

IoT sensors in Aquaculture – Barriers and Facilitators for sustainability in Brazilian Context

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Abstract

The UNEP has identified Artisanal Fisheries (AF) as the most important sector for meeting the twin needs of economic development and environmental sustainability. During 2004-14, fish exports from Brazil declined from 107,000 tons to 34,000 tons while fish imports grew from 158,000 tons to 403,000 tons due to low productivity of Brazilian AFs. Hence it is important to understand opportunities for productivity improvement of these fisheries. With productivity improvement and further expansion, sustainability issues should be considered carefully. In a project funded by the Newton Fund in the UK and FAPESC in Brazil, we explored drivers of sustainable development of AFs in Santa Catarina via a stakeholder workshop and field visits. We also interacted with officials at the EPAGRI, the research and agricultural extension organization of the State of Santa Catarina.

Findings of the workshop and field visits are briefly summarized below but will be elaborated during the presentation at the conference.

- The level of technology use in aquafarms in Brazil is basic. There were one or two instances of old mechanical technology but there is no integration with the latest electronic, IoT technologies.
- There is general lack of awareness of sustainability issues among most AFs. Since water supply is abundant, they tend to think pollution is not an issue. Without adequate efforts in treating the waste water before they leave aquafarms, pollution issues could be the most significant limiting factor for future expansion of AFs.
- There is a lack of awareness of the fish supply chains as most AFs do not directly deal with supermarkets or final consumers.
- Lack of financing and access to banks is also a serious bottleneck for future expansion.
- The AFs tend to work with traditional models of fishing. More training on new business models (e.g., (i) linking directly to market, (ii) using cooperative structures to ensure large supplying power and consequently winning bargaining power, and (iii) developing future contracts for supply of fish to the market to ensure all fish produced are sold on time) will help the entire AF industry.
- New Internet of Things (IoT) technologies should be developed with local culture in mind. It can be automatic resulting in fewer labour requirements but should be supplemented with proper

guidance documents (e.g., user manuals or online provision). Working with local knowledge centres such as EPAGRI is crucial for continued diffusion of these technologies to all eligible AFs and for regular advice on maintenance.

- Lack of supporting infrastructure for aquaculture development, e.g. analytic systems, ERP, e-learning, regulations, government support, legal frameworks, etc.

On the basis of the study, three areas can be recommended for future IoT and Big Data applications: (i) improving the monitoring and control of water quality, such as oxygen and temperature, by using sensors and remote control digital technologies; (ii) optimising and managing the fish feed to improve resource efficiency; (iii) – enabling fish farmers to have better access to information (e.g. suppliers information, weather, market demand and prices, costs, etc), knowledge and technical support and expert advice via mobile Apps.

Keywords

Internet of Things, Aquaculture, Brazil

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Biographies

Ramakrishnan Ramanathan is Professor and Director of Business and Management Research Institute, in the Business School of the University of Bedfordshire, Luton, UK. In the past, he has worked and taught in a number of countries, including the UK, Finland, the Netherlands, Oman and India. He has taught basic and advanced courses on Operations Management, Production Systems Management, Supply Chain Management, Optimization Theory, Data Envelopment Analysis (DEA), Management Science, Business Statistics, Simulation, Energy and Environment, Energy and Environmental Economics, Energy and Transport Economics, and others. His research interests include operations management, Industry 4.0, Big Data, Internet of Things, supply chains, environmental sustainability, economic and policy analysis of issues in the energy, environment, transport and other infrastructure sectors. He works extensively on modelling using techniques such as optimisation, decision analysis, data envelopment analysis and the analytic hierarchy process.

Prof **Yanqing Duan** is an established expert on the adoption, use and impact of emerging information and communication technologies in Agriculture and Aquaculture. Over the last 20 years, she has been involved in a number of funded research projects on using emerging ICTs in aquaculture sector and technology transfer to improve fish farming productivity. She has extensive experience and understanding on the effective adoption of technologies in Agriculture and Aquaculture sector and published many papers in this field. She has also been involved in a UK DFID Agri-TT (Agriculture Technology Transfer) project on helping Cambodian farmers to improve their farming productivity and sustainability.

Prof **Feng Dong** has led large scale research grants in healthcare, Internet of things and creative computing from national (UK) and international (Europe) funding bodies. He has expertise in big data management and storage on a cloud environment, mining and visualization of massive data, text mining and semantics of web information. He has successfully coordinated 4 research projects in recent years. He is the Principal Investigator of external research funding over 2 million Sterling.

Dr. **Tahmina Ajmal** (Senior Lecturer in Engineering) has been working in the sensor technology, designing novel optical sensors for different applications, using data from the sensors for diagnostics and prediction and smart sensing applications. For the last decade, main research focus has been on water engineering where she has developed sensors for testing water quality and used data from existing online sensors for diagnostics. Her research is multidisciplinary with collaborations from across University and around the world. Her recent project funded by Innovate UK is in collaboration with Business School with a focus on developing a smart digital environment for aquaculture industry in China. She is also a technology co-investigator in another multi-million Interreg project with business school on use of sensor technology for reducing waste in food industry across North West Europe. In addition, she is also a co-

investigator on another project with business school on improving sensor application for artisan fisheries in Brazil. She is also currently co-investigator in another Interreg project on reducing pollution from water borne vessels. She has large number of conference and journal publications to her credit and is currently reviewer of various IEEE journals and conferences in Photonics and Sensors.

Dr Samuel Van Ransbeeck is a research associate working on the Brazil fisheries project. His background is in composition and data sonification. His recent projects are centred around digital humanities, working with archives and data-driven storytelling. He did his PhD at the Catholic University in Porto, Portugal and has since worked in Universities in the UK. He has ample international experience. ORCID: <https://orcid.org/0000-0001-6959-6605>.

Prof **Joaquim Valverde** has extensive experience in engineering and project management systems and in data centre infrastructure with hardware and software required to operate [ERP,] IoT and Big Data applications. [He joined the IT field through programming courses at IBM in 1972. He worked in software development at ADP Systems, Eletroradiobraz, Cummings, Saab Scania, ABB and Paraná Telecom. He was a consultant at IBM (law enforcement systems) for 4 years. He started teaching “Data Base System development” at the Pontifical Catholic University of Paraná in 1984. Director of teaching and technology at ESEEI Colege - Paraná for 25 years.] Since February 2016 Prof Valverde has conducted research to architect an IT System for Sustainable Aquaculture at Instituto Federal Catrinense (IFC). In the research carried out with EPAGRI researchers and extensionists, and specialized bibliographic reading, he identified 12 main factors limiting the expansion of fisheries in Brazil, nine of which will not be equated without digital information and communication (ICT) systems. A business plan was created to implement an IT platform with 4 integrated subsystems: Transactional operations; Business Intelligence; e-Learning and Artificial Intelligence.

Prof **Silma Valverde** holds a PhD in Communication Processes and Digital Technological Innovations from the Methodist University of São Paulo, Brazil. She has experience in the organization and management of projects and work groups focused on the creation and sharing of explicit knowledge. She teaches in Undergraduate and Postgraduate Courses in the areas of Education and Information and Communication Technologies (ICT) at the Federal University of Paraná (UFPR). Between 2013 and 2017 she collaborated with the Distance Learning Implementation Team at the Federal Catarinense Institute - Campus Camboriú (IFC-CAM). She acted as Teacher, Tutor and Coordinated Courses in distance modalities and blended learning in the Center for Distance Education (NeaD) of IFC-CAM. She taught and coordinated the Education and Technology Hub of the Lato Sensu Postgraduate Program in Education. Acted as Pedagogical Manager of the Virtual Learning Environment and Producer of Didactic Materials for Teaching and Learning activity; Member of the Commission for the Elaboration and Systematization of the Stritu Sensu Course of Master in Education with a focus on Teacher Training and Technologies for Sustainability. Member of the TAF research group in Brazil, responsible for integrating the e-learning module and content in the IT Platform for Sustainable Aquaculture (PTI-AS).