

Overcoming Barriers to Frugal Innovation: Emerging Opportunities for Finnish SMEs in Brazilian Markets

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“*Industry, perseverance, and frugality make fortune yield.*”

Benjamin Franklin (1706–1790)

Polymath and a Founding Father of the United States

Frugal innovation has become a popular concept, in academia but also in industry at large. Although there has been a great deal of discussion about the relevance of frugal innovation to the developed world, the notion’s full acceptance within small and medium-sized enterprises (SMEs) still seems far in the distance. The opportunities and barriers seen with practical implementation of frugal innovation during the development processes have received little attention. This article considers these opportunities and barriers in the context of Finnish SMEs, providing insight specifically into the approaches these companies take in Brazilian markets. Qualitative data were drawn from a case study forming part of an extensive action research-based development project called SCALA, aimed at creating suitable and scalable mobile learning services for global markets. The concepts of frugal innovation and proceeding from user needs – essential parts of the development processes – are examined by observing three Finnish SMEs and their top managers, with particular focus on their interaction with Brazilian partners. Development sessions and meetings shed light on how the companies perceived and responded to testing their products/services with six individual schools in Brazil. Although frugal innovation is seen as essential for guaranteeing long-term competitiveness of Finnish SMEs – and access to rapidly growing, unsaturated emerging markets such as Brazil can be a step in the right direction – our study highlights numerous barriers and ways to overcome them in the real-world implementation of frugality in SMEs’ development processes.

Introduction

Frugal innovation has become a popular concept, in academia and industry alike. Over the years, this phenomenon has been seen as relevant not only for emerging markets (Hart & Christensen, 2002; Prahalad, 2010) but also for developed ones (Radjou & Prabhu, 2015; Weyrauch & Herstatt, 2016). Advanced economies with under-served customers are in dire need of low-cost products and services. Moreover, lacklustre growth, aging population bases, environmental constraints, growing demand for sustainability, and other factors create pressure for more frugality-oriented models of production and consumption in the developed world (Bound & Thornton, 2012; Hossain et

al., 2016). To serve poorer consumers in advanced economies, a frugality mindset associated with bottom-of-the-pyramid strategies must be instilled in firms and inherent in their business models (Angot & Ple, 2015). The necessity of such a mindset is becoming increasingly apparent: scholars and practitioners have now recognized its importance for businesses. This has pushed many to study the applicability of frugal innovation to advanced economies (Bound & Thornton, 2012; Fraunhofer ISI & Nesta, 2016; Tiwari et al., 2016).

Even though the results of these studies point to the importance of frugality-oriented products and services in advanced economies, the application of frugal innovation in most companies still remains far from reality.

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Multinational corporations display gradual strivings towards the acceptance of frugality in resource consumption or production, with examples being General Electric's culture of simplification, the Siemens SMART strategy, and Pearson PLC's frugal innovation strategy. However, there are many barriers to scaling up frugal solutions to larger markets. A recent study conducted for the European Commission (Fraunhofer ISI & Nesta, 2016) pointed to such obstacles, which include "possible disconnection between producers and users, the way producers conceive and develop the production and delivery processes of their frugal solutions, and different implications that tend to occur like standardization in the production processes." The small and medium-sized enterprises (SMEs) in advanced economies are finding it even more challenging to incorporate frugal strategies into their business.

As the relevance of frugal innovation grows, numerous efforts to understand this concept are being made. Most of the publications addressing frugal innovation have been attempts to propose frameworks to enrich our understanding of the concept of frugal innovation. Scholars have conducted both qualitative and quantitative studies to systematize the literature on frugal innovation. This is done by contrasting it against other forms of innovation, such as *jugaad* innovation in India (Radjou & Prabhu, 2014; Radjou et al., 2012), reverse innovation (Govindarajan & Ramamurti, 2011), grassroots innovation (Smith et al., 2014), bottom-of-the-pyramid innovation (Prahalad & Hart, 2002), and good-enough innovation or constraint-based innovation (Zeschky et al., 2014). Others have made efforts to address specific characteristics or provided definitions of frugal innovation (Brem & Wolfram, 2014; Tiwari & Herstatt, 2012; Weyrauch & Herstatt, 2016). Many other scholars have attempted organized surveys of research on frugal innovation (Hossain, 2016; Pisoni et al., 2018).

Earlier studies provide fruitful ground for understanding frugal innovation, including concepts related to it; prerequisites for it; defining criteria, characteristics, and attributes; and categories that can aid in identifying its similarities and differences in relation to other pertinent concepts. Notwithstanding the valuable contributions already made, a need remains for a study that investigates the opportunities and barriers linked to frugal innovation in practice in the development processes of SMEs in advanced economies.

Even though frugal innovation has received a lot of academic attention as an important underpinning for the

developed markets of the future, the approach by which it can be incorporated into firms' development processes needs further elucidation. Accordingly, we conducted a study, using data from work on the Scalable Mobile Learning Services for Global Markets (SCALA) project on conducting mobile-learning research and developing frugal-innovation knowledge and research for developing markets in Brazil.

For the purposes of this article, we adhere to Radjou and Prabhu's (2014) definition of frugal innovation: "Frugal innovation is the ability to do more with less by creating more business and social value while minimizing the use of resources such as energy, capital and time". Additionally, the study emphasizes the bottom-up development processes of Finnish SMEs towards meeting Brazilians' actual needs and designing adaptable solutions and services for them (Basu et al., 2013; Ostraszewska & Tylec, 2015). We discuss the potential of frugal innovation in Finnish SMEs, and we explore how they can use bottom-up development processes to overcome barriers when approaching emerging markets. The purpose of the study is to investigate three Finnish SMEs aspiring to scale mobile and virtual learning solutions and services to Brazil.

The work is structured thus: in the next section, we discuss frugal innovation as an opportunity for Finland. We also look at the prospects for Finnish SMEs in emerging markets. Then, we provide an overview of mobile learning services for Brazilian markets and explain our methods and approach. In the results section, we discuss the potential needs and barriers facing mobile and virtual learning services in Brazil. Final discussion and conclusions describe possible limitations of this study and potential traps, along with opportunities for overcoming them.

Frugal Innovation as an Opportunity for Finland

Frugal innovation is much more than low-cost innovation, even though it is generally viewed as such. It involves reconsidering the nature of innovation: "Frugal innovation is not just about redesigning products; it involves rethinking entire production processes and business models" (Soni & Krishnan, 2014). According to Prahalad and Mashelkar (2010), frugal innovation is about "doing more with less for more people". Frugal innovations are considered to be potentially disruptive and transformational, not only for emerging markets but also for developed markets (Immelt et al., 2009).

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Frugal innovation is strongly user-oriented; it is a creative approach to problem-solving that starts with user needs and works from the bottom up to develop contextually appropriate solutions (Fraunhofer ISI & Nesta, 2016). It is understood as a “holistic rethinking of products, services, underlying processes and business models so that companies can squeeze costs and expand the customer base, business and profit” (Jagati, 2011).

Even though the practice of frugal innovation had its beginnings in emerging markets and is generally seen as a necessity of resource-constrained economies, it is absolutely relevant to Finland and indeed to advanced economies in general. Among many other factors influencing Finland, pressing problems such as environmental constraints, an aging population, and highly saturated markets make frugal innovation highly relevant and applicable nationally.

The demand for frugal innovation within Europe – again, not only in Eastern Europe but also in developed economies – is likely to grow, in response to socioeconomic and demographic change and increasing resource constraints (Fraunhofer ISI & Nesta, 2016). Therefore, it is clear that underprivileged consumers too must be served in Finland. Moreover, this demand in the Finnish context will only escalate on account of lacklustre economic growth. In addition, frugal innovation has potential for tackling public-policy challenges in Europe such as delivery of good public services and promotion of social and economic inclusion (Fraunhofer ISI & Nesta, 2016). In a similar vein, frugal innovation, especially in terms of high-quality public services and ecological sustainability, seems highly relevant to Finnish society overall.

In addition, the role of technologies in frugal innovation seems significant. The “frugal potential” of many technologies has so far been under-explored (Fraunhofer ISI & Nesta, 2016). According to rankings in a report compiled by the United Nations Development Programme (UNDP), Finland is the world’s most technologically advanced country (Cordis, 2001). It is highly plausible that digital technologies could be utilized accordingly to deliver numerous frugal solutions to emerging markets; however, Finnish firms require deeper knowledge of frugal innovation and emerging markets in their bottom-up development processes, particularly if they are to supply frugality (i.e., the same or new for less) in their learning solutions and services (Basu et al., 2013; Hautamäki, 2016; Ostraszewska & Tylec, 2015).

Prospects for Finnish SMEs in Emerging Markets

In Finland, even though advocates of frugal innovation, among them business experts, entrepreneurs, scholars, and consultants, have started to market frugal innovation to Finnish companies (especially SMEs) for its potential, it is still not recognized as something significant enough to be pursued. This is regrettable given that emerging markets offer huge opportunities for Finnish firms. To avail themselves of such opportunities effectively in these markets, firms need to embrace frugal innovation and inculcate a frugal mindset so as to stay competitive in these markets. With the purpose of providing consumption opportunities to non-affluent consumers, a price-sensitivity consideration has to be incorporated into the firm’s business models (Prahalad & Hart, 2002; Wooldridge, 2010). At Finnish SMEs, the key precondition for frugal innovation is instilling a frugal mindset for development of low cost innovation. Firms need to “change the mindset of the employees, by changing the culture of the organization” (Agnihotri, 2015). Finnish firms need to adopt a new mindset, thereby understanding that making a profit is still possible in the case of low prices – through scalability (Hautamäki, 2016). Moreover, within this context, Finnish SMEs can choose to adapt their strategies to the principle of basic functionality at low costs.

Winter and Govindarajan (2015) recommend that, in designing frugal innovations, firms should avoid five “traps” by applying five specific design principles. The first trap is matching market segments to existing products, which can be overcome by defining problems independently of preexisting solutions. The second trap is trying to reduce prices by eliminating features; this trap, in turn, can be avoided by creating an optimal solution, not a watered-down one. Another trap is to neglect to think through all technical requirements. It can be avoided by analyzing the technical landscape behind the consumer problem. The fourth trap, neglecting stakeholders, can be sidestepped by testing products with as many stakeholders as possible. The final trap is to forget that products designed for emerging markets could have global appeal. Firms can overcome it by using emerging-market constraints as tools to create global winners.

According to Hautamäki (2016), Finnish firms have to improve their capabilities if they are going to produce frugal solutions. First of all, they need better knowledge of frugal engineering and bottom-of-pyramid markets. Second, they need to have better access and connec-

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tions to emerging markets. Third, they must also develop partnerships with local agencies and enterprises in emerging markets for establishing solid marketing and distribution channels. Fourth, they need to establish true, deep collaboration on innovation and production, marrying Finnish competencies in engineering and in information and communication technologies with the vast production capacities and low costs of emerging markets. Lastly, a need exists to build vibrant global business ecosystems between Finland and emerging markets.

Frugal innovation is essential for securing long-term competitiveness of Finnish SMEs. For organizations armed with this tool, access to rapidly growing, unsaturated emerging markets such as those in Brazil can be a step in the right direction.

Mobile Learning Services for Brazilian Markets

Revenues for mobile learning products and services in Brazil reached \$338.3 million USD in 2014 (Adkins, 2015). The growth rate is a robust 25.7%, and revenues are projected surge to over \$1.0 billion USD by 2019. Brazil generates Latin America's largest revenues for mobile learning, by a wide margin; they are four times higher in Brazil than in Mexico, the region's second-largest buying country (Adkins, 2015). In April 2015, Brazil had a population of just over 200 million people. Brazil accounts for one third of all mobile users in Latin America and is adding a million mobile-subscription users per month. As of May 2015, over 38% of the population accessed the web via mobile devices, with 8.7 million of these people using only mobile devices to access the Internet (Adkins, 2015).

More than 52 million smartphones were sold in Brazil in 2014, and 95% of all phones sold in Brazil are smartphones. By the end of 2014, 6.7 million 4G-enabled smartphones were in use there, marking a 416.5% increase from 2013 levels. Brazil's 4G users (31.7% of the population) are concentrated in São Paulo. In addition, more than 9.9 million tablets were sold in Brazil in 2014 (Adkins, 2015).

In Brazil, consumer users dominate the mobile learning market. The nearly recessionary economy notwithstanding, consumers are still buying mobile learning apps and edugames, and they are subscribing eagerly to value-added service (VAS) products for mobile learning. Usually, struggling economies see consumer spending diminish dramatically, but conditions have not

stopped Brazilians from buying mobile learning products, especially ones related to language learning and early childhood learning. These value-added services for mobile learning are reasonably priced, from \$2.50 to \$6.00 USD per month, and hence attract millions of consumers. It is estimated that the consumer segment of the market will account for above 60% of all mobile-learning revenues in Brazil in 2019 (Adkins, 2015).

Across Latin America, there were 38 mobile learning VAS products on the market in 2015, of which 13 were found in Brazil. Most of the mobile learning products are designed for consumers, though there are products on the market designed for schools. In addition, managing training and education services generally, not just institutional ones, requires supporting enormous user bases, and few suppliers can scale their service solutions to that extent. Therefore, revenues from these mobile learning products are somewhat limited, to those few companies that have the resources to scale their services to any quantity of users (Adkins, 2016).

Methods

Background

The empirical data used in the study come from a case study that formed part of a wider research and-development-based project, connected with SCALA, a project (programmed for September 2016 – April 2018) in which mobile-learning research is conducted and knowledge and research related to frugal innovation for developing markets in Brazil are developed. The research and development work of the SCALA project is funded by Business Finland (the national public funding agency), which is also actively supporting Finnish companies in accessing emerging markets through various services and programs.

Despite the challenging situation of the Brazilian economy, consumers there are keenly buying mobile learning products, which is not often the case in struggling economies. In addition, the interest in Finnish education and learning services is already high in Brazil.

Our research approach was experimental, learning- and business-driven, and iterative, and our study involved three Finnish case companies, researchers, and Brazilian research partners.

The aim of the study was to test the existing online learning services of the Finnish companies and obtain

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authentic feedback from the users (students and teachers) in Brazil, thereby enabling the further development of the services in a simplified manner. Moreover, the companies were eager to create contacts in emerging markets through their collaboration with Finnish research partners and Brazilian education partners. The case companies were small and medium-sized organizations operating nationally and internationally in the online learning business. Two case companies were providing learning solutions for mathematics or language skills, and the third one offered a virtual learning environment, which began testing with Brazilian partners more comprehensively in early 2018.

For this research, a case-study-based research strategy was chosen because of its capabilities in explaining and describing complex social phenomena. The need for a case study arises out of the necessity to understand the opportunities and barriers related to frugal innovation. The case study is an ideal strategy when the researcher has little control over events and when the focus is on a contemporary phenomenon in a real-life context. Therefore, specifically, a case study is the method of choice when the phenomenon studied is not readily distinguishable from its context (Yin, 2009).

This case study was qualitative. Qualitative researchers tend to collect data in the field at the site where the par-

ticipants experience the issue or problem under study. This up-close information gathered by actually talking to people directly and seeing them behave and act within their context is a core characteristic of qualitative research (Creswell, 2007). The data collection in case-study research is usually extensive, drawing on multiple sources of information (Creswell, 2007). The empirical data in our case came from development sessions, learning-solution testing, and pilot weeks with Brazilian students and teachers (Table 1). Additionally, face-to-face and online meetings with the SCALA project group in Finland and Brazil are part of the dataset, alongside background inquiries from the Finnish SMEs. The documentation used in this study consists of notes, emails, written background inquiries, observations, video recordings, photographs, and shared written and verbal feedback.

In this case study, the researchers were not solely observers; they took part in the jointly designed pilot weeks and testing as developers, users, or facilitators. Whatever the roles of the authors were in the course of the research, the first author is aware that a position internal to the study influences the way one interprets data (particularly related to the pilot weeks in Brazil). Mindful of such issues, the researchers analyzed the data in cooperation, and the case companies and other participants from the project group reviewed the res-

Table 1. Outline of the data gathering

Timeframe	Testing Content	Data	Documentation	Participants
March 2017	<ul style="list-style-type: none"> Online learning solutions in Java, math, and English 	<ul style="list-style-type: none"> 6 schools 6 student groups 	<ul style="list-style-type: none"> Notes, photographs, and a questionnaire 	<ul style="list-style-type: none"> 180 students 9 professors/teachers 2 researchers
October 2017	<ul style="list-style-type: none"> Mobile learning apps: 4 math apps & 4 English apps 	<ul style="list-style-type: none"> 6 schools 8 student groups 	<ul style="list-style-type: none"> Notes, photographs, video recordings, and a questionnaire 	<ul style="list-style-type: none"> 144 students 8 professors/teachers 2 researchers
November 2017	<ul style="list-style-type: none"> Newly developed 8 mobile learning apps (math & English) 	<ul style="list-style-type: none"> Workshop 	<ul style="list-style-type: none"> Notes, photographs, and co-created written materials 	<ul style="list-style-type: none"> 33 students 2 company representatives 4 teachers 2 researchers
September 2016– March 2018	<ul style="list-style-type: none"> Virtual learning environment 	<ul style="list-style-type: none"> Project meetings Learning/testing meetings (ongoing until end of March, 2018) 	<ul style="list-style-type: none"> Notes, videos, presentations, and co-created learning content 	<ul style="list-style-type: none"> Varied approx. from 6 to 24, CEOs, professors, teachers, researchers, or students

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ults collectively at the project meetings. The data-based inquiry was based on content analysis – for example, evaluating the common themes that arose, adversarial feedback, user experiences, and suggestions for improvements of the learning solutions tested.

The data-gathering process

Two week-long pilot implementations were carried out in the São Paulo region in 2017. In March, 207 students aged 12–46 and in October, 144 students aged 13–52, from basic education and adult vocational schools, participated in the testing, which covered Finnish online learning solutions (in the first pilot study; see Table 2) and mobile application prototypes (in the second; see Table 3). Each testing session lasted approximately 1–1.5 hours.

In March, Java programming, mathematics, and English e-learning content formed the core of the pilot phase. The existing Finnish learning solutions were not adaptable as such to the Brazilian schools and education systems, and therefore in-depth testing sessions and comprehensive user experience from students and teachers were required to develop human centric, easy-to-use adaptable designs for Brazilians (Basu et al., 2013). Because the learning solutions were not yet optimized for usage on a mobile device, students tested them primarily via different browsers on their smartphones (mainly with an Android system). Additionally, some student groups combined use on smartphones and personal computers. For younger students, teachers incorporated the testing into the course or led the testing via a laptop computer with screen content projected for the whole classroom.

One of the significant outputs of the pilot in March 2017 indicated that online learning services as such are not marketable in Brazil. Instead, mobile learning applications are desired and willingly used. Based on the given feedback and to meet the mobile-learning requirements of Brazilian students, for the second pilot week, eight distinct mobile application prototypes were co-created by Finnish students of business information technology and two case companies. Four applications concentrated on mathematical skills, and the other four were created for learning English. Executing the required changes in their learning solutions, within the timeframe of the project, was rather challenging for the case companies. Hence, the Finnish students were involved to allow the development of learning solutions to continue. The case companies instructed and supported the students' work. Furthermore, students were

keen to co-create solutions for companies' real-life problems and simultaneously receive credits towards their studies.

In addition to the testing of mobile-learning applications, there were several meetings with Brazilian professors and personnel from several schools. The aim of these meetings was to establish separate piloting with the third Finnish case company, scheduled for implementation in early 2018 and expected to last six weeks. The virtual learning environment and the learning context of waste management will form the core of the piloting, with the virtual platform of the case company having been pre-tested with a broad spectrum of teachers from Finland and Brazil in 2017. Additionally, that virtual platform has been utilized in online meetings among the project partners.

Results and Discussion

The aim of this study is to emphasize the bottom-up development process of Finnish SMEs in meeting the actual needs of Brazilian users and designing adaptable solutions and services for them (Basu et al., 2013; Ostraszewska & Tylec, 2015). The starting point for technology development typically is technology-centered and assumptions are made concerning the needs of the users. The existing Finnish learning solutions were not adaptable as such in Brazil, thus it was necessary to conduct in-depth testing sessions and to gather comprehensive user experiences from students and teachers.

The teachers had worked hard to familiarize themselves with the Finnish learning services, to understand the opportunities they represented in Brazilian teaching, and to prepare the classes to integrate the use of mobile learning services into their students' learning processes. The feedback from Brazilian students and teachers in the first pilot week (in March 2017) indicated a fundamental need for mobile learning applications that comprise offline solutions alongside online platforms. The Android system was highlighted especially strongly during the development process, because Android smartphones are widely used in Brazil.

All the teachers supported the sessions and guided the researchers from Finland in negotiating the language differences between Portuguese and English during both pilot weeks. Very important information was gathered in October also, related, for example, to the editors used by the mathematics applications and to applying pedagogical approaches that should enhance the

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Table 2. The first pilot study in Brazil in March 2017, which focused on online learning solutions

School	Ages	Participants	Subject
Brisabella <i>Escola Estadual Professora Brisabella de Almeida Nobre</i>	12–13	36	English
	15–16	26	Math
FSA <i>Colégio da Fundação Santo André</i>	18–46	29	Math
	19–27	46	English
Alcina <i>EME Prof Alcina Dantas Feijão</i>	13–14	16	Math
	18–26	19	Java
	18–26	8	English
USCS <i>Municipal University of São Caetano do Sul</i>	20–34	27	Java
Total		207	

Table 3. The second pilot study in Brazil in October 2017, which focused on mobile learning applications

School	Ages	Participants	Subject
FSA <i>Colégio da Fundação Santo André</i>	19–46	24	Math
FSA <i>Colégio da Fundação Santo André</i>	14–15	25	English & Math
Brisabella <i>Escola Estadual Professora Brisabella de Almeida Nobre</i>	14–15	26	English
	14–15	27	Math
Alcina <i>EME Prof Alcina Dantas Feijão</i>	13–14	12	Math
	16–41	7	English
ETEC <i>Escola Técnica Estadual do Centro Paula Souza at Mauá City</i>	18–52	23	Math
Total		144	

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learning experience of a student using mobile applications in general. The most successful application from the students' standpoint was a language application with which the user is able to practice pronunciation of English. Overall, the students indicated a desire for more gamified and audio-based applications and instruction in the Brazilian education system.

Access to the Internet is sometimes problematic in Brazil. Additionally, based on the feedback and user experience in the second pilot in October, Brazilians often keep applications open, and these applications are quite diverse. For example, having sufficient memory capacity available to accommodate social media services and multiple mobile learning applications on a single smartphone can be rather challenging. The development work of the Finnish companies and students on mobile learning applications should not only focus on having the feature work in an offline mode but also to reconsider the content and amount of the adaptable application(s). Consequently, in November 2017, the feedback and video-recorded user experiences from the pilot week in October were shared with the Finnish students who had co-created the prototypes with the SMEs. The students were eager to see how well their applications had been accepted and how they had fared in testing at the Brazilian schools. The students improved and developed their application prototypes further in line with the feedback given. For instance, the four math applications were combined into a unified application solution. The completed mobile learning applications were launched in a digital distribution service in December 2017. At present, Finnish SMEs are making the decisions as to whether they will use the cost-effectively developed applications in their future business and which learning products should be chosen for Brazilian markets. As one of the CEO stated after the workshop in November: "the smart and skillful students have been doing their work very well as well as cost-efficiently, now it is up to us how we will use the developed apps or should we co-create a different type of learning solutions or applications completely. However, I feel that the project is going to be finished a bit too early since not all our products can be changed rapidly or tested separately with newly established contacts and users."

Access to the fast-growth, unsaturated Brazilian market is significant for securing the long-term competitiveness of Finnish SMEs. However, as they expand their business and design frugal solutions for emerging markets, there are always wrinkles that need to be taken into consideration. The study highlighted some traps

related to mobile learning solutions and possible opportunities for dealing with these traps.

First of all, the technical requirements for mobile learning solutions in Brazilian markets need to be analyzed carefully. Finland's education system and learning solutions are highly valued in countries around the world, with Brazil being no exception. However, most online learning systems require continuous Internet access, which is not available in Brazil as readily as it is in Finland, and the Finnish SMEs were not prepared for this significant difference in the beginning of the project and before the user feedback. The knowledge of somewhat limited Internet access was shared before the pilots in Brazil, but the influence on performing different tasks by users was not acknowledged comprehensively. In addition, the infrastructure of Brazilian school buildings is not designed for mobile-learning devices. For example, the possibility of recharging their batteries is not always guaranteed; there is a shortage of sockets in the classrooms. Furthermore, the virtual learning environment is not optimized for smartphone use (it is currently better suited to laptops or, in some cases, to tablets, even though some learning material can be downloaded and updated offline). Therefore, there is a need for mobile learning applications with offline solutions alongside online platforms. This has to be taken into consideration by the Finnish SMEs that offer mobile solutions in Brazilian markets.

Second, the study provided insight into the actual needs related to mobile learning solutions in Brazilian markets. No learning solutions already offered by Finnish SMEs were suitable in Brazil. Instead of matching Brazilian markets to existing learning solutions, one has to understand the real needs of Brazilian users. For example, there were design and implementation errors in the learning solutions. Most importantly, it was noted that a Portuguese language option is needed in the initial learning solutions and the manuals. The pedagogical skills and education systems are also rather different between Finland and Brazil. For example, in the Nordic region, problem-based learning methods or self-directed group work is commonly used in various disciplines and at many levels of education. The same is not true of Brazil. Such differences have to be acknowledged by the Finnish SMEs, especially when the virtual learning environment is to be used in formal education. Further, focusing on development of mobile learning applications that will suit Brazilian markets is strongly recommended. For example, offline solutions suiting specific markets could be developed, tasks could be translated and the pedagogical approaches localized,

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and audiovisual materials could be viewed by means of Portuguese-language subtitles.

Third, Finnish SMEs are small and may lack the resources to cater to user requirements in large emerging markets. Had the case companies not collaborated with the Finnish and Brazilian education and research partners, it would not have been possible to approach the schools, obtain the actual user feedback, or observe the diversity of the Brazilian schools. In addition, unexpected circumstances might have had a bigger impact than expected. For example, the holiday seasons differ significantly between Finland and Brazil, which escalates unexpected obstacles into development processes (both countries having several national holidays and long summer vacations over the course of a year), and therefore, it would have been rather challenging for the case companies to test their services and solutions and then make suitable changes within the timeframe of the project. In our study, the case companies were small and did not possess the resources to concentrate primarily on the mobile learning applications at all times. Overcoming that hurdle entailed engaging Finnish students to enable the product development to continue. It is clear that Finnish SMEs' solutions must mesh with the resource crunch and be planned accordingly.

Last, understanding the stakeholders, especially when they belong to different cultures, is of tremendous importance. An essential factor that emerged early in the SCALA project is that Brazilians tend to be very open and sociable. It is important to consider some aspects of this when one negotiates with them. For instance, in business and otherwise, people significantly prefer face-to-face meetings initially. That creates a bond and helps in becoming familiar with business partners. Likewise, as several teachers at the Brazilian university said, "The real problem is not about products or services – plenty of applications and online services are available. It is more about the service solutions. The companies should prefer to provide integrated and personalized solutions for us here in Brazil. In particular, developing applications with certain Brazilian schools and acknowledging their specific curricula would be more beneficial to Finnish SMEs."

Conclusion

We investigated the opportunities and barriers connected with Finnish mobile learning solutions and services in Brazilian markets. This work highlighted the need for frugal innovation in practice during the bottom-up development processes employed by SMEs. It also recog-

nized that, whatever the competition in Brazilian markets might be, those Finnish SMEs that provide comprehensive solutions based on actual user needs instead of merely offering products and services, and that focus on integrating them with Brazilian partners' operations, can be successful. It was revealed that frugal innovation processes need to be incorporated into the development processes of Finnish SMEs from the very outset. The possibilities for scalability to Brazilian markets could be considered from the bottom-up perspective: one could proceed from the experiences and future demands of users (students) and synthesize that valuable feedback with input from decision makers on school management, municipal, and government levels. Thereby, undesirable methods, inappropriate devices, and irrelevant high-tech investments for various separate levels of education could be diminished – or possibly avoided completely.

Most Finnish SMEs lack resources compared to multinational companies for catering to user requirements in emerging markets. One of the best management practices in resource-constrained conditions could be engaging students in the development processes wherever possible, for example, in this particular case, combining local knowledge and skills from Brazilian and Finnish students. This could provide the desired help to SMEs towards solving the challenges of resource scarcity. Compared to SMEs, for example, bigger companies have better access to emerging markets. They have monetary resources alongside manpower. Most importantly, they have existing technical equipment as well, for instance, they have their own servers, which our case companies lacked. Although one of the SMEs was interested in investing in a server in Brazil, the Brazilian partners highly recommended establishing partnerships and sharing hubs with local partners instead.

Furthermore, all the CEOs were very pleased to have the opportunity to run intensive pilots in Brazil and to gain insightful and diverse feedback from the users for their own solutions and services. This would not have been possible for the SMEs to accomplish had they approached the Brazilian markets on their own accord. This study also drew attention to the need to create value for all stakeholders, including Finnish SMEs and emerging Brazilian markets, and it focused on the possibility of creating business ecosystems in collaboration with local Brazilian actors. This study contributes to knowledge of frugal innovation and develops the body of research especially in relation to Brazilian markets. Instead of emphasizing the top of the pyramid and the

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various levels in the hierarchy of education, focusing on millions of users with reasonably priced mobile learning solutions offer a competitive advantage for Finnish SMEs that specialize in mobile and virtual learning solutions and that wish to access emerging markets. Brazilian markets offer great potential for frugally developed mobile learning solutions, with many consumers buying mobile learning applications and edugames, and with many being avid subscribers to mobile learning value-added services.

The novelty of our study is related to the bottom-up development approach focusing on actual user needs in Brazilian learning context before entering the markets, because the usual approach is for (Finnish) companies to contact top-level school management or government. This research may be useful for Finnish SMEs who could benefit from this knowledge. Most often, Finnish SMEs innovate for developed markets; if they become aware of the benefits of adopting a frugal approach to innovation, they could perhaps find new markets for their products.

The study has a few obvious limitations, some of which are inherent to work of this nature. The samples sizes were small, so the findings are best treated as exploratory. Furthermore, the study was conducted with a specific set of Finnish SMEs and Brazilian schools; hence, these do not explicitly represent the business environment for mobile learning services and their providers in either country. That said, the upcoming piloting for the virtual learning environment will supplement this research. In addition, collaboration among Finnish and Brazilian students using the same learning service simultaneously will deepen understanding of the significance of the user experience for the implementation of frugality in the development processes of SMEs, particularly as they approach emerging markets.

By linking frugal innovation and digital technologies, we demonstrate to SMEs how frugal potential of technologies can be utilized. Finnish SMEs currently uninterested in emerging markets may in future deliver frugal digital technologies to emerging markets and develop their own knowledge and understanding of frugal engineering.

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