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Implications of Reverse Innovation for Socio-Economic Sustainability: A Case Study of Philips China

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Abstract: The idea of reverse innovation, local innovation happening in emerging markets for the global market, has gained much academic and managerial attention in recent years. The purpose of this study is to understand how reverse innovation has successfully diffused into the product and market development strategies at Philips Inc., a prominent multinational company (MNC) of the modern era. Furthermore, the study presents the success achieved by these innovations at both the domestic and global levels, along with their implications regarding socio-economic sustainability in emerging markets. In order to investigate the research questions, a case study of Philips China was conducted involving three product innovations that were found to be suitable examples of reverse innovation. After the study of extant literature on the topic, drawing from research databases, newspaper articles, and company press releases, five semi-structured interviews were conducted with key managers and a market practitioner to gain sufficient understanding for this exploratory study. Subsequent case analysis concludes that these innovations are examples of reverse innovation representing a new paradigm change in innovation flow. This flow of innovation from emerging markets to developed markets as confirmed by Corsi's framework could potentially disrupt developed markets as well as contribute to ensure healthy living conditions for the population living in developing countries. If so, this represents a sustainable socio-economic change in-line with the United Nations' Sustainable Development Goal (SDG) of "ensuring healthy lives and promoting well-being for all at all ages." This is relevant as Philips aspires to be a prominent private sector player in achieving the above-stated goal by defeating non-communicable disease and strengthening local healthcare systems.

Keywords: reverse innovation; Philips Inc.; socio-economic sustainability; emerging markets; China; frugal innovation; SDG

1. Introduction

The idea of reverse innovation, local innovation happening in emerging markets for the global market, has gained much academic and managerial attention in recent years. Govindarajan [1] first coined the term, which involves innovations emerging in the developing world considering the local constraints, and later traveling uphill to find applications in the developed world [2]. This phenomena is also called "blowback innovation" [3]. After the financial crisis of 2008, emerging economies, with a population of 5.5 billion and \$30 trillion GDP, are becoming the new epicenter of global growth. Many multinational corporations (MNCs) are heading toward these emerging markets (such as China and India), which offers them the next big growth opportunity to redefine trajectories of products and of

technological and business model innovations. In doing so, the most critical challenge for the MNCs will be how to design and diffuse such innovation strategies, which can help them to tap enormous emerging market potential [4].

While existing literature on reverse innovation includes extensive research about the opportunities and risks of reverse innovation concerning MNCs, minimal research has been conducted on the question of how reverse innovation can be organized in MNCs and of what the socio-economic implications are that reverse innovation can bring to emerging markets. In addition, there are many successful cases of frugal innovation, whereas there are only a few examples of successful reverse innovation [5]. This is because the implementation of reverse innovation is much more difficult for MNCs, as such a phenomenon requires a fundamentally different business model than that of products designed for developed markets [6]. Using the in-depth case study of Philips Inc., the purpose of this research is to understand how reverse innovation is being organized at MNCs, the level of success achieved by their products, and the implications for socio-economic sustainability in emerging markets.

The paper is structured as follows: In the next section, we will review the relevant literature about the opportunities and impediments offered by emerging markets in connection with reverse innovation. In Section 3, we will describe our methodological approach before presenting our three case studies from various divisions of Philips Inc. in Section 4. In Section 5, we will analyze and explain how MNCs can organize reverse innovation and develop relevant propositions. The article finally concludes with theoretical and managerial implications and provides future research direction.

2. Literature Review

Recent studies have shown that innovation is one of the major instruments of growth strategies for MNCs, which can help them to enter new markets by offering sustainable solutions to individual markets, to increase market share, and to gain decisive competitive advantage [7]. In the case of emerging markets, Govindarajan [1] believes that the reverse innovation phenomenon has become a strategic priority for MNCs to capture emerging markets. Traditionally, innovations have always traveled from developed countries to developing countries. However, recently emerging markets have started to capitalize on their untapped resources to generate enormous growth, resulting in an increase in average incomes for the large, thriving middle class in those markets. Additionally, developing countries are expected to contribute two-thirds of the global economic growth, which further signifies the role of emerging markets and the need to develop appropriate strategies to tap into this significant market potential [8].

Developing disruptive product propositions for such markets offers a major opportunity to MNCs aspiring to establish a solid foothold in these markets [9]. MNCs aspiring to expand in emerging markets usually face a variety of challenges [10,11]. Firstly, the MNCs operating from developed markets are not aware of the aggressive price to performance ratios required for operating in emerging markets. Another dilemma facing MNCs is conventional innovation theories not being applicable to emerging markets, although the logic for innovations flowing downhill from developed countries to the emerging world is intuitive and natural, which can make MNCs less sensitive to demand originating from resource-constraint emerging markets [12]. This fundamental difference in types of products and business models challenges MNCs to make adjustments to their organizational structures and procedures to suit the requirements of reverse innovation, especially with regards to R&D teams, which require changes in ideation, development process, and decision-making to be able to conduct truly global innovation [6,13,14]. Cramer [15] considers reverse innovation an antidote against the “tailored down” products that does not meet emerging market consumers’ needs. Missing this huge market and business opportunity offered by the “emerging middle class” [16] will exterminate MNCs’ current profits at the top of the economic pyramid [17]. This statement is further justified by the ever-increasing introduction of low-cost innovations in developed markets, targeting consumers who are not willing to pay for premium solutions, as noted by Lee *et al.* [18]. Therefore, Govindarajan [13] rightfully emphasizes reverse innovation being an opportunity for MNCs to develop far from home

and succeed everywhere. Developing products in emerging markets not only lowers the cost but also helps them to fend off furious competition from fellow Western as well as emerging market MNCs.

Lowering costs or achieving frugal capabilities, according to Sharma and Iyer [19], is the first step toward achieving reverse innovation. Frugality, being an essential component of reverse innovation, also offers a linkage between reverse innovation and sustainability. However, there is little empirical evidence in the literature on the direct linkage of reverse innovation and sustainability. Rao [20] explains how cost-conscious emerging markets' customers are demanding low-cost, high-quality products to improve their lifestyle. This demand trend involving simple, sometimes technologically cutting-edge, solutions emerging from resource constraint bases has a lot to offer for sustainable development, which may compel developed market players to offer the same solutions in order to cater to the needs of cost- and resource-constrained customers in those markets.

3. Data and Methods

This study addresses the following three research questions:

- (1) How is reverse innovation being implemented (in terms of market and product development strategies) at Philips China?
- (2) How successful have these product innovations been in domestic and global markets?
- (3) What socio-economic implications do these product innovations have for emerging markets?

3.1. Research Design

The study adopts a case study approach, due to the novelty of the reverse innovation phenomenon and lack of appropriate empirical insights into reverse innovation's organizational implementation [21]. We achieved the above-stated goal by adopting qualitative research based on case studies of three Philips products [22]. We used this approach as it provides a basic understanding of the diffusion and design of reverse innovation strategy [6].

3.2. Case Selection

As part of our ongoing study of reverse innovation [23], we investigated the current literature, research databases, and relevant public press for reverse innovation examples [6]. We then identified Philips as an example for our case study on reverse innovation, as Philips has almost a century-old legacy of being a multinational that considers emerging markets as its major customer base. Philips offers products ranging from lamps and consumer goods to healthcare and automotive accessories. According to Matheson [24], Philips Inc. is no stranger to innovations meant for emerging markets. In fact, it has a long history of success in these emerging markets. It entered the Indian subcontinent back in the 1930s and has now become a leader in lighting, consumer care, kitchen appliances, and healthcare systems. The main driver behind this success has been a current assessment of customer's unmet needs and a value provision through products superior in technology and design. Philips has not only brought technology to these emerging markets, but it also took up the challenge of penetrating semi-urban and rural markets with complex socioeconomic stratification and vastly underdeveloped infrastructure. For example, Philips introduced Vardaan, as part of its color TV range specifically targeted for the rural and semi-urban areas of India. Philips customized its TV to be able to operate at a voltage range of 90–270V, thereby eliminating the extra cost incurred by the installation of a voltage stabilizer. Additionally, Philips launched the first cell-battery-powered radio, which was a popular hit in rural and semi-urban areas of the Indian subcontinent, facing chronic power outages [8].

Studies by Li and Kozhikode [25], Prahalad and Mashelkar [26], and Quintane *et al.* [27] show that Philips is committed to producing for Asian markets based on customers' needs. Instead of bringing developed market products to be sold in emerging markets, Philips has successfully identified different lifestyles and cultural values of emerging market customers and has designed its product line accordingly. Philips also used innovative promotional strategies to penetrate semi-urban and rural

markets with affordable, high-quality products. Another important aspect of the Philips success story is the presence of one of the largest distribution networks, which enables high levels of penetration. This network was built on the basis of sound partnership with major retailers and distributors [28,29]. However, with the advent of the Internet and explosive growth of e-commerce, Philips was quick to adapt to change in the e-commerce channel to achieve even greater market penetration. Allowing local management to run the operations in emerging markets, especially Research and Development (R&D) activities, enabled Philips to learn local insights and design a strategy that fits well with the dynamics of emerging markets [29].

This provides an exciting opportunity to study the reverse innovation phenomenon implemented, over a range of different products. Additionally, Philips operates globally, with an extensive subsidiary network, and has a full-fledged Philips innovation campus in Shanghai supporting local R&D activities. Table 1 shows our case study details, which include three Philips' products (an automotive air purifier, a noodle/pasta maker, and an Ultrasound ElastPQ) and their socio-economic benefits.

Table 1. Case study details.

Business	Product	Socio-Economic Benefits
Automotive accessories (B2C/B2B)	automotive air purifier	Protection against in-car air pollution
Kitchen appliances (B2C)	noodle/pasta maker	Food safety and revival of centuries-old noodle-making tradition
Healthcare (B2B)	Ultrasound ElastPQ	Non-invasive assessment of liver cancer

3.3. Data Collection and Analysis

The data were collected through secondary research sources as well as five semi-structured (in person or email) interviews, where in-person interviews generally lasted between 40 and 90 min on average (see Appendix 1). The semi-structured interview method was used to encourage fruitful discussion in line with the exploratory nature of the study. In order to further understand the case, we also studied the annual reports, company trade presentations, and press releases, which helped us to avoid the limitations of using only one method of study [30,31]. The research team then wrote each product case separately and cross-checked with the interviewees via emails to avoid any mistakes through misunderstandings. The first interview was conducted with Mr. Fangzhong Shen, who is the Product Marketing Manager at Philips Lumileds, and is responsible for automotive air purifiers in Indian and Chinese markets. Subsequently, the second interview was conducted with Ms. Serena Wen, Senior Product & Marketing Manager Kitchen Appliances, Consumer Marketing Philips. Serena is in charge of the marketing strategy for noodle/pasta makers. Ms. Xiaomin Li, who is a Senior Scientist at Intelligent Clinical Solutions and Services at Philips Healthcare, China, was also interviewed to gather a better understanding of Philips ultrasounds with elastography (ElastPQ). We also contacted Mobility Accessories Business Manager Albrecht Kraus for his views on challenges related to organizing reverse innovation as well as the acceptance of innovation originating from China in the developed world. Finally, in order to gain general insights about the implications of reverse innovation for the Chinese economy, the research team also contacted Mr. Pascal Mariner for an interview, who is the CEO of Swissnex China and Vice Consul General for Switzerland in Shanghai. All the products were studied at strategic levels for similar patterns, as we are interested in studying the overall organization of reverse innovation.

3.4. Assessing Implications of Sustainability

Assessing sustainability outcomes is not easy to measure because of the complex interrelationship among the indicators and the lack of consensus regarding the definition of sustainability in the extant literature. Thus, the choices of indicators are subject to the requirements and viewpoints of the

accessories. However, these viewpoints and requirements are needed to be explained clearly, in order to establish the applicability of sustainability assessments [32,33]. In this study, we have focused on the implications of reverse innovations for sustainability. For this purpose, we measured the capability of reverse innovations to promote sustainability by using a total of nine indicators grouped in three sets of triple bottom line: environmental, economic, and social indicators. These indicators were determined under two conditions. Firstly, these indicators are related to the Sustainable Development Goals (SDGs) shown in Table 2, where we identify the SDGs these indicators are drawn from. Secondly, they were able to measure the sustainability of the reverse innovations under study [34]. However, it is worthwhile to mention that the indicators defined in this study lack universal application, as they are drawn keeping in view the nature of reverse innovations and related SDG themes.

Table 2. Indicators for sustainability assessment and their relationship with sustainable development goals (SDGs).

No.	Sustainability Indicators for Reverse Innovations	Indicators Based on the SDGs
Ecological sustainability indicators		
1	Are these reverse innovations improving the environment users live in, for example, by pollution prevention or pathogen removal/health?	3, 9, 11
2	Are these reverse innovation products material-efficient by being recyclable/reusable?	9, 12, 15
3	Do these reverse innovations cause potential environmental hazards such as noise, waste, emissions, etc.?	9, 12, 15
Economical sustainability indicators		
1	Do these reverse innovations help in making health systems more cost-effective?	1, 3
2	Do these reverse innovations carry a high cost-to-benefit (with regard to health) ratio for the users?	3, 11
3	Do these reverse innovations provide meaningful solutions to their users at affordable prices?	1, 3, 11
Social sustainability indicators		
1	Do these reverse innovations improve the basic living conditions in terms of air, water, food, or shelter?	1, 2, 3
2	Do these reverse innovations improve awareness about healthy lifestyle and customs?	3
3	Do these reverse innovations ensuring better health and well-being for the marginalized people of the society?	1, 3, 11

4. Results

4.1. Automotive Air Purifiers (GoPure)

Deteriorating air quality in China has led to the introduction of automotive air purifiers. A main threat comes from high concentrations of particulate matter in the air such as PM 2.5 and PM 10, as these pollutants can cause life-threatening diseases such as cancer, asthma, and in some cases even a heart attack. This problem was further intensified by the fact that particulate matter was accompanied by volatile organic compounds (VOCs). The deadly combination of particulate matter and VOCs mainly affects four groups: people who are suffering from respiratory issues, pregnant women, the elderly, and children. These groups became the early adopters of in-car air purifiers.

It all started in 2008, when an automotive accessory survey revealed that Chinese drivers are concerned about poor in-car air quality. Therefore, in 2010, Philips devised its first universal model (UAAP) of air purifiers for cars with the help of a local mobility R&D team based in Shanghai. Today, on-board air purifiers are a source of pride for Philips. Currently, Philips is the market leader in terms of market share, followed by VOSSON, 3M, and Midea. In the last five years, this company saw massive year-to-year growth for its air purifiers. Philips acknowledges the key role played by local Chinese engineers in the development of its air purifiers and plans to develop products where

markets are seeking solutions. “China is a leading country in many aspects. Ten years ago, a lot of core innovations were developed in Europe. We have managed to turn it around right now, as we do the core innovations in China” reported Albrecht Kraus [35], Mobility Accessories Business Manager for Philips in China.

Major international and local players such as Panasonic, Hisense, Lenovo, and Haier have also entered the air purifier market. So far, the main advantage of Philips is that it offers an efficient solution to ensure pure air in the car cabins by using HESA plus HEPA filtration, as this technology has no side effects on human health and removes 99.9% of harmful substances. To date, only 2% of the Chinese passenger vehicles are equipped with air purifiers; this represents more room for sales, as having more purified air inside the car than outside is an attractive sales pitch. This seems to be making things easy for Philips, as it is currently the market leader in automotive air purifiers. However, Philips did not position its automotive air purifiers as a health solution but as a lifestyle product that makes driving a vehicle a healthy, fatigue-free experience. As air quality became an even more serious problem, Philips introduced the Air Quality Index (AQI) via APP and device display to help indicate the quality of the air inside the car *versus* the outside environment.

Philips usually uses a below-the-line (BTL) promotion technique to promote its automotive air purifiers by using leaflets, brochures, and product demos at point of sale (POS) and as well as by organizing events aimed at increasing awareness among the target audience. As mass marketing may not be a suitable promotional technique for innovative products such as automotive air purifiers at this stage. The idea is to connect with the early adopters through social media networks, blogs, and search engine optimization. Additionally, organizing campaigns and events at schools and FM radio channels at a later stage is done. This provides real-time information about the working of the product.

Recently, many automobile manufacturers in China have also shown interest in automotive air purifiers (AAP). Additionally, automotive air purifiers are becoming popular in Japan for protection against allergies and asthma as well as to ensure sanitization. These automotive air purifiers produced in China are being exported to the Americas as well as European markets. However, the most significant upcoming opportunity for automotive air purifiers awaits in the Indian market. As India is also an emerging market with highly polluted air, its citizens are facing life-threatening air pollutants such as particulate matter PM 2.5 and PM 10 as well as VOCs such as NO₂ and ozone.

“I am pretty satisfied with profitability of AAP in China and we will look to replicate this success in India, in the coming years” reported Mr. Shen, Automotive Air Purifier Product Marketing Manager for Philips China. At present, 95% of the revenue for automotive air purifiers is being earned from the Chinese market, with more than 200,000 units sold here annually. Total AAP market size is expected to rise to \$1 billion by 2020. Elsewhere, India is a growing market for air purifiers with a total market size of USD \$39 million, expected to grow at CAGR (compound annual growth rate) 50%. India’s air quality shows a regular value of 200–280 with some days going above 400, which is four times the World Health Organization (WHO)-recommended level.

Shen attributes this overwhelming success to the crucial support of top management, who consider automotive air purifiers as a major category of the mobility accessories business. For example, “After a global financial crisis of 2008, Dominiek Plancke, who was then CEO of BG Automotive, vigorously supported automotive air purifiers, as he was of the view that these innovations will be the drivers for growth during difficult times” said Shen.

Internally, the main challenge of organizing reverse innovation is whether the organization has the will and the competence to pursue this strategy. Albrecht was of the view that “Multinational companies, with their headquarters and decision-making centers in highly developed countries, often practice ‘asymmetrical thinking’: [. . .] they believe that developed countries can come up with global innovations, and they often regard innovations in developing countries only fit for local markets. So while they see the need in local-for-local innovations, they cannot imagine that developing countries can innovate on a global scale. It would be interesting to study the root causes for such thinking.

We see the first signs of a paradigm change here, for example, in the mobile communication market, in markets relating to digital connectivity, or in the electrification of mobility.”

Similarly, Shen said that “Reverse innovation is an end-to end process, so if an organization is to pursue reverse innovation, it must possess the same amount of competence in both emerging and developed markets to be successful, especially in terms of marketing and channel capabilities. For example, the China commercial team for AAP products is very experienced, so we are trying to develop the same channel capabilities globally, where consumer insight and acceptable technology level can be different.”

Shen believes that reverse innovation is an expansionary strategy for multinationals; however, the main challenge is to bring the price of the product down to affordable levels. Emerging countries like India have a tariff rate of up to 21% with sales tax at 14.5%, which makes it almost impossible to maintain a healthy profit margin while selling products at a lower rate. Introducing a new product at a higher price in price-sensitive markets like India and China is a detrimental preposition. Nevertheless, Philips charges affordable prices for its products despite its superior quality and features. As one example, in China, for automotive air purifiers, the starting price is 400 RMB. For the rest of the world, the pricing strategy is to keep prices even lower to encourage greater market penetration.

Albrecht is optimistic about the future, and according to him, the “barrier for global expansion is often internal. With the increasing importance of online sales, the consumers in the end will have more and more power to decide which innovation to buy, and they seldom care about the originating country.”

4.2. Noodle Maker/Pasta Maker

The idea of the noodle/pasta maker came from the Kitchen Appliances Innovation & Development Team (KAIND), which is based in Shanghai, China. The main insight was to help Chinese people maintain their traditional art of noodle making, which extends back thousands of years, especially in Northern China, where noodles are a staple food along with rice. The machine is meant to facilitate a new generation of Chinese people to engage in do-it-yourself (DIY) noodles, a skill that had been quickly fading. Another important insight is based on the fact that impurity is a part of our contemporary life, whether related to air, water, or food. Ensuring food safety for avoiding health-related issues is currently an important concern. The noodle maker not only helps us to ensure proper food safety but also provides complete control over the ingredients of the noodles.

This product found a useful application in global markets outside China. The noodle maker was shortly introduced in Japan for making a variety of noodles including udon, ramen, soba, and others. Unlike the Chinese, Japanese people go to restaurants and supermarkets to buy noodles, as they lack noodle-making skills at home. For them, the taste and texture of the noodles is the main concern. The Philips Noodle Maker assists in making tasty homemade noodles with excellent textures. In 2014, noodle maker machines entered the US and Australian markets as pasta makers. The idea was again to ensure food safety and fun-filled pasta making experiences at home. Additionally, the pasta maker was introduced in the European market as well as the South American nations of Argentina and Uruguay.

Philips is also the market leader in the case of noodle/pasta makers, with Joyoung and Midea being its only two competitors. Joyoung presents some competition to Philips in the Japanese market, whereas Midea mainly operates in the Chinese market. Unlike AAP, where the Chinese market represents the major portion of sales, 40,000 noodle maker units were sold in China, whereas 200,000 units were sold in the rest of the world (ROW), with North America being the largest market. Consequently, the Philips noodle/pasta maker is thus far the most successful example of reverse innovation originating from China and making its way uphill to the developed markets. This reinforces the view that meaningful innovations by MNCs in developing markets can successfully disrupt developed markets. Serena is also confident about the continued growth of noodle makers in the Chinese market and predicts that the “noodle maker market will be growing at 30% annually as Chinese people revert to noodle-making traditions and healthy eating habits.”

Convincing people to switch from eating processed pasta to enjoying homemade pasta has been the main volume driver, although the use of processed food represents a major challenge as explained by Serena Wen, Sr. Product and Marketing Manager for KA Consumer Marketing at Philips China: “I consider ‘processed food’ as the biggest competitor. By processed food, I mean consumption of instant noodles, especially in the case of Korea, where people do eat noodles at least twice a week, but those are mostly instant noodles.”

“Internally, I would say the biggest challenge is to hit the mass price points to drive penetration. More research and resources are needed to improve the product and bring down the cost to affordable levels. Top management tends to see the commercial side of the product performance. So, in order to bring down the price, there are two main aspects that play a key role: volume of sales generated by the product and the cost of material used to manufacture the product, and, in the case of noodle makers, sales volume is growing at a slow process, whereas the cost is increasing at the rapid pace of 30% per year,” said Serena.

Nevertheless, Serena sees reverse innovation as an expansionary strategy as the noodle/pasta maker has recently found new markets in Argentina, Uruguay, and some other Europe countries, whereas it is already doing well in North America, Japan, and Australia.

4.3. Philips Ultrasound Machine ElastPQ

Hepatitis B virus (HBV) infection is a major public health problem in China. Approximately 7.18% out of 1.3 billion Chinese are HBV carriers. Additionally, approximately 25% of these patients later develop chronic hepatitis B (CHB), which in turn results in cirrhosis, causing liver cancer in 3%–10% of these patients. Approximately 500,000 Chinese individuals die due to cirrhosis and liver cancer every year, the highest figure in the world.

Until recently, the only way to diagnosis liver cancer was liver biopsy, which is a painful and expensive way to diagnosis this disease. The Philips China Healthcare R&D team in Shanghai recently developed the ultrasound technology ElastPQ. This is a shear wave-based elastography technique that can measure the stiffness of liver tissues expressed in kPa and can be used to find abnormality, as an indication of liver disease. To ensure better assessment, Philips is working in collaboration with several hospitals in China, in order to collect biopsy data. These data are fed into the ultrasound machine database, thus performing simple, accurate, non-invasive, and single-step imaging of liver tissues that is affordable and painless for patients. Currently, only 20% of patients in China have access to this technology, but many hospitals in Western China have been increasingly adopting this technology. “The main driver behind adoption of the technology is government health guidelines in China. Similarly, in the EU, governments recommend that hospitals use elastography to diagnose liver diseases,” said Xiaomin Li, Senior Scientist, Intelligent Clinical Solutions and Services at Philips Healthcare, China.

Ultrasounds ElastPQ, launched in 2012, is still a new product in the market. Its clinical uses continue to be explored. “Clinical uses for this ultrasound technology are still being explored. Medical practitioners are yet to be educated about the benefits of [this] non-invasive method of diagnosis for liver diseases; these market practitioners rely on the high-quality research from the scientists in the field in order to establish the clinical efficacy of the product. Furthermore, like Philips, many other key players in [the] health industry, such as GE, Siemens, and Supersonic, have launched similar products, which is a good sign, as an increase in competition will lead to better quality products available at affordable rates,” said Xiaomin.

5. Discussion

5.1. Organizing Reverse Innovation

The examples presented in the preceding section provide several key insights about how reverse innovation is being organized at MNCs and what the major internal as well as external barriers faced by MNCs in the due process are.

As Albrecht explained, “Reverse innovation can play an important role in a global expansion strategy since it originates from a core (local) insight in an extremely price-sensitive and competitive environment. Only if the value/cost ratio is exceedingly high will it survive the initial market introduction stages in a developing country. From here, it will be easier to penetrate other developing or highly developed countries. The ‘conventional’ innovation approach, starting from innovation in highly developed countries often meets substantial barriers to penetrate into developing countries due to high price points and/or insufficiently developed core propositions.”

In all the three cases discussed in this study, we saw that China was the epicenter for several successful innovations. These results can be further supported by a recent KPMG global automotive executive survey conducted in 2016 [36]. The survey has named China as the #1 place to launch new innovations, as 16% of executives think that China is not only a huge market for business, but it is also the best place for piloting new product ideas. Albrecht [35] believes that “China in particular is an attractive market for growth. Chinese consumers are more and more hungry for meaningful innovations with the right quality and the latest technology.”

In order to further clarify how reverse innovation is being implemented in the case of Philips in China, we used Corsi’s [37] framework to explain global innovation flow in the cases discussed. For an innovation to be a strong case of reverse innovation, it must be one of the cases shaded in dark color in Figure 1. To establish this relationship, we analyzed the three elements required to classify a product as a “reversed product life cycle.”

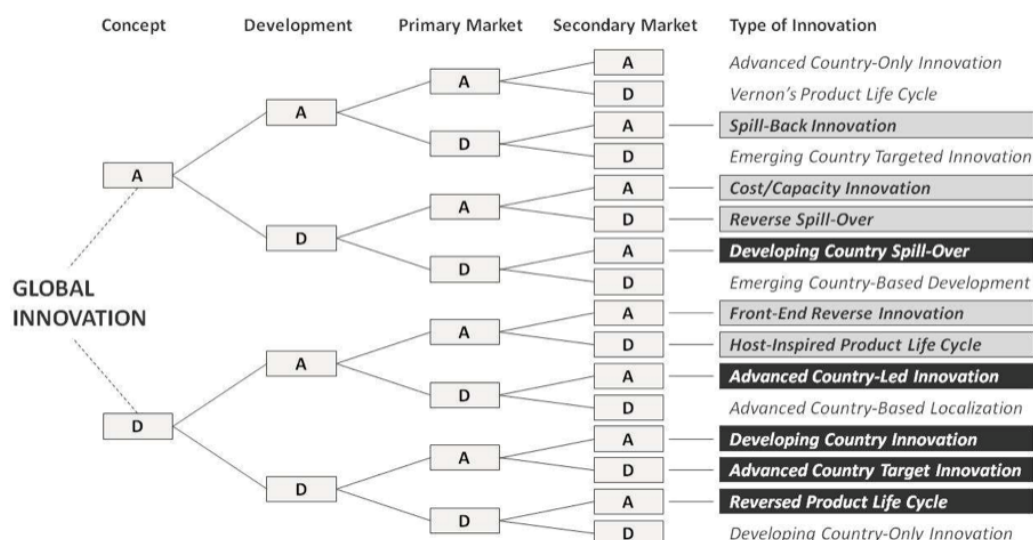


Figure 1. A map of global innovation flow (Adopted from Corsi [37]). Note: “A” stands for advanced country; “D” stands for developing country; black color: strong cases of reverse innovation; gray color: weak cases of reverse innovation; transparent color: not considered as reverse innovation.

Ideation: The first precondition for an innovation to be categorized as reverse innovation is that it should originate from a developing country. In all three cases used as examples of reverse innovation, we found that the origin of the idea was China. In the case of automotive air purifiers, a market study conducted in 2008 about car accessories led to the realization that Chinese drivers are concerned about the in-car air quality. Similarly, noodle makers were developed to ensure food safety and to preserve the extensive history of homemade noodles. In the case of ultrasound technology ElastPQ, the high prevalence of cirrhosis and liver cancer patients among the Chinese population was the keyinsight behind this product idea.

Development: In order for an innovation to be classified as a strong case of reverse innovation, its development must take place in an emerging market. This does not necessarily imply that the product will be inferior in terms of technology. As in the case of MNCs, the local R&D teams borrow

the technological know-how from their Western counterparts. In the above examples, we see that local R&D teams located in Shanghai, China developed all three products.

Market Introduction: Empirical evidence shows that all three products were initially launched in a primary market that is China, and Philips is the market leader in the case of automotive air purifiers and noodle makers. In contrast, for ultrasound technology, ElastPQ Philips is among the leading players along with GE, Siemens, and Super Sonic. Finally, these products found applications in the developed world as well, which introduced them to the secondary market for these products. The noodle/pasta maker is so far the most successful product at home and abroad, with North America being the largest market outside China. In contrast, automotive air purifiers are catching up, as they are being adopted by people with allergies and other respiratory issues.

From the above analysis using Corsi's [37] framework, we can safely establish that the three cases used as examples of reverse innovation can be classified as reversed product life cycle, as they represent the "DDDA" innovation flow shown in Figure 1. These products are inspired and developed in developing markets such as China, and they have been later commercialized in the developed world.

From this case study, we also learned that MNCs can design and diffuse reverse innovation into their strategy by taking three major steps, as demonstrated in Figure 2. Firstly, they need to understand the local constraints: for this purpose, they would be required to conduct robust market research, as companies looking to develop disruptive innovation need to be sensitive about consumer context and convert cues to meaningful innovations [38]. Based on this research, they can launch a pilot product to observe the response of the customer toward the product. This period is marked by low internal gross margin and high cost. Secondly, to manage operations locally means acquiring local capabilities by forging partnerships with local firms as well as providing greater autonomy to the local subsidiaries; these findings are supported by studies by Hang *et al.* [11] and Govindarajan [1]. This will result in the lowering of cost and the development of a better understanding of customer demands. Finally, to achieve frugal innovation, it is necessary to produce locally [39]. This allows firms to avoid paying large sums of tariff applicable to imported goods in emerging markets, while at the same time producing at a low cost. This strategy provides a low-cost manufacturing base for products to be commercialized in developed markets. Since consumer insights as well as technological requirements can be widely different, enabling local teams to engage in continuous R&D efforts to improve the product according to changing customer demands is a necessary strategy, as is developing in-house R&D aimed at exploiting existing technologies in a new context. These methods are crucial to giving birth to disruptive product innovations [11]. The combined effect of high volume of sales and lower production cost will increase the internal gross margin of the firm.

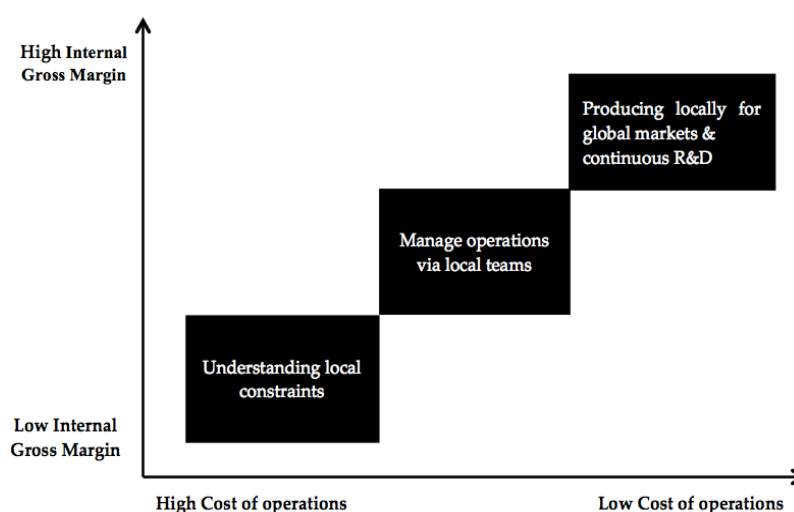


Figure 2. Organizing reverse innovation (authors' own contribution).

5.2. Managing Sustainability

With sustainability being a prominent part of the Philips vision, along with the concrete goal of improving the lives of 3 billion people a year by 2025, this enables it to focus on sustainability and innovation-related efforts. At Philips, the approach toward innovation is to gain a deep understanding of people's needs and to offer solutions that can have a positive impact on their lives. Already in 2015, Philips claims to improve the lives of 2 billion people, measured in terms of people touched by Philips' care, well-being, and green products.

Philips, as per its sustainability policy, strives to make the world healthier and more sustainable through meaningful innovation. Philips is committed to the United Nations Sustainable Development Goals (see Appendix 2-Table A3), which are aimed at improving the lives of people as well as the health of our planet. Philips aims to be a leading private sector participant in achieving sustainable development goals by focusing on the following goals:

Goal 3: Ensure healthy lives and promote well-being for all at all ages;

Goal 7: Ensure access to affordable, reliable, sustainable, and modern energy for all;

Goal 12: Ensure a sustainable consumption and production pattern.

Philips believes that reducing the burden of non-communicable diseases and strengthening local healthcare systems are the crucial components of any strategy to achieve Goal 3. Reverse innovation examples, discussed in this study, seem to fall in line with the effort to defeat non-communicable diseases. Air purifiers provide confidence and reassurance to the people that they are breathing air that is free of particulate matter and germs. Similarly, the noodle/pasta maker is encouraging people to adopt healthier eating habits. Ultrasound machines, on the other hand, serve to strengthen local healthcare systems by introducing this pain-free, low-cost method to assess liver diseases.

Over the years, various sectors of Philips Inc. have worked closely with Philips' corporate technologies to define a portfolio of innovations areas that can safeguard Philips' future success as an organization. These innovation areas include various socio-economic trends, including aging populations and the growth of deadly chronic diseases, increasing the need of health care systems in emerging markets and lifestyle changes. As a result, aspects of socio-economic sustainability are embedded in many innovation-related activities at Philips [40]. We can therefore further classify the examples of reverse innovation discussed in this study into various innovation activities. For instance, Ultrasound ElastPQ and Smart Air purifiers can be defined as care products as they support the curative side of people's health, whereas pasta makers can be referred to as a well-being product, as it supports healthier lifestyle choices.

The need for socio-economic sustainable solutions in emerging markets is very much present, despite the fact that these so-called emerging markets have achieved explosive economic progress in recent years. However, a large population in these emerging markets still suffers socio-economic problems such as pollution, deadly diseases, and food safety concerns. Reverse innovation, with its basic starting point as understanding the local constraints by empowering local teams to manage them, enables the provision of sustainable solutions to these markets. In this case study, we used a triple bottom line—ecological, economic, and social indicators (see Table 3)—to evaluate the extent to which the innovative studies in this paper promote sustainability (see Appendix 2 for the detail of analysis).

Table 3. Summary of sustainability assessment findings.

No.	Sustainability Indicators	Car Air Purifier	Pasta/Noodle Maker	Ultrasound EP
Ecological sustainability indicators				
1	Are these reverse innovations improving the environment users live in, for example, by pollution prevention and pathogen removal/health?	Y	Y	N
2	Are these reverse innovation products material-efficient by being recyclable/reusable?	Y	Y	Y
3	Do these reverse innovations cause potential environmental hazards such as noise, waste, emissions, etc.?	N	N	N
Economical sustainability indicators				
1	Do these reverse innovations help in making health systems more cost-effective?	N	N	Y
2	Do these reverse innovations carry a high cost-to-benefit (w.r.t health) ratio for the users?	Y	Y	Y
3	Do these reverse innovations provide meaningful solutions to their users at affordable prices?	Y	-	Y
Social sustainability indicators				
1	Do these reverse innovations improve the basic living condition in terms of air, water, food, or shelter?	Y	Y	N
2	Do these reverse innovations improve awareness about healthy lifestyle and customs?	Y	Y	-
3	Do these reverse innovations ensure better health and well-being for the marginalized people of the society?	N	-	Y

Note: "Y" represents Yes; "N" represents No; "-" represents Neutral.

5.2.1. Ecological Sustainability

From an ecological standpoint, these three products can be classified as green products. Philips believes in creating products that not only fulfill the brand's promise of high-quality, innovative products at affordable rates, but also works toward reducing the environmental impact by using a product life cycle approach. The focus of this approach is to reduce resource consumption, energy consumption, use of hazardous material, emissions, and packaging material, while at the same time increasing product lifetime and recyclability. For example, car air purifiers are designed and tested for safe use in automotive conditions. The product itself is meant to improve the quality of the air that the users breathe. It should be noted that air purifiers currently lack justifiable clinical evidence in terms of efficacy of these products. Nevertheless, Philips is an enthusiastic participant in defining GB standards for air purifiers in China. These standards helped manufacturers to develop clear and measurable cleaning efficiency claims in terms of CADR (clean air delivery rate) and noise level for their products. Similarly, Philips uses advance and replaceable HEPA (High Efficiency Particulate Arrestance)-based filtration technology. In contrast, some manufacturers use ionizer technology, which has potential negative consequences, e.g., ionizers produce ozone gas, which is hazardous to human health (as listed by the US Environmental Protection Agency and Singapore's National Environmental Agency). Philips has adopted a similar approach for all of its products by continuously working toward reducing their environmental and carbon impact.

5.2.2. Economic Sustainability

Ever since Philips was founded in 1891, it has acted as a sustainable entrepreneur. Today, Philips proactively employs sustainability as a key business driver for health and well-being in developed and emerging markets; thus, it aims to go beyond complying with the regulations. The innovations discussed in this paper potentially increase the disposable income of the users

by providing affordable sustainable solutions characterized by high cost-to-benefit ratios. Air purifiers, for example, significantly reduce particulate matter, bacteria, viruses, and smoke, and are available for a cost as low as USD 100. Similarly, ultrasound ElastPQ is a much less expensive way to assess liver diseases than a biopsy. Similarly, noodle makers save overall cost of consumption while providing considerable control over the ingredients used for making noodles/pasta. These innovations also have the potential to develop into new industries, creating a large number of new jobs. Already, the car air purifiers industry in China has developed at a significant rate in the past four years.

5.2.3. Social Sustainability

Philips strives to engage in business opportunities that address environmental and social issues while creating opportunities for growth and innovation at the same time. For example, the three innovations studied in this paper are all aimed at addressing certain environmental and social issues to ensure the health and well-being of the users. Air purifiers improve the quality of air that users and their families breathe in, ensuring safety against dangerous levels of air pollution (several times more than the WHO's acceptable pollution levels). In-car air is many times more polluted than outdoor air because car air valves are close to the ground and suck in car exhaust from neighboring cars. This deadly air pollution in emerging economies such as China and India is causing diseases like cancer, asthma, and bronchitis. So far, the Philips automotive business group Lumileds has launched several campaigns in China to educate the local population about the threats of air pollution and thus has improved awareness about the air pollution issue and its remedies through effective communication. Similarly, the noodle maker has two important benefits; firstly, it has brought the traditional art of noodle making back to life. Secondly, it has provided a way to ensure food safety by providing control over the ingredients of the noodles. This machine is finding a new market for itself but under a different name, called the pasta maker, which provides homemade pasta. This kind of product will surely compel people to adopt healthy eating habits. Currently, China is the country with the highest number of people who die from liver cancer every year. Liver biopsy is an expensive and painful procedure for the patients suffering from liver diseases. Ultrasound ElastPQ technology is a convenient solution to assess the stiffness of liver tissues and therefore provide a non-invasive way to assess liver diseases. This strengthens local healthcare systems to deal with non-communicable diseases.

6. Conclusions

From the analysis of the cases involved in this exploratory study, it can be suggested that reverse innovation represents the new paradigm change in innovation. This flow of innovation from emerging markets to developed markets can not only cause disruption in developed markets, but the most important contribution can be the uplift in the living conditions for populations living in developing countries by ensuring their health and well-being for all at all ages. This can lead to a sustainable socio-economic change in the developing part of the world. MNCs such as Philips, with a long legacy of serving emerging markets, can be torchbearers for Western MNCs to experiment with reverse innovation and thus exploit the untapped business potential offered by emerging markets. For this purpose, understanding local constraints, managing operations locally, offering new products, and producing locally for global markets can be the ideal toolkit.

6.1. Implications of Reverse Innovation as a Viable Strategy for MNCs in Emerging Markets

All the interviewees were convinced that reverse innovation is not a defensive strategy but that it is an expansionary strategy for the MNCs in emerging markets. There are several different implications of reverse innovation for MNCs, as explained by Pascal Mariner: "For MNC, there is a huge learning opportunity in China based on the competencies and the mindset of the people. For the competencies, MNCs can borrow from the fast speed of development, the well-organized workflow in certain industries, and the fact that Chinese manufacturing can scale, adapt (agility), and learn fast

how to reduce costs. As formindset, there is a huge desire to succeed, and this can also be a motivator. Finally, MNCs can also learn about how to function in a complex and chaotic environment.”

6.2. Implications of Reverse Innovation for the Economy of China

Emerging governments must take note of reverse innovation, as it has implications for the economy, as Pascal mariner argued that “this might help China gets more recognition for other parts of its model than simply producing cheap goods. Reverse innovation would help internationalize some companies or some parts of China’s excellence in manufacturing faster. This would help a lot for China’s soft power.”

7. Limitations

Reverse innovation, as a field of study, is still in its nascent stage, and the extant literature available with regards to organizing reverse innovation at MNCs is very limited. Despite this fact, this investigation responds to the call for more case-studies research. Limited empirical evidence in the literature creates a situation where the authors had to make numerous assumptions with respect to the findings of the study. Secondly, the limitations of the interview method regarding limited access to information in order to protect the confidentiality of sensitive company information provides limited insights regarding organizing reverse innovation as well as the success of these innovations in terms of sales. For instance, in the case of the ultrasound technology ElastPQ, being a scientist, the interviewee was unable to comment on the commercial side of the product. Thirdly, the use of Corsi’s framework, although it fits well, provides limited accuracy to the claims of the authors; more robust evaluation methods can provide more reliable assessment for reverse innovation cases in the future. Finally, the inclusion of examples from multiple MNCs can lead to more insightful findings. Regarding the assessment of sustainability, the most significant problem is the inability of these methods to assess in totality the effects of the practices undertaken toward sustainability, as environmental, economic, and social aspects are usually intertwined and subject to trade-offs.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix 1. Data

Table A1. List of interviewees.

Business Group/Company	Name & Position	Date
Lumileds (Mobility), Philips	Mr. Fangzhong Shen (Product Marketing Manager)	12 August 2015
Kitchen Appliances, Philips	Ms. Serena Wen (Marketing and Product Manager)	2 September 2015
Healthcare, Philips	Ms. Xiaomin Li (Scientist for ElastPQ)	19 November 2015
Lumileds (Mobility), Philips	Mr. Albrecht Kraus (Mobility Accessories Business Manager)	1 March 2016
Swissnex China	Mr. Pascal Mariner (CEO, Vice Consul General)	27 June 2015

Table A2. Additional data sources.

	Topic	Source
1	Product presentations for GoPure Compact and GoPure Slimline Range	Fang zhong Shen Product Marketing Manager, Philips
2	Philips e-store for GoPure Range	Philips official website
3	Philips eyes major role for China in R&D: China Daily	China Daily
4	Product Leaflet Philips Avance Collection	Serena Wen Sr. Marketing Manager, Philips
5	Philips e-store for Avance Collection	Philips official website
6	Philips e-store for Ultrasound ElastPQ	Philips official website
7	Philips Liver Elastography	Philips YouTube channel
8	“How Philips Innovates for Sustainability,” Henk de Bruin Global Head of Sustainability at Royal Philips	Thomson Reuters Foundation News
9	Philips is committed to the United Nations Sustainable Development Goals	Philips official website
10	Philips Annual Report 2014	Philips official website
11	Philips Approach to sustainability	Philips official website
12	Sustainable Innovation-Philips	Philips official website

Appendix 2. Sustainability Evaluation

Table A3. United Nations Sustainable Development Goals (SDGs).

United Nations Sustainable Development Goals (SDGs)
Goal 1 End poverty in all its forms everywhere
Goal 2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture
Goal 3 Ensure healthy lives and promote well-being for all at all ages
Goal 4 Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 5 Achieve gender equality and empower all women and girls
Goal 6 Ensure availability and sustainable management of water and sanitation for all
Goal 7 Ensure access to affordable, reliable, sustainable and modern energy for all
Goal 8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
Goal 9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
Goal 10 Reduce inequality within and among countries
Goal 11 Make cities and human settlements inclusive, safe, resilient and sustainable
Goal 12 Ensure sustainable consumption and production patterns
Goal 13 Take urgent action to combat climate change and its impacts
Goal 14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development
Goal 15 Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
Goal 16 Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
Goal 17 Strengthen the means of implementation and revitalize the global partnership for sustainable development

Table A4. Evaluation table for Car Air purifier.

Sustainability Indicators	Impact	Refs	Supporting Arguments
Ecological			
1. Are these reverse innovations improving the environment users live in, for example, by pollution prevention and pathogen removal/health?	Yes	GoPure Product presentation	<i>“Remove 99% of particulate matter and toxic gases in 1m3 chamber”</i>
2. Are these reverse innovation products material-efficient by being recyclable/reusable?	Yes	GoPure Product presentation	<i>“Filter replacement needed after approx... 6 months use”</i>
3. Do these reverse innovations cause potential environmental hazards such as noise, waste, or emissions etc.?	No	N/A	<i>See Analysis Section 5.2.1</i>
Economic			
1. Do these reverse innovations help in making health systems more cost-effective?	No	N/A	<i>Product has no direct link with the health systems (can be classified as a preventive measure)</i>
2. Do these reverse innovations carry a high cost-to-benefit (w.r.t health) ratio for the users?	Yes	GoPure Product presentation	<i>See Analysis Section 5.2.2</i>
3. Do these reverse innovations provide meaningful solutions to their users at affordable prices?	Yes	N/A	<i>See Analysis Section 5.2.2</i>
Social			
1. Do these reverse innovations improve the basic living conditions in terms of air, water, food, or shelter?	Yes	GoPure Product presentation	<i>“Remove 99% of particulate matter and toxic gases in 1m3 chamber”</i>
2. Do these reverse innovations improve awareness about healthy lifestyle and customs?	Yes	N/A	<i>See Analysis Section 5.2.2</i>
3. Do these Reverse innovations ensuring better health and well-being marginalize people of the society?	No	N/A	<i>Product is meant to be used by the car owners therefore has limited user base</i>

Table A5. Evaluation table for noodle/pasta maker.

Sustainability Indicators	Impact	Refs	Supporting Arguments
Ecological			
1. Are these reverse innovations improving the environment users live in, for example, by pollution prevention and pathogen removal/health?	Yes	N/A	See Section 4.2
2. Are these reverse innovation products material-efficient by being recyclable/reusable?	Yes	N/A	See Analysis Section 5.2.1
3. Do these reverse innovations cause potential environmental hazards such as noise, waste, or emissions <i>etc.</i> ?	No	N/A	See Analysis Section 5.2.1
Economic			
1. Do these reverse innovations help in making health systems more cost-effective?	No	N/A	Product has no direct link with the health systems (can be classified as a preventive measure)
2. Do these reverse innovations carry a high cost-to-benefit (w.r.t health) ratio for the users?	Yes	N/A	See Section 4.2
3. Do these reverse innovations provide meaningful solutions to their users at affordable prices?	-	N/A	See analysis Section 5.2.2
Social			
1. Do these reverse innovations improve the basic living conditions in terms of air, water, food, or shelter?	Yes	N/A	Section 4.2 & See analysis Section 5.2.3
2. Do these reverse innovations improve awareness about healthy lifestyle and customs?	Yes	N/A	Section 4.2 & See analysis Section 5.2.3
3. Do these Reverse innovations ensure better health and well-being for marginalized people of the society?	-	N/A	See analysis Section 5.2.3

Table A6. Evaluation table for Ultrasound machine ElastPQ.

Sustainability Indicators	Impact	Refs	Supporting Arguments
Ecological			
1. Are these reverse innovations improving the environment users live in, for example, by pollution prevention and pathogen removal/health?	No	N/A	<i>Product is a part of healthcare system aimed at assessment of liver diseases and therefore has no direct link with preventive measures</i>
2. Are these reverse innovation products material-efficient by being recyclable/reusable?	Yes	N/A	<i>See Analysis Section 5.2.1</i>
3. Do these reverse innovations cause potential environmental hazards such as noise, waste, or emissions etc.?	No	N/A	<i>See Analysis Section 5.2.1</i>
Economic			
1. Do these reverse innovations help in making health systems more cost-effective?	Yes	N/A	<i>See Analysis Section 5.2.2</i>
2. Do these reverse innovations carry a high cost-to-benefit (w.r.t health) ratio for the users?	Yes	N/A	<i>See Analysis Section 5.2.2</i>
3. Do these reverse innovations provide meaningful solutions to their users at affordable prices?	Yes	N/A	<i>See Analysis Section 5.2.2</i>
Social			
1. Do these reverse innovations improve the basic living conditions in terms of air, water, food, or shelter?	No	N/A	<i>Product is a part of healthcare system aimed at assessment of liver diseases and therefore has no direct link with preventive measures</i>
2. Do these reverse innovations improve awareness about healthy lifestyle and customs?	No	N/A	<i>See Analysis Section 5.2.3</i>
3. Do these Reverse innovations ensuring better health and well-being marginalize people of the society?	Yes	N/A	<i>See Analysis Section 5.2.3</i>

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