This paper was presented at The ISPIM Innovation Conference – Innovation, The Name of The Game, Stockholm, Sweden on 17-20 June 2018. The publication is available to ISPIM members at www.ispim.org.

Frugal Innovations for Food Security: An Australian Case Study

Rajnish Tiwari

Hamburg University of Technology, Institute for Technology and Innovation Management, Am Schwarzenberg-Campus 4, 21073 Hamburg, Germany.

E-Mail: tiwari@tuhh.de

Gerrit Anton De Waal*

RMIT University, School of Management, Building 80, Level 9, Room 62, 445 Swanston Street, Melbourne, Vic 3000, Australia.

E-Mail: gerrit.dewaal@rmit.edu.au

* Corresponding author

Abstract: Increasing population of humans and animal livestock, rapid urbanization and reduction in available arable land coupled with the negative impacts of climate change constitute a major threat to global food security. Implications of this threat can be far-reaching for both developing and developed economies. There is an urgent need to enhance productivity, efficiency and effectiveness in the entire value chain of the food processing industry by employing modern technologies that support "affordable excellence". At the same time, many consumers, especially in the developed world, are voluntarily adopting simplicity and moderate lifestyles, opening new avenues for creating frugal offerings. In this paper, we employ an explorative-qualitative research approach to examine the potential scope of frugal innovations in enhancing food security. The empirical research is set in the context of Australian food processing industry and investigates the current prevalence of frugal practices and their chances and challenges.

Keywords: Frugal Innovation; Global Food Security; Sustainable Development Goals; Food Processing Industry; Affordable Excellence; Australia; Inclusive Innovation; Social Innovation; Global Innovation.

1 Introduction

Around 795 million people, close to 13% of global population, were estimated to be undernourished in 2015, notwithstanding various development gains over the previous decades (FAO, 2015). Moreover, the world population is estimated to increase by another 2.2 billion between 2017 and 2050 reaching 9.8 billion, further driving up global demand for food, especially in the developing economies of Africa and Asia (UN-DESA, 2017). Not included herein is the requirement for fodder for a growing animal livestock for dairy and meat produce (PMSEIC, 2010, Swaminathan and Bhavani, 2013). Projections show

that by 2050 the supply of grains will fall considerably short of the increased demand. To aggravate the matters, yields of major food crops in tropical regions are being adversely affected by the changing climate (UN-ESCAP, 2010). Rising costs for food can push many vulnerable individuals and households into poverty, undernourishment or starvation with potentially severe humanitarian, economic and social implications (Gustafson, 2013).

At the same time, the world is beset with a tremendous loss of raw produce and waste of food due to inefficiencies in the value chains, unsustainable consumer habits and partly due to unreasonable government policies (Gustavsson et al., 2011, Lipinski et al., 2013). Studies estimate that between 27-32% of all food produced globally is either lost or wasted; for fruits and vegetables the share of loss/wastage can be as high as 55% (Ganguly et al., 2017). According to a UNO report, "Much work [.] remains to be done to eradicate hunger and achieve food security across all its dimensions" (FAO, 2015: 4). This awareness partly emanates from the realization that there has been a general lack of investment in agriculture and inadequate attention has been paid to food security. Especially the difficulties faced by small-scale farmers in agro-ecologically poor areas due to the lack of appropriate and affordable technological solutions have been ignored (Gustafson, 2013).

The present paper investigates if and how frugal innovations, targeted at achieving "affordable excellence", can help ensure better food security, greater social inclusion and ecologically sustainable economic development. The study investigates whether and to what extent frugal innovations can contribute to ensure global food security in an environmentally sustainable manner, and what societal, policy and business drivers and barriers need to be addressed.

The study uses a hybrid research design combining elements of qualitative empirical research with conceptual work. The empirical research is set in a single-case context of Australia's food processing industry, allowing us to engage in thick description and identifying potentially interesting patterns (Barzelay, 1993, Eisenhardt, 1991). Australia, as a leading agricultural land, has a globally active food processing industry, which has traditionally focused on serving premium segments. Cost-effective, frugal solutions have generally not been in its focus. In recent years though, it has faced growth challenges (COA, 2012, Nguyen and Terrill, 2018). Combining perspectives from the economically developed world in respect of an issue predominantly prevalent in the developing world is promising since the issue constitutes a global challenge.

This paper is structured as following: after a brief introduction in section 1, we set the definitional framework for this study in section 2. In section 3, we connect food security with frugality, and develop a research framework to interlink these concepts. Section 4 contains our empirical case study and its detailed results. The paper ends with a concluding summary in section 5.

2 Conceptual Background

2.1 Food Security

The concept of food security has evolved from a purely production-driven approach to a more comprehensive understanding that the produced food should also be actually accessible and sufficiently nutritious while catering to social and cultural preferences (UN-ESCAP, 2009). Merely increasing productivity does not necessarily ensure that the produced food actually reaches the people that need it the most (De Rosa, 2018). Food security is, therefore, defined in the following terms:

> "A situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2015: 53).

Food security, thus, consists of four core elements: *availability*, *access*, *utilization* and *stability*. While food availability means that sufficient quantities of food with appropriate nutritious quality are available to a populace, food accessibility is generally concerned with ensuring that people actually have economic (affordable) access to obtain such food. Access can, at times, also be concerned with removing legal, political or social hurdles to obtaining food, but those aspects lie outside the scope of this study. Utilization refers to the capacity of the individuals to consume food in conjunction with an adequate diet, clean water, sanitation and healthcare so that physiological needs are met and a nutritious well-being achieved. Finally, stability is concerned with the capacity of an individual, household or population to withstand sudden shocks, such as economic or climatic crises, without losing access to affordable food (UN-ESCAP, 2009).

2.2 Food Processing Industry

Food processing can be defined as a process of value addition by methods such as grading, sorting and packaging of raw agricultural and horticultural produce with the purpose of making it fit for human consumption, enhancing shelf-life and improving nutritional quality (Tiwari, 2017b). Sub-sectors of the food processing industry include agriculture, horticulture, plantation, animal husbandry and fisheries (Meredien, 2013). **Figure 1** shows the value chain of the food processing industry.

Figure 1 Value chain of the food processing industry.

Source: adapted from Lipinski et al. (2013: 5).

Food processing industry contributes to poverty reduction and enhances food security in rural areas by adding value to, and increasing demand for, agricultural outputs (FAO, 2016).

2.3 Frugal Innovations

Frugal innovations refer to products and services that significantly reduce the total cost of ownership by focusing on core functionalities and reducing non-core features, leading to greater resource efficiency and optimised performance (Prabhu, 2017, Weyrauch and Herstatt, 2016). A study of the media discourse of frugal innovations by Bergmann and Tiwari (2016) showed that generally the following characteristics are associated with

them (in order of relevance): (a) affordability, (b) complexity reduction and simplification, (c) robustness, (d) resource efficiency, (e) focused functionality, (f) user-friendliness, and (g) growth opportunities.

Based on a study of the determinants of acceptance for frugal products, which showed that customers of frugal products and services may be driven by both financial and non-financial considerations (Tiwari, 2017a), this model was subsequently extended to further refine the concept of affordability by explicitly including non-monetary dimensions. Frugal products and services should not be merely ensuring financial affordability to their individual customers, but also should be affordable to the society as such by minimizing externalisation of indirect social costs. Furthermore, they must be affordable in terms of the infrastructure they require for a smooth operation and should ideally either fit in the given eco-system or require minimal, additional investments. Finally, environmental affordability is also of critical importance so that significant reduction in total cost of ownership/usage does not lead to undesirable and avoidable negative ecological impacts, e.g. due to inflationary rebound effects (Tiwari, 2017c).

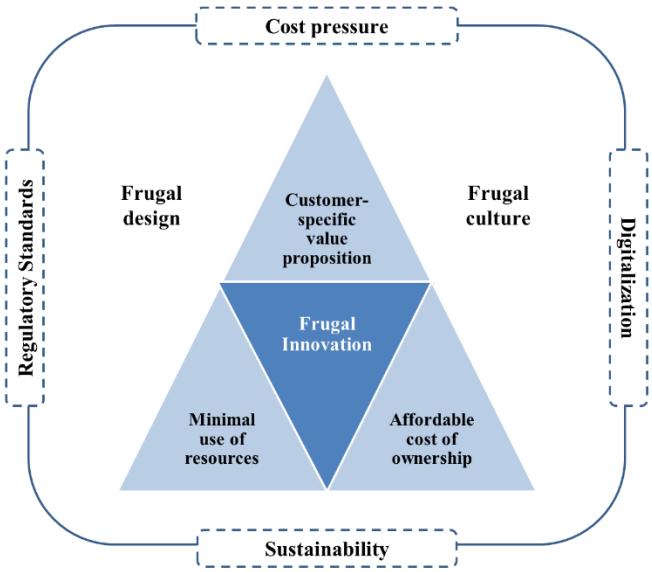

Figure 2 A framework for frugal innovations.

Source: Adapted from Kalogerakis et al. (2017).

As can be seen in Figure 2, frugal innovations, at their core, carry a customer-specific value proposition in conjunction with minimal use of resources and an affordable cost of ownership, which increases their context-specific appropriateness. This generally requires a frugal design and a frugal organisational culture. On the whole, the increasing relevance of frugal innovation is driven by the growing cost pressure, need for ecological sustainability, the increasing regulatory standards and the opportunities provided by digitalization (Kalogerakis et al., 2017). It, therefore, seems likely that frugal innovations have a potentially significant societal impact in both developing economies and industrialized nations (Bound and Thornton, 2012, Kroll et al., 2016).

3 Connecting Food Security and Frugality

3.1 Current & Emerging Challenges for Food Security

Ensuring food security necessitates that nutrient rich vegetables and other food items are produced, processed and made available in the market "throughout the year at an affordable cost to urban and rural population" (Ramachandran, 2013: 375). This seems particularly challenging considering that global demand for food is expected to double between 2010 and 2050, necessitating an annual increase in production worth 44 additional tonnes (cf. COA, 2012). According to projections by Indian Council for Agricultural Research (ICAR), food demand in India alone is estimated to grow even more than 3-fold for certain food items, e.g. meat and eggs, already by 2030 (ICAR, 2011), see Figure 3. The magnitude of this challenge can be illustrated by the example of food grains, whose demand in India is expected to grow from 192 million tonnes in 2000 to 345 million tomes in 2030, absorbing and requiring an additional yield of 5.5 million tonnes every year till then (ICAR, 2011).

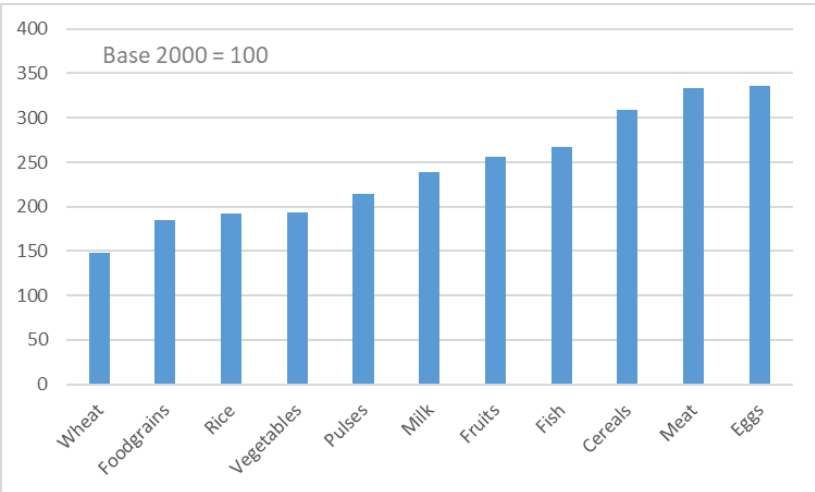

Figure 3 Projected increase in food demand in India between 2000-2030**.**

Source: Authors' illustration based on ICAR (2011) data.

Increasing food-demand and environmental challenges resulting from climate change, land degradation, and loss of biodiversity are intensifying pressure on the system (EMF, 2016: 40). The problem is further compounded by the continuing urbanization, which is reducing the availability of arable land (EIU, 2017, IFPRI, 2017). In words of Swaminathan and Bhavani (2013: 384), a key challenge facing countries, such as India, "is to produce more and more from diminishing per capita arable land and irrigation water resources and expanding abiotic and biotic stresses". Most of the farmers worldwide are smallholders (Ganguly et al., 2017). For example, over 80% of farm-holdings in India are less than 2 hectares in size and many of them live in dry regions, necessitating technologies for dry-land farming (Swaminathan and Bhavani, 2013).

The absence of affordable and effective solutions for storage, preservation and transportation of perishables food products, such as vegetables and fruits, often leads to

unstable prices and uncertain availability (Gopalan, 2013). There is a need for cost-effective solutions along the entire food-processing value chain, from production, processing and logistics right up to consumption, that are affordable and suitable for small-scale operations. Solutions are required for both increasing food yield and ensuring proper access and utilization in a stable manner. Although food security is generally brought in connection with agriculture and the food processing industry, there are other areas which have an intersection with it, such as weather monitoring (Howell et al., 2018), or public infrastructure. According to Vachani and Smith (2008), poor public infrastructure in remote areas of developing economies often leads to high transportation costs of goods. Inhabitants often pay price-premiums in the range of 20-25% for the agricultural inputs and consumer goods in comparison to urban areas. Therefore, innovative solutions that are especially suitable for small-farmers and rural areas have to be developed and disseminated across the entire primary and secondary value-chain. On the other hand, established firms in economically-developed nations have traditionally focused on creating solutions for resource-endowed large enterprises (Ganguly et al., 2017, Kitinoja and Cantwell, 2010, Tiwari, 2017b).

Innovative solutions to control temperature variation during transport, storage and packaging are required to improve the shelf-life of perishable products (Ganguly et al., 2017). A study by Ellen MacArthur Foundation in India's context suggests that digital technologies could provide one effective tool to ensure knowledge and asset sharing, transform food supply chains and enhance resource-efficiency (EMF, 2016). Digital solutions, e.g. virtual platforms with mobile connectivity, could increase efficiency in the value-chain (Ganguly et al., 2017).

Finally, food security is not merely a problem of the developing world. Between 5-14% of populations in industrialized nations, such as Canada, New Zealand, USA, and Australia have been reported as having experienced food insecurity (Lê et al., 2013). Furthermore, industrialized nations are often dependent on import of raw material from the global south, will likely also face the impact of this development on multiple levels, such as difficulties in procurement of raw produce and other commodities necessary for food consumption, industrial production as well as in the form of immigration pressure. In case food scarcity leads to problems in law and order in certain world regions, there may be more refugees fleeing problem-spots for safety and/or economic reasons eventually leading to concerns regarding national security (PMSEIC, 2010). Ensuring global food security – through availability of affordable and sufficient food for everyone – is, therefore, a major challenge and a crucial component of the sustainable development goals (SDGs) of the United Nations in the years to come (EIU, 2017, Tiwari, 2017b, UN, 2018).

3.2 Conceptual Framework

Scholars have brought frugal innovations in connection with food security as a means to "ameliorate intractable social problems that plague developing societies and lead to inclusive growth" (Sarkar, 2011: 240). Frugal (state-of-the-art, cost-effective) technologies for processing plants, food machinery & packaging can help reduce food loss/waste and enhance food security (Tiwari, 2017b). Indian Council for Agricultural Research proposes three measures to minimize post-harvest losses: (a) "compress supply-chain by linking producers and markets"; (b) "promote processing of food commodities

in production catchments to add value before being marketed"; and (c) "develop small-scale processing refrigerated chambers or cold storages using conventional and non-conventional sources." (ICAR, 2011: 14).

There are several cases of successful, frugal solutions in the food processing industry and other related segments of the secondary value-chain that showcase how these can be developed and deployed. For example, ICAR (2018: 73) reports development of a low cost Soil Plant Analysis Development (SPAD) meter to measure chlorophyll content of crop leaves. The SPAD meter has been developed as a compact, hand-held and portable unit that can be connected to android smartphones for display and data logging. The unit can measure the optical density difference at two wavelengths with high accuracy under normal temperature and humidity conditions. While its performance is reported to be similar to other commercial products in the market, with a price-tag of less than USD 75 (Rs. 5000) it is more than 20-times cheaper than existing commercial devices. This device may be used by farmers for assessing nitrogen requirement of the crop. Neethirajan and Jayas (2011: 40) report possible usage of low-cost nano-sensors "in food packaging to monitor the quality of food during various stages of the logistic process to guarantee product quality up until consumption". This can also help take corrective measures, as and when necessary and avoid food losses. Examples from other application and country contexts include production of agricultural equipment and tools with corresponding capacity-building measures for local community in Sudan (Vinanchiarachi, 2006), the development of an IT-based market information system for rural farmers in Kenya that enables substantially lower transaction costs (Mukhebi, 2004). For several more examples, see Annual reports of ICAR, or De Waal et al. (2018).

An analysis of the conceptual considerations and available examples suggests that the development and dissemination of frugal solutions for all parts of the food processing value-chain is co-related with the possibilities of digitalization and capacity building.

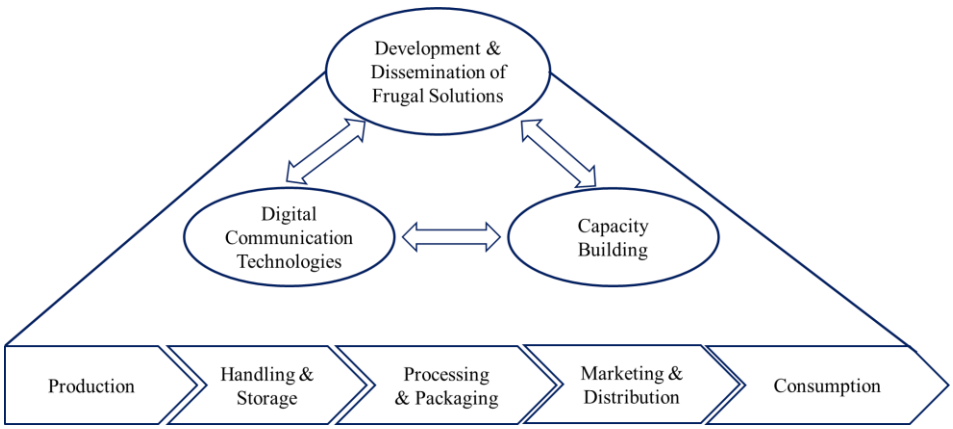

Figure 4 A virtuous cycle of frugal innovations for the food processing value chain.
Source: authors' illustration.

While development and dissemination of frugal (technological and non-technological) targets affordable excellence, these are in many cases enabled by digital, mobile (tele-) communication technologies. On the other hand, digital communication fosters the

diffusion of solutions to their intended target groups and enhances the effectiveness and the efficiency within the supply-chain. Both these factors augment capacity building of relevant stakeholders, which in turn can also help the development of frugal solutions as well as their communication. Thus, together these factors create a virtuous cycle. For the purpose of visual illustration, we combine adapted elements from the "Cycle of Success for African Harvest" model of Hooten et al. (2005) and the food-processing value-chain model of Lipinski et al. (2013), see **Figure 4**.

4 Case Study of the Australia Food Processing Industry

4.1 Research Design

The research approach employed for generating empirical insights is depicted in **Figure 5**. At first, the established global perspective on the emergence of frugal innovations and their potentials and challenges was analysed and published information about its known relevance to the food processing industry collected. In order to generate a nation- and industry-specific perspective we implemented a "knowledge transformation process" consisting of four primary steps. The process began with an industry-specific workshop in collaboration with the RMIT School of Management, RMIT Food Research and Innovation Centre (FRIC), and Center for Frugal Innovation of Hamburg University of Technology (Germany). FRIC's database was used to identify potentially interesting industry experts representing business firms, industry associations, government institutions and academics.

The workshop took place with 20 participants on October 23, 2017 in the premises of FRIC. This workshop itself consisted of four stages. Participants were first asked to participate in a short survey that captured their familiarity with and the understanding of frugal innovation, their perception of its potential relevance to Australia's food processing industry and the challenges associated with its implementation. This was followed by 3 talks by subject-matter experts to familiarize the participants with the established global perspective in an interactive section with open discussion.

This was followed by 3 focus group discussions. The insights generated in the focus groups were documented and the participants again took part in a post-workshop survey whose structure was similar to the pre-workshop survey. This way, changes in perception of the participants after information exchange and group discussion could be tracked. The workshop results were utilized to generated preliminary insights and identify relevant research questions. The conceptual model was then refined and enriched by 8 in-depth expert interviews. For reasons of space, we report here only key points, for a detailed report of the results, please refer to De Waal et al. (2018).

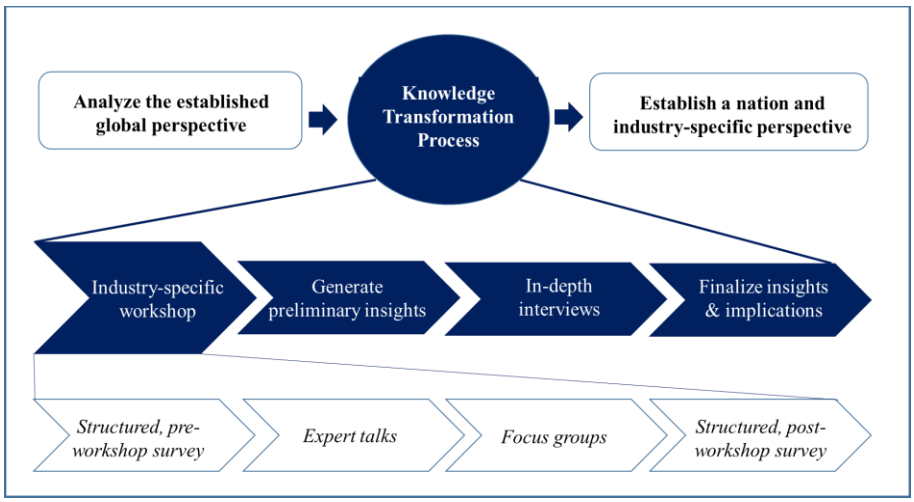

Figure 5 Research design for the empirical study.

Source: authors' illustration.

4.2 A Brief Profile of Australia's Food Industry

The food industry constitutes a "high value sector of the domestic economy" in Australia (DotT, 2011: i). According to a "State of the Industry Report" issued by Australian Food & Grocery Council (AFGC, 2017), the total turn-over of Australia's food and beverage, grocery and fresh produce sectors (together "the industry") totalled AUD 127.4 billion in fiscal year (FY) 2015-16 (AFGC, 2017). The share of food and beverage processing in it stood at almost 82% (AUD 102.4 billion). While the industry accounts for more than 32% of the value-add in Australia's manufacturing industry, it has faced slow growth and the relative share of food and beverage processing in the industry has even seen decline. There were 30,748 businesses active in the industry as of FY 2016-17 and provided employment to 320,302 people. In nominal terms, in FY 2016-17, the industry exported products worth AUD 32.6 billion, while imports stood at AUD 35.3 billion. In real terms (after adjusting for inflation), the exports reportedly registered a decline of 15.4%, while imports remained stable with a reported decline of 0.02%. The USA remains Australia's top-most trade partner (AUD 9.2 billion), but China and India have emerged as new and quite important export destinations. In FY 2016-17, China has, for the first time, topped the list of export destinations (AUD 5 billion), leaving behind the USA (AUD 4.4 billion) and Japan (AUD 3.4 billion). India, too, advanced to the top-7th position as a trade partner with exports worth AUD 1.6 billion, ahead of countries such as Singapore (AUD 1.3 billion), the UK (AUD 742 million), or Germany (AUD 240 million) in the top-10 list. France dropped out of the list altogether.

Domestically, many consumers have turned towards more frugal patterns of consumptions (Chhetri et al. 2009). This trend is also confirmed in a High Level Strategy Group report submitted to the Ministry of Industry and Innovation: "Australians demand value (which includes quality) for money, especially in a fragile world economic environment; their preferences are also changing to healthier, more convenient foods" (COA, 2012: 10).

The Prime Minister's Science, Engineering and Innovation Council has predicted both globally and domestically increasing demand for "Efficiency in food production, processing and distribution and responsibility in purchasing and consumption to reduce wastage and minimise costs […]" (PMSEIC, 2010). Australian businesses and government have identified the opportunities in growing Asian markets and plan to "develop new technologies, processes and investment" to cater to their demands (COA, 2012).

4.3 Empirical Study

4.3.1 Pre-and post-workshop surveys

The workshop participants were asked to rate their perception of certain characteristics generally associated with frugal innovation on a scale of 1 ("agree fully") to 5 ("do not agree"). As **Figure 6** shows, most participants initially associated frugal innovations with focused functionalities, reduction in total cost of ownership, a significantly lower price point and ease of use. The discussions during the workshop led to some interesting changes in perception. For example, the participants in the post-workshop survey ranked the need for creating an attractive value proposition and ensuring robustness and scalability much higher than previously. Ecological sustainability was valued now as high as the need for having a significantly lower price point.

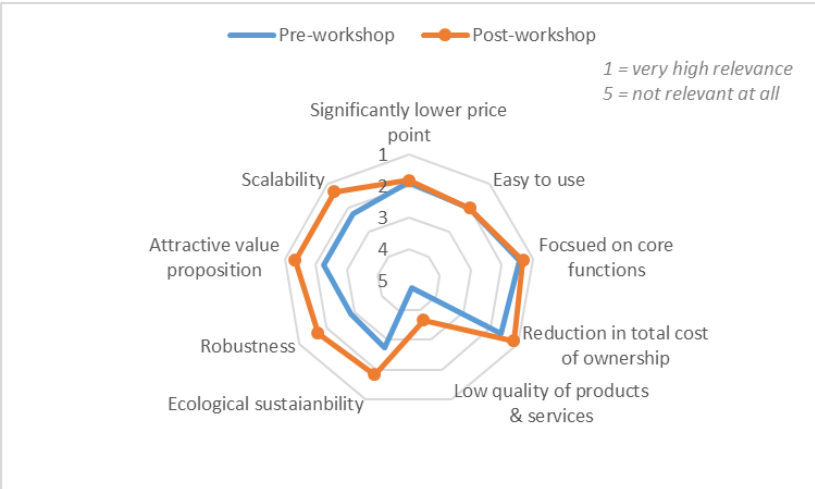

Figure 6 Pre- and post-workshop perception of frugal innovation.

Source: authors.

Overall, the participants seemed to have a positive perception of frugal innovations and only very few people associated them with low quality products & services. In the pre-workshop, most participants associated frugal innovations with emerging/developing economies; ranking them on average with 1.1 on a scale of 1 ("highly relevant") to 5 ("not relevant at all"). Relevance for the domestic market or for other developed economies was ranked lower (1.7, and 1.6 in that order). Ensuring societal access to products (societal participation) was ranked 1.9, while sustainable use of resources was

ranked lowest 2.0. Nevertheless, post-workshop the participants revised their perceptions towards frugal innovations. Their relevance for domestic market was ranked now as high as for the emerging/developing economies (both 1.3). All other dimensions too saw positive changes in the perception.

Asking the participants about the challenges that they associated with implementing frugal innovations in firms also revealed an interesting pattern. While in the pre-workshop most people ranked adaptation of the firm's internal innovation process as the most significant challenge, ranking it 1.8 on a scale of 1 ("very high relevance") to 5 ("not relevant at all"), whereas eventual internal resistance by firm employees was seen as the least important problem (ranked 2.7). In the post-workshop the participants evaluated all the challenges surveyed significantly higher, see **Figure 7**. Insufficient knowledge of actual customer needs and wants was now identified as the most significant challenge.

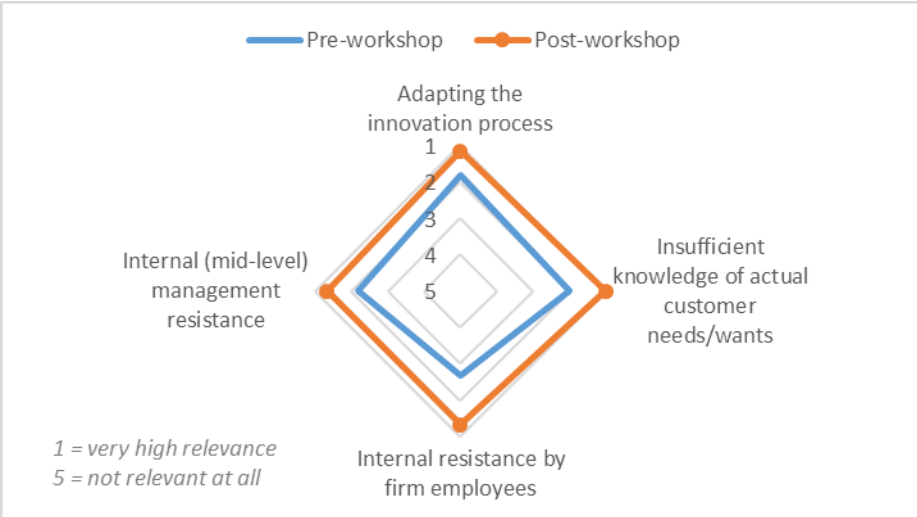

Figure 7 Pre- and post-workshop perception of challenges associated with implementing frugal innovation.

Source: authors.

4.3.2 Results of Focus Groups

Participants were divided into 3 (self-selected) trans-disciplinary focus groups of roughly similar sizes with a discussion period of 90 minutes at their disposal, and at the end present their results in a meeting of all workshop participants and explain their findings. The first focus group deliberated upon the strategic imperative of frugal innovation in Australia, the second group discussed issues related to the implementation of frugal innovation processes and target markets. The third group was tasked to identify challenges associated with frugal innovation in the Australian context. Eventual policy implications were one recurrent theme through all groups.

Strategic Imperative of Frugal Innovation

In terms of strategy, this focus group's deliberation was on the relevance of frugal innovations to Australia's food industry today and how it was likely to change within next 5 years. The group was also supposed to discuss about the underlying factors for this perceived relevance and the eventual policy implications.

The participants agreed overwhelmingly that the Australian food industry, in general, needs to engage in frugal innovation to retain its global competitiveness by utilizing the untapped market potential in the unsaturated and growing economies, explicitly recounting the idiom, "necessity is the mother of inventions". As regards concrete importance for individual firms the participants felt that it will depend on the "world view" of individual firms, shaped by their size, market strategy, and the objectives pursued by the relevant stakeholders. Some participants felt that larger firms would be more likely to engage in frugal innovations, while smaller firms may be more inclined towards focusing on premium segments in the domestic market. Other factors that determine the importance of developing a frugal innovation strategy include the demands of a firm's different stakeholders (the pressure that different stakeholders might exert on the firm to start engaging in frugal innovation), the particular structure of the firm (fully domestic versus some degree of internationalisation), and the (perceived) firm-specific strategic imperatives. For example, do firms perceive frugal innovation as critical to their future sustainability, or is it something they can ignore without negative consequence?

On a policy level, the participants felt the need for "early education" for the relevant stakeholders as well as for domestic consumers to understand the need of frugality and reducing food waste. Some participants explicitly mentioned the need for adapting the "Aussie Culture" towards being more resource-savvy. Need to enable access to funding, especially for high-risk projects, in developing disruptive, unconventional solutions were also mentioned.

Implementation of Frugal Innovation Processes and Target Markets

The second focus group dealt with the topic whether frugality can be implemented in the innovation value chain of the food processing industry in Australia and what parts of the (innovation) value chain are most critical for their successful implementation. In addition, they also discussed which target markets are most promising for Australian food-sector firms, and any eventual policy implications.

The participants felt that there is a strong need for implementing frugality in Australia's food sector and called upon firms to "meet the customer needs and not over". The suggestion was that there is a need for change in the mind-set ("way of thinking") to counter the current practice of "over-engineering". They also emphasized the need for firms to adapt their front-end innovation process to ensure frugal customers' needs are captured correctly and recommended collaborative new product development (NPD) processes with external partners in the new markets they intend to serve, as well as internal cross-functional collaboration. They also felt the need for developing affordable cold-chains and packaging solutions to reduce waste in the developing nations.

As regards potential export markets for frugal products, the focus group, given Australia's geographic proximity, agreed that emerging markets in the Asia Pacific region should be targeted first. In the domestic market, young families appear to be an attractive segment as the high cost of living may enhance their receptivity for frugal

products. Another attractive segments are community-based organisations that normally depend on hand-outs and are driven by low-cost motives as well as customers of organic products that were perceived to be more open for frugal solutions due to ethical/ecological considerations.

In terms of policy recommendations, the participants called upon the government to streamline the regulatory framework. While the high regulatory standards, in general, were seen as a competitive advantage for Australia, the participants also saw tendencies of "over-regulation" in certain respects of safety standards and product norms. For example, the extremely stringent and overcautious best-before and use-by dates were mentioned as adding little value to consumers and drive up costs and food wastage. The group also recommended partnerships with developing nations to transfer food safety skillset to target countries; reducing 'serving size' in Australia and educating the customer-base accordingly.

Challenges associated with Frugal Innovation in the Australian context

The third focus group deliberated upon the challenges that food processing companies are likely to encounter if they decided to pursue strategies for frugal innovation, and how those challenges may differ for individual companies. Especially the question of mind-set was put forward for discussion.

The participants' discussion showed that there were considerable uncertainties regarding the concrete cost implications and customer expectations while simplifying or "going natural". Capturing the *real* customer needs for frugal products was seen as a major challenge by the participants who were unsure of deciding when a product has actually met customer expectations. The second most discussed challenge was to decide in a product-specific context whether there exists a frugal market for it and if yes, who ought to be the targeted customers. Another challenge pointed-out was, how a manufacture can readily adapt his business processes for a cost-effective solution. The group also emphasized a strong role for process management and its strong role in product development. The group agreed that frugal innovation/R&D processes need to be implemented in firms for successful development of frugal products & services. Furthermore, the group recommended a "business culture change" coupled with goal reassessment and leadership endorsement for the frugal innovation strategy in firms. Finally, the group saw defining brand standards as a major challenge, in terms of product positioning "good, better or best" categories with the help of value engineering and wondered whether "good" is already frugal or "can/must be taken further"?
On policy front, the identified challenges imply streamlining of regulatory guidelines so as to provide a better orientation in product development for frugal segments.

Overall, the focus groups revealed considerable openness for frugal innovations and their strategic relevance in Australia's food industry. Nevertheless, there is also a significant amount of uncertainty about who exactly should engage in frugal innovations and how the challenges associated with them can be mastered.

4.3.3 Results of In-depth Interviews

The results of the pre- and post-workshop surveys and the 3 focus groups were summarized into preliminary insights and ascertained in 8 semi-structured interviews with representatives of firms and industry association. The personal interviews lasted between 45-60 minutes.

The experts largely concurred with the findings and confirmed the overall strategic imperative of frugal innovations for Australia's food industry. Some confirmed the existence of their own frugal product lines ("home brands") targeted at cost-conscious consumers, others reported dual strategies – premium products for the domestic market and frugal products for emerging markets in the Asia Pacific. They also confirmed the uncertainties that they believe to be facing in regard to implementing frugal innovation. Some participants raised the issue of how firms would deal with incorporating frugal with their existing brands in ways that won't "harm" their reputation with customers or "cannibalize" into their existing product lines with higher margins.

An additional challenge identified during expert talks was that of consumer acceptance and the consumer perception of quality. Some consumers apparently tend to reject the better-quality-yet-cheaper version of products *presuming* quality deficiencies, suggesting a possible research gap.

4.4 Industry-specific Summary

The case study revealed an interesting picture about the prevalence of frugal innovations in Australia's food industry. On the one hand, the awareness about frugal innovation in Australia was found to be still relatively low. On the other hand, the participants to this study, after listening to the three expert talks at the workshop, were quick to identify very specific opportunities for frugal innovation that include things such as low-cost milk powders, low-cost shredded cheese, more efficient use of fruit and vegetable 'uglies', targeting young families that struggle financially, and a greater exploitation of seafood farming. This shows that a concerted effort is required to educate both the market and food producers of how critically important it is for not only Australia, but the rest of the world, to address the very important issues of food security, as well as to exploit the emerging market potentials in the developing economies and segments of domestic market with attractive product propositions via frugal innovation.

The question of customer acceptance of new products versus trusted and familiar products was raised by more than one expert and at this point it seems necessary to conduct further research to better identify characteristics of domestic consumer segments more receptive for frugal products and services. An impression was gained that innovation strategy of food sector firm in Australia is somewhat "biased" towards product development – e.g. focusing on ingredients, removing sugars, adding health benefits, catering for niches – and not paying sufficient attention to process innovation and addressing improvements within other areas of the value chain.

The study showed that many Australian food processing firms still struggle with frugal innovation. Even if they know about its importance, many do not know where to begin and lack understanding of what the needs of frugal customers are. Compliance matters and regulations reportedly take up much of their time. Some food producers convey the

picture of being risk-averse and hesitate opening-up their innovation process to external partners, especially in the emerging and developing economies.

On the positive side, participants' companies in this study tend to be very aware of issues related to ecological sustainability with regard to both products and responsible ways to running their businesses that includes recycling. They also were found to be aware of increasing customer demand for convenience, healthier and more affordable foods, as well as the organic movement. Thus, the basic openness for frugal solutions seems to be present. It is now rather about reducing uncertainties about the challenges in implementing frugal innovations and about creating a conducive policy framework to support this trend.

5 Conclusions

Factors such as increasing global population (including that of animal livestock held for producing dairy and meat), effects of climate change and unsustainable consumer habits pose a serious challenge to global food security. Apart from the need to increase the yield from crops, there is also a need to ensure a stable and economically affordable access to sufficient and nutritious food to people. Ways and means have to be found to enhance shelf-life of products and minimize loss and wastage of food, opening up new potentials in the entire food sector in general, and for companies in the food processing industry in particular.

Processing of raw agricultural and horticultural produce has been at very low levels in many developing countries leading to widespread losses in transportation. Food processing technology and equipment that could ensure greater resource efficiency and reduce unwanted losses in the value chain have been often developed in the industrialized nations and been generally too costly to afford for many potential customers in emerging economies (Kitinoja and Cantwell, 2010). Food-processing firms in industrialized nations have traditionally aimed at developing premium products for affluent customers in their home countries and other comparable markets. There is a growing need for affordable solutions across the globes, but core rigidities stemming from years of relative success in traditional markets can hinder firms from identifying and exploiting these opportunities (Herstatt et al., 2017).

Our conceptual study supported by qualitative empirical research in the context of Australia's food industry shows that frugal innovations can be employed as a means to ensure better social inclusion and to achieve SDGs. We identify some core drivers and barriers of frugal innovations in the food processing industry. While increasing health consciousness and growing environmental concerns are among key drivers of frugal solutions in the industrialized nations, the imperative for frugal (technological) solutions in the global south lies in the need for affordable machinery in the value chain to ensure greater yield, higher level of processing and reduction in losses incurred in transportation from fields to the consumer. Mind-set issues often lead to development of non-frugal solutions, while many regulatory standards, especially in the developed world, have been set with the intention of promoting technological development and at times inappropriately, and possibly inadvertently, hinder a frugal approach.

Frugal innovations are also found to promote environmental sustainability. Through minimizing over-engineering and by ensuring greater resource efficiency firms are able to reduce their ecological footprint in a focused manner. It was discovered that certain manufacturers of processed food have developed strategies that target at developing food products (e.g. cakes) with less number of ingredients, leading to a reduction in the number of work-steps and therefore in labour and material costs. Furthermore, less number of ingredients are less likely to contain allergenic side-effects so that the size of the potential target customer group increases significantly and the product becomes attractive for health-conscious customers. Through refinement of value chains the unnecessary loss of raw produce can be avoided, and a more conscious consumption leads to less wastage of food. Therefore, frugality is expected to have direct positive implications for sustainable development.

Our study has two-fold practical implications. First, it shows managers and decision-makers in firms the imperative of frugal innovations in the food processing industry, both as a measure to achieve economic growth as well as to cope with resource constraints. Second, it reveals the need for policymakers to recognize the positive effects of frugal solutions in ensuring global food security. These effects can be, however, only achieved if research policies are no more singularly focused on extending the frontier of science, but also take into account social inclusion. Furthermore, policies that inadvertently lead to unnecessary wastage of food products need to be critically examined and recalibrated.

Finally, the present study is based on a conceptual work and intentionally draws on benefits of thick description an in-depth single case study. The research insights generated seem plausible but need further refinement and validation in a quantitative survey. The authors intend to conduct this research in multiple country-settings to enhance its generalizability. Furthermore, the research gaps, e.g. questions of customer need identification and customer acceptance, mind-sets as well as corporate culture, identified in the study constitute future avenues of research in this field.

Acknowledgements

The empirical case study for this paper was enabled by RMIT University's College of Business International Visiting Fellowship for Rajnish Tiwari (Grant no. 341199) in October 2017. The research for this paper has also benefitted from a grant (no. 16|1670) of Germany's Federal Ministry for Education and Research (BMBF) to investigate potential relevance of frugal innovations. Furthermore, Rajnish Tiwari would like to thank Claussen Simon Foundation for supporting his research at TUHH with a generous post-doctoral grant.

References

AFGC 2017. State of the Industry 2017. Barton ECT: Australian Food and Grocery Council, in cooperation with Ernst & Young (E&Y).

BARZELAY, M. 1993. The Single Case Study as Intellectually Ambitious Inquiry. *Journal of Public Administration Research and Theory,* 3**,** 305-318.

BERGMANN, S. & TIWARI, R. 2016. Visibility and Acceptance of Frugal Innovation in German-speaking Countries. *Scientific Symposium on Potentials of Frugal Innovation in Industrial Countries.* Leipzig: Fraunhofer Center for International Management and Knowledge Economy.

BOUND, K. & THORNTON, I. 2012. *Our Frugal Future: Lessons from India's innovation system,* London, NESTA.

COA 2012. *Food Processing Industry Strategy Group: Final Report of the Non-Government Members,* Canberra, Commonwealth of Australia, Department of Industry, Innovation, Science, Research and Tertiary Education.

DE ROSA, M. 2018. Land Use and Land-use Changes in Life Cycle Assessment: Green Modelling or Black Boxing? *Ecological Economics,* 144**,** 73-81.

DE WAAL, G., TIWARI, R. & MCMURRAY, A. 2018. Frugal Innovation in the Australian Food Processing Industry. Melbourne: RMIT University.

DOTT 2011. Australia's Food Processing Sector: Submission by the Treasury to the Senate Select Committee on Australia's Food Processing Sector. Parkes, ACT: Government of Australia, Department of the Treasury.

EISENHARDT, K. M. 1991. Better Stories and Better Constructs: The Case for Rigor and Comparative Logic. *Academy of Management Journal,* 16**,** 620-627.

EIU 2017. Global Food Security Index 2017: Measuring Food Security and the Impact of Resource Risks. London: Economist Intelligence Unit.

EMF 2016. Circular Economy in India: Rethinking growth for long-term prosperity. Cowes: Ellen MacArthur Foundation.

FAO 2015. *The State of Food Insecurity in the World - Meeting the 2015 international hunger targets: taking stock of uneven progress,* Rome, Food and Agriculture Organization of the United Nations (FAO), jointly with IFAD and WFP.

FAO. 2016. *Food and agricultural industries* [Online]. Food and Agriculture Organization of the United Nations. Available: http://www.fao.org/ag/ags/food-and-agricultural-industries/en/ [Accessed October 27 2016].

GANGULY, K., GULATI, A. & VON BRAUN, J. 2017. Innovations spearheading the next transformations in India‘s agriculture. Bonn: Center for Development Research (ZEF), University of Bonn.

GOPALAN, C. 2013. The changing nutrition scenario. *Indian Journal of Medical Research,* 138**,** 392-397.

GUSTAFSON, D. J. 2013. Rising food costs & global food security: Key issues & relevance for India. *Indian Journal of Medical Research,* 138**,** 398-410.

GUSTAVSSON, J., CEDERBERG, C., SONESSON, U., OTTERDIJK, R. V. & MEYBECK, A. 2011. Global Food Losses and Food Waste: Extent, Causes and Prevention. Rome: Food and Agriculture Organization of the United Nations.

HERSTATT, C., TIWARI, R. & BUSE, S. 2017. Innovating for Emerging Markets? An Assessment of German Hidden Champions' Strategies. *In:* BURR, W. &

STEPHAN, M. (eds.) *Technologie, Strategie und Organisation: Festschrift zum 65. Geburtstag von Alexander Gerybadze.* Wiesbaden: Springer Gabler.

HOOTEN, D., GRIFFY-BROWN, C. & WAMBUGU, F. Crossing disciplinary boundaries in technology management: leveraging biotechnology and information technology solutions for feeding children in Africa. PICMET, 2005 Portland. 302-309.

HOWELL, R., BEERS, C. V. & DOORN, N. 2018. Value capture and value creation: The role of information technology in business models for frugal innovations in Africa. *Technological Forecasting & Social Change,* 131**,** 227-239.

ICAR 2011. Vision 2030. New Delhi: Indian Council of Agricultural Research.

ICAR 2018. Annual Report 2017-18. New Delhi: Indian Council of Agricultural Research.

IFPRI 2017. *Global Food Policy Report,* Washington, DC, International Food Policy Research Institute.

KALOGERAKIS, K., FISCHER, L. & TIWARI, R. 2017. A Comparison of German and Indian Innovation Pathways in the Auto Component Industry. *Working Paper no. 100.* Hamburg: Institute for Technology and Innovation Management, Hamburg University of Technology.

KITINOJA, L. & CANTWELL, M. 2010. Identification of Appropriate Postharvest Technologies for Improving Market Access and Incomes for Small Horticultural Farmers in Sub-Saharan Africa and South Asia. Alexandria: World Food Logistics Organization.

KROLL, H., GABRIEL, M., BRAUN, A., MULLER, E., NEUHÄUSLER, P., SCHNABL, E. & ZENKER, A. (eds.) 2016. *A Conceptual Analysis of Foundations, Trends and Relevant Potentials in the Field of Frugal Innovation (for Europe),* Luxembourg: Publications Office of the European Union.

LÊ, Q., AUCKLAND, S., NGUYEN, H. B., TERRY, D. R. & BARNETT, T. 2013. The Paradox of Going Hungry when there is So much Food: The Perspective of Vulnerable Youth and Their Caseworkers. *Journal of Food Security,* 1**,** 10-15.

LIPINSKI, B., HANSON, C., LOMAX, J., KITINOJA, L., WAITE, R. & SEARCHINGER, T. 2013. Reducing Food Loss and Waste. *Creating a Sustainable Food Future.* Washington, DC: World Resources Institute.

MEREDIEN 2013. Indian Food Processing Industry. Mumbai: Meredien Business Consultants Pvt. Ltd.

MUKHEBI, A. 2004. Reaching the Poor in Rural Kenya with Market Information: A case Study of a Market Information System. *CTA Seminaron the Role of Information Tools in Food Security.* Maputo, Mozambique.

NEETHIRAJAN, S. & JAYAS, D. S. 2011. Nanotechnology for the Food and Bioprocessing Industries. *Food and Bioprocess Technology,* 4**,** 39-47.

NGUYEN, N. & TERRILL, D. 2018. *The two-speed food processing industry in Australia: Agribusiness Bulletin* [Online]. Available:

https://www2.deloitte.com/au/en/pages/consumer-industrial-products/articles/two-speed-food-processing-industry.html [Accessed May 7 2018].

PMSEIC 2010. Australia and Food Security in a Changing World. Canberra: The Prime Minister's Science, Engineering and Innovation Council, Govt. of Australia.

PRABHU, J. 2017. Frugal innovation: doing more with less for more. *Philosophical Transactions of the Royal Society A,* 375.

RAMACHANDRAN, P. 2013. Food & nutrition security: Challenges in the new millennium. *Indian Journal of Medical Research,* 138**,** 373-382.

SARKAR, M. B. 2011. Moving Forward by Going in Reverse: Emerging Trends in Global Innovation and Knowledge Strategies. *Global Strategy Journal,* 1**,** 237-242.

SWAMINATHAN, M. S. & BHAVANI, R. V. 2013. Food production & availability - Essential prerequisites for sustainable food security. *Indian Journal of Medical Research,* 138**,** 383-391.

TIWARI, R. 2017a. Frugality in Indian Context: What Makes India a Lead Market for Affordable Excellence? *In:* HERSTATT, C. & TIWARI, R. (eds.) *Lead Market India: Key Elements and Corporate Perspectives for Frugal Innovations.* Heidelberg: Springer.

TIWARI, R. 2017b. Propositions for a high-quality, affordable and sustainable Food Basket: Scope of cooperation between India & Germany in areas relating to food processing industry. Hamburg: Consulate General of India.

TIWARI, R. 2017c. Prospects for frugality in the developed world *InnoFrugal 2017.* Helsinki: The Nordic Frugal Innovation Society.

UN-DESA 2017. World Population Prospects 2017 – Data Booklet. New York: United Nations - Department of Economic and Social Affairs (Population Division).

UN-ESCAP 2009. *Sustainable Agriculture and Food Security in Asia and the Pacific,* New York, United Nations' Economic and Social Commission for Asia and the Pacific.

UN-ESCAP 2010. *Economic and Social Survey of Asia and the Pacific 2010: Sustaining Recovery and Dynamism for Inclusive Development,* New York, United Nations' Economic and Social Commission for Asia and the Pacific.

UN 2018. The Sustainable Development Goals Report 2017. New York: United Nations.

VACHANI, S. & SMITH, N. C. 2008. Socially Responsible Distribution: Distribution Strategies for Reaching the Bottom of the Pyramid. *California Management Review,* 50**,** 52-84.

VINANCHIARACHI, J. 2006. Grassroots Innovations Serving as Rural Growth Impulses. *The 15th IAMOT (International Association for Management of Technology) Conference.* Beijing.

This paper was presented at The ISPIM Innovation Conference – Innovation, The Name of The Game, Stockholm, Sweden on 17-20 June 2018. The publication is available to ISPIM members at www.ispim.org.

WEYRAUCH, T. & HERSTATT, C. 2016. What is frugal innovation? Three defining criteria. *Journal of Frugal Innovation*, 2**,** DOI 10.1186/s40669-016-0005-y.