the innovation process in many countries (Friebe, 2017). Nonetheless, as necessity is the mother of invention, in times of crisis, it might be required to forego barriers like regulatory aspects and protectionism, to rapidly address urgent needs (Harris, Bhatti, Buckley, & Sharma, 2020). This represents an extreme case to explore the research gaps identified in the previous part – if an innovation is assessed as being both frugal and reversible in a targeted HIC (in this case, Belgium), is it enough to be considered having a commercial potential and thus implementable by local entrepreneurs (in this case, the healthcare sector)? Thus, the practical part is organized as follows. This introduction (section 5) briefly introduces our research strategy and highlights the specificities of the Belgian healthcare sector – i.e. its main characteristics and challenges. Then, section 6 clarifies the chosen research design – the research protocols, validity criteria as well as analysis methods. To conclude, section 7 presents the main findings, while the discussion (section 8) confronts them to the literature as well as to the opinions of experts from the field.

5.1. RESEARCH STRATEGY

This study investigates Belgium's receptiveness to the integration of foreign frugal innovations (FI) in its healthcare (HC). To do so, a set of innovations was evaluated by 3 distinct panels to identify what are the transferable FI into Belgian HC, what factors makes the rest of them not transferable, and what are the general dynamics around innovation in the Belgian HC. First, data on innovations that emerged as a response to COVID-19 from all around the world has been collected through desk research, with the condition of being sufficiently documented to be evaluated (Step 1). Then, the chosen set of 41 innovations went through the first panel of medical and FI experts to assess their **frugality** – *Medical Frugal* (MF) panel (Step 2). The 9 innovations deemed frugal were then simultaneously submitted for evaluation to two panels, the first one to assess their ***reversibility*** (Step 3) – *Medical Reverse* (MR) panel – and the second one to assess their **commercial potential** (Step 4) – *Entrepreneurs* (ENT) panel. See **Figure 13** for a schematic view of the research strategy.

The designed mix of quantitative and qualitative evaluations led to three types of final results for each innovation. The first is when the innovation meets both *reversibility* and *commercial potential* criteria – thus judged as ***transferable***. The other two are, if it satisfies only one criterion or none of the criteria is met. The first two scenarios served as a basis to answer and discuss two main research questions (R.Q.), as well as three hypotheses based on the literature, that will be developed further below in the methodology section.

Figure 13: Illustration of the research strategy



5.2. CONTEXT AND CHALLENGES IN HEALTHCARE

This section aims to describe the specific and highly complex sector that is healthcare with a focus on its challenges as well as the Belgian system's peculiarities. The context created by the COVID-19 crisis will also be addressed. Numerous elements are necessary to thoroughly understand the research, but also to have a grasp on what has been happening to Belgian HC over the past decades. Additionally, the impact of the gaps in Belgian HC that have surfaced through the pandemic as well as how FI and RI can be viable in Belgium will be explored.

5.2.1. CONTEXT

Among human rights standards, *the right to the highest attainable standard of health* implies a state responsibility to ensure an equal opportunity in the access to the health system (WHO, 1995). However, this is a goal that is far from being achieved as health protection remains a major issue worldwide (Arshad, Radić, & Radić, 2018). The quality and the ease of access vary significantly, due to societal and economic forces, between countries as well as within them (Prime, 2017). Moreover, global HC systems, in both LICs and HICs, are facing significant challenges – such as ageing population, increase of chronic diseases, etc. – that are

to become even more critical in the future. Paradoxically, life expectancy continuously improves (Prime, 2017). Additionally, there is an increase of countries' expenditure in HC that must be slowed, both in terms of national budget and citizens' out-of-pocket expenses (Song et al., 2012). Vanderaa (2018) reports that the share of GDP spent on the public health and social care underwent, between 2000 and 2015, an increase of 17%. And this growth is expected to be faster than the economic growth over the next 50 years – even more with the economic crisis that COVID-19 has created (Rumbold, Smith, Hurst, Charlesworth, & Clarke, 2015). This growth is mainly because of the fast technological and scientific progress, which increase the costs of care (Schokkaert & Van de Voorde, 2014). Moreover, a simple reduction of the expenditure in healthcare would involve a substantial and certain social cost as the poor would be on the first line (Vanderaa, 2018). Be that as it may, spending more on HC does not always mean better service. For instance, India is the market where the most new HC products are launched (Arshad et al., 2018). In other words, cost-sensitive innovations also exist in HC. It is a common belief among the researchers that there is a considerable opportunity for shared learning, in the HC challenge that both HICs and LMICs will face together.

5.2.2. SECTOR CHARACTERISTICS

Healthcare is a high emotion service as a patient with intense feelings – such as pain or fear – expects to have a quality service. Customer experience is critical in the sector. Most services are *want* services whereas healthcare is a *need* service (Berry, 2019). The majority of the decision-power is in the hands of the clinicians due to the complexity of the service as well as *patient timidity* (Berry, Davis, & Wilmet, 2015). Moreover, there is a consequential aspect, i.e. medical error is reported as the third leading cause of death in the US (Makary & Daniel, 2016). This has an impact on diffusion and adoption cycles, which are usually long. The time gap between a scientific discovery with medical applications, and its transfer into a clinical practice is too long, estimated by Morris, Wooding, and Grant (2011) as a lag of 17 years. This has been described by several entrepreneurs as a considerable entry barrier – the selling cycle is extended, which harms new start-ups.

In addition, HC is globally characterized by an excessive waste of resources spent. The waste of the annual spending in the USA is estimated between a quarter and a half (Cutler, 2018). The operation tasks have a broad range of contributors, highlighted by Berry (2019), such as inefficient processes, overtreatment and so forth. Schokkaert and Van de Voorde (2014) mention other factors such as therapeutic obstinacy and treatment techniques to the list. Furthermore, an indirect yet considerable source of waste is due to the emphasis on curative

activities rather than preventive initiatives. This eventually contributes to the phenomenon of stagnation of population health despite any increase of spending or medical services capabilities (Berry, 2019). This has been demonstrated in the Dartmouth Atlas of Health Care project, showing that an increase on the staff and infrastructure within a geographic market does not improve population health – in contrary it is counter-intuitive (Bekelman et al., 2016).

In the end, the difficult nature of the sector, combined with other factors, can put clinicians under huge amounts of pressure. This, in turn, reflects to their jobs negatively as they are physically and emotionally drained. A considerable number of burnouts but also medical errors are caused by this pressure (Berry, 2019).

5.2.3. BELGIAN HEALTHCARE'S PECULIARITIES

The complexity of Belgium's political and institutional structures eventually has consequences on the country's HC. To briefly summarize, the country is composed of different region and communities – six in total – with each having a certain power of decision, in addition to the federal state under which they operate. In healthcare, federal state decides on hospital budgets while the 3 regions have control on their structures – inevitably leading to misalignment. For the last decades, Belgian governments have been wicked in terms of stability and consistency, preventing the country of benefiting from a long-term vision for public services like HC. The federal state has been unable to build unified measures nor implement with the support of federated institutions (Antares-Consulting & ING, 2018; Vrijens, Renard, Walckiers, Meeus, & Léonard, 2014). Paradoxically, Belgian population has a good opinion on its level of health as well as the performance of the HC – most probably due to its complexity and disregard.

Over the past two decades, governments have undertaken several reforms aimed to limit the expenses in the HC as well as decreasing availability for studying medicine at university. First, the proportion of out-of-pocket expenses, i.e. amount remaining to pay by a patient after reimbursements, is one of the highest. Then, in terms of doctor per capita and their average age, the country also has had a poor evolution between 2000 and 2015 of barely 16% – one of the oldest and lowest headcounts in the OECD (Vanderaa, 2018). This reality, mixed up with the general increase of national debt, makes it unlikely for the state to invest. Instead, a budget rebalancing between the different areas is more likely. Recent studies affirm that a richer country is not to be relatively more efficient (Antares-Consulting & ING, 2018; Vanderaa, 2018).

Several benchmark analyses comparing Belgian HC performance to other systems – OECD and WHO countries - have been conducted and the results are relatively negative. Vanderaa (2018) exposed that between 2000 and 2015, Belgium was in the top 10 of the worst HC systems on 30 countries of the OECD. A main difference is that other countries are implementing long term plans. Belgium also required to do the same – especially to face crises such as of COVID-19 – through consistent reforms with long-term plans carried on by a federative government (Devos, 2019). Since 2008, four *Health System Performance Assessments* (HSPA) for Belgium were done accordingly to the Tallinn Charter. Already back in 2012, Belgium was showing bad to average results, many indicators arguing that measures should be taken to improve the country relative performance (Vrijens et al., 2014). Comparing these results with the 2019 HSPA, the conclusion is that there has not been much progress. Despite the patient satisfaction remaining as high as reported before, HC in terms of quality, accessibility, headcounts of staff, is comparatively lower. The efficiency, even though slightly improved, is hindered by considerable waste originated from the testing off target groups, overuse of equipment and screenings but also unsuitable treatments (Devos, 2019). As aforementioned, the report pointed that preventive and seniors care, as well as mental health, need to be reinforced (Devos, 2019). It is important to note that the last report was published right before the COVID-19 crisis.

5.2.4. COVID-19

In late 2019, a respiratory infection disease caused by a coronavirus has emerged. Despite its early virulent signs, the World Health Organization (WHO) waited until the 11th of February to officially declare the outbreak as a pandemic – naming it the *2019 novel coronavirus (2019-nCov)*, called *COVID-19* for sake of simplicity and pronunciation matters. By mid-August, it has caused around 750.000 global deaths with up to 21.000.000 confirmed cases around the globe. Belgium has suffered, with the highest fatality rate for several weeks. Important weaknesses, already highlighted in performance reports, have contributed to the worsening of the Belgian situation (Devos, 2019; Vanderaa, 2018).

In front of the pandemic, governments are facing a dilemma – choosing between public or economic health. The speed of the decision-making is crucial, with limited certainty and life-death consequences (Azoulay & Jones, 2020). This chaotic context has been an extreme thrust of the drivers for frugal innovation in every part of the world. In fact, each country faces the challenge to act hastily with scalable solutions under time and resource constraints. The

response has been classified by Harris et al. (2020) in three forms *repurpose*, *reuse* and *rapid deployment*.

In terms of product innovation, companies like Spentys transforming their production lines to produce personal protective equipment (PPE) illustrate the *repurpose* as an answer to shortages. On the process and policy side and in terms of *rapid deployment*, the approval processes have been accelerated by reducing the traditional regulatory constraints – innovation as a policy. However, accelerating the pace of clinical-trial approval comes with drawbacks such as no field-testing and chloroquine controversy as the cause of death in certain cases (Harris et al., 2020).

These barriers to quick responses have been identified, and a few ways to overcome them are already described in the literature. As exposed by Azoulay and Jones (2020), government innovation policies to tackle COVID-19 must disregard the uncertainty of R&D investments as the aggregate probability of prevention and treatment increases with the number of researches funded. These investments can be relevant if put into perspective such as when one considers the daily costs of lives, etc. Moreover, the intense use of digital tools to overcome the physical barriers caused by quarantine, led to a sharing of knowledge and co-creation processes on an international level, which might improve the uptake of reverse innovation (Harris et al., 2020). Furthermore, as demonstrated by Nathavitharana et al. (2020), optimized knowledge and data sharing enable gap identification and taking action to limit impacts in an epidemical context, which is an illustration of the power of open innovation. Additionally, the value of FI is more than ever displayed, even in the most technologically advanced HC systems, as new demands require rapid solutions at a low cost (Harris et al., 2020).

5.2.5. FRUGAL AND REVERSE INNOVATION IN HEALTHCARE

Frugal innovation and reverse innovation are intertwined and can be precious tools in order to build a more efficient and just HC system. As stated by Y. Bhatti et al. (2017), FI are not limited to LMICs. Moreover, as previously mentioned, Radojević (2016) argues that RI is *neither exclusively reserved for large Western multinational enterprises, nor for specific host countries or particular levels of development*. This interrelatedness appears to have become even more relevant in the case of healthcare innovation and in the context of COVID-19.

Many innovators in low- to mid-income countries (LMICs) responded to the growing demand for healthcare access by developing products appropriate to their resource-constrained environment. In addition to the urgency to improve its environment, the innovation process in

these contexts is driven by a flexible regulatory system mixed up with limited performance of standard approaches (Bhattacharyya et al., 2017; Immelt et al., 2009). The innovators in LMICs come up with new mindsets and approaches to HC service delivery, proposing new solutions – whether it be as a product or a process – and focusing on the core functionalities while reducing the costs (Prime, 2017).

The frugal paradigm, initially born in LMICs, has proven to have several applications in this global resource-constrained HC sector. Indeed, while Arshad et al. (2018) have shown that jugaad and grassroots entrepreneurs have a critical role in the development of HC innovations in emerging countries, it has been observed that recently, several MNCs are getting a hold of its potential, in both LMICs and HICs (see examples in

Appendix 1 Multinational corporations, in contrary to entrepreneurs, can set up the infrastructure and inject the budget required for these innovations to be scaled and diffused internationally – therefore becoming RI. Arshad et al. (2018) also highlighted the number of FI in HC by country of origin. The top five countries included four developed countries, which supports the idea that the FI paradigm is relevant and already present in several developed countries. The first market of the chosen innovations was mostly LIC – backing up the FI theory affirming that resource-constrained environments are source of frugality. However, as pointed out by Mazumdar-Shaw (2018), these affordable – and potentially disruptive – innovations emerging from LMICs are facing internal challenges such as regulation, bureaucracy, cultural risk aversion and lack of capital (Mazumdar-Shaw, 2018). As aforementioned, collaborations and shared knowledge can form a tool to overcome the peculiarities that hinder innovation in these limited contexts.

Furthermore, it is widely argued that frugal innovation in the medical sector is a disruptive way to meet the different healthcare needs. The literature affirms that the potential of FI is relevant for any field in HC. For the moment, most of them are in neonatology, general practice and orthopedics. Nonetheless, as highlighted by Dessap (2019), there are considerable impacts possible in fields like critical care – which are strictly regulated. In the latter, FI could come in handy for the intensivist as it could increase his medical autonomy as well as his ability to manage the critically-ill – no matter the environment. Creating a solution to address a need – i.e. design thinking – is relevant. In fact, if one takes a ventilator, the *need […] is ventilation, not the ventilator* (Dessap, 2019). This goes along with the statement that, nowadays, HC innovation focuses on a technology to then adapt it to the need it might solve. Rather, HC innovation should start with a need (Y. Bhatti et al., 2017).

As a reminder, the transfer of a frugal innovation (FI) into a different market is called a reverse innovation (RI), and fastens the innovation cycle. Snowdon, Bassi, Scarffe, and Smith (2015) describe RI in healthcare (HC) as the possibility of *learning and building capacity for leading change that has the potential to optimize resource use while also finding innovative approaches to deliver health services in a cost effective, sustainable manner*. In other words, as an opportunity to optimize efficiency whilst tackling problems. In many developed countries, including Belgium, the lack of competition due to publicly funded HC means less incentives for individual companies to innovate. Additionally, a lot of these firms are characterized by a change resisting culture – especially in HC. One should also bear in mind the complex bureaucratic system (Snowdon et al., 2015). Nevertheless, while many of these

innovations have proven their efficiency, the diffusion process – already slow and lengthy – is facing several barriers. The global adoption – *transferability, reversibility* – of FI in the healthcare (HC) of a new country is delayed. Mainly because of the inherent product or process adaptation to any country's healthcare. However, there are other challenges to overcome. The policy and institutional barriers in the sector vary among different countries. It can either be a driver for frugality or conversely, simply hinder it. Moreover, the social and cognitive bias among a large proportion of HICs professionals lead them to view innovations from LICs with prior assumptions and stereotyping, which eventually leads to misjudgment and inefficient use of potential healthcare solutions (Y. Bhatti et al., 2017; Harris et al., 2015). To conclude, finding innovations that fulfill the frugal criteria is the easiest step, while exploiting this potential, i.e. implementing them *locally and globally for both rich and poor* seems to be a difficult challenge (Y. Bhatti et al., 2017).

5.2.6. ROAD TO IMPROVEMENT

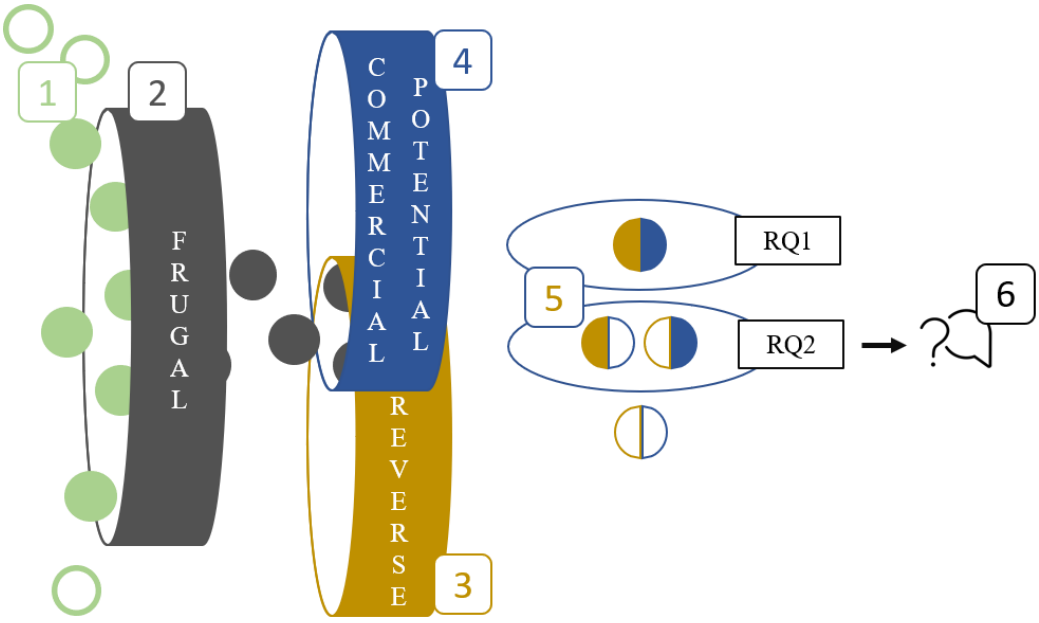
The literature exposes various reasons that makes it difficult to change any medical practice. The regulatory standards are paramount, which is one of the hypotheses tested in the practical part of this study. Conversely, innovation is undisputedly the main way to improve HC worldwide. Frugal innovation (FI) proposes potential disruptive solutions to address some of the major global healthcare (HC) needs. The increasing number of developed countries creating FI in HC, along with practical cases exposed in the literature, prove that FI's relevancy, sourcing and development is valid for both emerged and emerging worlds. RI can fasten the innovation process in HC. It can do so by leveraging the sector's competition and the indulgent bureaucratic processes existing in LMICs. The purpose of the introduction is to try and understand the different factors and have a grasp on the complexity of the HC. The challenges specific to Belgium have also been developed as the research aims to figure out how to integrate foreign FI in the Belgian HC. An exhaustive section on recommendations from the literature on how to improve HC in general, and examples of FI in HC, can be found in **Appendix 2**.

6. METHODOLOGY

As the literature review is finished, the following question remains: ***If an innovation is assessed as being both frugal and reversible in a targeted HIC, is it enough to be considered having a commercial potential and thus implemented by local entrepreneurs?*** This section outlines the research design that was used to shed a light to this issue, notably starting with three key research questions: *Which innovations linked to the COVID-19 crisis are frugal, reversible & can be transferred to Belgium?; What are the reasons hindering the transfer of these innovations in Belgian healthcare?; And to what extent are these reasons related to broader dynamics and receptiveness towards innovation in Belgian healthcare?*

The purpose of the research is to identify and categorize multiple innovations as response to COVID-19 (1) – see **Figure 14**, mainly retrieved online, then evaluate their *frugality* (2), *reversibility* (3), and *commercial potential* (4). The divergences and convergences of the respective results in *reversibility* and *commercial potential* criteria enable, on the one hand, to identify FI transferable in Belgium, and on the other hand identify factors hindering the transfer of these innovations (5). Moreover, the divergences can highlight point of discussion on possible global dynamics around innovation, specific to Belgian context, that are hindering the diffusion of foreign FI, i.e. RI (6).

Figure 14: Methodology with steps



In order to do so, quantitative and qualitative data will be gathered from, respectively, medical and frugal innovation specialists, Belgian healthcare experts, and Belgian

entrepreneurs in the healthcare system. This non-experimental descriptive approach supported by theoretical tools, will enable the testing of three hypotheses and provide answers to two main research questions, based on statistical and comparative analyses:

Research Questions and Hypotheses

R.Q.1. [Descriptive] Which innovations linked to the COVID-19 crisis are frugal, reversible & can be transferred to Belgian healthcare market?

Hypothesis 1.1. If an innovation is frugal and reversible in Belgium, then it would be transferable, i.e. also have a commercial potential according to entrepreneurs.

R.Q.2. [Descriptive + Interpretation] What are the reasons hindering the transfer of these innovations qualified as *frugal & reversible*, or as *frugal &* with *commercial potential*, in Belgium?

Hypothesis 2.1. The emergence of reverse innovation is hindered due to a social and cognitive bias on the country of origin.

Hypothesis 2.2. The emergence of reverse innovation is hindered by regulatory standards.

The rationale for these research questions and hypotheses is both based on literature and logical assumptions. First, it is argued that frugal innovation in healthcare (HC) is an opportunity to tackle global HC challenges – in both developed and developing countries (Arshad et al., 2018; Friebe, 2017; Mazumdar-Shaw, 2018; Prime, 2017; Ramdorai & Herstatt, 2015). This constitutes the main motivation behind R.Q.1. and R.Q.2. Therefore, logically, the assumption of Hypothesis 1.1. followed, as the role of the entrepreneurs in the process of a reverse innovation is ignored in the literature. Plus, the objective of the research is to confront theoretical concepts with the field reality. Conversely, Hypothesis 2.1. is based on the literature, as reported by Harris et al. (2015) and Y. Bhatti et al. (2017). Low-income countries innovations suffer from of judgments about their potential to offer solutions in US healthcare (Harris et al., 2015). In turn, Hypothesis 2.2. is already mentioned in the literature, as *the application of scientific methods for healthcare decision making […] which requires extensive clinical trial […] for regulatory approval […] is a very expensive and time-consuming approach* (Friebe, 2017). Furthermore, throughout the research, many preliminary interactions with experts in healthcare and/or in innovation pointed out the hindering force that regulation has on reverse innovation.

6.1. METHODOLOGY - LIST OF COVID-19 LINKED INNOVATIONS

As of May 2020, desk research and online data gathering was carried out to identify potential sources of innovation in the context of COVID-19. This corresponds to a *content analysis* method, which is common in the study of social sciences, as it has the advantage not to require direct contact with the entity (Prime, 2017).

The first step of this research technique was to sample sufficient documentation, through a *purposive sampling strategy* (Tongco, 2007). One of the sources was hackathons conducted by private entities as well as public institutions, such as the EU. Additionally, screening the recent publications in the literature regarding COVID-19 and reporting the best practices has helped completing the documentation. Besides, press articles and word of mouth provided additional fields to explore.

The following two stages, preceding the statistical analysis, were the definition of a unit of measurement and then, of a unit of rules and procedures to categorize the data (Kassarjian, 1977). The determined unit is, at first, the nature of the innovation, e.g. product, service, process, and also the addressee – patient, healthcare worker (HCW). The inclusion criteria were based on the reliability and quantity of data available for each entity, with regards to the required amount for the analysis levels that follow (FIH-ID, T-HOPE, *desirability*/*feasibility*). The fourth criterion relates to the set of information available, such as the description of an innovation, its components, processes, the country of origin, etc. The study has taken place at a time where the crisis was soaring around the globe and thus, the availability of data was indubitably limited. Furthermore, the selection of the innovations might have been influenced by other individual bias. As developed further, despite being a limitation that will reduce the reliability of the results, the research emphasizes on the comparison of two perspectives – medical and entrepreneurial – with an evaluation of the market fit. This comparison is based on the same set of data, rather than the separation of each set of results for the sake of reliability.

Table 3: Inclusion criteria to select examples of innovation as a response of COVID-19.

Inclusion criteria for an innovation as a response of COVID-19	YES	NO
1. Tackles directly or indirectly a consequence/challenge correlated with COVID-19		
2. Applicable in an area of healthcare		
3. Tested or attempted to be implemented		
4. Sufficiently documented to assess the criteria (affordability, adaptability, accessibility)		

6.2. METHODOLOGY – ASSESSING THE FRUGALITY

6.2.1. DESCRIPTION OF THE TOOL

In the beginning, the *Frugal Innovation for Healthcare Identification* (FIH-ID) tool has been developed by Prime (2017) as a criteria-based toolkit and methodology to assess the frugality potential in a given medical innovation or invention. In order to ensure its robustness, the author used a pilot study aimed to test a draft of the tool by assessing the frugality of a set of innovations in healthcare, in the context of a competition for all UK students. Two independent evaluators had to individually conclude, for each innovation, with respect to the criterion, whether it would meet it (Yes, No, Unknown) compared to the product alternative. Then, results of both evaluators were merged to assess the frugality based on predefined rules. This process has been done several times on extended number of cases, and the results of this study identified potential innovations that could be implemented through the NHS in the UK. Finally, the author proposed a last version for future works – the version that will be used in the practical part of this study. The tool relies on independent experts evaluating individually the frugality of a set of innovation according to the three criteria developed by (Y. A. Bhatti, 2014), from the definition *means and ends to do more with less for many* (Y. Bhatti et al., 2013).

6.2.2. CRITERIA

Once the data was ready, an online form has been provided to the first panels of experts. They were asked to perform a thematic content analysis and assess for each innovation whether it would meet the three FIH-ID criteria – *affordability, adaptability* and *accessibility* (Y. Bhatti et al., 2013).

Table 4: The 3 criteria are defined as follows (Y. Bhatti et al., 2013):

Affordable	Is the innovation more affordable than alternatives in terms of production, operation, purchasing, servicing and/or disposal?
Adaptability	Is the innovation adapted to the needs of the context to better perform, be at par with or be good enough?
Accessibility	Is the innovation scalable to benefit many in society in terms of its current accessibility, and/or potential for scalability?

6.2.3. RATERS

The FIH-ID is a criteria-based tool used to assess the frugality of an innovation. It relies on a pair of *Medical experts – Frugal* (MF), who were purposefully selected, with respect to their background. The assessors were in fact required to have experience and expertise in both general medical HC and innovation field of research. They also needed to be new users to the tool, an additional goal being to test the extendibility of this FIH-ID to novice users.

Table 5: Pair of experts in the *Medical – Frugal* (MF) panel

Experts	Healthcare Experience	Frugal Innovation Experience
Dr. Grazia Antonacci Researcher at Imperial College	Healthcare researcher and manager active in the sector for 10 years.	Knowledge of main concepts around frugal innovation developed over the last 10 months.
Mark R. Skopec Researcher at Imperial College	Research assistant in the Department of Primary Care and Public Health; holds a master's degree in Public Health.	Research area includes geographic bias (i.e. barriers to adopting frugal innovations from LMIC/LIC in a HIC setting).

With the objective of achieving academic robustness to the results but also testing the validity of the FIH-ID for novice users, a control panel of expert users was also formed. A random subset of the CIs was assigned to each of them, so that each innovation would be assessed by one expert. Then, the evaluation of the control panel would be considered when analyzing the overall results, in terms of inter-rater agreement variability.

Table 6: Control panel of experts in the *Medical – Frugal – Control* (MFC) panel

Experts	Healthcare Experience	Frugal Innovation Experience
Dr. Yasser Bhatti Associate professor at Queen Mary University of London	Expertise in emerging models of innovations and strategies – including healthcare – which promote inclusive and sustainable growth.	Co-author of *Frugal Innovation: Models, Means, Methods,* scholar of frugal innovation with proven track-record in research.
Dr. Matthew Prime Lecturer at Imperial College London	PhD candidate and orthopedic surgeon with more than 10 years of clinical experience.	PhD on frugal innovation in Healthcare, author of the FIH-ID.

6.2.4. DEFINITION OF THE UPDATED TOOL RULES

Following the introduction and acquaintance of the tool, each assessor (A1/A2) analyzed the innovations one by one and answered individually to the set of questions following the FIH-ID grid. Then, the results were merged and categorized following a consensus rule. First, at the sub-criteria level (SC), then at the criteria level, and finally the innovation level (I). One of the objectives of this study being to assess the potential innovation among a limited list, the rules defined were strict and aimed to minimize the number of results involving discussion, which are determined at the innovation level.

In case of the requirement of a discussion between the assessors, a second step consisted in the exchange between the latter on the uncertainty of the results in order to define a consensual choice between *Yes*, *Uncertain*, or *No*. The following tables illustrate the mentioned rules.

6.2.4.1. SUB-CRITERIA LEVEL

Table 7 illustrates the rules for outcome of each pair of response, which are stricter than the original framework as the *Discussion* only happens if one of the two expert says Yes.

Table 7.: Sub-criteria level rules

SC: A1/A2	**Yes**	**Uncertain**	**No**
Yes	Y	Discussion	N
Uncertain	Discussion	U	N
No	N	N	N

6.2.4.2. CRITERIA LEVEL

6.2.4.2.1. AFFORDABILITY

This criterion is composed of three sub elements, each corresponding to the perspective of a stakeholder – *care seeker, care provider* and *purchaser*. The rule is stated as validated if at least one of the three is met.

6.2.4.2.2. ADAPTABILITY

The three sub-criteria are *out-perform, at par,* and *good enough.* According to the FIH-ID instructions, only one of the three possibilities can be answered. When merging the two ratings, there are six results possible which are, *out-perform*, *at par*, *good enough*, *in between the two first*, *in between the two last* and lastly, *below good enough*. Considering the definition of FI, the only case where the criterion adaptability is **rejected** is when the innovation is considered as **below good enough**.

6.2.4.2.3. ACCESSIBILITY

Accessibility criterion is composed of two sub elements which are *widely accessible currently* and *potential for scalability*. The rule is validated if at least one of the two sub elements is met.

6.2.4.3. INNOVATION LEVEL

The general rule is to consider cases where there is at least a *Yes* and the rest is composed of *Yes*. The ideal case is when an innovation has all three criteria meet, i.e. Y-Y-Y. The other situations are Y-Y-D and Y-D-D, in which case the innovation is submitted to the two assessors who discuss to determine the outcome of each criteria.

Table 8: Innovation level rules

Innovation i	**Situation 1**	**Situation 2**	**Situation 3**	**Situation 4**	**Situation 5**
CI 1	Y	Y	Y	U	N
CI 2	Y	Y	D	U/N	Y/U
CI 3	Y	D	D	U/N	Y/U
Result	**Y**	**Discuss**	**Discuss**	**U**	**N**

6.2.4.4. IMPACT OF MEDICAL – FRUGAL – CONTROL PANEL ON THE DISCUSSION

The main purpose of the Medical – Frugal – Control (MFC) panel is to provide an expert-user opinion on the set of innovation. If an innovation meets one or two criteria according to the MF panel, yet the third one is stated as *Uncertain*, then the evaluation of the MFC is taken into consideration. In fact, if this criterion is met according to the MFC panel, then the innovation is sent for *Discussion*.

6.2.5. PROCESS

After being introduced to the FIH-ID and exposed to examples from the literature, both the MF and MFC panels were given two weeks to explore the selected innovations. Then, they were asked to evaluate each one through an online FIH-ID grid (see **Figure 9**). The innovations requiring a further *discussion* between the MF raters were then realized by the latter to come up with a final agreement on each of the selected 21 innovations.

6.2.6. DATA ANALYSIS AND INTER-OBSERVER AGREEMENT

In concordance with the work of Prime (2017), a proportion of agreement, a Kappa score, a prevalence index, a bias index were computed to analyze the *prevalence adjusted bias adjusted Kappa* (PABAK). The computations were done through Microsoft Excel, then

counter-checked on online two online calculators[1]. This has enabled the interpretation of inter-observer variation, taking into account the chance factor, and allowed the evaluation of the strength of the agreement. It was done on two levels. First, internally to the novice users' evaluation. Then, in comparison to the expert users to compute the variance. The interpretation of the Kappa coefficient has different scales from different authors. The chosen one for this study is Landis and Koch (1977) which is very similar to the benchmark scale of Altman (1991) ,both more detailed and less arbitrary than Fleiss and Cohen (1973). While the following provides an overview on the IRR, the evaluation results, as well as the recapitulative IRR tables can be found in **Appendix 4.2**.

Table 9: Interpretation of Kappa coefficient (Landis and Koch, 1997)

≤ 0	0.01-0.20	0.21-0.40	0.41-0.60	0.61-0.80	0.81-1.00
No agreement	None to slight	Fair	Moderate	Substantial	Almost perfect

The data analysis on the MF inter-observer agreement in **Table 10** displays for all 3 criteria a Percent Agreement around the overall agreement that is 50%, which is less than the acceptable level of 85% defined by Kassarjian (1977). These low agreement rates explain why a low Kappa score was achieved, possibly due to the lack of experience with the tool. In terms of prevalence index (PI), only the evaluations of adaptability achieve a high prevalence index (PI = 0.476). The very low PIs achieved for affordability, accessibility, and the overall agreement, suggest that when the assessors agreed, it was likely that the innovation was evaluated as Uncertain or No. The Bias Index (BI) indicates the extent of raters' disagreement on the proportion of positive or negative (Uncertain-No) cases. The MF evaluations' BIs demonstrates a limited influence except, again, for the adaptability (BI = 0.524). The high scores of PI and BI for the adaptability criteria are explained by the different interpretation of the two raters, one considering it as a scale on which inputting only Yes answers whereas the other one answered for each category with the 3 possible responses, to express *in-between scales* rating. Given the PI and BI scores for each criterion and the overall agreement, a PABAK was calculated to adjust the Kappa coefficient according to chance factor. As a result, the MF

[1] Kappa calculator https://www.statisticssolutions.com/KappaCalculator.html
PABAK calculator: http://www.singlecaseresearch.org/calculators/pabak-os#:~:text=PABAK%2DOS%20(Prevalance%20and%20Bias%20Adjusted%20Kappa%2DOrdinal%20Scale)&text=summarize%20your%20agreements%20in%20an,of%20ratings%20by%20two%20raters.

evaluation achieved a stable PABAK, ranging between 0.214 and 0.286, which represents a fair strength of agreement.

Table 10: Summary of the inter-rater agreement analysis – MF (before discussion)

	Affordability	**Adaptability**	**Accessibility**	**Overall**
Agreement (%)	49.21%	47.62%	52.38%	50.00%
Cohen's Kappa	0.214	0.000	0.263	0.200
Strength of the Agreement	Fair	None	Fair	Slight
Prevalence Index	-0.175	0.476	0	-0.008
Bias Index	-0.317	0.524	-0.190	-0.1349
PABAK	0.238	0.214	0.286	0.25
Strength of the Agreement	Fair	Fair	Fair	Fair

Following the discussion phase, the final MF evaluations have been compared with the control panel ones. The figures in **Appendix 4.2**. and in the table below on the agreement between MF and MFC panel demonstrate, for each criterion and overall, higher percent agreements rates between the two than the internal agreement of the MF panel. Indeed, except for the accessibility criterion (PA = 57.14), percent agreements on the rest are closer or higher than the acceptable threshold of 85 % defined by Kasasarjian (1997) and within the range proposed by Berelson (1952) of 66-90%. Regarding the PI and BI, the results suggested a low influence, except for adaptability with a strong prevalence index (PI = 0.857) which indicates that when raters agreed, they were very likely to support the notion that the innovation was more adaptable than the alternatives. The computation of the prevalence and bias indexes enabled the adjustment of the Kappa coefficients, increasing them considerably to a higher strength of agreement between fair (accessibility) to substantial (adaptability). Overall, these levels of strength of agreement are higher, and reflect moderate robustness of the results.

Table 11: Summary of the inter-rater agreement analysis – MF (after discussion) and MFC

	Affordability	**Adaptability**	**Accessibility**	**Overall**
Percent Agreement	71,43%	85,71%	57,14%	71,43%
Cohen's Kappa	0,471	-0,068	0,113	0,386
Strength agreement	Moderate	None	Slight	Fair
Prevalence Index	-0,048	0,857	0,190	0,333
Bias Index	0	-0,048	0,048	0
PABAK	0,5714	0,7857	0.3571	0,5714
Strength agreement	Moderate	Substantial	Fair	Moderate

6.2.7. WRAP-UP ON FRUGALITY ASSESSMENT

The objective of using the FIH-ID tool was to put aside innovations not assessed as frugal. Strict rules have been defined to limit the number of cases requiring further discussion, also increasing the reliability of the assessment, which shows a fair level of strength of agreement for the Medical Frugal experts, and moderate for the control panel (MFC). Thus, the innovations having passed will constitute the set of innovation that will be further analyzed in order to assess their *reversibility*, i.e. their transferability in Belgian HC system. The following analysis will be realized with the help of two types of contributors – on the one hand, Belgian medical experts and on the other hand, Belgian entrepreneurs, mainly working in healthcare.

6.3. METHODOLOGY – ASSESSING THE REVERSIBILITY

The purpose of this step is to assess the *reversibility* potential of the innovations as a response to COVID-19 that have been assessed as frugal in the previous step. The analysis has been done simultaneously with the entrepreneurial analysis. Articulated around 4 criteria, the T-HOPE tool is a score-based evaluation and have been used to build a survey submitted to 5 experts of the Belgian healthcare system. Additionally, the panel has been asked to estimate how a Belgian entrepreneur would evaluate each innovation's commercial potential according to the two criteria used in the entrepreneurial surveys, i.e. *feasibility* and *desirability*. In fact, this was done with the desire of crossing the results and analyzing the difference of perception between the two samples on three criteria – regulation, *feasibility* and *desirability*. The details of the results on this market-fit analysis can be found **Appendix 5**

6.3.1. CRITERIA

The Toronto Health Organization Performance Evaluation (T-HOPE) group gave its own name to the tool they have elaborated. The T-HOPE consists in a two-step criteria evaluation, similar to the FIH-ID methodology – first step to evaluate how good an innovation is performing in its LICs context, second one to evaluate *reversibility*. Only the second step was used to evaluate the *reversibility* of the frugal innovation as the FIH-ID was used to assess frugality. The criteria of the second step are *fills a gap in Belgian healthcare* (BE HC), *compatibility*, *novelty*, and *receptivity.* Due to arguments in the literature concerning how the regulation impacts innovation diffusion during the COVID-19 crisis, the compatibility criterion has been divided in two aspects – infrastructure and regulation. Ultimately, the purpose is to identify an innovation that would meet all *reversibility* criteria except the compatibility with

regulation, to then compare the results incoming from entrepreneurs' opinion on regulatory *feasibility*. The 4 + 1 criteria are defined as indicated on **Table 12.** (Bhattacharyya et al., 2017).

Table 12: Criteria of the Toronto Health Organization Performance Evaluation (T-HOPE)

Gap in BE HC	Creating solutions for unsolved (or imperfectly solved) challenges or unaddressed health issues or service gaps.
Compatibility-I	General compatibility with healthcare infrastructure in Belgium.
Compatibility-R	Compatibility with healthcare regulations in Belgium
Novelty	Innovation is a novel approach, or an established innovation used in a new way that has great promise
Receptivity	Openness and engagement of partners as well as those not considered partners but who may be impacted by the innovation

Each criterion is rated on a scale from 0 to 5, which is developed below. (Bhattacharyya et al., 2017). Then, the compatibility criterion mean is computed then summed with the other criteria to result in an overall score out of 20. For the sake of simplicity, further in the study, the scores will mainly be displayed in percentage.

Table 13: Criteria scoring system for T-HOPE (Bhattacharyya et al., 2017)

0 – 0%	No information exists, or the criterion is not applicable
1 – 20%	Demonstration that this has not been achieved
2 – 40%	Uncertain or conflicting demonstration
3 – 60%	Some demonstration of achievement
4 – 80%	Strong demonstration of achievement
5 – 100%	Significant demonstration of achievement

6.3.2. RATERS

The target HIC in this study is Belgium. Consequently, the selection of the experts constituting the panel took into consideration the experience in HC and knowledge in terms of innovation.

Table 14: Panel of experts in the *Medical – Reverse* (MR) panel

Experts	Healthcare Experience
Mathieu Louiset	Head of improvement services at PAQS ASBL. Member of the Patient Safety committee of the Institute for Healthcare Improvement (IHI).
Christophe Michel	Advisor at UNESSA – Federation of Hospital Institutions.
Azèle Mathieu	Manager at Lifetech.brussels with a mission to foster innovation and entrepreneurship in healthcare.
Steven Creve	ICT Manager at Clinic Saint-Jean Brussels.
Emmanuelle Ceysens	Advisor at Santhea – Federation of Hospital Institution.

6.3.3. DEFINITION OF THE ADAPTED TOOL RULES

The table below summarizes the rules to categorize the evaluation defined by the *reversibility* tool. For reasons developed in the results and discussion parts, the score interval for the interpretation of *refined analysis required* has been revised for this study. The upper half – above 65% - has been considered as *likely to be reversible*, while the lower half remained as *refined analysis required*.

Table 15: Original and adapted rules of T-HOPE framework (Bhattacharyya et al., 2017)

	Original interpretation (T-HOPE)	**Interpretation in this research**
Score ≥ 16 (80%)	High likelihood to be reversible in BE HC	High likelihood to be reversible in BE HC
(65%) 13 < Score < 16 (80%)	Refined analysis required	Likely to be reversible in BE HC
(50%) 10 < Score < 13 (65%)		Refined analysis required
Score ≤ 10 (50%)	Unlikely to be a reverse innovation	Unlikely to be a reverse innovation

6.3.4. PROCESS

The *Medical experts – Reversibility* (MR) panel has been briefly introduced to the T-HOPE tool. After providing a document containing examples of evaluation from the literature, an online form was provided. The form included for each innovation the T-HOPE criteria, with the option to provide a rationale if desired. For each innovation, an additional question was asked to each respondent in order to acquire their predictions on how a Belgian entrepreneur

would rate the *feasibility* and *desirability* of the innovation. To conclude, an open question on which additional factors were taken into account through the innovation evaluation was asked.

6.3.5. DATA ANALYSIS

Several authors, including Koo and Li (2016), suggest that the intraclass correlation coefficient (ICC) is a flexible solution that estimates the inter-rater reliability (IRR), thus being one of the most used analysis in presence of multiple coders. The ICC estimates the IRR based on the disagreement, whereas Cohen's Kappa, used for the FIH-ID results, focuses on agreement and is limited in flexibility (Hallgren, 2012). The choice of model has been done based on the consistency and choice of the raters as some of them skipped a few questions and were specifically picked. Therefore, the *model* used is the *Two-Ways Random*, i.e. ICC (2,k), which corresponds to the modelling of both the effect of rater and of ratee, the former one being fixed while the effect of the ratee is random. The relevant *type* selected for this analysis is the average-measures – in opposition to the single ones. The reason behind is the design of the study and the intended measurement protocol of the reliability which is meant to be based on the mean of 5 raters, rather than generalizing it to all subjects based on a single rater. Finally, the *definition* selected between absolute agreement and consistency is the second one, based on the objective of this research stage. The purpose is to look at the extent to which one rater's evaluation can be equated to another observer's score, taking into account a systematic error which would not considered in the absolute agreement definition (Koo & Li, 2016).

Table 16: Intraclass Correlation Coefficient scales – (Cicchetti et al., 2011; Koo & Li, 2016)

Cicchetti	**< 0.40**	**0.40-0.60**	**0.60-0.75**	**0.75-1**
Repeatability outcome	Poor	Fair	Good	Excellent
Koo and Li	< 0.50	0.50-0.75	0.75-0.90	0.90-1

The estimations of the ICC and their confidence intervals were calculated using SPSS statistical package version 26 (SPSS Inc, Chicago, IL), based on average rating (k=5), consistency – agreement, two-way random model.

To interpret and understand the inter-rater validity of the results that follows, the frequencies of responses, closely linked to the prevalence index, is insightful. The report available in **Appendix 5.2.** illustrates the various proportions for each answer in the scale per rater. There are significant internal discrepancies in the various experts rating repartitions. This can be explained by the fact that they were novice users of the T-HOPE and were intentionally

blinded to theory. These frequencies reflect the natural subjectivity when evaluating an innovation, which is influenced by numerous variables such as personal beliefs, market knowledge, and so on. An oral comment from one of the experts was that the medical sector is wide, and it is impossible to be an expert in each medical field the 9 innovations concern.

Therefore, to assess the validity and reliability of the ratings, intraclass coefficients (ICC) have been calculated to evaluate the IRR. The ICC – average, i.e. ICC (2,5), corresponds to the mean rating, which evaluates the reliability of the whole results taking into account the 5 raters. While the **Appendix 5.3**. details the ICC analysis, the summary table below demonstrates overall a *fair-to-good* level of reliability.

Table 17: Data reliability – Inter Correlation Coefficient*

MR data analysis	Gaps in Be	Compatibility	Novelty	Receptivity	T-HOPE	Desirability	Feasibility	Overall
ICC – single	.244	.248	.259	.077[a]	0.224	-.031	.180	0.252
ICC - Average	**.617**	**.622**	**.637**	**.251** [a]	**0.591**	**-.175**	**.524**	**0.627**
Confidence interval (95%)	-.065 .913	.238 .845	-.356 .958	-1.224[a] .832	.308 .781	-2.078 .697	-.325 .891	.429 .771

a : this criteria has not been answered enough times by some of the observers, one answering only once. Therefore, his evaluations on this criterion has been removed for the receptivity ICC, yet still included in the T-HOPE and Overall results.

6.4. METHODOLOGY – ASSESSING COMMERCIAL POTENTIAL

The purpose of the entrepreneurs' survey is to assess the commercial potential of the set of innovation, identified as frugal, in Belgian HC. An additional objective is to test out the existence of the social and cognitive bias regarding the origin of innovation, suggested recently in the literature by Harris et al. (2015).

6.4.1. LITERATURE-BASED STRUCTURE

The entrepreneurial literature on opportunity evaluation is relatively rich and includes characteristics of both opportunity and entrepreneurs as variables. It corresponds to the idea that objective characteristics have limited influence on the opportunity exploitation. Rather, this is being evaluated through a personal and subjective lens influenced by an entrepreneur's characteristics, such as emotions, experience or risk aversity. In this study, the opportunity

evaluation consisted in a quantitative survey distributed among networks of Belgian entrepreneurs in the healthcare sector. The survey aimed to capture the commercial potential of the shortlisted FI. Ultimately, the next layer of analysis is to compare the results from the entrepreneurs with the *reversibility* evaluated by the MR panel through the T-HOPE. Moreover, the results for the same innovation allow to have a look at the variance of scoring depending on person-specific characteristics – such as experience and risk aversity.

There is a broad range of person-specific and environment-specific factors that have been highlighted in the literature as influencing the process of evaluation of an opportunity. The criteria used to capture the commercial potential are structured following a simple framework suggested by Shapero and Sokol (1982) in the context of an entrepreneurship scholar education (see **Figure 10**). The framework implies three distinctive elements: perceived desirability, perceived feasibility, and propensity to act.

6.4.2. CRITERIA

Opportunity evaluation is *the subjective metal valuation of the opportunity based on individual appraisal of its opportunity characteristics* (Welpe, Spörrle, Grichnik, Michl, & Audretsch, 2012). Moreover, the *entrepreneurial event* (Shapero & Sokol, 1982) refers to the process of building entrepreneurial intentions, with the actions being influenced by social variables and environment. The underlying assumption is that, for an entrepreneur to pursue an opportunity, it requires the preexistence of the opportunity, a positive of negative event that disturbs the inertia, and a readiness to act after this event. The three criteria of the entrepreneurial intentions model resonate with the definition of Stevenson (1990) that opportunity is *a future situation deemed both desirable and feasible*, along with the fact that the actions taken depend on an individual's *propensity to act.*

The *perceived desirability* refers to the question *Should people want this?* – with regards to the attractiveness of an entrepreneurial opportunity. Elements include the market size, potential demand, growth potential, the duration of opportunity, competition, etc. (Winsor & Hanlon, 2016). This perspective was translated in the survey as the *desirability* level of an opportunity. This can be defined as its *perceived value or attractiveness* with the potential for profit being the main factor (Tumasjan, Welpe, & Spörrle, 2013). To assess the *desirability* of the innovation according to the respondents, the following items, originally proposed by Tumasjan, Welpe, & Spörrle (2013) were used: to what extent do you agree to the following statement:

- This innovation has a considerable potential for profit (Code: Desi_Q1)
- This innovation is attractive from a consumer's perspective (Code: Desi_Q2)

The *perceived feasibility* corresponds to the commitment and capital required for the exploitation of an opportunity – such as financial and human needs, required knowledge. *Feasibility* can be defined as the *perceived practicability or difficulty* (Tumasjan et al., 2013), i.e. the personal feeling of an entrepreneur towards his capabilities to go for the opportunity. The probability of success involves consideration of external factors such as market competition considerations but also regulatory environment. For the *feasibility*, the panel was asked the level of agreement with:

- This innovation's market would be highly competitive (Code: Feasi_Q1)
- This innovation requires considerable capital or knowledge (Code: Feasi_Q2)
- This innovation would collide with regulatory matters (Code: Feasi_Q3)

The *propensity to act* part of this framework aims to consider personal traits specific to each entrepreneur that affect their disposition to act. Among the various characteristics, this study focuses on the *ability to take risk* and the *experience* of the surveyed entrepreneurs. Ultimately, it will be used to analyze the distribution and probable tendencies in the *feasibility* and *desirability* evaluation. To measure these control variables, each respondent was asked the following questions:

- Years of experience as an entrepreneur in Belgium;
- Years of experience as an entrepreneur in the healthcare sector;
- Gender;
- Overall, I am not afraid of taking risks as a person in my life (agreement level);
- I am not afraid of taking financial risks (agreement level);
- I am not afraid of taking risks at work (agreement level);
- I am not afraid of taking risks concerning my own health and well-being (agreement level).

6.4.3. RATERS

The survey has been diffused in specific networks of Belgian entrepreneurs in HC like *Noshaq*, *Need4Health* and *Lifetech.brussels*. Additionally, numerous entrepreneurs have been contacted individually on LinkedIn. In total, 64 respondents participated in the survey.

6.4.4. SURVEY RULES

Following the revised scale of interpretation used in the previous step on the *reversibility* assessment, the *feasibility* and *desirability* criteria's averages have to be

respectively above 65% or the innovation to be qualified as implementable in Belgium from the entrepreneur point of view. The A/B testing, used to measure the potential social bias on the country of origin of a frugal innovation, requires a specific breakdown of the means per criterion and per survey.

Table 18: rules of the commercial assessment survey and its criteria – *feasibility, desirability*

Likert scale	1 Completely disagree	2 Disagree	3 Neutral	4 Agree	5 Completely agree
%	0%	25%	50%	75%	100%
Intervals	x < 50%		50% < x < 65%		65% < x
Outcome	Criteria not met		Uncertain		Criteria met

6.4.5. GENERAL PROCESS

The main objective being to assess the potential of the frugal innovation (FI) to be implemented in Belgian healthcare, respondents were asked to evaluate the opportunity through quantitative scales. After a brief introduction on the subject of the study, and the explanation of the criteria and questions, each innovation included 5 questions with a scale ranging from 1 (strongly disagree) to 5 (strongly agree) similar to 5-point Likert scale. The questions allowed the respondents to assess *desirability* and *feasibility*. At the end, participants were asked personal questions to link the results with an entrepreneur profile according to their experience and risk appetite, as well as contact details.

6.4.6. SOCIAL AND COGNITIVE BIAS RELATED TO THE COUNTRY OF ORIGIN – HYPOTHESIS 2.1.

The social and cognitive bias described in the literature suggests that one can unconsciously disregard an innovation due to its country of origin. Harris et al. (2015) argue that an innovation originating from an emerging country – e.g. Nigeria – is less likely to be attractive and diffused in a high-income country (HIC) compared to an innovation coming from another high-income country (HIC).

To investigate the *Hypothesis 2.1,* i.e. search for an actual social and cognitive bias among Belgian entrepreneurs, the A/B testing method has been used. The latter consists in randomly submitting one of the two versions of the survey with changing variables. In the framework of this study, the variable will be the country of origin – Survey A will reflect the

original country whilst Survey B will reflect a country whose perception might not be as positive as the original. For instance, an innovation originally from Australia was presented as coming from Vietnam. A subset of innovations will not be subject to this variation and will serve as control variable. The analysis to find out the bias will be done on the average variations.

6.4.7. DATA ANALYSIS AND VALIDITY

As a matter of assessing the scale reliability and internal consistency of the results, Cronbach's alpha has been selected. This coefficient alpha is relevant with the survey's design, i.e. multiple-question Likert scale, measuring potential hidden variables. The various rules on the acceptable level of reliability are alpha (α) between 0.6-0.7 and this study will consider equal or superior to 0.7 only for more robustness (Bernardi, 1994; Ercan, Yazici, Sigirli, Ediz, & Kan, 2007; George & Mallery, 2003). Alpha above 0.8 indicates a *very good level,* whereas values greater than 0.95 are subject to debate on whether they mean excellent internal consistency or possible redundancy. In order to evaluate the strength of the relationship when it comes to correlations, Cohen's standard is used (J. Cohen, 1988). The version 26 of SPSS was also used for both validity and correlation analysis with the Pearson coefficients.

Table 19 summarizes the various Cronbach's alpha tests that have been computed to measure the reliability of the various Likert scale of the survey, measuring the possible presence of latent variables by extracting a coefficient to interpret the unidimensional degree of the questions' variables.

Table 19: Cronbach's alpha analysis for the variables of the entrepreneurs' questionnaire

	***Desirability* 1 & 2**	***Feasibility* 1 & 2 & 3**	***Feasibility* 1 & 2**	***Feasibility* 2 & 3**	***Feasibility* 1 & 3**	**Risk Appetite**
Cronbach's Alpha	**.705***	.515	.312	**.632***	.219	**.814***

Based on the results displayed on the table above, considering that *desirability 1 & 2* and *risk appetite* score higher than the minimum set by George and Mallery (2003) at 70% for the Cronbach's alpha, they have been merged and treated with their average. Nonetheless, for the sake of capturing as many correlations as possible on the measured key variable, *desirability 1 & 2* are taken separately in certain statistical analysis. When it comes to *feasibility*, despite having a Cronbach's alpha close to 70% between *2 (capital/knowledge)* and *3 (regulation)*, all three sub-variables were considered separately through most analyses.

6.5. METHODOLOGY - CROSSING THE RESULTS TO ASSESS TRANSFERABILITY

In order to determine the alignment between the samples, the results of the surveys, filled by medical experts and entrepreneurs, were crossed to compare each innovation's performance on each criterion. Additionally, it allowed to describe and catch a glimpse into discrepancies and convergences. It also enabled the observation of the final *reversibility* potential level – a sum of 3 variables. Then, the results were carried back in an Excel and underwent statistical analysis through SPSS to identify potential correlations between the two surveys. While crossing the results incoming from both samples, the Hypothesis 2.2. was also tested. In fact, as the literature suggested that it is a factor that hinders the transferability of an innovation, the samples were consulted on the opinions concerning regulation.

6.5.1. ASSESSMENT OF FRUGAL INNOVATION TRANSFERABILITY (RESEARCH QUESTION 1 AND 2)

As a reminder, the R.Q.1 leading the way in this research consists in determining which innovations are frugal, reversible and can be transferred to Belgium. Additionally, the R.Q.2, which leans on the factors hindering the transferability of an innovation, has been partly addressed by the cross-analysis. While crossing the results, three variables – *reversibility*, *desirability* and *feasibility* – have been used to define the transferability of an innovation. The threshold for a FI to be considered as transferable followed the 65% limit previously mentioned. As the cross-analysis included three variables, only an innovation equal to or greater than 195% in aggregate was deemed as transferable. Furthermore, innovations scoring from 150% up to 195% were qualified as *uncertain* – in other words requiring a *refined analysis*. If the innovation scored lower than 150% in aggregate, then it was deemed not transferable to Belgian HC.

A general observation based on each innovation's scores was followed by the analysis of the numerous correlations between the components of the three variables. Among the correlations, the ones having the greatest coefficient as well as the most striking ones were used afterwards in the study, more specifically in the discussion part. In fact, some of these were crucial in order to bring an answer to the R.Q.2. The detailed analysis per innovation in to be found in the **Appendix 7.1.**

6.5.2. IMPACT OF REGULATION ON TRANSFERABILITY – HYPOTHESIS 2.2.

Several articles in the literature have mentioned the regulation as a factor hindering the *reversibility* of a FI, if not hindering the FI itself. Moreover, as HC is a sector that is highly

regulated, whether it be in HIC or LIC, this factor can be even more amplified. In order to test the validity of the hypothesis, both samples, medical experts and entrepreneurs, were asked to give their opinion about the regulatory compliance of each innovation. The variable representing the regulation was isolated in both surveys to enable the analysis of the difference of perception between the samples. Below the *compatibility* and the *feasibility* criteria, the regulation aspect was inserted as a sub-variable and thus, measured. In fact, the alignment between the medical experts and entrepreneurs on the regulation was also analyzed. Additionally, this has also allowed to measure the extent of the impact that regulation had on *compatibility* and *feasibility*.

6.6. METHODOLOGY – INTERVIEWS AND ADDITIONAL INSIGHTS

The final step of this study aims to provide further interpretation and insights on the quantitative and qualitative results of the T-HOPE, the entrepreneurs' survey and their junctions. After the elaboration of an interview guide three semi-structured interviews were conducted with three experts of innovation in healthcare (HC) in Belgium, which preferred to remain anonymous and therefore will be referred as *INT X*. The set of questions was designed in a funnel structure, exclusively composed of open questions articulated around three sub-topics on innovation in the sector. The first two topics were challenges of Belgian HC and the place of innovation in the sector. Then, the receptivity of Belgian HC to foreign innovations was discussed. And finally, frugal innovation (FI) and reverse innovation (RI) were discussed in depth through three sets of innovations communicated to each interviewee before the interview. These sets as well as the complete semi-structured interview guide can be found in **Appendix 8.1.** and **Appendix 8.2.** Each set gathered innovations deemed similar based on different factors and characteristics.

The first set is characterized by the use of technology as well as their potential post-crisis. Each component is an innovation as a process. Furthermore, the results in the Entrepreneurs questionnaire were quite similar. The second set is distinguished as the innovations were developed as a quick response to the COVID-19 crisis. Moreover, according to entrepreneurs, their *feasibility* is high, but their *desirability* is suspicious. The last set also gathers technological innovations with similar results in *desirability* and *feasibility* according to entrepreneurs. Nonetheless, each component is an innovation as a product – which renders them different than the ones in the first set.

The first interviewee – INT 1 – works as a business group leader in a major federation of healthcare companies, mostly composed of medium, large, and international companies. With more than 10 years of experience in the healthcare, both as a researcher and a professional, this interviewee is one of the references when it comes to market receptivity. In fact, his mission is to help members of the federation develop products and businesses in Belgium.

The second interviewee – INT 2 – has about 20 years of experience as an administrator in various healthcare institutions, from hospitals to healthcare networks, including the position of director in a major hospital of the country. He has been playing an important role in the diffusion of several innovations. He is also part of another committee where his task includes the elaboration of recommendations on the national healthcare for Belgian politics, as well as coordinating external audits on healthcare.

The third interviewee – INT 3 – has more than 15 years of experience in the healthcare sector. First as practitioner, he has been working in the quality management field of Belgian HC for about 10 years. He is responsible for several continuous improvement initiatives for these services, as well as supporting entrepreneurs in the diffusion of their medical innovations.

The insights shared by these interviewees were directly integrated in the discussion part to enrich the interpretation and analysis of the second and third research questions, as well as the on the hypotheses. The complete transcriptions of these interviews as well as a summary of it are to be found in **Appendix 8**

7. RESULTS AND ANALYSES

The result section is organized as follows. The first section presents the nine innovations that were assessed as *frugal* by the panels of experts. The second section presents the perceived *transferability* of said innovation by confronting the opinion of medical experts (about the *reversibility* of the innovations) with those of entrepreneurs (about *desirability* and *feasibility* of the innovations). Then, section 3 identifies the factors hindering transferability, and that emerge from the analysis. First, by looking at the samples separately to see the factors hindering the *reversibility* and the *commercial potential.* Second, a four step-analysis has been done to investigate possible information asymmetry, correlations, the so-called *origin bias* (Harris et al., 2015) and the impact of regulation as key hindering factors. Finally, a summary of the results on R.Q.1 and R.Q.2 is presented, serving as a basis for the discussion.

7.1. RESULTS & ANALYSIS – ASSESSING THE FRUGALITY

The desk researches conducted from April 2020 onwards resulted in the identification of 41 innovations as response to COVID-19, from all over the world. As developed earlier, selection rules were applied and reduced the list down to 21 innovations – considered relevant and with sufficient data. For the sake of simplicity, these innovations are all innovations as output – COVID-19 crisis required a fast reply, and the details are to be found **Appendix 3.**

The Frugal Innovation for Healthcare Identification tool (FIH-ID) has been used to assess the frugality of the 21 shortlisted innovations. The set underwent evaluation by two panels. The first one was composed of two experts in Healthcare and Frugal Innovation, yet novice users of the tool, and is referred as the MF panel – *Medical Frugal*. Simultaneously, each innovation has also been submitted to one of the two experts in HC and FI that constituted the *MF-Control* panel (MFC), who are two expert users of the FIH-ID framework. Constituting these two panels was aimed at ensuring the validity of the innovation identified as frugal, but also at observing if this theoretical tool could be used by novice users. The exhaustive results are to be found in **Appendix 4**.

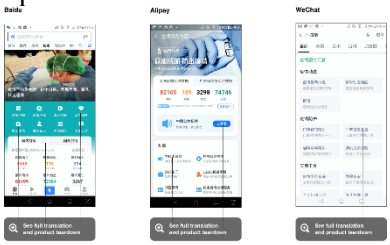
As shown in **Table 20**, four innovations have been identified as meeting all three criteria of frugality that are *affordability, adaptability and accessibility*.

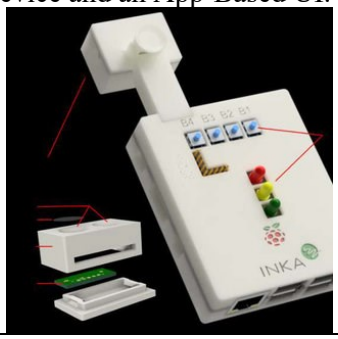
Table 20: Innovations assessed as frugal without discussion required

Name	Description	Affordability	Adaptability	Accessibility
No Hand Door Opener (Australia)	Hands-free, foot-operated door opener. Stainless steel and easy to install at the bottom. 	Care seeker provider and purchaser	At par	Potential for scalability
VentilatorPAL Pro (Netherlands)	Transforms a CPR-bag or manual resuscitator into a basic and low-cost mechanical ventilator 	Care provider and purchaser	Good- enough	Potential for scalability
Corrugated Cardboard Hospital Bed (India)	Use of disposable-recyclable corrugated cardboard beds for isolation of patient, easy to assemble. 	Care provider and purchaser	Good-enough	Potential for scalability
Laser-Cut Face Shield (India)	Reusable laser-cut face protective shields. Over a million unit produced in 2 weeks. The use of laser allows to produce faster, better and cheaper. 	Care provider and purchaser	Between at par and good-enough	Potential for scalability/ Widely accessible currently

Besides, 8 innovations went under further discussion between the two MF assessors: *5 for further discussion*, and *3 for further discussion* with regard to MFC's evaluations. The discussion was articulated around the affordability criterion for 8 innovations, and around the accessibility criterion in 3 cases. Of these 8 innovations, the 5 ones on the **Table 21** were validated, the rejected one can be found in **Appendix 4.5.**

Table 21: The validated innovations after MF discussion process

Name	**Description**	**Af/Ad /Acc**	**Affordability**	**Adaptability**	**Accessibility**
WeChat Entry Form (China)	Entry forms (e.g. drug information form) completed through the mobile application WeChat. This allows to limit contact with health workers & minimizes risks of infection, anticipate the medication needs, facilitates filtering, and optimizes the services. 	D-Y-Y **Final: Y-Y-Y**	Care seeker	Out-perform	Potential for scalability
Telehealth – example of post orthopedic surgery (Worldwide)	Through technology-aided replacement of in-person services with virtual ones, home-based physical therapy through digital tools is argued to facilitate recovery for patients, increase compliance, and ultimately optimize costs and outcomes. 	D-Y-Y **Final: Y-Y-Y**	Care seeker provider and purchaser	Between at par and good-enough	Potential for scalability/ Widely accessible currently
Hands-Free Dispenser (Tanzania)	Foot-operated, hands-free sanitizer dispenser. Made of stainless steel and easily adjustable. 	Y-Y-D **Final: Y-Y-Y**	Care seeker provider and purchaser	Between at par and good-enough	Potential for scalability

Self-Cleaning Face Mask (Israel)	USB-powered self-cleaning masks. The power coming from the USB cable goes to a heating element inside the mask which kills germs at a certain temperature. It takes 15-30 minutes to clean a mask. 	U-Y-Y **Final: Y-Y-Y**	Care seeker provider and purchaser	Between at par and out-perform	Potential for scalability
Self-Auscultation Device (Germany)	Record and classify a personalized lung function and sound baseline, then identify anomalies. Auscultation combined with advanced Signal Processing. Enables patients to monitor their lungs activity themselves through a Handheld Device and an App-Based UI. 	U-Y-D **Final: Y-Y-Y**	Care provider and purchaser	At Par	Potential for scalability

SUMMARY OF TRANSFERABILITY ASSESSMENT – MR & ENT:

Out of the 21 shortlisted, 9 innovations have been assessed as being frugal – 5 from HIC, 3 from LIC, and 1 available worldwide. This supports the assumption of several authors who argue that frugality is not a premise of emerging countries only – at least not anymore. The criterion of affordability appeared to be difficult to assess, i.e. 15,87% of agreement on the Yes before discussion. Overall, the evaluations achieve a level of Fair agreement internally, and Moderate – close to Substantial – agreement between the *Medical-Frugal and Control* (MFC) panels. The set of 9 identified FI is moving forward for assessment of their *transferability*, based on both Belgian medical experts (MR) and Belgian entrepreneurs' evaluations (ENT).

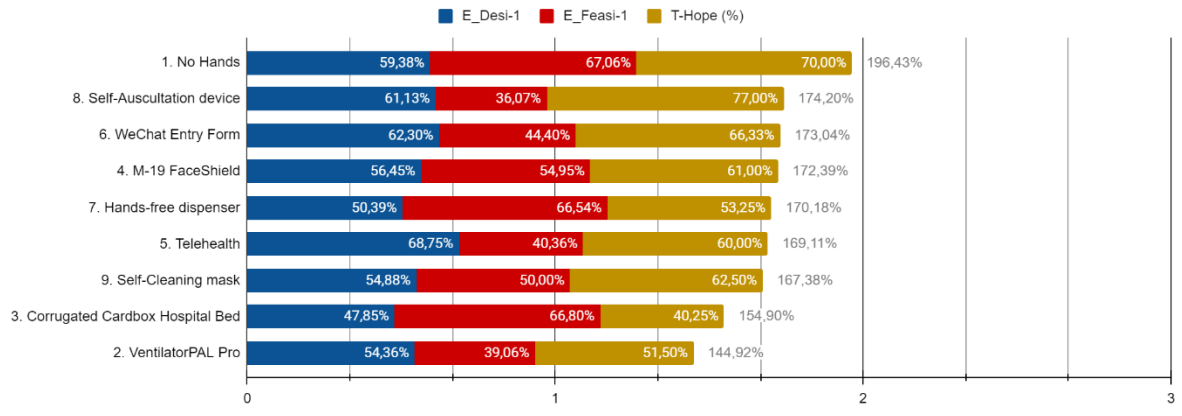
7.2. RESULTS & ANALYSIS – ASSESSING TRANSFERABILITY (RESEARCH QUESTION 1)

This section compares the results of the medical experts about reversibility (MR) and the entrepreneurs (ENT), with the goal to enrich the analysis by crossing the information from both samples. In turn, this will allow to shed a light on the R.Q.1 and R.Q.2 listed above. The former consists in a descriptive work on the innovations and their transferability in Belgian HC, testing Hypothesis 1.1. Therefore, this section first develops the outcome from the crossing of both panels' evaluations to answer R.Q.1.

The validity of the present results has been briefly exposed in the methodology and can be found in detail in **Appendix 5.3.** and **Appendix 6.3.** On the one hand, the Inter-Rater Reliability (IRR) of the *reversibility* was evaluated through the Intra-Class Correlation – ICC (2,5) – showing *fair* to *good* levels, except for *receptivity*. On the other hand, the validity of the *commercial potential* evaluations was assessed by computing Cronbach's alpha, showing high alpha between *desirability* components as well as between two out of the three components of *feasibility*.

In the framework of this research, the threshold for a variable to be *likely* is 65%. This decision is based on the results and comments from the MR panel, as well as the impact of the Likert scale on the scores of entrepreneurs' survey. This will be developed further below.

Figure 15: High-level criteria aggregated scores.



As illustrated in the **Figure 15**, out of the 9 innovations tested, the *No Hands* is the only one that can be considered as *likely to be transferable* – satisfying the R.Q.1. Moreover, the *VentilatorPAL Pro* is the only qualified as *not likely to be transferable.* On the other hand, the 6 remaining innovations are in the *uncertain* interval, and are ranging in a tiny spectrum of about 7% – this can be linked to several reasons that will be developed in the discussion.

For the sake of brevity, the section does not include the descriptions of the qualitative and quantitative evaluation for each innovation – it can be found in **Appendix 7.1.** Nevertheless, **Figure 16** and **Table 22** summarize the results of the two previous steps, i.e. *reversibility* assessment according to medical experts (T-HOPE) and the opportunity evaluation according to entrepreneurs (original survey).

Table 22: Recapitulative of innovations' scores, by decreasing order on each criterion.

	Reversibility **– Medical experts**	**Tot %**	**Perceived *Desirability* – Entrepreneurs**	**Tot %**	**Perceived *Feasibility* – Entrepreneurs**	**Tot %**
#1	8. Self-Auscultation	77.0	5. Telehealth	68,8	1. No Hands	67,1
#2	1. No Hands	70.0	6. WeChat Entry Form	62,3	3. Cardboard Beds	66,8
#3	6. WeChat Entry Form	66.3	8. Self-Auscultation	61,1	7. Hands-Free Disp.	66,5
#4	9. Self-Cleaning Mask	62,5	1. No Hands	59,4	4. M-19 Face Shield	55,0
#5	4. M-19 Face Shield	61,0	4. M-19 Face Shield	56,5	9. Self-Cleaning Mask	50,0
#6	5. Telehealth	60,0	9. Self-Cleaning Mask	54,9	6. WeChat Entry Form	44,4
#7	7. Hands-Free Disp.	53,3	2. VentilatorPAL Pro	54,4	5. Telehealth	40,4
#8	2. VentilatorPAL Pro	51,6	7. Hands-Free Disp.	50,4	2. VentilatorPAL Pro	39,1
#9	3. Cardboard Beds	40,3	3. Cardboard Beds	47,9	8. Self-Auscultation	36,1

A first observation is that the results of *reversibility* and *desirability* follow the same pattern, with the exception of *Telehealth*. Conversely, the results of *reversibility* and *feasibility* are more dispersed, with the *Corrugated Cardboard Beds* and *Hands-Free Dispenser* being in the lowest top 3 in the former and the highest top 3 in the latter.

Another interesting comparison is on the three digital innovations that are also process and/or service innovation – *Telehealth*, *Self-Auscultation Device*, and *WeChat Entry Form*. Indeed, this set of innovation scores relatively high in both *reversibility* and *desirability,* above or equal 60%. However, in terms of *feasibility*, all three innovations have poor scores below 45% which is within the rejection interval. These contrasted results will be enriched and developed with the correlations in the discussion part.

More importantly, the fact that out of the 3 innovations assessed a *reversible*, only the *No Hands* is assessed as transferable, invalidates Hypothesis 1.1.:

If an innovation is frugal and reversible in Belgium, then it would be transferable, i.e. also have a commercial potential according to entrepreneurs.

Then, the **Figure 16** displays that while *reversibility* (in yellow) and *desirability* (in blue) scores follow an alike pattern, the *feasibility* (in red) score tends to differ considerably from the two others. With the exception of *No Hands, M-19 Face Shield* and *Self-Cleaning Mask*. The correlations in the upcoming section will enrich these variations and what they represent.

The *No Hands, M-19 Face Shield* and *Self-Cleaning Mask* score along a similar range, despite the *No Hands* being the only one *likely to be transferable*.

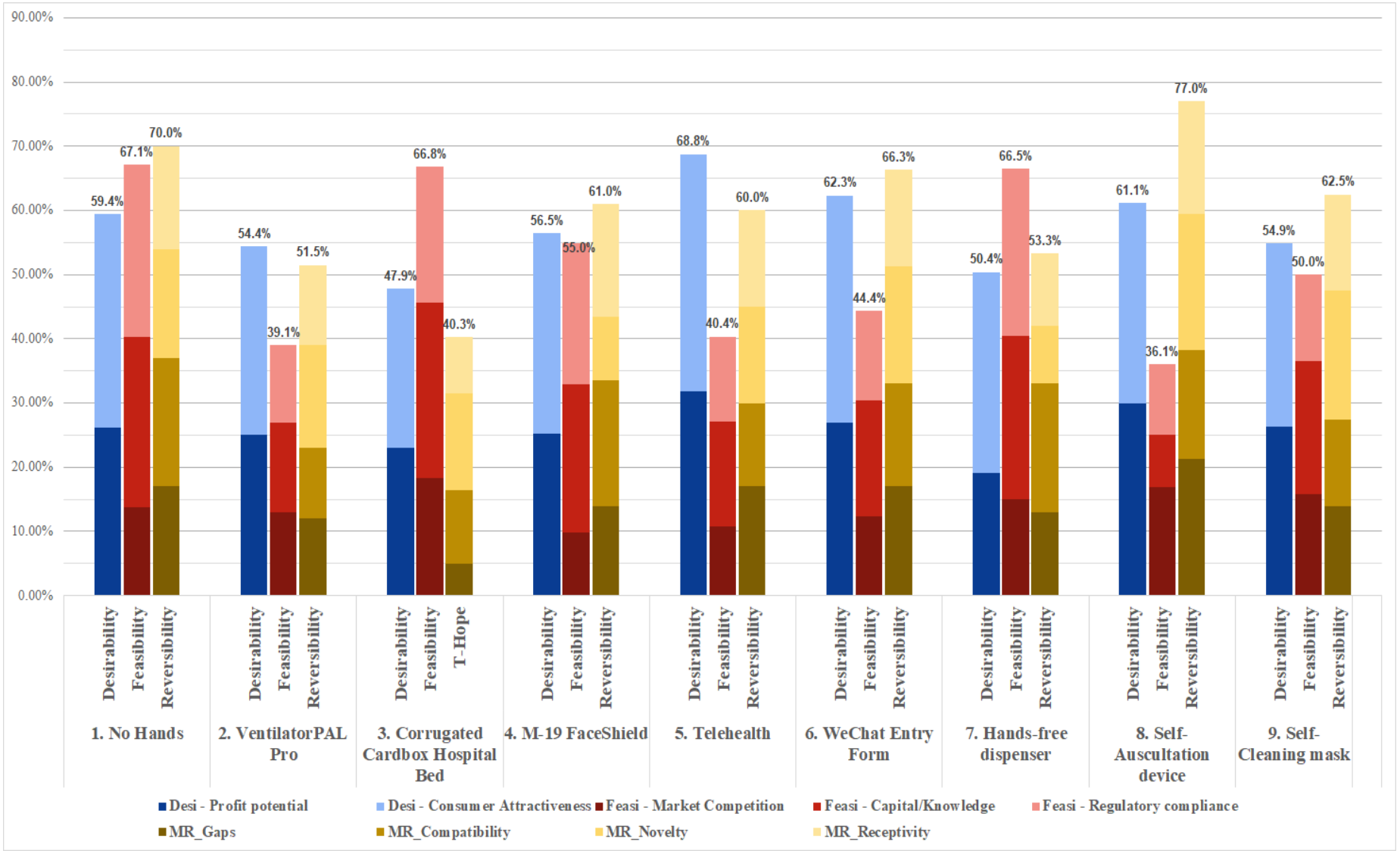
The *Corrugated Cardboard Beds* and the *Hands-Free Dispenser* results illustrate the fact that the *feasibility* is not sufficient to be transferred in a market – the market-fit is as important.

As aforementioned, the *Telehealth*, *Self-Auscultation Device*, and *WeChat Entry Form* have considerable differences – about 20% in average – between their scores in *feasibility* and their scores in *desirability* and *reversibility*. On the one hand, their scores show a high *desirability* for both entrepreneurs and for medical experts – i.e. *gap in BE HC* is high. On the other hand, these process innovations have the lowest *feasibility* rates, with low *compatibility* and *receptivity* scores.

SUMMARY OF *TRANSFERABILITY* ASSESSMENT – MR & ENT:

Overall, the *reversibility* follows the same pattern as *desirability* whereas the results are dispersed when compared to *feasibility*. As the *No Hands* is the only innovation deemed transferable, among the three judged as reversible, invalidates Hypothesis 1.1. None of the innovations is a hit nor a letdown. *Basic* innovations have a high *feasibility*, whereas the three process innovations have a *desirability* as well as *reversibility*. The correlations below will enrich this first glance on the results.

Figure 16: Recapitulative of innovations scores per criteria, with sub-criteria details



7.3. RESULTS AND ANALYSIS – FACTORS HINDERING TRANSFERABILITY (RESEARCH QUESTION 2)

To answer the second research question and explain the factors hindering the diffusion of frugal innovation in Belgium, both qualitative and quantitative data from the panels will be enriched. To do so, correlations and alignments of opinions between respondents' samples (medical experts vs. entrepreneurs) have been analyzed, along with the testing of Hypothesis 2.1. and 2.2.

7.3.1. IDENTIFYING FACTORS HINDERING THE REVERSIBILITY ACCORDING TO MEDICAL EXPERTS

For the *reversibility* assessment, each innovation has been evaluated on 4 (+1) criteria, with the original scale of the framework – T-HOPE – as in **Table 15**. In this research, none of the FI passed the *reversibility* test – above 80%, with 8 out of 9 innovations inside the theoretical *uncertainty* interval. Considering the lack of data and the novice profile of the tool's users, the decision was to divide the 50% to 80% interval to an upper and a lower half. With this distinction, the innovations below 50% were *not likely to be a RI*, between 50% to 65% were deemed *uncertain* whereas above 65% were considered *likely to be a RI*.

The recapitulative table (see **Table 22**) above displays 3 innovations within this 65% to 80% interval – the *Self-Auscultation Device* (77%), the *No Hands* (70%) and the WeChat Entry Form (66.5%). This limit of 65% serves as an intermediate level, as an innovation scoring above is considered as *likely to be reversed* – in comparison to the initial *very likely to be reversed* when above 80%. In terms of origins of the innovations, 1 innovation from a LIC is rejected, and the two other ones are within the uncertain interval, i.e. below 65%.

Looking at the sub-criteria level (**Figure 23**), a few first observations can be made. In terms of *gap in Belgian HC* and *compatibility - infrastructure*, the transferable FI – *No Hands* – and the three technological innovations – *Telehealth*, *Self-Auscultation Device*, and *WeChat Entry Form* – are scoring above or slightly below the threshold 65%. Moreover, 4 innovations score meet the *compatibility – regulation* criterion the three most *basic* ones – *No Hands*, *M-19 Face Shield*, and *Hands-free dispenser* – as well as the *WeChat Entry Form*. Then, the *novelty* scores tend to be moderate to high, with exception to the *M-19 Face Shield* and the *Hands-free dispenser.* Finally, the *receptivity* evaluations tend to be relatively low to moderate, with only the *M-19 Face Shield* and the *Self-Auscultation device* above 65%.

Beyond these results, qualitative comments have been made by the different medical experts, as they had the option to write down a *rationale* on their ratings. These comments are to be found in **Appendix 7.1.** , where both medical experts and entrepreneurs' evaluations are compared and summed up for each innovation. Besides, their comments will be used to enrich the **Table 26** in the discussion further in the research.

Moreover, the respondents were finally asked about other factors than the 4+1 criteria they were taking into account during the assessment. An additional consideration was regarding the environment, waste, decarbonation, and **more generally the sustainable development goals**. Three experts reported a high complexity in terms of *legal compliance*– illustrated with the intellectual property and the GDPR rules – and that more precise details on the FI would be required. Furthermore, two of them mentioned considerations for the user, as the adoption might require *change management* and impact the *training,* influencing the compatibility variable. Moreover, an expert mentioned several times an *IT tropism* to refer to the discrepancies in terms of openness and capabilities among HC institutions regarding technological solutions. Another referred to the *digital revolution maturity* in the sector as an important factor. Finally, two of them declared that the Belgian HC system is in a crisis, not only financially but also a ***burnout wave*** that is consistent with what has been reported by Berry (2019). The latter proposed service innovation as a way to improve the clinician's situation and HC in general, similar to **another expert reporting that healthcare has an important *humanization goal* to work on**.

To summarize, the low receptivity of the Belgian healthcare along with the limited IT capabilities of healthcare institutions seem to hinder reversibility. In addition, the high complexity of compliance from a legal perspective as well as the cost of change are to be noted. Furthermore, sustainability is reported as an emerging factor to assess the reversibility potential of an innovation. Besides, the *burnout wave*, independent from the innovation, can be explanatory. In sum, reversibility does not only depend on the characteristics of the innovation. Instead, larger structural concerns were mentioned by the medical experts to illustrate the Belgian healthcare's ability to integrate innovations.

7.3.2. IDENTIFYING FACTORS HINDERING THE COMMERCIAL POTENTIAL ACCORDING TO ENTREPRENEURS

This section presents the analyses done on the quantitative results of the entrepreneurs' evaluation on commercial potential and is structured as follows. First, the sample repartition and the results are exposed, after what a correlation analysis on these sole results is provided.

7.3.2.1. SAMPLE

The set of innovation previously assessed as frugal was presented in two randomized surveys. The A/B testing was done to investigate Hypothesis 2.1. on a potential discriminatory bias based on the country of origin. The version A displayed the original country whereas the version B displayed a false country. To illustrate, if the country of origin in version A was a HIC, then it would be changed to be a LIC in the version B. Each survey gathered 32 respondents, thus a total of 64 respondents have participated. In order to have a thorough understanding of the profiles of entrepreneurs participating, three variables – *gender*, *experience as entrepreneur* (general & in HC) and *risk aversity* – were measured. The details on the sample repartitions in line with these control variables are to be found in **Appendix 6.1.**

7.3.2.2. RESULTS FROM ENTREPRENEURS

The 65% limit defined for the *reversibility* analysis on the previous step, mostly due to the lack of data on the submitted FI, was also used for the entrepreneurs' results (see **Table 18**). As a reminder, the goal of the entrepreneurs' survey was to gather information concerning the commercial potential of each innovation. As illustrated on the recapitulative table above, the results from the entrepreneurs' survey are similar to the T-HOPE. In fact, none of the innovations scores above 80% and therefore, the same division – i.e. 50% to 65% or 65% and more – is set for the results. With regards to the Likert scale of the survey – 1: Strongly Disagree to 5: Strongly Agree, 50% represents the middle while 75% (Answer = 4) represents *Agree.* It was decided, for the sake of consistency with *reversibility* assessment, to separate this interval in half and consider the upper one as likely to meet the criteria. Thus, 50% to 65% represents *uncertainty* whereas 65% and above is *desirable / feasible.* Moreover, as for the T-HOPE analysis, a frequency report on entrepreneurs' answer for each value of the Likert scale submitted can be found in **Appendix 6.2.** The later shows that almost 80% of the answers were between 2-4, on an initial scale of 1 to 5, which has also influenced the 65% limit decision.

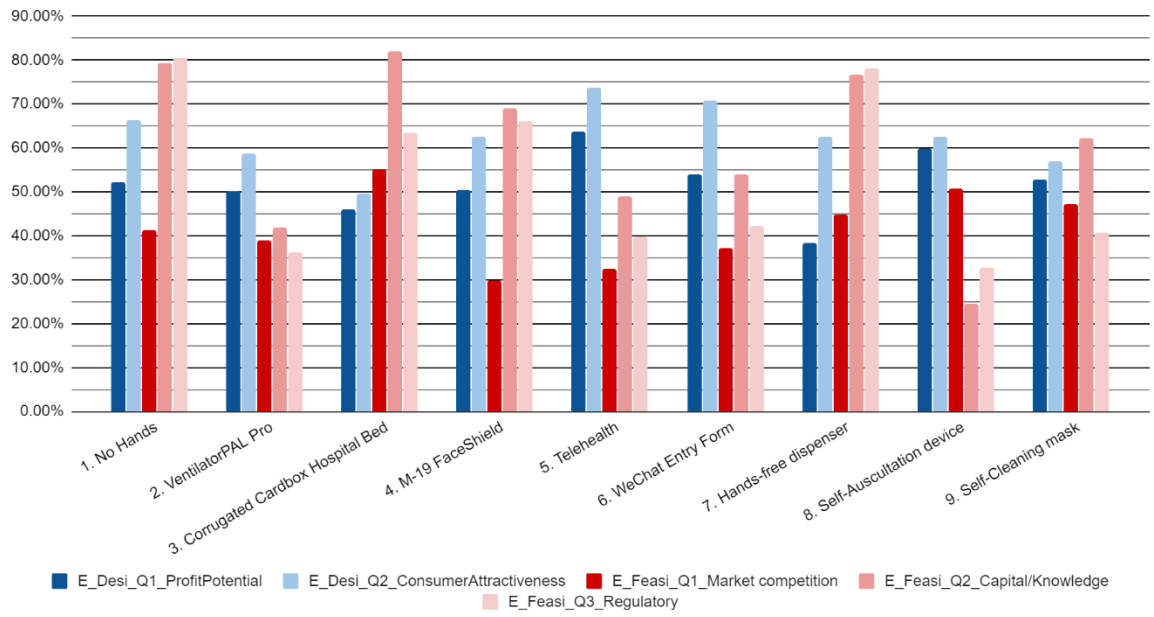
One can observe above on the recapitulative table (see **Table 22**). that the innovations with the **highest *desirability* scores are the ones representing a technological innovation, namely *Telehealth*, *WeChat Entry Form* and *Self-Auscultation Device***. Conversely, the

innovations with the highest *feasibility* scores are the most *basic* ones, i.e. innovations as a quick response to the COVID-19 crisis. These are namely *Corrugated Cardboard Beds*, *No Hands* and *Hands-Free Dispenser*. The 65% threshold is satisfied 4 times – once with the *desirability* variable and three times with the *feasibility*.

In order to have a better grasp of each variable, understanding each component forming the latter is key. As aforementioned, the entrepreneurs were asked to measure the *desirability* and *feasibility* of each innovation. In the following pages, a more thorough analysis of each component will be featured, based on figure below. Details on each innovation's score for each sub-criterion can be found in **Appendix 7.1.** , where both medical experts and entrepreneurs' evaluations are compared and summed up for each innovation.

So as to measure the *desirability*, and in line with Tumasjan et al. (2013), two affirmations – i.e. components of the variable – were presented to the participants. The first was on the *potential for profit* whereas the second one was on the *consumer attractiveness* of the given innovation. In turn, *feasibility* was measured through three different affirmations. At first, the *market competition* and the *required capital or knowledge* to develop the innovation were estimated, Tumasjan et al. (2013). At last, the *regulatory* ***compliance*** that the given innovation would face were rated, to take into account the specificities of the healthcare sector.

Figure 17: Results of *desirability* and *feasibility* per innovation



7.3.2.3. *DESIRABILITY* ACCORDING TO ENTREPRENEURS

Out of the sample composed of 9 innovations, a third was deemed relatively desirable by the participants. Indeed, only ***No Hands*, *Telehealth* and *WeChat Entry Form* scored higher than the average for both components**. One should also notice that the *Self-Auscultation Device* is almost as desirable as the latter 3 because the *consumer attractiveness* is barely 0.2% below the average. As a reminder, an innovation is considered *desirable* when the score is above 65%.

First, on the *profit potential* variable, the average of the 9 innovations for this component is slightly above half at 51.91%. The innovation that scores the lowest is the *Hands-Free Dispenser* with barely 38.28%. The latter and 3 other innovations – *VentilatorPAL Pro, Corrugated Carboard Beds* and *M-19 Face Shield* – score below average and can be qualified as laggards. The remaining ones are above average, with *Telehealth* scoring 63.67% – the highest of the sample. **The *Self-Auscultation Device* follows with 59.77% and scores considerably higher than the remaining innovations**.

Then, on the *Market Competition,* despite an average for the sample reaching 62.64%, barely 3 innovations are above it. In fact, *Telehealth* and *WeChat Entry Form* respectively score an impressive 73.83% and 70.7% alongside *No Hands*, the other innovation above the average. The *Corrugated Cardboard Beds* are deemed as unattractive from a consumer perspective with barely 49.61% – the lowest of the sample. The remaining 5 innovations score between 57% and 62.5% - rather close to the average.

7.3.2.4. FEASIBILITY ACCORDING TO ENTREPRENEURS

In spite of being laggards through the *desirability* lens, barely 2 innovations out of 9 were above average for all components. Notwithstanding their low *desirability*, *Corrugated Cardboard Beds* and *Hands-Free Dispenser* were deemed as the most feasible ones among the sample. As a reminder, an innovation is considered *feasible* when the score is above 65%

The first measure of *feasibility* was the *market competition* the average of this component is at 41.97% with 4 innovations out of 9 greater than it. According to the respondents, the *Corrugated Cardboard Beds* would be the innovation facing the greatest competition on the market with a score of 55.08%. Conversely, the laser-cut *M-19 Face Shields* and *Telehealth*, respectively scoring 29.69% and 32.42% form the innovations that would the least face competition.

Second, with 3 innovations out of 9 scoring remarkably high, the average of the *feasibility* in terms of *required capital/knowledge* reaches 59.81%. Indeed, *No Hands* at 79.3%, *Corrugated Cardboard Beds* at 82.03% and *Hands-Free Dispenser* at 76.56% catch attention compared to the *Self-Auscultation Device* scoring barely 24.61% - more than 15% lower than the second most capital/knowledge demanding innovation. One can recognize and assess its complexity as the *Self-Auscultation Device* uses a top-notch technology to operate.

Finally, the most noticeable innovations, deemed as non-colliding with regulatory matters – *regulatory compliancy* by the entrepreneurs, are *No Hands* and *Hands-Free Dispenser* which respectively score 80.47% and 78.13%. The plainness of these innovations renders them easily accessible and therefore not crashing into regulatory or sanitary standards. Once again, the *Self-Auscultation Device* scores the lowest of the sample with 32.81% – meaning that the innovation would face serious regulatory challenges according to the respondents. In general, this component has an average of 53.30%.

7.3.2.5. CORRELATION ANALYSES ON ENTREPENEURS' EVALUATIONS

In aggregate, when the whole database undergoes statistical analysis, there are correlations between the control variables – experience, risk appetite and gender – and components of both variables – *desirability* and *feasibility* – as well as correlations among the variables themselves. In other words, components of *desirability* are also correlated with components of *feasibility* and vice versa, as illustrated in the sections below. The exhaustive lists and tables of correlations can be found in **Appendix 6.4.** while the following analyses shows only the most striking and relevant ones. When it comes to the assessment of the hypothesis concerning social and cognitive bias due to the country of origin of the innovation, it is to be realized further in the study. In fact, in order to isolate the bias, the database has been treated differently.

Cohen's standard is used to evaluate the strength of the relationship. Coefficients between 0.10 and 0.29 represent a small effect size whereas coefficients between 0.30 and 0.49 represent a moderate effect size, and coefficients above 0.50 represent a large effect size (J. Cohen, 1988).

As aforementioned, at first the correlations Between *desirability*, *feasibility* and control variables were analyzed. In this segment, it appears in the results that the first component of *desirability*, i.e. *potential for profit*, is negatively correlated with 3 control variables – *experience as an entrepreneur, risk appetite* and *gender*. The former is a negative correlation

indicating a very small effect size whereas the two latter are positive and indicate a small effect size. This leads to *average desirability* being correlated with *risk appetite* and *gender* – both positive and indicating a very small effect size. Across the results on the whole database - details to be found in **Appendix 6.4.** – it turns out that there is not any significant correlation between the components of the *feasibility* variable and the control variables.

After that, the analysis focused on correlations between components of *desirability* and *feasibility*. In the results illustrated in correlation tables, numerous correlations between components of *desirability* and *feasibility* appear. First, within each variable, strong correlations that resonates with the validity analysis (see 6.4.7.) appear. Between *desirability* components, there is a large effect size coefficient (0.544); and between the second and third components of *feasibility*, namely *capital/knowledge required* and *regulatory compliance*, almost a large effect size coefficient (0.463).

Furthermore, each sub-variable of the *desirability* is negatively correlated with each sub-variable of the *feasibility*. All the correlations indicate a small effect size except the one between *consumer attractiveness* and *market competition* which indicates a moderate effect size. This eventually leads to the *average desirability* being negatively correlated with each sub-variable of *feasibility*.

In other terms, **when an innovation is deemed more desirable – profit and consumer attractiveness wise, entrepreneurs tends to consider the opportunity as less feasible**. This is consistent with the above-mentioned observation that while *reversibility* and *desirability* scores are moving hand in hand, the *feasibility* score tends to differ considerably from the two others (see **Table 22**).

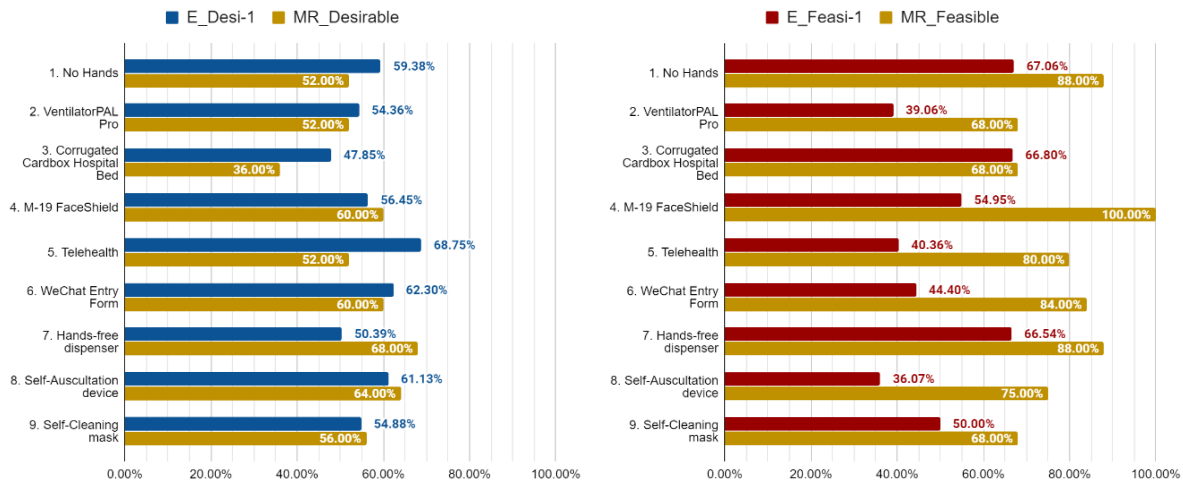
7.3.3. IDENTIFYING FACTORS HINDERING THE TRANSFERABILITY – CROSSING REVERSIBILITY AND COMMERCIAL POTENTIAL

After looking separately at the factors affecting the *reversibility* (medical experts) and the commercial potential (entrepreneurs) evaluations, crossing the two panels' evaluation enables further analysis. The following section aims to shed a light on more generalizable elements that can influence the transferability of foreign FI into Belgian HC. First with a correlation analysis, the testing of the two hindering factors from Hypothesis 2.1. and 2.2. – social bias and regulation - will follow.

7.3.3.1. ALIGNMENT

In addition to the T-HOPE criteria on *reversibility*, the experts of the MR panel were asked for each innovation to give their estimation on how entrepreneurs would evaluate the same innovations in terms of commercial potential. Indeed, each MR observer was purposely selected for also having interest and/or involvement regarding innovation and entrepreneurship. The assumption underlying this analysis is that the complexity of this sector might translate into misinformation between experts and entrepreneurs. Therefore, a comparison was made, on panels' respective aggregated scores – all components - on innovations' *desirability* and *feasibility*, and the results are displayed in the figure below.

Figure 18: Alignment on *desirability* (2 components) and *feasibility* (3 components) scores



On the *desirability* criterion, the variations are moderate with scores moving relatively similary, except for two innovation. Indeed, the *Telehealth* is deemed 16.75% more *desirable* according to entrepreneurs (in blue) than according to medical experts (MR). The *Hands-Free dispenser* shows the opposite variation, 18% more desirable from the perspective of the MR panel.

On the *feasibility* aspect, the variations are more considerable. Indeed, for all innovations, **the entrepreneurs** (in red) **assessed a lower general *feasibility* than the medical experts** (in yellow) **did** – whether it be *profit for potential* or *consumer attractiveness*. The most striking differences being for the *M-19 Face Shield* and the three technological FI – *Telehealth*, *WeChat Entry Form,* and *Self-Auscultation device.*

7.3.3.2. CORRELATIONS BETWEEN REVERSIBILITY AND COMMERCIAL POTENTIAL

It appears through the results that most of the components are correlated between themselves. The most striking ones can be found on the table below and will be used in the discussion part to try and bring clarifications about their meanings, while the exhaustive details can be found in **Appendix 7.2.** Overall, *reversibility* is closely linked with both dimensions of commercial potential, positively with *desirability* and negatively with *feasibility* as the correlations table displays.

Table 23: Main correlations between *reversibility* and *commercial potential* components

Variables	**Coefficient of correlation**	**Correlation & Effect Size**
Capital/Knowledge required & Gap in BE HC	**-0.423****	**Negative correlation & moderate effect size**
Capital/Knowledge required & Novelty	**-0.315****	**Negative correlation & moderate effect size**
Regulatory compliance & Gap in BE HC	**-0.277****	**Negative correlation & small effect size**
Regulatory compliance & Novelty	**-0.274****	**Negative correlation & small effect size**

*/** if correlation is significative

Among the highest coefficient of correlations, four sub criteria of *feasibility* and *reversibility* variables shows significant negative correlation – small to medium size effect. This should be interpreted having in mind that the *feasibility* in terms of *capital/knowledge required* and *regulatory compliancy* are closely interlinked ($\alpha = 0.632$). **In fact, the above correlations suggest that the more an innovation is considered as novel and/or answering a need in Belgian healthcare system, the less it is deemed feasible by entrepreneurs in terms of resources required and regulation**. This constitutes a considerable finding that will be partly investigated in the Hypothesis 2.2. section and enriched through the interviews in the discussion part.

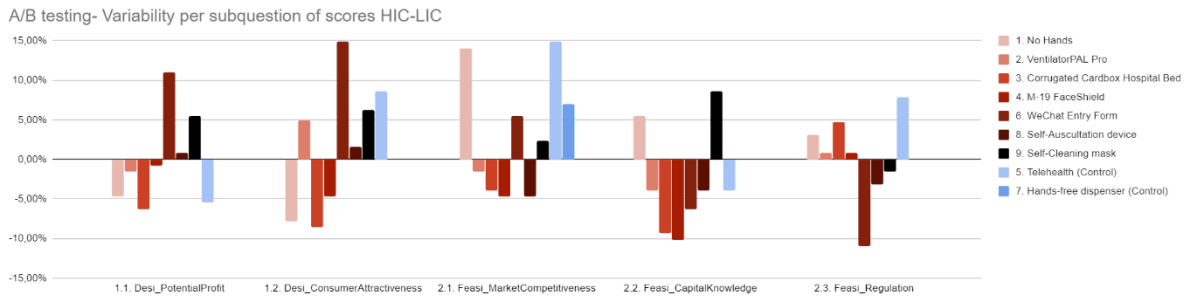
7.3.3.3. HYPOTHESIS 2.1.: BIAS ON THE ORIGIN OF THE INNOVATION

As aforementioned, to investigate the Hypothesis 2.1 according to which a social bias regarding the country of origin of a frugal innovation is hindering the diffusion and adoption, i.e. reverse innovation. To test the Belgian entrepreneurs' possible social and cognitive bias, the A/B testing method was used. The variable being the country of origin, one sample was given the original country whereas the other sample was given a country with a supposedly opposite perception to the original. For instance, for *M-19 Face Shield* – declared country in

survey A is India (LIC); declared country in survey B is Italy (HIC). This section includes 3 analyses: the comparison of the averages on the declared country, the correlations based on the evaluations of the 7 tested innovations, and the discrepancies of correlations between the answers of innovations depending on the declared country.

First, considering that through the A/B testing, the totality of respondents has not been presented the same country of origin for each innovation, the differences of average scores seemed relevant. Therefore, the figure below displays the difference of average for each sub-question and for each innovation, between the score when the declared country of origin for the same FI is a HIC and when the declared country of origin is a LIC.

Figure 19: Difference of averages when declared country



As mentioned above, two control innovations were featured and can also be traced on the chart (in blue). One can observe that the variations are not particularly remarkable, even showing the opposite result – i.e. higher results for the same variable when presented as coming from a LIC compared to presented as from a HIC – than what the presence of a social bias suggest. In fact, *Telehealth*, being a control innovation has a variation reaching almost 15% for the *market competition* component of the *feasibility* variable. Thus, the social and cognitive bias does not strike through this first layer of analysis conducted through the average differences, which is why correlations analyses were done.

Indeed, among the 9 innovations in the survey, 7 were presented as coming from either a HIC or a LIC – depending on the sample. At first, to see if there is any correlation, a statistical analysis on the 7 innovations data subset is realized through SPSS, as reported in detail in **Appendix 7.3.** It appears **that several correlations exist between both variables, *desirability* and *feasibility*, and the *actual country of origin***.

In fact, there is a significant positive small size correlation between *desirability's* both components, and *actual country of origin,* meaning that innovations from HICs have higher

scores of *desirability.* Furthermore, there is a significant negative small to medium size correlation between two components of *feasibility* and *actual country of origin,* meaning that innovations from HICs are associated with a lower level of *feasibility.* Conversely, these correlations indicate **that *desirability* decreases when the country of origin is a LIC. Moreover, the *feasibility* increases if the country of origin is a LIC.**

Nonetheless, as the innovations in the survey include 4 innovations incoming from HIC and 2 from LIC, the correlations with the variable *actual country of origin* have to be treated with caution. Therefore, they can be questioned but should not be neglected. In fact, one should bear in mind that frugal innovations are very context specific. In other words, an innovation deemed desirable or feasible in a part of the world might not be the same elsewhere. **These results display that despite a high *feasibility*, innovations from LICs can simply be less desirable – independently from a discriminatory bias based on the country of origin.**

Finally, as this layer of analysis is not conclusive in the quest of finding a social and cognitive bias, another step of analysis to analyze the data more thoroughly is to be realized. In this step, the results in the database will be split in 3. The first subset will gather the answer of 32 respondents having perceived the 7 innovations as incoming from a HIC. The second one will collect the answer of the remaining 32 respondents having been presented the 7 innovations as incoming from a LIC. Finally, a third one will gather the answers of all 64 respondents for the 2 control innovations. The ultimate goal is to isolate the specific differences in correlations with a more thorough look at the data when the innovations are declared as coming from a High- versus Low- Income country. With 3 separate sets of data, a comparison between the correlations among the variables in the latter is expected to shed light on an eventual social and cognitive bias. For the sake of simplicity, all suitable correlations will be presented in the **Table 24** below.

Table 24: Recapitulative table on correlations comparison between HIC, LIC, CTRL sets

Variables	**HIC**	**LIC**	**CTRL**	**Correlation & Effect Size***
Potential for Profit *(*Desi_Q1*)* **&** ***Risk Appetite***	0.131*	0.109	0.072	Positive correlation and small effect size (HIC)
Potential for Profit *(*Desi_Q1*)* **&** ***Gender***	0.168*	0.080	0.078	Positive correlation and small effect size (HIC)

Potential for Profit *(*Desi_Q1*)* ***&*** ***Actual Country of Origin***	0.150*	0.046	N/A	Positive correlation and small effect size (HIC)
Consumer Attractiveness *(*Desi_Q2*)* ***&*** ***Actual Country of Origin***	0.177*	0.029	N/A	Positive correlation and small effect size (HIC)
Average Desirability ***&*** ***Actual Country of Origin***	0.186*	0.042	N/A	Positive correlation and small effect size (HIC)
Capital/knowledge Required (Feasi_Q2) ***&*** ***Actual Country of Origin***	-0.275**	-0.429**	N/A	Negative correlation and small effect size (HIC) Negative correlation and moderate effect size (LIC)
Regulatory compliance (Feasi_Q3) ***&*** ***Actual Country of Origin***	-0.295**	-0.225**	N/A	Negative correlation and small effect size (HIC) Negative correlation and small effect size (LIC)

*/** if correlation is significative

It appears through the results that several correlations, as listed above, exist. In the HIC data, significant correlations between the *desirability* components and control variables exist. Yet, neither the LIC nor the CTRL data displays any significant correlations for the same variables. Therefore, they should be treated with caution. Besides, though other correlations with the *actual country of origin* variable do exist, the correlations with this variable should be treated carefully. Indeed, the A/B tested innovation incorporates 5 FI from HIC and 2 FI from LIC, and these innovations are very different from each other. Nonetheless, there still is a difference in the correlation when the 7 innovations are under HIC or LIC declared countries. For instance, *desirability components* have higher positive correlations when FI are declared as originating from HICs, and that could reflect an indirect bias – for instance, a correlation between *risk appetite* and *higher desirability* that only exists if the innovation if declared as coming from a HIC. However, the variations of the last 2 negative correlations are not similar. Indeed, *capital/knowledge required* has a considerably higher negative correlation with *actual country of origin* for innovation presented as originating from LIC than from HIC. On the other hand, *regulatory* ***compliance*** has a lower correlation when *actual country of origin* is LIC. Therefore, the fact that the results are heterogeneous prevent them to be interpreted as reflecting the social and cognitive bias on the country of origin.

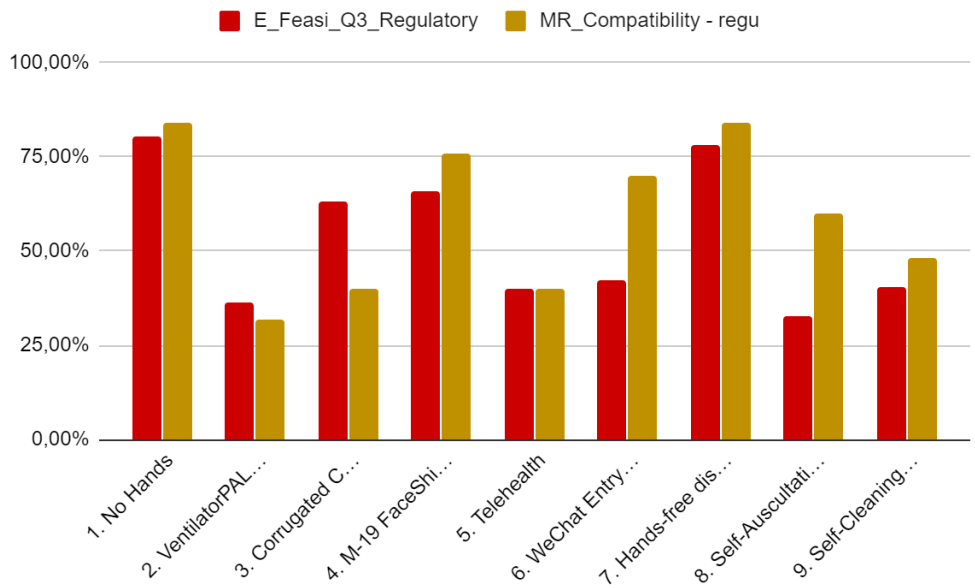
Overall, despite the literature confidently affirming the existence of a social and cognitive bias, **the correlations did not give noticeable evidences that would confirm the existence of a direct bias effect**. Therefore, the Hypothesis 2.1. is rejected.

7.3.3.4. HYPOTHESIS 2.2.: REGULATION HINDERING REVERSE INNOVATION

As developed earlier, some of the tested frugal innovations have contrasted scores. Sometimes *desirability* and *reversibility* are high whereas *feasibility* is low. The literature (Friebe, 2017), and some explanations from the experts, suggest that a major barrier to successfully transfer a FI in a HIC is the regulatory aspect. To see if that applies to the Belgian HC sector, this section investigates whether there is an alignment between the two panels' perception on the regulatory compliance variable. Additionally, the extent of the impact that regulation has on the *feasibility* and *reversibility* will be analyzed.

First, owing to the fact that the literature considered regulation as an important factor hindering FI to be reversed and implemented in a HIC, both the medical experts and entrepreneurs were consulted on regulation. In fact, the variable representing the regulation was isolated in both surveys in order to analyze the differences in the results with and without the regulatory aspect. This was firstly done based on the assumption that entrepreneurs and medical experts may have not access to the same knowledge regarding regulation *feasibility/compatibility*. The figure below illustrates *regulation* variable in both panels, isolated from other components.

Figure 20: Respective evaluations of the regulatory compliance variable



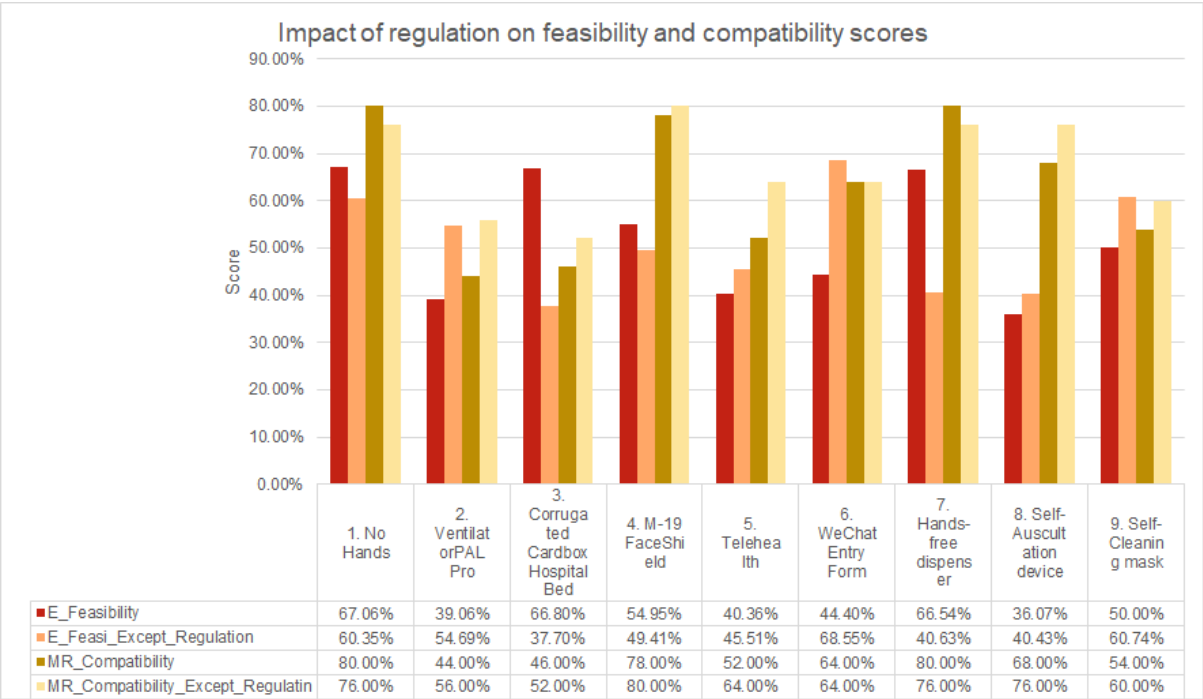
The results of entrepreneurs and medical experts are mostly alike. Nonetheless, it seems reasonable to note that there are relatively substantial variations for *Corrugated Carboard Beds*, *WeChat Entry Form* and *Self-Auscultation Device*. **The former is deemed more feasible according to entrepreneurs, regulatory wise, whereas the latter two are deemed more feasible according to medical experts.**

In addition to that, the *regulatory* ***compliance*** component of *feasibility* has a correlation of barely 0.110 with *regulatory compatibility* component of *reversibility*. Despite a significant positive correlation, the coefficient of correlation indicates a small effect size. In other words, this means that if an entrepreneur believes an innovation would collide with regulation, the chances that a medical expert agrees are greater.

As the results incoming from the figure above only allow to measure the alignment of entrepreneurs and medical experts concerning *regulation*, a more thorough look in the data is required to have more insights to discuss about the Hypothesis 2.2. Thus, below, a comparison of the results of *feasibility* with the isolated *regulation* variable has been realized.

Indeed, looking at the impact of regulation on *reversibility* and *feasibility*, the figure below displays the impact that the *regulation* component has on for each sample, namely medical experts and entrepreneurs. To do so, the *feasibility* and *compatibility* variables scores are displayed with and without the sub-criterion on regulation.

Figure 21: Impact of the isolated *regulation* variable on *compatibility* and *feasibility*



	1. No Hands	2. VentilatorPAL Pro	3. Corrugated Cardbox Hospital Bed	4. M-19 FaceShield	5. Telehealth	6. WeChat Entry Form	7. Hands-free dispenser	8. Self-Auscultation device	9. Self-Cleaning mask
E_Feasibility	67.06%	39.06%	66.80%	54.95%	40.36%	44.40%	66.54%	36.07%	50.00%
E_Feasi_Except_Regulation	60.35%	54.69%	37.70%	49.41%	45.51%	68.55%	40.63%	40.43%	60.74%
MR_Compatibility	80.00%	44.00%	46.00%	78.00%	52.00%	64.00%	80.00%	68.00%	54.00%
MR_Compatibility_Except_Regulatin	76.00%	56.00%	52.00%	80.00%	64.00%	64.00%	76.00%	76.00%	60.00%

On the entrepreneurs' side, when *regulation* component is isolated, *feasibility* tends to increase for technological innovations which are *VentilatorPAL Pro, Telehealth WeChat Entry Form, Self-Auscultation Device* and finally *Self-Cleaning Mask.* Other innovations such as *Corrugated Cardboard Beds* and *Hands-Free Dispenser* see their *feasibility* plummet when the *regulation* aspect is isolated.

Furthermore, the correlations bring an additional perspective on this matter. In fact, the *regulatory compliancy* component of the *feasibility* has a significant positive correlation with *capital/knowledge required*. The coefficient of correlation is 0.463 indicating an almost large but yet moderate effect size, which is consistent with the high Cronbach's alpha computed at 63.2%. This can, among many other things, imply that if an innovation requires more capital and knowledge – thus, is a technological innovation – then, there are more chances that this innovation would collide with regulatory matters. The latter is supported by the negative correlation between *novelty* and *regulatory compliancy*, with a coefficient of correlation of -0.274 indicating a small effect size.

From the medical experts' perspective, the pattern is quite similar – technological innovations' *feasibility* increases when the *regulatory compatibility* component is isolated. Except the *Corrugated Cardboard Beds*, the remaining innovations follow the same pattern, i.e. increase or decrease similarly to entrepreneurs' side.

Moreover, as for the entrepreneurs, the correlations bring another perspective. The components of *compatibility*, namely *regulatory compatibility* and *infrastructure compatibility* have a significant positive correlation with a coefficient of correlation of 0.835 indicating a large effect size. Even though the validity of this correlation does not meet the minimum sample of answers (N=60), this coefficient is consistent with the other results. This means, among others, **that if a medical expert estimates that an innovation would be compatible with the Belgian HC infrastructure, there are more chances that the innovation would be compatible with the regulation.**

Indeed, the literature argued that regulation in a HIC can be a major setback for reversing and implementing FI. Be that as it may, based on the figure above, the impact of regulation on the *feasibility* is mixed. On the one hand, technological innovations see their *feasibility* increase with the *regulation* isolated. On the other hand, the results of innovations as a quick response to the COVID-19 crisis are mixed. For instance, *No Hands* and *Hands-Free Dispenser* see their *feasibility* decrease whereas, it increases for the *M-19 Face Shield*,

Self-Cleaning Mask and *VentilatorPAL Pro*. Both entrepreneurs and medical experts seem aligned on the impact of regulation. In addition, the correlation between the *regulatory compliancy* with capital/knowledge *required* supports the fact that technological innovations would collide with regulatory matters.

This analysis shows that, at least for this set of innovation, **the *reversibility* of a frugal innovation in Belgian healthcare is not as hindered by the regulation as thought when emitting the Hypothesis 2.2.** Indeed, besides a few misperceptions between the two panels on it, the isolated effect of regulatory *feasibility/compatibility* is surprisingly contrasted and depends for each innovation. Conversely, it is the criterion that gathered the most comments from the experts, showing concerns and describing a certain complexity on this critical area. Finally, these results have to be considered while bearing in mind the fact the regulatory variable is closely linked with other criteria. For instance, the *knowledge/capital required* and *regulatory compliancy* components of *feasibility* having a relatively high Cronbach's alpha at 63.2%.

7.4. SUMMARY OF RESULTS

Crossing the evaluations of medical experts and entrepreneurs on several levels provided precious insights. Concerning the first research question, only one innovation passes the threshold. The *No Hands* is slightly above the minimum set to be considered as *likely* to be transferable.

Then, the investigation of the second research question, namely factors hindering the transferability of a FI, shed a light on several relations between the criteria submitted to the panels. The *desirability* and the *reversibility* levels are consistent with each other. Whereas the *feasibility* scores tend to vary in an opposite way to the latter two, around the 50% mean, which is supported by a number of moderate effect sized correlations. **Moreover, there is a significant misalignment in the perception of *feasibility* between medical experts and entrepreneurs, the latter scoring lower levels of this variable – especially on technological frugal innovations**.

In order to enrich these findings and explore to what extent the identified factors relate to broader dynamics in Belgian healthcare and elsewhere, the discussion part will enable confrontation between findings to the existent literature as well as to the opinions of the experts from the field, i.e. interviewees.

8. Discussion

Based on the literature, a number of factors were presumed to be hindering the transferability of an innovation. In the research, these factors are explored by compiling and comparing the evaluations of the Belgian medical experts and entrepreneurs, which led to interesting insights to answer both R.Q.1 and R.Q.2. The answers to the first one and Hypothesis 1.1. were quite straight forward. Conversely, the second research question required to dig into each panel separately. Thereafter, the insights acquired enable to bring an answer to a closing question at the light of the literature enriched with additional experts' opinions.

8.1. RESEARCH QUESTION #1

8.1.1. FINDING FRUGAL INNOVATIONS AS A RESPONSE TO COVID-19

As stated in the beginning of this study, the research is focused on the *innovation in the making* area and the first step served as a basis for practical part. The set of 42 innovations as a response to COVID-19 – initially determined then reduced to 21 meeting the selection rules set – represents only a minimal portion of what has been developed around the globe. However, its diversity, in terms of variants and origins, is already insightful. In fact, innovations like *Thermal Drones Screening* or *3D printed Face Shields* are consistent with the repurpose, reuse and rapid deployment forms of response described by Harris et al. (2020). The overrepresentation of HICs' innovations can be explained by data and personal constraints. Indeed, publications in English and French were prioritized for the sake of simplicity. Furthermore, the list of innovation shows that COVID-19 crisis naturally triggered international collaboration – from grassroots innovators to multinational corporations. For instance, the shortlisted set includes several open source innovations which are a form of open innovation. Indeed, multiple internal and external stakeholders are collaborating and sharing knowledge in the innovation process (Chesbrough, 2003). Despite the tragic side of this crisis, the efficiency and relevancy of the OI paradigm has been witnessed (Gabriel, Stanley, & Saunders, 2017). In the framework of this study, the rapidity of internal innovation processes and expansion of each innovation's market potential to an international level stood out. Moreover, COVID-19 created resource-constrained settings, with consequences like individual mobility restrictions that has led to the emergence of innovations such as *Telehealth* and *WeChat Entry* that were, until then, unconceivable solutions in many developed countries.

The methodology used to assess the frugality was the last suggested version of the FIH-ID tool of Prime (2017), adapted to the context of the study with the addition of a Medical-

Frugal-Control (MFC) panel, composed of experts users of the framework. One of the MF assessors reported the difficulty to evaluate the affordability criterion, due to *limited cost-effectiveness data*, making it harder to classify an innovation as frugal. Nonetheless, Dr. Prime affirmed that "*unclear" might be due to the lack of data. Note that the context being the fresh and recent COVID-19, the goal is to assess the potential of frugality*. Dr. Prime also stated that when assessing frugality, *adaptability and accessibility are the key components for potentiality, and affordability is the confirmatory step*, which backs the reliability of the results along with the use of a control panel and stricter rules.

To conclude, out of the 21 innovations submitted, 9 were assessed as frugal, 11 as uncertain and 1 was rejected. The mixed origins of the 9 FI – 5 from HICs and 3 from LICs – is an additional observation supporting the literature idea that FI is a relevant paradigm for both developing and developed countries. In other words, frugality already exists in HIC.

8.1.2. ASSESSING TRANSFERABILITY OF FRUGAL INNOVATIONS IN BELGIAN HEALTHCARE

R.Q.1. <u>Which innovations</u> linked to the COVID-19 crisis are frugal, reversible & can be <u>transferred to Belgian healthcare market</u>?

The *No Hands* innovation is the only one exceeding the 65% limit to be considered as *likely to be transferable* into Belgian HC. The *No Hand*s is a foot-operated stainless-steel door opener (see **Table 20**) with application beyond the sole HC sector. While the scores on *reversibility* and *feasibility* are above 65%, it is important to note that its *desirability* criterion is rather moderate with 59.4%. One of the medical experts questioned its relevance by reporting that there are different types of doors in different hospitals – similar to the comment given by the first interviewee. Another concern was about the low *receptivity* criterion, as an expert brought up that behavioral changes and safety matters must be taken in account. Altogether, it turns out that the aggregate score makes it theoretically *likely to be transferred*, despite the sub-criteria that could hinder the implementation in practice. On the other hand, as it can have other applications than in the limited sector of HC, this innovation could be relevant in other markets. In conclusion, this example **demonstrates that reverse innovations are both market and context specific, and one can wonder what the *desirability*, *feasibility* and *reversibility* levels without the COVID-19 crisis would be.** The fact that it is a relatively simple innovation, with possible applications in other sectors and markets, is likely to impact positively the global potential of the *No Hands* innovation.

The strategy to answer R.Q.1 was similar to the entrepreneurial way to test opportunities regarding potential consumer – akin to the *lean start-up* approach. Each innovation assessed as frugal served as a possible value proposition, while the two stakeholders evaluating it were the potential supplier and customer. The latter is to be nuanced as the medical experts are neither customers as such nor the decision-makers. Yet, their thorough knowledge was deemed sufficient for them to assess decently. Overall, this sequential methodology follows a logical sequence for opportunity evaluation. Conversely, applying it to the complex and highly heterogenous sector of HC tends to reduce the accuracy of the results, possibly overlooking a gap between the theoretical and practical transferability of the FI.

8.1.3. COMMERCIAL POTENTIAL BASED ON FRUGALITY AND REVERSIBILITY – HYPOTHESIS 1.1.

The R.Q.1 included an underlying assumption, based on the literature, that an innovation assessed as frugal and reversible has, theoretically, a *commercial potential* to be transferred in a market. Hypothesis 1.1. brings the perspective of the entrepreneurs – key actors in the diffusion and adoption of an innovation.

Hypothesis 1.1. ***If an innovation is frugal and reversible in Belgium, then it would be transferable, i.e. also have a commercial potential according to entrepreneurs.***

Three innovations have successfully passed both the frugality and *reversibility* assessments – *No Hands, Telehealth,* and *Self-Auscultation Device*. While the latter two scored a high *desirability*, their *feasibility* scores were among the worst. In other words, despite being ***frugal*** and ***reversible***, an innovation can be not transferred due to other factors such as regulation. The Hypothesis 1.1. can be invalidated with this observation. One of the main reasons is that these types of innovations initially arose from context-specific and resource-constrained environments. The chosen FI share the similar global context – COVID-19 – but disparities in countries' HC systems, cultures and receptivity to innovation remain a substantial factor. The **frugal innovations as a quick response to a crisis often also exist in different forms in Belgium and other high-income countries**. For instance, Spentys' *3D printed Face Shields (Belgium)* can remind the *Laser-Cut Face Shields (India)*. Moreover, Y. Bhatti et al. (2017) argue that developed counties tend to start innovating from a technology and then find a need – especially in healthcare. Instead, one should be starting with a need and look across industries to find the most cost-effective technologies to transfer in the development of the innovation. This limitation is backed by all three interviewees, describing Belgian HC as aiming for technological progress above all. INT 3 illustrated by saying that simpler

innovations answering the same need, such as the *Hands-Free sanitizer,* could not be successful without having esthetical adjustments such as *plastic cover, improved design or color choice.* This pattern can remind the concept of *design thinking* where the end user is considered as a crucial stakeholder from the beginning (Kolko, 2015; Simula et al., 2015). Overall, this displays the importance of the role of entrepreneurs in the diffusion and adoption process, as they are the ones tasked to adapt the frugal innovation to the expectations in their home market.

8.2. RESEARCH QUESTION #2

The assessments made by the panels of experts allow to take a closer look to factors hindering the transferability of FI in Belgian HC. The analysis of the sub-criteria as well as other statistical analyses enabled to identify substantial correlations on top of the testing of Hypothesis 2.1. and 2.2. as possible barriers to FI diffusion.

R.Q.2. What are the reasons hindering the transfer of innovations qualified as *frugal & reversible* or as *frugal & with commercial potential*, in Belgium?

8.2.1. FACTORS HINDERING REVERSIBILITY - MEDICAL EXPERTS PERSPECTIVE

The second step of the T-HOPE is articulated around four criteria – *gap in target HIC, compatibility, novelty* and *receptivity*. The scale of interpretation has been adapted to the present study, with the threshold of 65% being considered as *likely to be reversible.* With this condition, three FI are judged *likely* to be reversible in Belgium. These are the *Self-Auscultation Device*, *No Hands* and the *WeChat Entry Form*.

Figure 22: The *Self-Auscultation Device*

Altogether, except the *Corrugated Cardboard Beds*, all innovations scored above 50%. The ones below 65% are mostly composed of innovations that have emerged as an immediate response to COVID-19. This type of innovation has also appeared in Belgium and one can assume that in times of crisis, stakeholders would tend to look on a national level rather than trying to reverse frugal innovations emerging elsewhere.

Taken separately, the results of the assessment have shown three significant observations. First, *receptivity* scores were relatively low, which can give a on the sector's receptiveness. Then, **the *compatibility – regulation* variable had low levels on innovations like the *VentilatorPAL Pro* – displaying that *risky* and *intrusive* innovations are subject to more regulation.** This has been confirmed by the INT 1 and 2 who developed the various categories and level of regulation an innovation would face. Finally, the three technological innovations scored the highest scores in *gap in Belgian HC*, backing up the literature reporting that HICs would rather innovate around a technology than a need. Technology could mean higher costs, but a frugal adaptation of an existing technology can be fruitful – such as *Telehealth* or *WeChat Entry*.

As pointed out by the INT 3 as well as medical experts, these lower *receptivity* and *compatibility* levels can be explained by the less commercial nature of the technological innovations – i.e. lower income for healthcare institutions. The INT 2 stressed the strong resistance to digital transformation incoming from various stakeholders in the sector. **An expert referred to this as an *IT tropism* – i.e. fear of change**. Nonetheless, the literature argues the necessity to embrace IT as sufficient digital maturity is reached and risks are lower (Le Bas, 2016). In fact, as pointed out by INT 2, digital literacy is widespread, and the majority of the patients could easily accept digitalization.

8.2.2. FACTORS HINDERING COMMERCIAL POTENTIAL – ENTREPRENEURS PERSPECTIVE

Entrepreneurs play a major role in the diffusion of innovations. Therefore, Belgian entrepreneurs were approached to acquire insights about the *desirability* as well as the *feasibility* of each determined innovation. In total, 64 respondents participated in the survey through which, additionally, an A/B testing to isolate a social and cognitive bias was conducted.

The results were quite similar to the T-HOPE results as none of the innovations scored above 80%. Thus, the same division, i.e. 50% to 65% or 65% and more, respectively meaning

uncertain and *desirable* or *feasible*, was set. In the survey, each sub-criterion was measured through an answer on a scale from 1 to 5. As up to 80% of the total answers were between 2 and 4 and led to 6 innovations qualified as *uncertain*, one can question the relevance of the Likert scale used in the survey. While 8 out of 9 innovations scored above 50% in terms of *desirability*, only 4 were above 50% in terms of *feasibility* in addition to the *Self-Cleaning Mask* scoring barely 50%. Thus, the results are mitigated as none of the innovations scores above 130% in aggregate.

Furthermore, when taken separately, two main observations appear. First, two sub-variables of *feasibility* are overlapping with a correlation of 0.463. In other words, **when an innovation faces more *regulatory* barriers, the *capital and knowledge required* tends to increase and vice versa**. Then, despite the lack of a striking correlation among their sub-variables, *feasibility* and *desirability* are negatively correlated. In fact, INT 3 explained this duality by affirming *numerous good innovations, frugal or not, […] that are desirable, but not feasible due to regulation and reimbursement rules*.

As aforementioned, in times of crisis, stakeholders prefer searching for national innovations due to, notably, time constraint. In addition to the Likert scale limitation, one can also bear in mind that in order to become a reverse innovation, the initial frugal innovation may sometimes require adjustments – usually done by entrepreneurs. Alongside being context specific, other barriers such as the market fit and regulation do exist. These were mentioned by the INT 1 as he affirmed that, on the one hand, despite high *feasibility*, if an innovation does not fit the market, then it isn'would not be implemented. On the other hand, despite high *desirability*, an innovation can collide with regulatory standards.

In conclusion, the data collected through 64 respondents displayed that there are many factors which are intertwined in the diffusion and adoption of a foreign frugal innovation in Belgium. The results were quite plain as none of the innovations was a hit nor a complete letdown. Different **organizations are working closely to create a friendly environment that could allow reverse innovation to occur more easily**. However, the conservatism and the desire to keep the status quo still constitute a barrier. As Wood and Williams (2014) assert, opportunities can often be under-exploited while the resources are under-employed by entrepreneurs. Thus, resource efficiency can be used in addition to *desirability* and *feasibility* when evaluating potential opportunities. Going back to the literature, the concept of *absorptive capacity* of the organization (W. M. Cohen & Levinthal,

1990) and its impact in the reversibility of a frugal innovation could be an interesting avenue for future researches. Moreover, as revealed by Zahra and George (2002), an organization's *absorptive capacity* can be a primary source of creating and sustaining a competitive advantage. In this case, trying to get a hold on how entrepreneurs can nurture *absorptive capacity* (W. M. Cohen & Levinthal, 1990) can be fruitful for further researches.

8.2.3. FACTORS HINDERING THE TRANSFERABILITY – CROSSING THE TWO RESULTS

Four aspects have been explored to identify barriers to FI diffusion in Belgian HC – an alignment between medical experts and entrepreneurs regarding an innovation, a correlation analysis, an examination of a social bias regarding the country of origin and the focus on the regulation. For the untransferable innovations, a brief discussion can be found **Appendix 7.1.**

8.2.3.1. ALIGNMENT AND INFORMATION ASYMMETRY

While evaluations on *desirability* tended to be consistent between the two panels, the *feasibility* scores showed significant discrepancies, and the level of agreement of the MR panel on *feasibility* was *fair/good*. For all the submitted innovations, entrepreneurs assessed considerably lower *feasibility* levels than medical experts – especially on the three technological FI. It is consistent with the role played by the medical experts and the interviewees who share knowledge to guide entrepreneurs in HC A better communication on what is needed and transferable according to medical expert with entrepreneurs could raise the perceived *desirability* and *feasibility*. This might display the complexity when innovating in Belgium, backed up by INT 2 and 3 affirming that **it is easier for a Belgian entrepreneur in healthcare to target neighboring countries first, and then come back to Belgium**. In a nutshell, the complexity requires thorough understanding of the HC system and thus, can hinder innovation.

8.2.3.2. CORRELATIONS BETWEEN REVERSIBILITY, DESIRABILITY AND FEASIBILITY

Potential for profit and *consumer attractiveness* both have a significant positive correlation with *reversibility*, with respectively, 0.154 and 0.142 as coefficient. On the other hand, *capital/knowledge required,* and *regulatory compliance* have a significant negative correlation with *reversibility*, with respectively, -0.350 and -0.232 as coefficient.

In other words, this means that an innovation deemed more desirable by entrepreneurs would be more reversible according to medical experts. The correlations display that both

potential for profit and *consumer attractiveness* are positively correlated with the *gap in Belgian HC* and *receptivity* – two of the sub-criteria of *reversibility*. In fact, this goes along with the idea that **if an innovation is to fill a gap in the Belgian HC, with a good receptivity, there are more chances that the innovation would generate profit as well as attracting customers**. In addition, the robustness of the T-HOPE is displayed through these correlations.

Besides, this means that technological innovations which require more capital and knowledge, thus, more likely to collide with regulation at first glance, would be less reversible according to medical experts. The most striking correlations *capital/knowledge required* has is with *gap in Belgian HC, novelty* and *receptivity* with respectively -0.423, -0.315 and -0.299. In turn, *regulatory* ***compliance*** has significant negative correlations with *gap in Belgian HC* and *novelty* with respectively -0.277 and -0.274. That is to say, paradoxically with the *desirability*, **an innovation that would bring novelty and fill a gap in Belgian HC according to medical experts would be less feasible according to entrepreneurs.**

In a nutshell, the results show that if an innovation is desirable, then it has more chances to be reversible. Yet, when an innovation is feasible, then it has less chances to be reversible. In other words, as a FI is context specific, despite its *feasibility*, it might not be relevant to transfer it – the market fit is crucial as mentioned by the interviewees. One of the limitations of this study is that the MR panel was short of 2 additional experts who would have allowed to realize internal correlations for the *reversibility* results. In turn, this could have provided another evidence on the fact that when an innovation is more desirable, or less feasible, it is more reversible.

8.2.3.3. BIAS ON THE ORIGIN – HYPOTHESIS 2.1.

The multinational companies challenging the assumption that products intended to be sold on LICs were not good-enough to compete in HICs are at the very origin of RI (Immelt et al., 2009). Nonetheless, the literature affirms that innovation coming from LICs face social judgments and suffer of a negative image that hinders their *reversibility* (Harris et al., 2015).

Hypothesis 2.1. The emergence of reverse innovation is hindered due to a social and cognitive bias on the country of origin.

This study investigated, through an A/B testing in the entrepreneurs' survey, whether the bias on the country of origin was present among Belgian entrepreneurs in HC. The tested

variable was the country of origin declared in each FI's description. Each one of the surveys included the same questions with one displaying the actual country of origin whereas the other displayed a country deemed opposite to the original one. For instance, Australia became Vietnam. This manipulation was a deliberate choice, as it was considered being one of the simplest ways to trigger the potential social bias. While 7 innovations were tested, 2 served as control with the sample groups equally and randomly split.

As the difference in the average of both surveys was not conclusive, two additional layers of analysis were conducted. On the one hand, correlations linked to declared country of origin were examined. On the other hand, a restructuration of the data into 3 subsets – *originating from HIC*, *originating from LIC* and *control* – was realized to infer potential insights. Nonetheless, none was convincing as the correlations were insignificant or indicated small effect size.

Despite the bias suggested by the literature, averages and correlations have shown otherwise – at least in Belgium and in the framework of the research. The results were exposed during the interviews, to try and understand whether a bias does exist. The INT 1 mentioned the importance of the market fit rather than the country of origin. In fact, as a FI is context specific, its transfer could be irrelevant in a different environment. He also reported the regulatory challenge – CE mark, a European certification. Including a Belgian innovation in the set could have been fruitful but the *Spentys 3D Printed Face Shield* did not pass the frugality assessment. Besides, the INT 2 argued that Belgian HC has a conservatist structure regarding innovation, whether it be from within or from foreign countries. This is backed up by the negative correlations of *novelty* with *capital/knowledge* and *regulatory compliance* – respectively -0.315 and -0.274. In addition, INT 3 also affirmed that the main barrier would be regulation and not a social bias.

In conclusion, the Hypothesis 2.1. on a social and cognitive bias among Belgian entrepreneurs is considered invalidated. In addition to the indecisive A/B testing, the interviewees agreed that larger structural barriers exist rather than a bias.

8.2.3.4. REGULATION HINDERING REVERSE INNOVATION – HYPOTHESIS 2.2.

Another obstacle mentioned by the literature is that, whereas flexible regulatory contexts enables the emergence of frugal innovation in low- to mid-income countries, regulation in high-income countries is a barrier to reverse innovation – even more in largely regulated sectors like healthcare (Dessap, 2019).

Hypothesis 2.2. The emergence of reverse innovation is hindered by regulatory standards.

In order to test this hypothesis, at first, the alignment of perceptions among medical experts and entrepreneurs was explored. Then, as the regulation sub-variable was isolated in each survey, its impact on *feasibility* and *reversibility* was measured.

The difference of perceptions was analyzed and revealed an approximate alignment between both samples. Nonetheless, three innovations - *Corrugated Carboard Beds*, *WeChat Entry Form* and *Self-Auscultation Device* – have shown some differences. The former was deemed more feasible in terms of regulation according to entrepreneurs. The *WeChat Entry Form* and *Self-Auscultation Device,* **deemed more feasible by medical experts, are digital process innovations, that challenge traditional healthcare.** They also have the highest scores in *novelty* and *gap in Belgian HC* criteria rated by the MR panel. These two variables, rated by medical experts, are negatively correlated with two *feasibility* sub-variables rated by entrepreneurs. This backs up the observation that if an innovation is more desirable, then it will be less feasible. In this case, technological innovations as such are expected to collide with regulation. Moreover, the INT 1 and INT 3 pointed out that this is even more amplified when traditional healthcare practices are challenged by the innovation. The slowness to shift in terms of digitalization was also mentioned on multiple occasions by INT 2.

In terms of regulation's impact on *feasibility* and *reversibility*, some scores are striking when the regulation is isolated – some innovations see their *reversibility* increase while their *feasibility* decreases. As unexpected as it might be, these variations can be partly explained by the inter-correlations among the measured variables. It constitutes another limitation of the study as for the sake of simplicity, scores of the *feasibility* sub-variables were taken as a whole – despite a quite low Cronbach's alpha at 51.5%.

To enrich the findings of this research, three interviews have been conducted. All three interviewees confirm that regulation slows down if not completely hinders innovation. An indirect consequence of the regulation is that patient contribution as well as Belgium's social expenses are among the most expensive around the globe (INT 2). However, more money does not always mean higher quality (INT2 & 3). It is striking to note that INT 1 sees regulation as a filter to offer the best solutions to the patients whereas the INT 3 reports it as an excuse to justify the conservatism in the sector. INT 3 mentions the incapacity to innovate due to regulation and reimbursement matters – despite a visible need. Instances such as Agoria, INT 1's employer, have a role to lobby to higher instances through *position papers, recovery plans*

and so forth. Nonetheless, the problem, as mentioned by the INT 3, is that these instances generally gather large companies who are not keen to change and want to conserve regulation to discourage new entrants. If the National Institute for Health and Disability Insurance (NIHDI) refuses to reimburse a novel solution, either no adoption will occur, or adoption will be at the expense of the patient or the healthcare institution. An exception can occur if a health insurance company (i.e. *mutuelle santé*) decides to reimburse its members for a specific care, such as osteopathy which is reimbursed in Belgium. In a nutshell, a deeply rooted conservatism combined with a complicated regulation characterize Belgian healthcare. In addition, the reimbursement policies have a substantial impact, directly influencing its performance (Devos, 2019). Therefore, through the interviews, it appears that the relative inefficiency of Belgian healthcare's response to COVID-19 is not a surprise. Other factors such as the lack of a good-enough mindset, the lack of cost-sensitiveness, the lengthy process of innovation, and so forth, hinder the transferability of frugal innovation, and innovation in general. Belgium is not structured to be receptive to foreign frugal innovation, i.e. to reverse innovations.

Overall, one can assume that regulation will indubitably have an impact on the transferability. However, its extent depends on the perspective of the entrepreneur or the medical expert. It is important to note that the most *basic* innovations tend not to face the same challenge in terms of regulation. The INT 1 explained that different regulations exist for different types of innovations – i.e. if the innovation is riskier, regulatory standards will be higher. In his words, *innovating in Belgium is more expensive but results in higher quality*. Conversely, when consulted with this affirmation, the INT 3 argued that it is barely an excuse to justify a complexity that favors larger companies and blocks entrepreneurs. This can remind the importance and complementary roles of both stakeholders, mentioned in the literature. As a reminder, the grassroots entrepreneur is free of the heavy organizational structure which, in turn, enables him to generate frugality. On the other hand, the MNC has the resources to scale the innovation and bear the costs. As the INT 3 declared, the entrepreneur has a limited capital for. Thus, if regulators – conservatists – judge his innovation as a threat to the status quo, they will oblige him to go through all the regulatory processes. In other words, make him liquidate his capital through time. **As a result, regulation is a considerable factor hindering diffusion. Perhaps even more amplified in the Belgian context, as it results in higher costs to innovation.** Nonetheless, this research barely sheds a light on the tip of the iceberg as the topic requires further research to better seize the dynamics. The fact that no substantial difference

appeared in the *regulation* variable through the A/B testing can be explained by the lack of data concerning the technical aspects of the set of innovation presented to entrepreneurs.

8.2.4. RECAP OF FACTORS HINDERING TRANSFERABILITY

The findings of the research have been enriched through three interviews conducted with experts in healthcare. The acquired insights will appear on the recapitulative **Table 26**. Nonetheless, it seems relevant to list quotes from the interviews that have stressed the importance of various factors. The **Table 25** below contains striking quotes from the interviewees, while a summary of the interviews can be found in **Appendix 8.3.**

Table 25: Quotes from interviewees.

Interviewee	**Quote**
INT 1	[Belgium is receptive to] *innovation only and if only the quality is at-par […], even if the price is lower.*
INT 2	[Innovation] *diffusion depends on the nature of the value proposition, what and how it disrupts the current solution can be a barrier […] and always depends on the decision of the HC administration.*
INT 2	*Change is seen as a threat* [in healthcare]
INT 2	*Healthcare system […] is hermetic to innovation.*
INT 3	[Good-enough is not accepted in Belgium, even when] *60% of reliable diagnosis is better than no diagnosis at all.*
INT 3	*It is easier for a Belgian entrepreneur [in healthcare] to succeed outside the country than in Belgium.*

Table 26: Recapitulative table on factors hindering transferability.

Factor	**Results**	**Interpretations (enriched with interviews)**
Complex healthcare apparatus // Information asymmetry *The complexity of the interactions between the stakeholders of HC is a barrier to entrepreneurs (Interviews)*	• Entrepreneurs score *feasibility* lower than medical experts; • Negative correlation between *reversibility* and *feasibility;* • High complexity of legal compliance; • Impact of reimbursement; • Low receptivity overall;	• Healthcare sector in Belgium requires expertise to get a hold of the boundaries; • Entrepreneurs might lack the required knowledge to efficiently tackle gaps; • INT 2 and 3 suggest targeting another country then coming back to Belgium; • INAMI's role to decide reimbursements plays a major role in innovation diffusion.
Social bias on country of origin *LICs suffer from negative image Harris et al. (2015)*	• No significant findings in the results;	• All interviewees rather indicated market fit as barrier.
Regulation *Regulatory standards and processes in Western HC tend to hinder RI Friebe (2017)*	• Alignment of perceptions between medical experts and entrepreneurs; • Technological innovations collide with regulation;	• INT 1 reports *riskier* innovations more likely to collide with regulation; • All interviewees agree that regulation endorses status quo – which, in turn, causes waste.

	• Higher complexities in regulation tends to increase the capital and knowledge required to pursue innovation, i.e. high cost to innovation (Correlation = .463, Cronbach's Alpha = .623).	• All interviewees mention difficulty to digitalize (i.e. replace traditional methods); • INT 3 indicated that heavy regulatory processes can be used by lobbyists to discourage innovators • Entrepreneurs have a time constraint – lengthy regulatory matters play against them as mentioned by INT 3; • Lack of lobbying for entrepreneurs and innovators mentioned by INT 3.
Market fit *FI tend to be too context-specific Hossain (2018)*	• Innovations with high *feasibility* but low *desirability*;	• INT 1 stressed on the importance of market fit rather than a bias; • INT 3 illustrated market fit with example where an innovation is not adopted due to language barriers.
Conservatism *There is a structural dynamic for status quo, hence hindering drivers for innovations and progress (Interviews and preliminary exchanges with actors of Belgian HC)*	• Technological innovations deemed less *feasible*; • Insufficient IT capabilities of healthcare institutions; • High costs of change; • Negative correlation between an innovation's degree of novelty/answering a gap in Belgian HC, and the feasibility in terms of regulation and capital required;	• INT 3 mentioned the conservatist mentality among practitioners; • INT 2 and 3 a preference in Belgian HC for *human interaction* rather than digitalization; • Digital solutions have a disruptive power and thus, is *feared*; • *Information technology tropism* mentioned by a medical expert; • INT 1 and 2 mention that the diffusion of digital solutions is based on willingness of doctors; • The disruptive potential of reverse innovation is a threat to MNCs (Simula et al., 2015) – resistant to change according to INT 3. And MNC have strong lobbies to keep the status quo.

The table above displays a list of factors explored and discovered in the framework of the research. Though reverse innovation (RI) has a disruptive potential, faced to the COVID-19 crisis, barriers such as the need for rapidity, rigid structure and many others can hinder the transferability of frugal innovation (FI). In fact, one of the major reasons that renders FI genuinely effective is its thorough understanding of the social, regulatory and competitive environments. When reversing an innovation, one might lose its most valuable virtues. Nonetheless, the literature affirms that RI also constitutes an opportunity for shared learning among HICs and LICs (Bhattacharyya et al., 2017). The results show that the 3 innovations qualified as *likely* reversible are the ones having scored the highest in the *gap in Belgian HC*. In other words, one can assume that a FI tackling a gap in the HC sector, such as the *Self-Auscultation Device*, is more likely to become a reverse innovation than an innovation bringing a completely new technology, such as the *Self-Cleaning Mask*.

To wrap up, the true challenge remains adapting these innovations from low-income to high-income countries – and vice versa as RI can happen the other way around (Radojević, 2016). As Harris et al. (2020) suggest, the greater use of digital tools allowed the most effective innovation – the sharing of new knowledge through social media – overcoming the traditional boundaries of knowledge diffusion and innovation adoption. Adapting the innovations incoming from LIC to HIC is complex but one can think of notions such as *systems approach* or *design thinking* which nurtures creative problem-solving. Additionally, as mentioned by the interviewees, innovations in Belgium start with a technology rather than a need (Dessap, 2019). Identifying a genuine need to tackle is fundamental. To overcome the hermeticism of Belgian healthcare, structural changes as well as a shift in mindsets need to occur.

8.3. CONTRIBUTIONS

Throughout the research, interactions with the numerous stakeholders have brought up an issue – very few publications, if none, try and explore frugal and reverse innovation in Belgium. The conservatism of the healthcare sector when it comes to innovation can be factor explaining this lack of interest in the potential of frugal innovation (FI) and reverse innovation (RI). The actual context of COVID-19 has naturally given way to an analysis in the healthcare sector. Thus, one can assume that the scope of the research has enabled an analysis in the context of a crisis – rendering the research a little more peculiar. Worldwide, innovation became necessary to efficiently tackle the COVID-19 pandemic. In the light of the events, exploring the receptivity of Belgium to innovation in healthcare has revealed Belgian healthcare's conservatism – at least in this extreme context.

The main contribution is on the role of regulation. By isolating the variable in both parallel surveys, a sharper focus on regulatory matters has been brought, thereby advancing the T-HOPE framework. The findings and correlations suggest that if an innovation brings more novelty or fills a gap in Belgian healthcare, there are less chances of it being feasible – resource and regulation wise. The impact of regulation in terms of transferability has been thoroughly investigated through the Hypothesis 2 2. It has been revealed that regulation does have an impact on transferability. Nonetheless, its extent depends on the perspective of the rater. Moreover, through interviews, INT 1 affirmed that, on the one hand, regulation allows only the best innovations to make it in Belgian healthcare – protecting the patients. On the other hand, INT 3 confirmed that this is barely an excuse to justify the closure of Belgium to innovations. The regulatory stiffness increases the costs of entering the Belgian market – INT 2 and 3 even suggested entrepreneurs to start in a nearby country before coming back to Belgium.

On top of that, the Toronto Health Organization Performance Evaluation (T-HOPE) has been used to diagnose the Belgian healthcare (HC) system, by putting in perspective is criteria with the entrepreneur *commercial potential* evaluations. Indeed, articulating the *reversibility* variables with *potential desirability and feasibility* enabled to reveal potential asymmetry of information on Belgian HC innovation, as well as precious correlations showing its dynamics. The results have shown the top of the iceberg that is the imperfection of the system, which also means perfectible aspects have been identified, supporting some of the recommendations of previous publications on its efficiency and possibly serving as basis to better design the reform.

8.4. LIMITATIONS AND FUTURE RESEARCHES

The scope of the research being limited, this section will list the various limitations as well as recommendations for further research.

The various statistical analyses that have been conducted on the results indicate an adequate validity with fair-to-good levels of agreements. However, the robustness of the results could have been higher, especially on the *reversibility* assessment. On the *frugality* assessment, the last version of the FIH-ID framework includes a situation where the rater is asked to answer only one of the sub questions of a criterion. As aforementioned, it can be problematic when computing Inter Rater Reliability (IRR). Future users of this tool should keep that in mind when designing the rules and methodology to assess inter-observer agreement.

As a consequence of the crisis, the research conducted to determine the innovations constituting the initial set were mainly collected online. In fact, considering the context, the possibility to choose innovations presented at gatherings or summits, such as realized by Prime (2017) was impossible. Besides, the scope of the research was modest compared to the work realized by the author of the FIH-ID. Indubitably, the lack of data concerning technical and financial aspect can be explained by the limitative online research.

In addition, the users of the tools, that have realized the *frugality* and *reversibility* assessments, were novice users. On the one hand, the inexperience of the users was on purpose to confront theoretical framework to field reality. On the other hand, this has led to inconveniences explained above. Despite the creation of a panel composed of expert users to counterbalance, one can question using novice users. This can be avoided with pilot phases where one gets acquainted with the tool prior to the assessment.

As aforementioned, a limitative aspect in the entrepreneurs' survey is the Likert scale. In fact, 1 to 5 being too narrow, a large majority of respondents chose to place scores between 2 and 4 – avoiding a strong agreement/disagreement while answering. It means that a larger scale can be used in future researches that measure the commercial potential similarly to this research.

Overall, for comparative purposes while testing the Hypothesis 2.1. on the social bias, adding a frugal innovation originating from Belgium would have been fruitful. Nevertheless, the only initially selected Belgian innovation did not pass the frugality test. In fact, as the literature indicated, the research was aiming to reveal a bias. However, no significant

correlations indicating the existence of a cognitive and social bias concerning the country of origin has appeared through the A/B testing.

When it comes to regulation as a barrier to transferability, once again, no substantial difference has been revealed. One can assume that the lack of data concerning the technical aspects of the set of innovation in the entrepreneurs' survey can be explanatory. Besides, the scope of the research was to acquire data from entrepreneurs in the shortest amount of time possible – a lengthy survey discouraging participation. A deeper study with less innovations identified as frugal yet more documented could provide more reliable results on the bias.

In the end, the *innovation as an output* approach was chosen. The selected innovations were assessed on their potential, independently from their future or potential host country. Given the results and the importance of having *absorptive capacities* to deal with such innovations – i.e. less burnouts, more IT literacy, and so forth – one can only imagine the relevance of more process studies on frugal and reverse innovation that embrace innovation in the making. For one thing, this research builds on the legacy of *innovation as an output.* As a reminder, the research conducted by (W. M. Cohen & Levinthal, 1990) demonstrated the importance of *absorptive capacity*, i.e. the ability of an organization, to seize the value of a new information to then assimilate it in order to apply it to commercial ends. In other words, through an *innovation as a process* lens, analyzing Belgian healthcare institutions' *absorptive capacity* can lead to compelling results. Additionally, investigating the processes and mindsets of the Belgian entrepreneurs who responded to COVID-19 crisis with a frugal approach seems highly relevant.

In order to discover and explore more thoroughly factors hindering transferability, case studies based on specific innovations can also be fruitful. In fact, the amount of data concerning innovations examined in this research was limited. Besides, exploring the frugality of an innovation, its *reversibility* and *commercial potential* – i.e. transferability – in a different context than the COVID-19 can help reveal other aspects, not found through this research.

A more rigorous analysis of correlations can also be made by presenting the panels with a larger set of innovation. In fact, mixing frugal innovations with non-frugal innovations can help infer interesting correlations and further, causalities, to better capture the receptivity to FI.

The Medical-Reverse (MR) panel was formed with the participation of 5 experts. With the addition of 2 more experts, intra-class correlations could have been realized. This can

enable future researches to explore other horizons such as using the T-HOPE criteria with an ICC analysis that would be helpful to identify a country's healthcare system's dynamics.

As Belgium is hermetic to innovation – at least in healthcare – a further investigation on the benefits of open innovation and user innovation can also be considered. Analyzing the receptivity of Belgium to innovation as a whole – and not limited to a sector – can reveal aspects not found through this research. One should also bear in mind that, as mentioned by INT 2, for healthcare, Belgium's innovation score is biased by the highly innovative pharmaceutical sector. Overall, open innovation and user innovation paradigms have the potential to reduce information asymmetry between different stakeholders, but it requires a huge mindset shift.

Moreover, a qualitative study on the role of entrepreneurs in Belgian healthcare can be useful to better grasp their importance. In fact, the receptiveness of Belgium to innovation can be enhanced by nurturing a mindset that stands by innovation. As aforementioned, the mentalities in the country do not seem to accommodate a good-enough approach that could be beneficial on several levels. Trying to understand how a frugal mindset can be set up in Belgium can be fructuous. Furthermore, trying to align the perspectives of the medical experts and entrepreneurs by inducing both stakeholders to exchange views can be productive. Finally, keys additional actors like federations, regulators, unions, healthcare institutions, should also be analyzed to better grasp the whole picture of the Belgian HC system, hence revealing how to effectively improve it.

VIII. CONCLUSION

Consequently, the question that arises is *what can be done*. Luckily, **something can be done, and has to.** The complex questions revolving around a stimulus plan for Belgian healthcare (HC) involve a myriad of factors and stakeholders, thus requiring discerning and sharp knowledge and thorough understanding of the sector. However, the purpose of this thesis is to report on the various ideas – presumed and discovered throughout the study. In the introduction of this research, a question had been asked:

"After all, if an innovation is less costly, provides to many more, and does so more competently, then it would be adopted in any country, right?"

Unfortunately, it appears that things are not as simple as that. The *systems approach*, which enables to tackle complex issues, was mentioned in the literature. Throughout the research, the findings have demonstrated the complexity of transferring frugal innovations in Belgium. In fact, the negative correlation between *desirability* and *feasibility* is striking. How come and why an innovation that could fill a gap in Belgium cannot be feasible? The complexity of the regulation, the reimbursement policies as well as the wasteful conservatism are paramount. Belgium is a complex country and will remain so in the near future. Changes should first occur in the mindsets for having a sustainable positive impact on innovation. Therefore, to get a hold of each stakeholder's interests, tackling the healthcare problem with a systems approach seems crucial.

To start building an efficiency-integrated structure, one should aim to hold the people in charge more accountable. Inspiration from the best practices of HC systems like the NHS would indubitably be fruitful. A solution suggested by INT 2 would be to charge a fixed amount per disease, based on the average cost. In that way, doctors would be incentivized to provide treatment efficiently, while allowing freedom for experiments and further treatments if desired, but at their own cost. In the same vein, INT 3 defends the idea of granting a fixed annual financial allocation to HC institutions, as each would have to manage their activities in a more competent way to make profit. Overall, HC institutions need to improve management practices, build strategy and aim to perform. While the INT 2 reports that considering HC as a business is hazardous, examples in several Asian countries are showing that competition and performance ratings tend to boost the efficiency and outcomes of HC institutions. The same INT 2 affirms that one could consider the ranking of hospitals, or a smarter repartition of areas

of care, based on their performances and the types of needs the population around a hospital tend to have.

In the second place, Belgian HC should pursue further innovation, and an appropriate analogy would be the famous WD-40 story. Its name stands for *Water Displacement Forum 40th formula* – which indicated that there have been 39 failed attempts before finding the right product. In the HC sector in Belgium, if the first attempt is a failure, the innovation is usually rejected, and the process has to be aborted as mentioned by the INT 3. A first driver of innovation already exists when, for example, a health insurance company takes the initiative to reimburse some cares. This can be extended by reimbursing patients cured in novel ways. A suggestion from the authors of the present study would be to divide the financial allocation received by HC institutions, with a conditional portion of it aimed at testing and implementing innovations and which could be tracked in various ways. This resonates with a suggestion of INT 2, which is to make mandatory for each healthcare institution to test at least 5 innovations a year. Besides, hackathons and other contests are proven to be source of great innovations and served as a basis for several studies on FI and RI (Prime, 2017). While the federal state decides hospitals' budgets, federated entities oversee the structure – resulting in disarray in most cases. Change can only occur when both levels agree, which can be complicated. Aligning the roles can be fruitful and drive innovation.

Finally, as Belgium is all about compromises and negotiations, inducing a change means facing lots of resistance. Indeed, the findings of this study have shown that the more novelty an innovation brings, the least feasible it tends to be from the perspective of entrepreneurs. Moreover, larger companies tend not to perceive real incentives for frugal approaches (M. Zeschky et al., 2014). Nor do they make it easier for an entrepreneur to come up with an innovation due to its disruptive potential. But as Y. Bhatti et al. (2017) report *many of the innovations had similar objectives, are addressing the same problem or have common operating models or technologies*. Indeed, a country's healthcare system can be compared to other ones and sorted to form groups of countries sharing similar characteristics (Vanderaa, 2018). Thus, a suggestion is the creation of international healthcare entrepreneur networks, from both HICs and LICs. As aforementioned, this can enable *distance diffusion* reported by Hossain et al. (2016). By pursuing OI and FI on an international level, faster and more cost-efficient innovation processes can be achieved – avoiding 39 attempts to find the 40th formula. It could result in proven FI that will be easier to reverse in Belgium, along with a frugal mindset promoted within the network. Moreover, the involvement of patients in FI processes, with

voluntary resource-constrained R&D settings, might lead to FI developed locally. In other words, it could bring the argument that these innovations work elsewhere, and generate interest among population – as similarities among populations' needs in terms of care is a driver for adoption (Simula et al., 2015). Building on this idea of networks regrouping different countries might be encouraged by identifying the potential groups. On the one hand, based on the similarities – current diffusion variables such as language or similar HC system. But on the other hand, by mixing developed and developing countries based on their complementarity. Cooperation groups can enhance and fasten the innovation process in a more sustainable way, leveraging the co-learning opportunities between LIC and HIC (Bhattacharyya et al., 2017). Another unforeseeable crisis like COVID-19 could be prepared for rather than triggering disorganized innovation. Moreover, it could also induce evolution among mentalities – nurturing an innovation culture and a frugal mindset – but also to diminish the social and cognitive bias HIC could potentially have regarding LIC innovations – in spite of the findings of this research. Ultimately, as reported by the INT 3, it would lead to strengthen the voice of entrepreneurs, thanks to the power of the many.

To wrap-up, the complexity of the Belgian healthcare combined with the conservatism in terms of innovations is tremendously wasteful. Not only innovations from within are very difficult to put in place, foreign innovations also struggle to enter the kingdom. In fact, for frugal innovations, the task is even more difficult as the *at par* level of quality compared to alternatives is the minimum as indicated by INT 1. In addition, the lack of a frugal mindset is a substantial barrier to successfully reverse innovations. In the very beginning of the research, one could innocently believe that Belgium, as well as any other high-income country, would be receptive to innovations – especially if they allow to reduce costs while optimizing services. But even if some FI are desirable – e.g. *WeChat Entry Form* – the system's receptivity is just not there. Nonetheless, the numerous interactions with a panoply of stakeholders in healthcare have enriched this research in various ways, from its beginning till the very end. It has allowed enlarging its scope and address factors discovered as things progress. To conclude, the researchers would emphasize on one thing – healthcare is universal and the myriad of issues arising around the globe should be tackled accordingly. The interests and the welfare of the global population should be paramount, above any political or commercial interest. The COVID-19 crisis has displayed how fruitful international collaboration can be and one can only imagine the virtues to continue this momentum. It is a difficult task to determine the perfect type of frugal innovations that would be successful in Belgium.

"Give a man a fish and you feed him for a day; teach a man to fish and you feed him for a lifetime" (Chinese proverb)

Be that as it may, similarly to the proverb above, Belgium needs to learn *how to fish* – i.e. how to generate frugal innovation, how to nurture a frugal mindset – instead of receiving a *fish* – i.e. a frugal innovation, foreign or not – once in a blue moon.

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X. LIST OF FIGURES

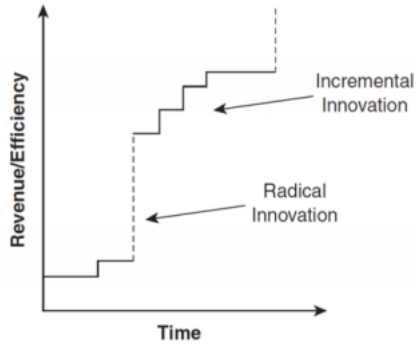

Figure 1. Radical and incremental innovation (O'Sullivan, Dooley, 2009)

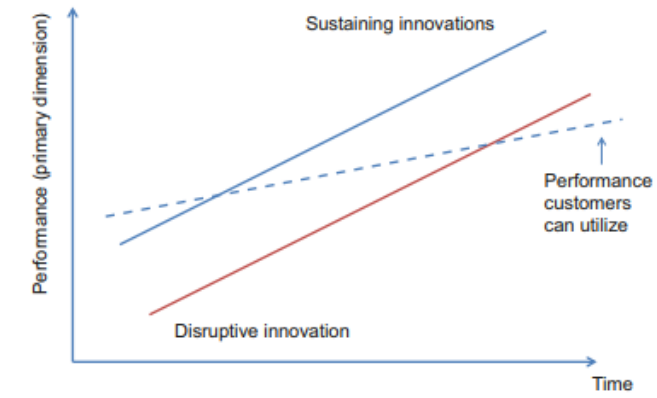

Figure 2. Representation of the evolution of disruptive innovation. (Christensen 1997)

TYPE OF BENEFIT / TYPE OF SERVICE	Core	Delivery
Separable	Core/Separable	Delivery/Separable
Inseparable	Core/Inseparable	Delivery/Inseparable

Figure 3. Matrix of service innovations (Berry 2019)

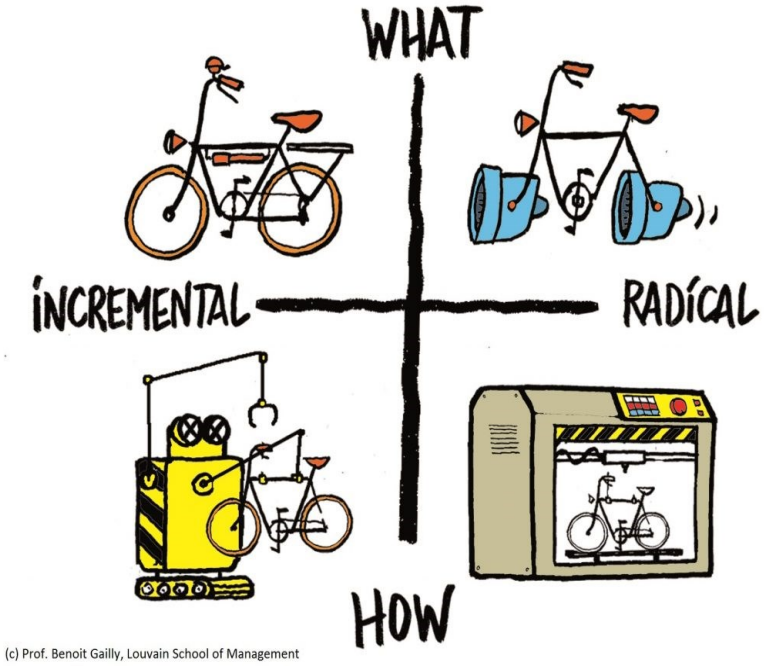

Figure 4. Innovation as process/product vs incremental/radical (Gailly, 2020)

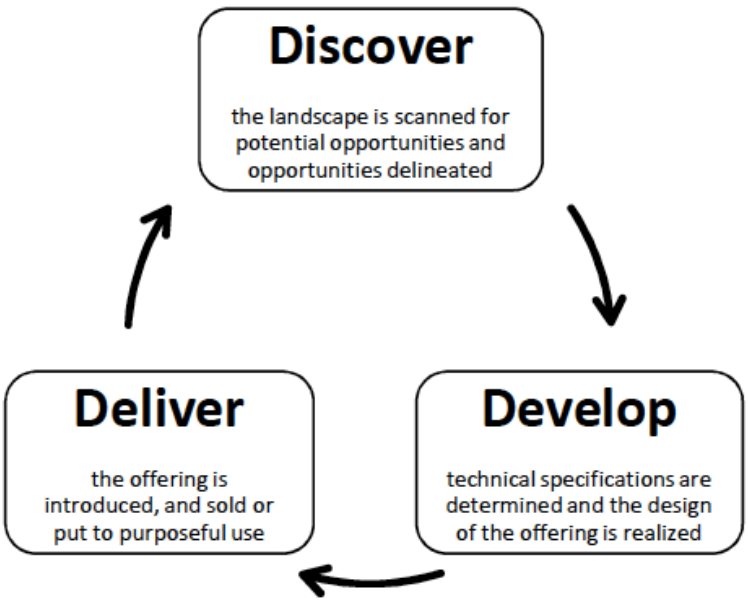

Figure 5. The Innovation Cycle. Kahn (2018).

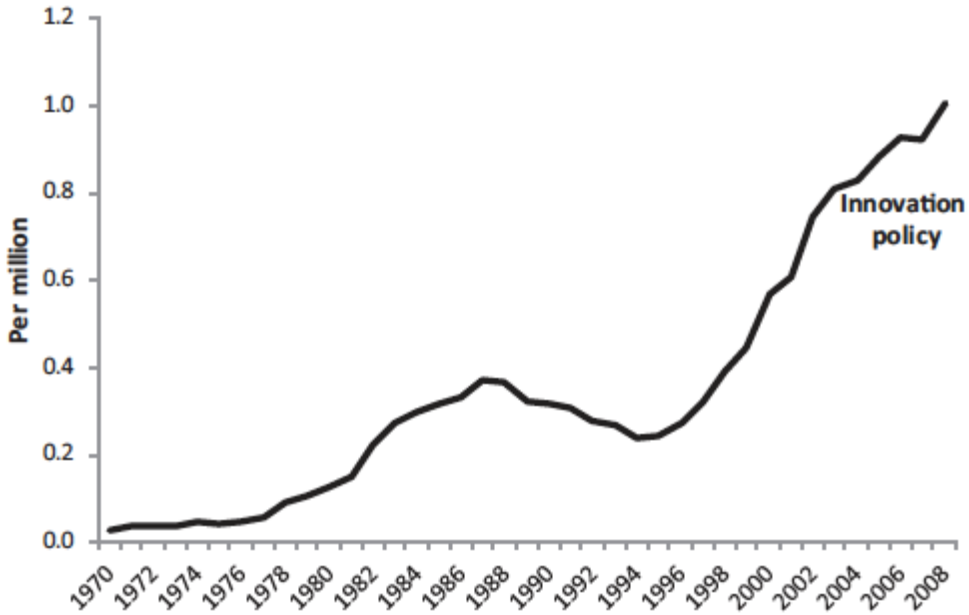

Figure 6. The frequency of the term 'Innovation Policy' according to Google. Edler & Fagerberg (2017)

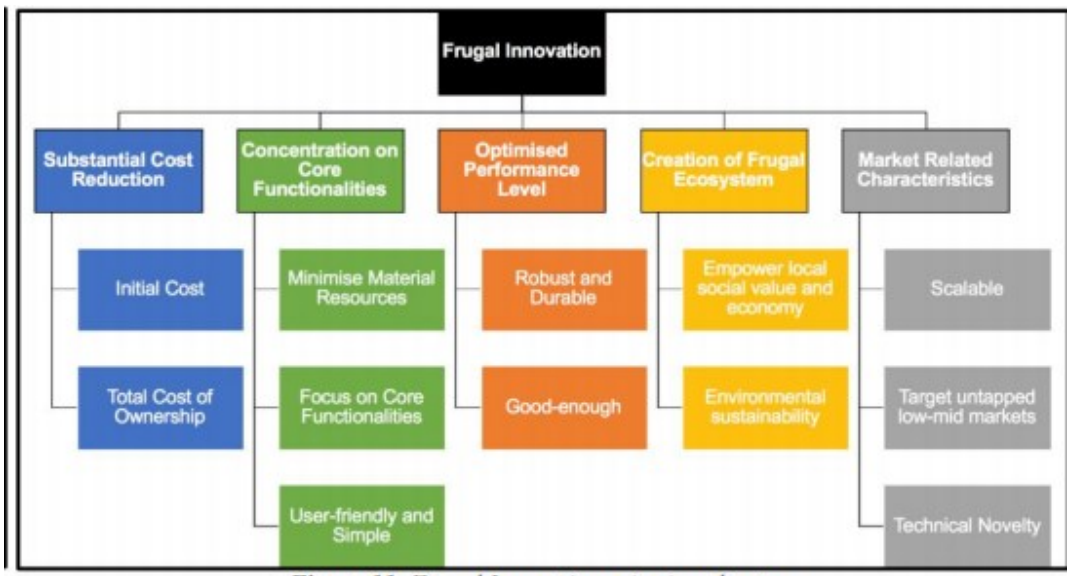

Figure 11: *Frugal Innovation criteria value tree*

Figure 7. FI criteria value tree (Cachola, 2019)

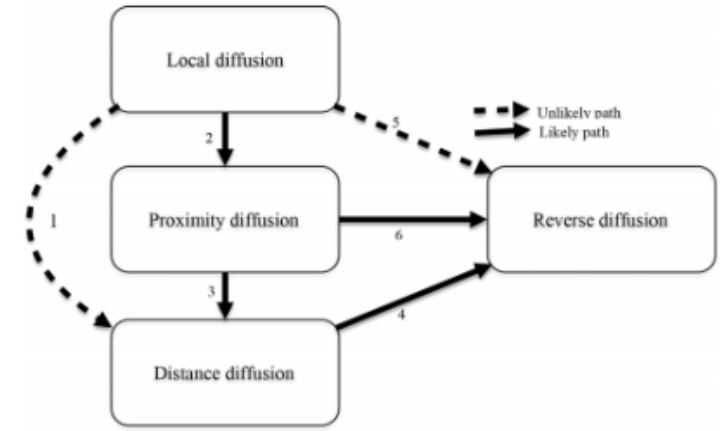

Figure 8. Diffusion patterns of frugal innovation (Source: Hossain & al 2016)

Name of Innovation				
Signal the best options for each of the following factors.				
Frugal Innovation Criteria	**Response**	**Level of Evidence**		
		Weak Internal (Subjective claims)	**Strong Internal** (Objective data of benefits)	**Externally Validated** (External Report or Peer-Reviewed Publication)
Affordability: Is the offering more affordable than alternatives for the? (Please answer for each category)				
• Care Seeker? (e.g. Patient)	Yes			
	Unclear			
	No			
• Care Provider? (e.g. Hospital/Clinic)	Yes			
	Unclear			
	No			
• Care Purchaser? (e.g. Insurer/Govt.)	Yes			
	Unclear			
	No			
Adaptability: Is it adapted to the needs of the context to better perform, be at par or be good enough? (Please answer for only one category)				
• Out-perform? (e.g. Solution better than existing)	Yes			
	Unclear			
	No			
• Be at par? (e.g. Solution same as existing)	Yes			
	Unclear			
	No			
• Be good enough? (e.g. Solution not as good as existing, but acceptable)	Yes			
	Unclear			
	No			
Accessible: Is it accessible to and scalable to benefit many in society in terms of? (Please answer for only one category)				
• Widely accessible currently?	Yes			
	Unclear			
	No			
• Potential for scalability?	Yes			
	Unclear			
	No			
FIH –ID Tool Outcome: Potential frugal innovation if you have at least a "yes" for each frugal criteria	**FIH-ID Outcome**	**YES**	**UNCLEAR**	**NO**

Figure 9. FIH-ID framework (Prime, 2017)

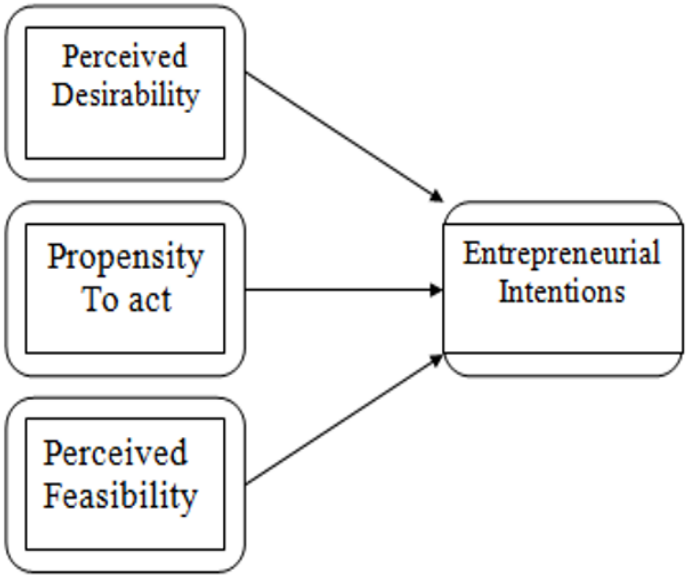

Figure 10. Entreoreneurial event (Shapero (1982)

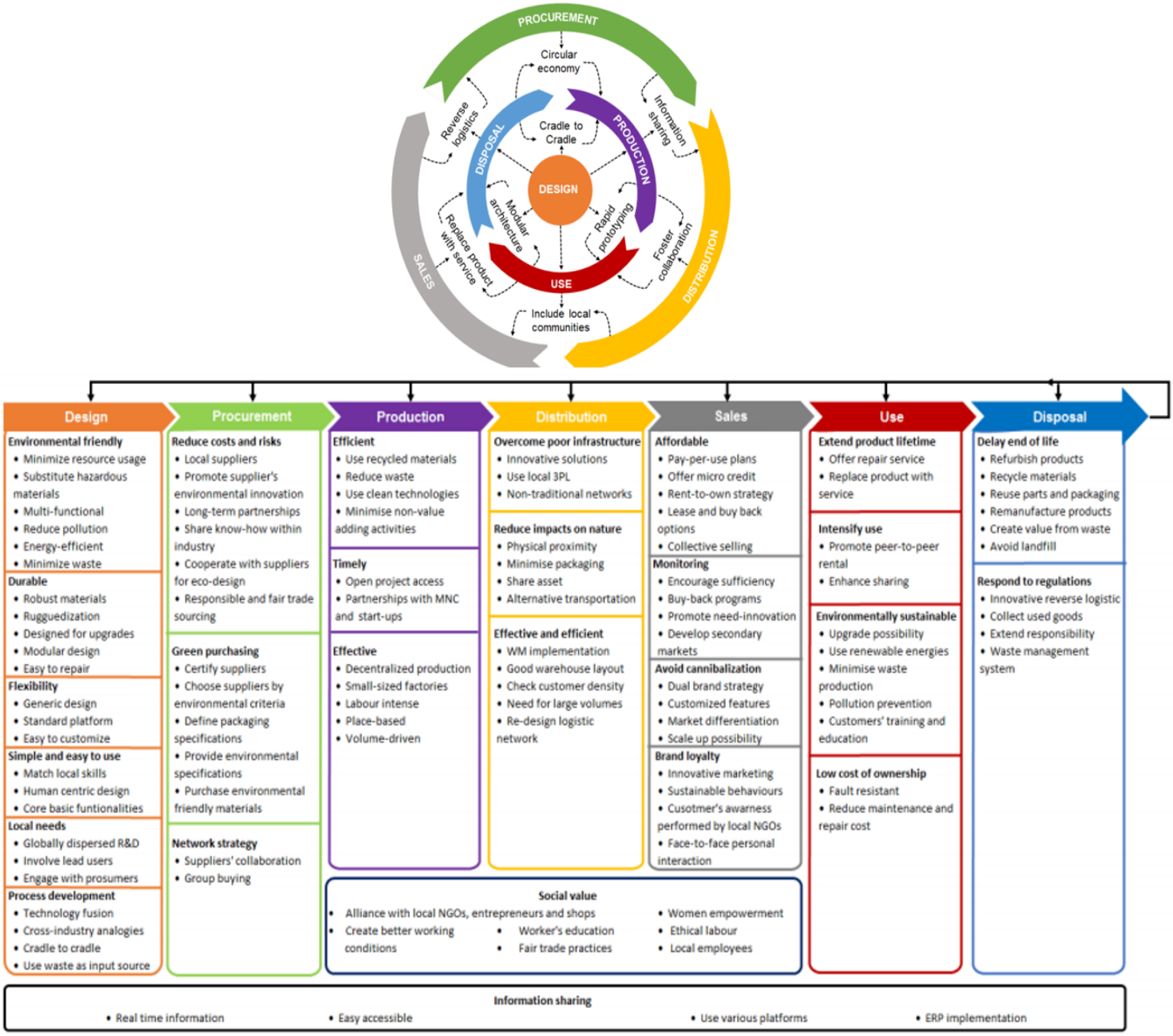

Figure 11. Framework for Frugal Innovation Supply Chain. Rocca (2016)

Gap	Description	Trend
Performance	Because of their low incomes, customers in poor countries are prepared to make significant sacrifices in performance – at the right price.	First, technological improvements raise performance to the point that rich-world customers are interested. Second, tighter budgets in rich countries force consideration of ultra-low price options
Infrastructure	Rich-world infrastructures are built; emerging-economy infrastructures are under construction.	Aging infrastructure in the rich world will need to be replaced.
Sustainability	Poor countries face many of the most daunting sustainability challenges on the planet.	Sustainability pressures rise in the rich world.
Regulatory	Regulatory systems in emerging economies are less developed and present fewer delays when a company is getting innovative solutions to market.	Governments in the rich world eventually approve new technologies or revise regulatory requirements.
Preference	Each country has distinct tastes and preferences.	Customers in the rich world are influenced by poor-country preferences.

Figure 12. 5 needs gaps framework (Govindarajan & Trimble, 2012)