Institution: University of Bedfordshire

Unit of Assessment: 17 Business and Management

Title of case study:
Supporting SMEs and food producers: capacity building and digital transformation

Period when the underpinning research was undertaken: 2010-2020

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	**Role(s) (e.g. job title):**	**Period(s) employed by submitting HEI:**
Ram Ramanathan	Prof of Operations Management	2011-present
Yanqing Duan	Prof of Information Systems	1995-present
Usha Ramanathan	Senior lecturer	2011 -2016
Guangming Cao	Principal lecturer	2009 – August 2020
Elly Philpott	Senior research fellow	1994-2015

Period when the claimed impact occurred: 2013-2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact (indicative maximum 100 words)

Research by Business and Management Research Institute (BMRI), examining technology adoption among food supply chain SME's, has resulted in important impacts for SME's in the UK and internationally. Digital technologies are making significant impact on business performance and success. However, SMEs, especially in food supply chains, are seriously lagging in comparison to their larger counterparts. BMRI research has led to positive impact and influenced the adoption of Big Data, analytics, Internet of Things, and smartphone Apps, among food producers and SME's. It has resulted in (i) better digital awareness and improved knowledge and skills, (ii) increased levels of digital technology adoption, and (iii) improvements in food supply chain performance in the form of food waste reduction and increased productivity.

2. Underpinning research (indicative maximum 500 words)

Advancement in emerging digital technologies, such as big data, Internet of Things (IoT) and analytics, provides many opportunities for business in all size to improve their productivity and resource efficiency. Large companies have already taken advantages of digital transformation for business benefits and competitive advantage, but SMEs, especially in food supply chains, are seriously lagging their larger counterparts. The BMRI team aimed to increase the level of digital technology adoption by undertaking rigorous and applicable research underpinned by relevant theoretical considerations. More specifically, BMRI's research examined the barriers to technology adoption by food supply chain SME's, identified the critical success factors, and developed new insights and theoretical frameworks that influenced on the academic field and practical applications. Building on BMRI's expertise in business and information systems research and their established collaboration with partners in the EU, China and Brazil, the research team led by Prof Ramanathan and Prof Duan carried out extensive desktop research and empirical investigation using qualitive and quantitative methods, including technology piloting, surveys, workshops, company visits, focus groups, interviews, and case studies with key stakeholders to help companies transform their business practice with the power of digital technologies. BMRI's research made a significant positive impact on and influenced the adoption of Big Data, analytics, IoT, and smartphone Apps among food producers and SMEs in Europe, and internationally. With BMRI's longstanding track record in researching and publishing original work on understanding the critical factors and processes influencing the success of SMEs of technology adoption, it was very successful in receiving significant amount of funding from different sources that enabled the to undertake impactful research reported in this case study (3.6). The underpinning research can be demonstrated in the following achievements, outputs and impact areas.

Identified the challenges and barriers to technology adoption in SMEs and food producers - SMEs have interest in exploiting digital technologies, such as Big Data, IoT, Business Analytics, and smartphone Apps, but most digital technology studies mainly target large companies. Based on the field studies involving technology adoption piloting studies, workshops, focus groups, interviews and surveys in the UK, China, Brazil, Cambodia between 2010 - 2020 with SMEs and food producers, unique new insights were gained regarding the barriers and challenges associated with digital technologies adoption. Findings were mapped out with relevant underpinning theories (e.g. actor network theory and technology-organisation-environment (TOE)

framework). Improved theoretical frameworks and in the context of SMEs' technology adoption and adoption barriers were proposed and published to guide future research and practice (3.1–3.5). Informed by the research findings on SMEs knowledge and skills gaps, and training requirements, relevant and focused training materials were created for training workshops and capacity building events in the UK, China, Brazil, and EU countries (e.g. France, Ireland, the Netherlands, UK, Germany and Poland).

Identified critical success factors and established the best practice from relevant theoretical and practical perspectives - To develop in-depth insights, research carried out at BMRI investigated the factors affecting the adoption and implementation success of digital technologies used for SME's. It used different theoretical lenses, such as: TOE framework, social network analysis, actor network theory, organisational absorptive capacity theory, and dynamic capability. The theory application and extension enabled BMRI's research generate systematic and focused insights and knowledge reflecting digital uptake by SMEs in the form of critical success factors (such as capacity, external support, systems quality and alignment to the business processes) from extended TOE framework (3.1-3.5) and the dynamic adoption process from the actor network theory (3.2).

Identified research challenges and opportunities that have provided a sound basis for advancing research and development in the field - Based on the systematic literature review and extensive empirical research on the use and impact of digital technologies, BMRI's research identified critical research challenges faced by researchers and provided suggestions and inspirations for future research opportunities (3.3&3.5). As a result of BMRI's research, Prof Ramanathan and Prof Duan were invited to give keynote speech in numerous international conferences and events and served as expert evaluator for major funding programmes (e.g. H2020 and ESRC).

Designed, developed and implemented affordable and relevant digital technologies systems for advancing precision aquaculture and reducing food waste – In collaboration with EU and international partners, BMRI team has successfully applied large research grants, e.g. REAMIT (EU), TAF (UK-Institutional fund), ADPAC (Innovate UK and BBSRC) and AgriApp (DFID) (3.6). These funded projects enabled the team to collaborate with software developer and digital technologies providers to design, develop and implement the affordable and relevant systems for SMEs and food producers (3.6). For example, BMRI team conducted systematic literature review and field research to identify technical specifications and system design features for piloting and implementing digital systems for agriculture and aquaculture farms and small enterprises (3.3, 3.5 & 3.6). Through digital technologies demonstrations, BMRI's team helped firms reducing food waste in supply chains and thus improved sustainability in the UK and Europe.

3. References to the research (indicative maximum of six references)

3. 1 Duan, Y.; Miao, M.; Wang, R.; Fu, Z. and Xu, M: "A Framework for the Successful Implementation of Food Traceability Systems in China". *The Information Society*. 33 (4), 226-242, 2017, ABS 3*, DOI:10.1080/01972243.2017.1318325

3. 2 Eze, S.; Duan, Y and Chen H.: "Examining Emerging ICT's Adoption in SMEs from a Dynamic Process Approach". *Information Technology & People*. 27(1), 63-82, 2014, ABS 3*, DOI:10.1108/ITP-03-2013-0044

3. 3 Feng, H; Wang, X; Duan, Y; Zhang, J and Zhang, X.: "Applying blockchain technology to improve agri-food traceability: A review of development methods, benefits and challenges"; *Journal of Cleaner Production,* 260, July, 2020, Impact factor: 7.246, DOI: 10.1016/j.jclepro.2020.121031

3. 4 Ramanathan, R; Philpott, E; Duan, Y and Cao, G.: "Adoption of business analytics and impact on performance: a qualitative study in retail", *Production Planning and Control*, 28 (11-12), 985-998, 2017, ABS 3*, DOI: 10.1080/09537287.2017.1336800

3. 5 Zhang, Y.; Wang, L. and Duan, Y.: "Agricultural Information Dissemination using ICTs: A Review and Analysis of Information Dissemination Models in China". *Information Processing in Agriculture*. 3(1), 17-29, 2016, DOI:10.1016/j.inpa.2015.11.002

3. 6 BMRI's notable funded projects supporting the underpinning research on supporting the technology adoption in SMEs and food producers in this case study include:

Name	who the grant was awarded to	the grant title	sponsor	period of the grant	value of the grant.

REAMIT	University of Bedfordshire	Improving Resource Efficiency of Agribusiness supply chains by Minimising waste using Big Data and Internet of Things sensors	Interreg North West Europe Programme 2014-2020	11-Jan-2019 to 10-Jul-2023 (extended due to COVID-19 Pandemic)	€2 925 102.35 (equivalent to £2 543 567.26 at exchange rate £1 = €1.15)
TAF	University of Bedfordshire	Implementing technology solution for sustainable development of artisanal fisheries in Santa Catarina	British Council (Newton Fund Institutional Links)	01 April 2018 to 31 Sep 2020 (extended due to COVID-19 Pandemic)	£49,951.00
ADPAC	University of Surry (Academic lead) & Chelsea Technology Group (Industrial lead)	Advancing Digital Precision Aquaculture in China	BBSRC) and Innovate UK	Feb 2019 to March 2022	BBSRC - £457,264 Innovate UK - £519,689
AgriApp	Foreign Economic Cooperation Centre (FECC) of Ministry of Agriculture in China	Application of mobile Internet technology for agricultural information dissemination in Cambodia	Department for International Development (DFID), UK	Sept 2013 - Feb 2016	£280,000 (Phase1 £150k; Phase 2 £130k)
UoB QR China Project	BMRI	Supporting SMEs in using Big Data and Analytics in China with UK Experience	Internal QR funding	Jan 2018 – July 2018	£5000

4. Details of the impact (indicative maximum 750 words)

Digital technologies are making significant impact on business performance and success. However, SMEs, especially in food supply chains, are seriously lagging their larger counterparts. With the significance financial support of funded research projects (3.6), BMRI's research allowed the team to identify key challenges facing SME's, develop suitable training courses, and design and develop affordable, relevant, digital systems for capacity building and digital transformation. It resulted in a more even playing field, helping food supply chain SME's by (i) **raising awareness and improving knowledge and skills among the beneficiaries, (ii) increasing the level of SME digital technology adoption (including Big Data, analytics, mobile Apps, and Internet of Things) in SMEs and government support agencies, and (iii) helping to improve food supply chain performance in the form of food waste reduction and increased productivity, helping SME's compete with larger operators.** By helping to reduce food waste (e.g., food processors and supermarkets in EU) and increase productivity (e.g., fish farmers in China and Brazil), BMRI is helping companies to improve their financial and environmental performance. BMRI's successful stakeholder engagement strategy, including collaborative workshops and pilot implementation, was an important factor in the resulting impacts, helping SME's better understand the constraints and opportunities. The pilot implementation schemes supported by ADPAC, REAMIT, TAF and AgriApp projects helped to accelerate the digital technology adoption among participating farmers, SMEs, technology providers, and government support agencies.

BMRI's research identified that one of the key barriers that prevented SMEs from adopting the most relevant and effective digital technologies was their lack of awareness, understanding about new technologies and their benefits. Building people's capacities is key for successful digital transformation. To address this challenge, BMRI's research activities raised the awareness and

improved SMEs' knowledge and skills using capacity building workshops, field visits, pilot implementation demonstrations, and providing expert advice. BMRI's research found that Big Data and IoT could provide many benefits to SMEs. However, SMEs often have a misperception about technology applications and fear of high level of investment. The impact activities highlighted that relatively good benefits could be obtained by SMEs using minimal investments for maximum return. The capacity building workshops that involved using successful cases, best practice guidelines, and system demos have helped SMEs understand this rule.

From 2014, working with local academic and local partners (e.g. China Agricultural University, Instituto Federal de Educação, Ciência e Tecnologia Catarinense in Brazil, Ministry of Agriculture, Forestry and Fisheries in Cambodia, Nottingham Trent University, Images & Réseaux and Valorial in France), 18 capacity building workshops and training events and two EU sympodiums were organised in the UK (4), EU (2 in Ireland, 1 in Poland, 1 online), China (5), Brazil (3), India (2), and Cambodia (2), targeting food producers, SMEs, IT service staff and local technology providers. Feedback and follow up visits to SMEs that attended workshops run in China (5.3 & 5.6) and Brazil (5.1 & 5.2) demonstrated the impact on their positive attitudes towards technology applications that resulted in their subsequence intention/action in actual adoption. The workshops in Brazil "*developed better knowledge and understanding on the business benefits with the use of new digital technologies (e.g., sensors) in closely monitoring water quality*" (5.2). Capacity building activities helped participating Chinse fish enterprises *"to understand the gaps and areas for improvement" and "raised our awareness on the potential and business benefits of digital transformation for improving our productivity and reducing costs*" (5.3). Through capacity building workshop and company visits, one sensor technology company in Yantai stated, "*As a result of our improved capacity and vision, we have improved and are continuingly improving our products and services to aquaculture companies and increased our product range and sales*." (5.3)

With the improved understanding of the role of Big Data, analytics, and IoT for implementation among food producers and SMEs, the research has helped artisanal fish farms in Brazil (5.1&5.2 TAF project), aquaculture SMEs in China (5.3 & 5.4 ADPAC and BMRI QR projects), food supply chain SMEs in the EU (5.5 & 5.6 REAMIT), and farmers in Cambodia (5.7 & 5.8 AgriApp) to adopt these relevant technologies, leading improvements in productivity and reductions in food waste.

ADPAC helped aquaculture enterprises to achieve precision aquaculture for resource efficiency by using smart sensors and data analytics tools (5.4). The project *"motivated us to adopt relevant and affordable IoT sensors and big data analytics developed by the project to monitor water quality and fish behaviour in our farming sites*" (5.4). "*The pilot implementation of sensors and analytics systems has enabled us to use the new digital technologies to closely monitor parameters related to the health of fish and linking the monitored data to decision-makers for quick decisions to optimize feeding, improve water quality, and improve fish health/growth for better productivity and resource efficiency*" (5.4). "*As a ADPAC project pilot implementation company, we are serving as a technology demonstration site for other aquaculture companies in China and are actively promoting the adoption of precision aquaculture digital technologies more widely in China*" (5.4).

TAF involved the local government support agency EPAGRI in capacity building workshops, using sensors and mobile App in its experimental ponds. "*As a result of the capacity building and our positive experience in using sensors in our ponds, we are able to demonstrate the real benefits to local farms and provide more relevant and better support and services*." (5.1&5.2) Three fish farmers participated in TAF "*have developed better knowledge and understanding on the business benefits with the use of new digital technologies*" and are in the process of adopting sensors and mobile Apps (5.1&5.2). TAF inspired an undergraduate researcher in Brazil to launch a small start-up company called FishLabs after he graduated and left the team. Its purpose was to provide low costs digital toolkits for fish farms, allowing them to use IoT sensors and smartphone apps. *"Inspired by the TAF project's idea of digital transformation of fish farms in Brazil and using the knowledge, experience and skills gained by our participation in TAF, we launched a small startup company called FishLabs*." (5.2 testimonial from FishLabs).

BMRI is leading REAMIT that is making positive impacts on reducing food wastes by implementing IoT sensors and big data analytics in North-West Europe. The project aimed to avoid loss of 1.8 MT of food and 5.5 MT of CO2 emissions a year in NWE when it ends in 2023. So far, technology demonstrations have been initiated in six EU food companies (an online supermarket, called Picnic, in Netherlands, a supermarket in Germany, one frozen food producer in France, and one frozen producer and two meat producers in the UK) in deciding the best strategies for fitting IoT

sensors in trucks/warehouses to continuously monitor food quality. This assisted the companies by helping them to install and test smart sensors and big data analytics for reducing food waste (5.5). "*Picnic is participating in REAMIT project by piloting REAMIT developed digital devices and systems. As a REAMIT pilot company, we are benefiting from REAMIT technologies in that they will not only provide full visibility of the conditions in which food is transported but also enable us to use the information to ensure that all the products are transported under ideal conditions and no food is becoming waste due to adverse storage conditions. The use of sensors will enable us to be more effective and sustainable by monitoring and optimizing our delivery operations.*" (5.6 testimonial from a company involved in technology implementation). The project was praised by the Chair of Chartered ABS Research Committee as an exemplar for impactful research and highlighted its collaborative approach between academics and stakeholders (5.5). However, the COVID-19 pandemic has significantly affected the project progress in piloting technology implementation in the companies involved in REAMIT and TAF due to the delay caused by lockdown and the closure of partner businesses.

For the Cambodian AgriApp research challenge project, "*Cambodian agricultural ministry staff, researchers, extensionists and young farmers all welcomed the new channel for disseminating information and for discussing agricultural practices."* (5.7). The project helped multiple beneficiaries including farmers, technology service providers, and government support agencies in technology transfer and value chain development (5.7). Nearly 150 local key farmers from a commune centre covering twelve villages in the Kampong Chhnang Province participated in the pilot training and extension (5.7 field visit news & 5.8 project phase two practical extension report). AgriApp was "*An eye-opening experience that offers new and innovative ways for disseminating agriculture information and addressing farmers' problems timely and effectively*" (Cambodia government agriculture extension officer) (5.7 policy briefing). Cambodian Ministry of Agriculture, Forestry and Fisheries piloted the app in two districts of Cambodia and "*The results are promising and merit further scale-out*" (5.8 AgriTT achievements overview report).

5. Sources to corroborate the impact (indicative maximum of 10 references)

5. 1 Sources of TAF impact information and capacity building events: project website: www.thetafproject.com; project workshops and field visits news: www.beds.ac.uk/bmri/projects/current/taf-project/ beneficiary EPAGRI news: www.epagri.sc.gov.br/index.php/2019/10/10/epagri-apoia-desenvolvimento-de-software-que-vai-dar-orientacao-tecnica-a-piscicultores/.

5. 2 Four testimonials for TAF impact in Brazil - government support agency EPAGRI, start-up company FishLabs, and two Fish Farms, provided as PDF: **5.2a)** – Fishlabs, **5.2b)** - Dr Silvano from EPAGRI, **5.2c)** - fish farm – Luchetta, and **5.2d)** - Fish farm – Ofelia.

5. 3 Sources for BMRI QR China project impact: Two testimonials (Chinese SMEs)&project news on capacity building&field visits provided as PDF **5.3a)**Oriental Ocean&**5.3b)** Dongrun China. www.beds.ac.uk/news/2018/june/bedfordshire-experts-help-chinese-and-indian-smes-to-adopt-big-data-technologies and www.beds.ac.uk/bmri/news/news-2018/big-data/.

5. 4 Sources for ADPAC impact: project website: www.adpac.info/ and testimonials from an aquaculture company in China (Mingbo Aquatic Co. Ltd), provided as PDF **5.4a)** Mingbo Aquatics – fish farming company.

5. 5 Sources for REAMIT information and impact- project website: www.reamit.eu/; project impact update: www.nweurope.eu/media/9399/reamit-newsletter-jan-20.pdf and www.nweurope.eu/news-events/latest-news/nwe-making-an-impact-highlights/ (page 98)

5. 6 Testimonial for REAMIT from a pilot company called Picnic (an online supermarket in Netherlands), provided as PDF **5.6)** Picnic.

5. 7 Sources for AgriApp impact – Project information and impact news: www.beds.ac.uk/bmri/projects/past/agritt/ - Policy briefing of AgriApp impact by AgriTT programme: knowledgeshare.sainonline.org/wp-content/uploads/2017/04/AgriApp-%E2%80%93-adapting-ICTs-for-mobile-agricultural-information.pdf, Farming monthly news: www.farmingmonthly.co.uk/education-skills/8854-professor-helps-cambodias-agri-business-sector-improve-knowledge-transfer/

5. 8 Sources for AgriApp impact achievement – AgriTT programme achievement overview report: knowledgeshare.sainonline.org/wp-content/uploads/2017/04/AgriTT-Achievements-Overview.pdf (page 22) & project phase two practical extension final report (submitted-REF)