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Innovation and Technology

Technology In Microinsurance

How New Developments Affect the Work of Actuaries

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Tables

Acronyms

ACRE	Agriculture and Climate Risk Enterprise
AgRISE	Agricultural Remote-sensing-based Insurance for Security and Equity
AI	Artificial Intelligence
ARPU	Average Revenue Per User
CCE	Crop-Cutting Experiment
CCRIF SPC	The Caribbean Catastrophe Risk Insurance Facility Segregated Portfolio Company
CGAP	Consultative Group to Assist the Poor
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station
GLM	Generalized Linear Model
GPS	Global Positioning System
GSMA	Global System for Mobile Communications, originally Groupe Spécial Mobile
IAA	International Actuarial Association
IBISA	Inclusive Blockchain Insurance using Space Assets
IBNR	Incurred But Not Reported
IFAD	International Fund for Agriculture Development
IFPRI	International Food Policy Research Institute
IOT	Internet of Things
IT	Information Technology
IWMI	The International Water Management Institute
MALCOLM	Mobile Application Linked to Claims Operations and Learning for Microinsurance
MI	MicroInsurance
MiCRO	The Microinsurance Catastrophe Risk Organization
MNO	Mobile Network Operators
NASA	National Aeronautics and Space Administration
NDVI	Normalized Difference Vegetation Index
NDWI	Normalized Difference Wetness Index
NGO	Non-Governmental Organization
P2P	Peer to Peer
PBI	Picture-Based Crop Insurance
PMFBY	Pradhan Mantri Fasal Bima Yojana

PRIDIT	Principal Component Analysis of Ridit Scores
RFID	Radio-Frequency Identification
SaaS	Software-as-a-Service
SAR	Synthetic Aperture Radar
SOA	Society of Actuaries
TAGIC	Tata AIG General Insurance Co.
TSP	Technical Service Providers
UAV	Unmanned Aerial Vehicles
USGS	United States Geological Survey
VAT	Value-Added Tax
WHO	World Health Organization

Executive Summary

Low-income people face various challenges in accessing financial products. In overcoming these challenges, a growing number of innovations and technologies have emerged in the arena of microinsurance. Moreover, there is a growing number of reference reports which highlight the evolving intersections of the actuarial profession with technological innovation.

This literature review provides insights on emerging technologies that interact with the actuarial profession within the space of microinsurance for the purpose of establishing a frame of reference for actuaries to use in their work. Furthermore, it intends to spark readers' interest in, and create a vision for, how microinsurance and its associated technologies may impact the actuarial industry in the future.

As well, this report assembles publicly-available literature from desktop studies and key-person interviews. Each piece of literature is categorized under one of the following four sections: rating, distribution, claims adjudication, and payment facilitation. These sections are then subcategorized by type of technology. The literature in each section highlights how technology impacts the given aspect of the insurance process. Discussion begins with an overview of the technology, a description of how the technology impacts the specific aspect of the microinsurance process, and possible implications and applications for actuaries as a result of the technology.

Challenges in microinsurance. Microinsurance faces several challenges that hinder the industry from growing. A lack of quality data prevents efficient underwriting of microinsurance products. Distrust from customers due to a lack of understanding of the product and/or previous negative experiences with insurance reduces the demand for microinsurance. Coupled with this distrust, inaccessibility to sparse rural areas increases the challenge of bringing microinsurance products to scale. The often physical nature of claims processing and the lack of access to formal financial services, such as banks, leads to relatively high operating costs and a long claims turnaround time. Finally, nominal and unpredictable profit margins may discourage insurance companies from providing microinsurance products.

Technology and microinsurance rating. Technology is helping to address both the lack of good quality data and the lack of technical expertise in the microinsurance space. This improves rating processes. Remote-sensing data can be employed to develop the index used in index-based insurance under certain circumstances, like when the insurance payout is dependent on the triggering of an objective index designed to align with the actual loss experience. More broadly, innovative ways to gather big data on low-income people are emerging. For instance, machine-learning and other statistical techniques can be used to make underwriting more targeted and efficient. Pricing tools can also help local insurers in developing countries who might lack the technical expertise required to price the insurance products. Given the improved access to quality data, actuaries can help price microinsurance products more efficiently and conduct data analytics that inform other managerial decisions, such as product design or targeted customer acquisition. The data can also inform advice to customers, thus improving their well-being. Lastly, when providing technical expertise for microinsurance, it is also important for actuaries to communicate technical information in a clear and simple manner to reach a non-technical audience.

Technology and microinsurance distribution. Distribution is one of the most significant challenges in delivering high-quality insurance products to low-income people. How does technology assist insurers in reaching clients in large numbers while still addressing the constraint of low margins, minimal financial infrastructure, and the many other challenges in distributing microinsurance? Innovative distribution channels addressing these constraints include the mobile network operators and the agent-led insurance platforms. Technologies applied in mobile-health (also known as "m-health"), digital marketing, artificial intelligence, and chat bots can also promote the distribution of microinsurance. Still, actuaries involved in

mobile-distributed microinsurance need to apply their risk management skills within complex and constantly changing ecosystems. Actuaries are also involved in the data analytics perspective of distribution, from setting up the back-end system to collecting the appropriate data to analyzing consumer behavior change through the implementation of new technologies. Last, but not least, with a high level of professionalism, actuaries also have the duty of whistleblowing when a microinsurance product is being mis-sold or public interest is not being protected.

Technology and microinsurance claims adjudication. In microinsurance, it is important that claims are processed quickly and transparently. This allows insurers to reduce expenses and fraud, as well as instills trust in customers. Timely payouts also address the financial needs of the customer at the time of financial shock. Technologies that address these issues include claims administrative systems, smartphone applications, remote-sensing, Internet of Things (IoT), blockchain, and machine-learning. Actuaries can also leverage the technology employed in claims processing and contribute to these goals. Technologies can provide access to new data, which can then be analyzed to make insurance processes more efficient. Furthermore, this process may also impact the assumptions actuaries use in pricing and reserving.

Technology and microinsurance payment facilitation. In servicing low-income households, insurers incur high-transaction costs from collecting frequent premiums from persons who may not have bank accounts and are paying out claims of lower nominal value. However, mobile money and mobile airtime have been used as substitutes for banks to enable quick, convenient, and relatively low-cost payments of premiums and claims. New, transformative technologies like blockchain and other online platforms (including e-commerce platforms and remittance applications) are also emerging within the space of microinsurance. The actuarial analytics skillsets working with big payment datasets will provide greater understanding about customer behaviors and details relating to their risk profiles. As well, actuaries need to capture appropriate payment facilitation costs into their expense model for microinsurance products.

Applications for actuaries. How is the actuarial profession keeping up with the technological disruption in microinsurance? As new products and environments continue to emerge, actuaries must continue to evolve in their ability to serve all aspects of the insurance market. This report recommends that actuaries can contribute to the following areas (among others):

- Data analytics. For instance, better client segmentation and further understanding of customer behavior through new data gathered from technological advances can improve marketing and customer servicing.
- Data collection and setting up of back-office systems. New technologies like satellite, IoT, mobile platforms, and tablets are contributing to collecting better datasets. Actuaries play an important role in ensuring that these constructed systems are capturing key data points.
- Implementation of new technologies. Actuaries have the technical expertise to monitor the implementation of Insurtech, such as blockchain and AI applications (like chatbots and machine-learning), in the microinsurance space.
- Capacity building in technical skills. Technical capacity in the insurance industry is often in demand in emerging economies. Actuaries could provide technical training for microinsurance practitioners and grow the actuarial profession where they lack actuarial resources.
- Regulatory and risk management. In the relatively young industry of microinsurance, actuaries can also take on the role of providing guidance and advice from a regulatory perspective.

Technology in Microinsurance

How New Developments Affect the Work of Actuaries

1. Introduction

1.1 RESEARCH OBJECTIVE

Microinsurance is a strategy that makes appropriate insurance coverage available to low-income people. Financial losses that result from health, business, casualty, life, and natural disaster risks may produce devastating consequences for vulnerable populations. In overcoming the various challenges faced by low-income people, a growing number of innovations and technologies have emerged in the arena of microinsurance. Moreover, there is a growing number of reference reports that highlight the evolving intersections of the actuarial profession with technological innovation. As a result, the Society of Actuaries (SOA) commissioned the MicroInsurance Centre at Milliman to develop a literature review on the use of technology in microinsurance.

To give a frame of reference for actuaries to use in their work, this literature review provides insights on emerging technologies that interact with the actuarial profession within the space of microinsurance. This report also provides a foundation for understanding the evolving role of technology in microinsurance, as well as its potential impact on insurance and the actuarial profession. Furthermore, it intends to spark readers' interest in and create a vision for how microinsurance and its associated technologies might impact the actuarial industry in the future. It also provides ideas for how key 'micro Insurtech' topics could evolve in the future.

1.2 METHODOLOGY

To achieve the research objective, this literature review assembles a collection of publicly-available articles, reports, presentations, books, blog posts, podcasts, videos, and other resources that actuaries and other interested stakeholders can reference. The resources were assembled through desktop research and key-person interviews[1].

Definition of microinsurance. The term "microinsurance" first emerged in the late 1990s. Defining it since then has been a subject of much debate within the development sector and, thus, it is continually evolving. In this paper, the definition of microinsurance has been broadly defined as: "Risk pooling products that are intentionally designed—in terms of costs, coverage, distribution, and marketing—for low-income individuals, families, and businesses." The online resources gathered, therefore, focus on highlighting how technology has aided in addressing the needs of the financially vulnerable through insurance.

Scope of resources included. Mass insurance or inclusive insurance products that are designed to sell insurance to the masses (i.e. are not specifically focused on a low-income target market) are included in a few cases where a relevant technology has been developed in an emerging economy. The term "microinsurance" has also been used to describe insurance products that have small premiums to cover specific events on-demand, such as travel or damage to specific possessions, like smartphones. These types of insurance products are omitted from this study, as they do not specifically cater to the risks that concern financially vulnerable people. Literature that highlights both successes and challenges in implementing the technology in the microinsurance space has also been included.

[1] Full list of interviewees can be found in Appendix A

1.3 BACKGROUND – MICROINSURANCE AND TECHNOLOGY

There are many challenges to offering valuable and sustainable microinsurance. While a full discussion of these challenges is out of the scope of this literature review, several key challenges are worthy of mention:

- *Rating*: While the positive impact of microinsurance has been acknowledged, its commercial viability remains a question mark for many insurers. One of the greatest challenges faced by actuaries working in the microinsurance space is the lack of data or, in some cases, no previous data experience at all.

- *Distribution*: A key aspect of the viability of microinsurance is the ability to reach clients at scale. However, low-income populations are often located in remote rural areas, with little knowledge about insurance as a risk management tool and no access to traditional distribution channels. For these people, minimal trust in insurance can be expected.

- *Claims adjudication*: For microinsurance to be sustainable, providers also need highly efficient operations. For example, claims must be processed in a simple, quick, and effective manner in order to cope with microinsurance being a (nominally) low-priced product. They also need to be processed with few complications in order to build trust.

- *Payment facilitation*: In working with a largely unbanked population, how does an insurer even make a claim payment? Or collect regular premiums? Finding cost effective and easy ways to make high-volume, low-value transactions is a big challenge.

Application of technology to address microinsurance challenges. Against the backdrop of the numerous challenges facing the development of microinsurance, many innovative technologies have emerged. The development of mobile-enabled financial services over the past decade has allowed insurance to be distributed to millions of customers with no prior experience of it. Mobile money has opened a new claims payment channel to an unbanked population. As well, the advancement in big data platforms and the use of satellite technologies has enabled estimation of the risk profile of under-served and previously under-served populations. Another important development is the offering of weather index insurance: Technologies have permitted sending automatic payments to small-scale farmers at time of loss. These, and other examples of pioneering technologies, are facilitating many success stories in microinsurance and are highlighted throughout the resources in this paper. The following technologies are discussed:

- Remote-sensing, including satellites (Discussed in context of ratings and claims adjudication)
- Big data, machine-learning, and data mining
- Pricing tools
- Mobile networks
- Telemedicine
- Digital marketing channels
- Artificial intelligence and chatbots
- Administrative systems (software)
- Smartphone applications
- Internet of Things
- Blockchain
- Mobile money
- Airtime as a payment

A word of caution: Lessons learned from technologies in microinsurance. While technologies can enhance a product life cycle, there are potential limitations. It is important for actuaries and insurance professionals to choose appropriate technologies and avoid common pitfalls. It is not uncommon to hear of microinsurance programs spending over a year building a back-end technological platform, only to realize in the first month of sales that there is no customer demand. Even with the support of advanced technologies, understanding consumers and their needs before designing a microinsurance offering remains critical. Microinsurance technologies should be tools which

allow the needs of low-income populations to be met. They should add value to clients while balancing the cost of technology with both short- and long-term benefits.

Key observations that actuaries can use in their work. The lessons learned from technologies in the microinsurance arena are applicable for all actuaries. This report highlights publicly-available resources that demonstrate how technology is being used in microinsurance, as well as what the technological implications are for actuaries. For example, the emergence of big data can bring immense opportunity for actuaries, yet it also has associated risks. How do technologies like satellites and automated weather stations impact agricultural insurance? In regard to telemedicine, does technology allow patients to access quality remote health care and, if so, is it a good fit with microinsurance? As the insurance industry is continuously disrupted by technologies, actuaries must understand their impact to the environment within which they practice. The actuarial profession has evolved significantly, from pencil and paper, to calculators and spreadsheets, and now towards big data and artificial intelligence. Technology must be embraced for the actuarial profession to continue moving forward. Moreover, why should actuaries not be the leaders of these initiatives created to improve insurance offerings?

1.4 STRUCTURE OF THE LITERATURE REVIEW

The resources included in this literature review are categorized according to four key topic areas: rating, distribution, claims adjudication, and payment facilitation. The literature in each of the four topic areas highlights how technology impacts that particular aspect of the insurance process. Each topic area contains several sub-sections that discuss the key technologies.

Each technology sub-section contains:

A brief overview of the technology.

A description of how the technology impacts the specific aspect of the microinsurance process (rating, distribution, claims adjudication, or payment facilitation).

Possible implications and applications for actuaries in the microinsurance space as a result of the technology.

A collection of resources available. For each resource, a summary outlines the content, why it is important to actuaries, and what the reader will learn. Electronic links and reference information are also provided.

Section 3 summarizes and provides a discussion of key considerations for actuaries and the future.

Table 1 below provides an overview of the resources discussed in this paper.

Table 1

LIST OF RESOURCES ON TECHNOLOGY AND MICROINSURANCE, BY RESOURCE TYPE AND LINE OF BUSINESS

RESOURCE	RESOURCE TYPE	LINE OF BUSINESS				
		HEALTH	AGRICUL-TURE	LIFE	PROPERTY	CROSS-CUTTING
General resources on technology and microinsurance						
2(a) *Role of insurtech in microinsurance: How is insurtech addressing 5 challenges in microinsurance?* Cenfri, 2017	Research paper; Database					X
2(b) *Technology for microinsurance scoping study* Microinsurance Innovation Facility, 2008	Research paper					X
2(c) *Leveraging data, analytics and technology* Munich Re Foundation, 2017	Presentation slides					X
Resources on technology related to microinsurance rating						
2.1.1(a) *Big data for small policies* Cenfri, 2016	Article					X
2.1.1(b) *Leapfrog and Omidyar Network target unbanked billions in Cignifi deal* Cignifi, 2017	Blog post with video					X
2.1.1(c) *ZhongAn Technology Launches AI-Powered Data Platform for China's Insurance Industry* Fintech News Hong Kong, 2018	Article	X				
2.1.1(d) *Optimizing Insurance Policies with Machine-learning* Decentralized Insurance Developer Conference, 2018	Blog post with video				X	
2.1.2(a) *Remote-sensing for index insurance: Findings and lessons learned for smallholder agriculture* International Fund of Agricultural Development (IFAD), 2017	Report		X			
2.1.2(b) *Spatial Rice Yield Estimation Based on MODIS and Sentinel-1 SAR Data and ORYZA Crop Growth Model* Remote-sensing 2018, 10(2), 293; doi:10.3390/rs10020293, 2018	Journal article		X			
2.1.2(c) *Satellite-based insurance protects farmers from destructive floods* Geospatial World, June 2017	Article with video		X			
2.1.2(d) *Pula and Protecting Smallholder Farmers through Insurance* Accion, 2018; Positive Returns, 2018	Podcast; Blog post		X			
2.1.2(e) *CCRIF SPC (The Caribbean Catastrophe Risk Insurance Facility Segregated Portfolio Company) Annual Report; and Understanding CCRIF: A Collection of Questions and Answers* CCRIF SPC, 2018 (annual report) and 2015 (book)	Annual report; Book		X		X	
2.1.2(f) *Rethinking agricultural insurance: Lessons learnt from the Agriculture and Climate Risk Enterprise (ACRE) Africa* Microinsurance Network, 2017	Article		X			
2.1.2(g) *MiCRO: Bringing Insurance Solutions to Central America's Vulnerable Populations* Actuaries Digital, 2017	Article		X			
2.1.3(a) *CelsiusPro launches new Crop Insurance Pricer for India* CelciusPro, 2018	Press release; Video		X			
2.1.3(b) *Health microinsurance instructional pricing tool* Milliman, 2015	Tool; User manual	X				
Resources on technology related to microinsurance distribution						
2.2.1(a) *Insights on Mobile Network Operators as a distribution channel for microinsurance in Asia* Microinsurance Network, 2016	Report					X
2.2.1(b) *Spotlight on mobile-enabled insurance services* GSMA (Groupe Speciale Mobile Association), 2018	Report					X

RESOURCE	RESOURCE TYPE	LINE OF BUSINESS				
		HEALTH	AGRICUL-TURE	LIFE	PROPERTY	CROSS-CUTTING
2.2.1(c) *Regulating m-insurance in Zimbabwe: managing risk while facilitating innovation* FinMark Trust, 2014	Report (draft)			X		
2.2.1(d) *OKO's pitch at the Youth Summit now on YouTube* OKO, 2018	Video		X			
2.2.2(a) *How mobile microinsurance will impact the health insurance industry – Interview with Jose Martin, Global Health Manager at BIMA*, R2G (Research 2 Guidance), 2018	Article with Q&A	X				
2.2.2(b) *M-health: remote access* The Actuary, 2015	Article	X				
2.2.3(a) *Can technology push microinsurance further? 4 reasons to say yes* CGAP (Consultative Group to Assist the Poor), 2015	Blog post					X
2.2.3(b) *The Development of WeChat Marketing & Distribution of Insurance Products in China* Society of Actuaries, 2018	Report & Podcast	X				
2.2.4(a) *The HeartiLab medium blog* Medium / Hearti, 2018	Blog post					X
2.2.5(a) *Designing microinsurance products using mobile money in Tanzania* Arcada, 2017	Masters thesis	X		X		
Resources on technology related to microinsurance claims adjudication						
2.3.1(a) *Stonestep – 'Microinsurance as a service' platform* Digital Insurance Agenda, 2018	Video					X
2.3.1(b) *Microcare Insurance Uganda* International Labour Organisation , 2013	Case study	X				
2.3.1(c) *Learning from Others' Mistakes*, International Labour Organisation, 2015	Research paper	X				
2.3.1(d) *The Moment of Truth: Claims Management in Microinsurance* International Labour Organisation, 2014	Report					X
2.3.2(a) *Use of mobile technology in enrolment and claim settlement of cattle insurance -- Tata AIG* International Labour Organization, 2015	Report		X		X	
2.3.2(b) *Picture-based crop insurance: Is it feasible?* IFPRI (International Food Policy Research Institute), 2017	Project papers		X			
2.3.2(c) *Using InsurTech to overcome barriers to non-life insurance* Microinsurance Network, 2018	Report				X	
2.3.2(d) *A Presentation on Crop Insurance Portal and CCE Agri Mobile App* Department of Agriculture & Cooperation, Ministry Of Agriculture, Government of India, 2016	Presentation slides		X			
2.3.2(e) *Mobile phone app launched to strengthen new insurance scheme for India's farmers* International Water Management Institute (IWMI), 2018	Press release		X			
2.3.3(a) *Use of Satellite Data for Effective Implementation of Crop Insurance, Efficacy of Satellite Data Use in PMFBY (Pradhan Mantri Fasal Bima Yojana)* Satsure, 2018	Newsletter		X			
2.3.3(b) *Using Satellite Data to Scale Smallholder Agricultural Insurance* CGAP (Consultative Group to Assist the Poor), 2018	Report		X			
2.3.4(a) *Uprooting Uncertainty – UAVs for agricultural insurance sector* FICCI (Federation of Indian Chambers of Commerce and Industry), 2018; Geospatial World, 2016	Report; Article		X			
2.3.4(b) *Lumkani uses Fire Insurance to Protect Families in South Africa* Venturekast, 2019; Global Innovation Exchange, 2018	Podcast; Report			X		

RESOURCE	RESOURCE TYPE	LINE OF BUSINESS				
		HEALTH	AGRICUL-TURE	LIFE	PROPERTY	CROSS-CUTTING
2.3.4(c) *Cattle insurance through electronic identification chip technology -- IFFCO-Tokio*, International Labour Organisation, 2012	Report		X			
2.3.5(a) *Blockchain technology for inclusive finance: Can it add value to microinsurance organisations?* Microinsurance Network, 2016	Presentation slides		X			
2.3.5(b) *This autonomous insurance from space is an agricultural risk game-changer* Widgetlabs, 2018	Blog post		X			
2.3.6(a) *i-Buka – Britam*, International Labour Organisation, Last Updated January 2019	Case study	X				
2.3.6(b) *Optimizing Insurance Policies with Machine-learning* Decentralized Insurance Developer Conference, 2018	Blog post with video				X	
2.3.6(c) *The significance of claims fraud in microinsurance and a statistical method to channel limited fraud identification resources* Actuarial Society 2014 Convention, Cape Town, 2014	Paper					X
Resources on technology related to microinsurance payment facilitation						
2.4.1(a) *State of the industry report on mobile money 2018* GSMA (Groupe Speciale Mobile Association), 2019	Report					X
2.4.1(b) *Linda Jamii -- Changamka Microhealth Ltd* International Labour Organisation, 2016	Case study	X				
2.4.1(c) *Emerging Practices in Mobile Microinsurance* GSMA, 2012	Research paper			X		
2.4.2(a) *Scale: thinking big – case studies* ILO International Labour Organisation & Cenfri, 2013	Research paper / Case study					X
2.4.2(b) *Case Study: Metropolitan Cover2go* FinMark Trust & Cenfri, July 2010	Research paper			X		
2.4.2(c) *Designing Mobile Microinsurance Products: Premium Payment Methods* CGAP, 2014	Blog post					X

2. Literature Review

2.0 GENERAL RESOURCES RELATING TO TECHNOLOGY AND MICROINSURANCE

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The following three resources provide a general introduction to the topic of technology and microinsurance:

Resource 2(a): Role of Insurtech in microinsurance: How is Insurtech addressing 5 challenges in microinsurance?	
Reference information	*Publisher*: Cenfri *Publication date*: February 2017 *Authors*: Denoon-Stevens, C., Esser, A. & Smit, H.,
Resource link	Report: http://cenfri123.wpengine.com/publications/role-of-insurtech-in-microinsurance/ Database: http://cenfri123.wpengine.com/databases/insurtech-tracker/
Type of resource	Research paper and database
Summary	Cenfri conducted a research project to provide a comprehensive overview of active Insurtech initiatives in emerging markets. The scoping exercise identified 157 initiatives across middle- and low-income countries in Latin America, Africa, and Asia. The project has produced a research paper and an online database tracking Insurtech firms on a global level. ***The research paper*** highlights how technology in the emerging and developing world is applied in a variety of ways to the delivery of insurance. It has listed the six distinct categories of technological applications from their research as: new data and analytics, digital platforms, technology-enabled partnerships, peer-to-peer insurance, index-based insurance, and demand-based insurance. It provides a summary overview of each category. The paper has also listed the top five operational challenges in microinsurance as: lack of information on consumers, inadequate access to consumers, different and new consumer needs, customers inexperienced with formal financial services, and constrained business models. It also discusses how technology has managed to address each challenge. The paper concludes by recommending that those interested in this space should focus on the following: new business models that allow for product innovation, technology applications that bridge experience levels, technology solutions that allow for lower-cost data analytics, and technology that lowers the cost of doing business. ***The database***, or Insurtech Tracker, provides a dynamic list of firms and organizations that operate Insurtech initiatives in emerging markets. It includes the country the insurance project or business is conducted in, the challenge they address, the Insurtech category they fall under, and the firm's website. As of March 2019, the database contained 403 entries and was last updated in February 2017.

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Resource 2(b) – Technology for microinsurance scoping study	
Reference information	*Publisher*: International Labour Organisation *Publication date*: November 2008 *Authors*: Berende, M. & Gerelle, E.
Resource link	https://microinsurancenetwork.org/sites/default/files/MIP2_technology_and_microinsurance.pdf
Type of resource	Research paper
Summary	The objective of this study was for the CGAP Working Group on Microinsurance and the Microinsurance Innovation Facility to catalogue and illustrate existing technologies applicable to microinsurance (Excerpt, Summary, p. vi). This was done through a market survey across the industry—the appendix includes a write-up of the companies surveyed. The report describes the technology available as of 2008 that is used in the areas of customer interface, transaction processing, and data analysis and processing. Some key excerpts include: *"The main conclusion to be drawn from the analysis is that reducing transaction costs is one of the major challenges facing microinsurance. Making progress on this front will reduce administrative overheads, with direct impact on customers' premiums."* (Section 4, p. 22). *"The recommendation is that local solutions be developed in a managed way to stimulate local ownership and innovation but at the same time encourage coordination between developers to avoid repeatedly reinventing the wheel."* (Section 4, p. 22).

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Resource 2(c) – Leveraging data, analytics and technology	
Reference information	*Publisher*: Munich Re Foundation *Publication date*: November 2017 *Authors*: Shezi, M. ofHollard, for the Microinsurance Network
Resource link	https://www.munichre-foundation.org/dms/MRS/Documents/Microinsurance/2017_IMC/Plenary3-IMC2017-Prestentations-Mandla-Shezi/Plenary3%20IMC2017%20Prestentations%20Mandla%20Shezi.PDF
Type of resource	Presentation slides
Summary	Hollard, an insurance company in South Africa, describes how they are applying technology to different aspects of their business, as well as how they plan on leveraging technology going forward. They describe how they use machine-learning for target customer acquisition (Excerpt, slide 7), engage with their customers via mobile communication (Excerpt, slide 8), and have implemented an automated underwriting system for life applications (Excerpt, slide 10). They are developing a platform for customers to connect, bank, and insure all on the same platform (Excerpt, slide 12), eventually feeding into a data-technology-analytics ecosystem that uses the mobile phone as the enabler (Excerpt, slide 13).

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2.1 RATING

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One challenge in developing microinsurance products is a lack of the data needed to generate the risk profile and calculate the insurance premium. Technology can help with collecting data used for generating risk profiles, which can then be used to calculate the premiums. Technologies discussed in this section include:

- Innovative ways to gather **big data** on low-income people, including **machine-learning** and other statistical techniques that can make underwriting more targeted and efficient.
- **Remote-sensing data,** which can be employed to develop the index used in index-based insurance. In this scenario, the insurance payout is dependent on the triggering of an objective index that is designed to align with the actual loss experience. Higher quality data and better designed models in which to interpret that data can help create a more efficient insurance product.
- **Pricing tools,** which can help automate the pricing process, give inputs and assumptions, and provide information on the possible insurance prices for local insurers, who often lack actuarial expertise.

2.1.1 BIG DATA AND MACHINE-LEARNING

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Description of the technology: SAS, a global analytics firm, defines big data as a term that describes a large volume of data.[2] Even though the data by itself is not a technological advancement, complex algorithms for machine-learning or predictive analytics are expected to produce more robust analyses with larger datasets, thus maximizing the functionality of this technology. Machine-learning in this context refers to using these large datasets to find patterns, as well as the usage of statistical techniques to better understand the customer base.

How it supports microinsurance rating: Emerging markets have typically suffered from a lack of traditional information, particularly for low-income consumers (see Resource 2.1.1 (a), para. 2). However, data on those who previously had no access to formal financial services can come in the form of customer data from mobile network operators (MNOs) or social media data, both of which can reveal key information such as customer preferences and behavioral traits. Cignifi, a data analytics company, uses a machine-learning platform to generate credit scores from mobile data. This can be used to create a risk profile that makes underwriting more targeted and efficient (see Resource 2.1.1 (b)).

Zhongan Technology, the technology arm of China's first online-only insurer, is contributing to big data in insurance by putting together a health data library with data from medical insurance directories and drug databases across China. This data can be used for more efficient health microinsurance pricing. Zhongan Technology also provides analytics that can help detect patterns in the data for targeted health microinsurance product design (see Resource 2.1.1 (c)). Etherisc is an Insurtech start-up that is using blockchain technologies to develop microinsurance products. They demonstrate another example of using machine-learning to price insurance products quickly and more efficiently (see Resource 2.1.1 (d)).

[2] SAS website. Accessed 9 April 2019. https://www.sas.com/en_us/insights/big-data/what-is-big-data.html.

Applications for actuaries: With technology collecting large datasets for credit and insurance purposes, actuaries can work with experts in the statistics or data science disciplines to apply machine-learning and other statistical techniques. This allows actuaries to gain more insight into their customers' characteristics and overall risk profiles. As with any new methodology, establishing procedures and understanding the strengths and weaknesses of the applied models are important to avoid pricing errors. Actuaries should also be mindful of relying too heavily on granular models when pricing for new markets. Closely monitoring the claims experience ensures the insurance product is being priced at a sustainable level.

Resources:

Table 2

RESOURCES ON BIG DATA / MACHINE-LEARNING FOR RATING PURPOSES

Resource	Location	Line of Business	Key Lesson
2.1.1 (a)	Global	Cross-cutting	Big data can be used to develop the microinsurance market
2.1.1 (b)	Global	Cross-cutting	Mobile usage data can act as a proxy for credit scores
2.1.1 (c)	China	Health	Consolidated health databases can help develop health insurance products
2.1.1 (d)	Global	Property (Motor)	Machine-learning can be used to price insurance products sold through blockchain

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Resource 2.1.1 (a) – Big data for small policies	
Reference information	*Publisher*: Cenfri *Publication date*: October 2016 *Author*: Nordin, K.
Resource link	https://cenfri.org/blog/big-data-for-small-policies/
Line of business	Cross cutting
Type of resource	Article
Summary	The article lists possible applications of **big data** for microinsurance.
Why should actuaries read it?	This is important for actuaries for **product development** and **underwriting** purposes. This article describes how big data can be applied to pricing insurance. Actuaries can develop and test these new pricing models to see how well they measure up to expected results, and to understand how and why the results may differ. Not much has been written yet about pricing microinsurance products using these techniques. Thus, it will be interesting to see the impact of parsing through large amounts of data to better understand the customers and their risks in the context of microinsurance.
Special insight	*"Preferences and behavioral traits revealed through social media interactions could inform which distribution channels or marketing strategies to prioritize and make for a more tailored product design."* (Excerpt, para. 3). *"By applying sophisticated algorithms to big data, providers can also better understand and **model the risks** they are underwriting and be more efficient at **premium pricing**. This could include learning what diseases are more prevalent in various locations, by analyzing outpatient data; or optimizing price and collection frequencies, by assessing financial behavior and affordability for a specific target audience."* (Excerpt, para. 4).

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Resource 2.1.1 (b) – Leapfrog and Omidyar Network target unbanked billions in Cignifi deal	
Reference information	*Publisher*: Cignifi *Publication date*: June 2017 *Author*: Not available
Resource link	https://cignifi.com/leapfrog-and-omidyar-network-target-unbanked-billions-in-cignifi-deal/
Line of business	Cross-cutting
Type of resource	Blog post with video
Summary	Cignifi is a data analytics company that uses a **machine-learning platform** to generate credit scores from mobile data to allow the unbanked access to formal financial services. Cignifi uses *"nonfinancial data such as mobile calling and texting patterns, the routine of being at a workplace or home, and regular contact with reputable borrowers,"* as a proxy for conventional finance-based credit scoring. (Excerpt, para. 6)
Why should actuaries read it?	This is important for actuaries for **product development** and **underwriting** purposes. In the interview conducted in the video, Stewart Langdon from Leapfrog Investments and Jonathan Hakim, CEO of Cignifi, discuss how Cignifi's technology allows insurance companies in emerging economies to understand their customers' creditworthiness when previously there was no financial fingerprint. This will allow them to generate a risk profile for each customer, which can be used for product development and a more efficient pricing process. They are starting to apply this machine-learning technology more specifically to insurance and are hoping to provide more information on how this can be done in the near future.
Special insight	The world's low-income consumers may have difficulty accessing formal financial services, including insurance, because they do not have credit histories. Cignifi generates credit scores for the previously unbanked based on their mobile phone usage, which creates a risk profile that makes underwriting more targeted and efficient. The credit score may also be used to reduce customer acquisition costs for microinsurance products through targeted marketing.

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Resource 2.1.1 (c) – ZhongAn Technology Launches AI-Powered Data Platform for China's Insurance Industry	
Reference information	*Publisher*: Fintech News Hong Kong *Publication date*: August 2018 *Author*: Not available
Resource link	http://fintechnews.hk/6308/insurtech/zhongan-technology-saas-insurance-data/
Line of business	Health insurance
Type of resource	Article
Summary	ZhongAn Technology and AXA Tianping have *"launched a domestic **SaaS (Software-as-a-Service) platform** designed for insurers called the Intelligent Open Platform for Insurers."*(Excerpt, Intelligent open platform for insurers section, para. 2) *The platform aims to consolidate an immense library of data, some that might not otherwise be available to insurers. The platform also provides access to data processing and an AI technical team."* (Excerpt, Intelligent open platform for insurers section, para. 8)
Why should actuaries read it?	This is important for actuaries for **data analytics** and **pricing** purposes. This database may be a rich resource for pricing health microinsurance products in China. If the data on this platform is on a large enough scale, it could also be used to develop and test machine-learning and predictive analytics algorithms. These can then be used to design and price other microinsurance products which may not have as rich a data source.
Special insight	*"Through their insurance provisions, ZhongAn Technology has accumulated immense data which covers 70% of the latest medical insurance directory, 180,000 drug databases, and connections across hundreds of hospitals across the country."* (Excerpt, Intelligent open platform for insurers section, para. 1) "*The goal is for medical and insurance ecosystems to adopt the SaaS to bring more convenience, accuracy and efficient insurance data, and all for lower costs than they might be used to."* (Excerpt, Intelligent open platform for insurers section, para. 5) *"The platform was built based on in-depth analysis, consolidation and value exploration of medical data it has to provide the following 3 core areas – access to medical records, insurance repository and risk management services."* (Excerpt, Intelligent open platform for insurers section, para. 7)

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Resource 2.1.1(d) – Optimizing Insurance Policies with Machine-learning	
Reference information	*Publisher*: Decentralized Insurance Developer Conference *Publication date*: January 2018 *Author*: Etherisc
Resource link	https://blog.etherisc.com/optimizing-insurance-policies-with-machine-learning-ml-cc44ee33a3b2
Line of business	Property (motor) insurance
Type of resource	Blog post with video
Summary	The video for the presentation demonstrates how a decentralized insurance model made possible through blockchain makes the insurance market more efficient. They then explain how **machine-learning** can make the model work through facilitating ratemaking, fraud detection, and loss assessment.
Why should actuaries read it?	This is important for actuaries for **modeling**, **data analytics,** and **risk management** purposes. Actuaries can combine their insurance knowledge together with their statistical expertise to design the machine-learning algorithm and test it to understand the robustness of the model. For instance, the presenter from Etherisc mentions that each model fits with different criteria, so "*It's not about finding the true model under the data. It's about building several models and choosing the best one.*" (Excerpt, Training models for insurance section, para. 1) An actuary can ensure that the lessons learned from how products are currently priced are applied to this technology to ensure the model works as it is expected to. If it works well, it can reduce the time taken to price insurance products.
Special insight	*"Actuaries use different computation models for calculating various costs. For instance, the Tweedie generalized linear model (GLM), has been used for decades to compute for pure premiums."* (Excerpt, Training models for insurance section, para. 1) Etherisc introduces TensorFlow, which is a machine-learning interface that can be trained using Tweedie GLM or any other model that can be used for pricing insurance.

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2.1.2 REMOTE-SENSING TECHNOLOGY, INCLUDING SATELLITES

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Description of the technology: Remote-sensing is defined by the USGS (U.S. Geological Survey) as "the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance from the targeted area."[3] Earth observation data can be gathered using remote-sensing technology, such as satellites. Satellite technology has now improved in such a way that publicly-available images have resolution suitable for designing index insurance products. (See Appendix B for information on index-based insurance.) Other earth observation data sources that are not highlighted in this section could include weather stations, drones, or aircrafts.

According to IFAD's report on using remote-sensing for index insurance, *"Satellites collect different types of datasets based on specific biophysical dynamics, such as cloud temperature to estimate rainfall, evaporation and transpiration of water from the soil/plant system (evapotranspiration), soil moisture content or vegetation greenness. These data are typically calibrated with some ground information to create index data. The index is designed to proxy yield loss based on the remote-sensing parameters used."* (see Resource 2.1.2(a), p. 19)

[3] USGS website. Accessed 9 April 2019. https://www.usgs.gov/faqs/what-remote-sensing-and-what-it-used?qt-news_science_products=7#qt-news_science_products.

Specific examples of satellite data that have been used in microinsurance are shown in Table 3. Further details on other types of satellite data and how they have been used to develop indices for index insurance products can be found in Resource 2.1.2(a).

Table 3
TYPES OF SATELLITE DATA AND THEIR APPLICATION

Satellite (Source)	Data	Application	Resource
Sentinel-1 (European Space Agency)	Synthetic Aperture Radar (SAR)	Proxy for crop yields	2.1.2 (b) – RIICE
MODIS (NASA - National Aeronautics and Space Administration)	Normalized Difference Vegetation Index (NDVI)	Proxy for crop yields	2.1.2 (b) – RIICE
Landsat (NASA and USGS - United States Geological Survey)	Satellite imagery	Flood assessment	2.1.2 (c) – IWMI, 2.1.2 (g) – MiCRO
Not specified	Cloud cover	Proxy for drought	2.1.2 (d) - Pula

How it supports microinsurance rating: Crop indemnity insurance for smallholder farmers in rural areas is costly to implement. Individual field visits for loss assessment can be time-consuming and incur high expenses, thus reducing the affordability of such insurance. Adverse selection from a lack of information, as well as moral hazard behavior, can also increase the insurance costs and create inefficiencies. Index-based insurance (see Box 1) can address many of the issues of serving smallholder farmers. Remote-sensing data is used to design the index, which is then used to price the insurance product and determine when a claim payout is triggered and what that payout is.

The precision of the model to price index insurance and proxy for losses can be increased by combining remote-sensing data from satellites with other data sources. Specific examples from the literature regarding how the remote-sensing data is used include:

- To simulate a crop-growth model, remote-sensing data was combined with other non-remote-sensing data, including meteorological, soil, and agronomic management data. The model also used agronomic management information, such as rice variety duration, crop establishment method, water management, and amount of inorganic nitrogen fertilizer. The model was used to develop the index for area-yield index insurance. (see Resource 2.1.2 (b))
- For index insurance protecting against losses from drought, remote-sensing data can be combined with GPS coordinates collected with a tablet during a field visit. This allows one to more accurately pinpoint the pixel on the satellite that corresponds with the farm's location, reducing basis risk. (see Resource 2.1.2 (d))
- To model the losses from natural disasters, remote-sensing data that estimated the risk of a tropical cyclone, earthquake, or excess rainfall were combined with a geo-referenced database of assets. That data then created an exposure database that provides the economic value of the exposed assets. (see Resource 2.1.2 (e))

Applications for actuaries: Pricing index-based insurance products uses remote-sensing data as a proxy for risks faced by the vulnerable in emerging economies, such as low crop yield, or natural disasters such as tropical cyclones and earthquakes, flooding / excessive rainfall, and drought. Actuaries can help develop the risk models that use this data together with other sources of data to estimate the risk profile of the insured area, which can then be used to develop the index and price the insurance product. It is important to understand the limitations of the model, such as the potentially wide confidence interval of the loss distribution, and how that impacts premium pricing. This may be the case particularly if there are only a few historical data points as inputs, since the number of data points is dependent on how long satellites have been collecting usable data.

Another challenge when developing an index is to minimize the basis risk, such that the index reflects the actual loss experience of the smallholder farmer. It is important to create a monitoring system that can assess the quality of the index. Josh Ling, Senior Microinsurance Specialist for the International NGO Mercy Corps, advises that *"If the index insurance is consistently over- or under-paying in a particular region, for a particular hazard, when compared to*

original assumptions, pricing and product design must be adjusted to ensure the product's long-term viability" (see Resource 2.1.2(g), para. 7).

According to Agrotosh Mookerjee, Chief Actuary at Risk Shield, a microinsurance consulting firm, satellite data can work with weather station data when developing the index to reduce basis risk. Satellite data increases the quality of data available to calibrate the index, as weather station data tends to be prone to human error, take time to collect, is costly to obtain, and tends to have gaps. Weather station data coupled with satellite data can help increase the precision of the index. How the different data are used together depends on the specific location of each project, as that determines the risk to be covered by insurance and the type of data available. [4] Taking a step back, monitoring the product also helps to check if the risks that the index is designed to cover are reflecting the risks that the insurance product is trying to address in the first place (see Resource 2.1.2(f)).

Finally, with new technology to integrate in the pricing model, developing the risk model requires cooperation and communication with experts in other fields such as hydro-climatologists and agro-economists. This might also require communication with local government or local insurers, hence it is important to be able to communicate a technical topic, such as index insurance pricing, in a non-technical manner.

Resources:

Table 4

RESOURCES ON REMOTE-SENSING TECHNOLOGY, INCLUDING SATELLITES, FOR RATING PURPOSES

Resource	Location	Line of Business	Key Lesson
2.1.2 (a)	Senegal	Agriculture	Index insurance is feasible, but requires large upfront costs
2.1.2 (b)	Vietnam	Agriculture	Satellite data with other earth observation data can estimate crop yield for area yield index insurance
2.1.2 (c)	Bangladesh and India	Agriculture	Satellite data can identify extent, depth and duration of flooding for flood insurance
2.1.2 (d)	Eastern Africa	Agriculture	In addition to developing an index, satellite data can be used to provide agronomic advice to smallholder farmers
2.1.2 (e)	Caribbean and Central America	Agriculture	Parametric insurance for national-level financial protection against natural disasters requires complex modeling
2.1.2 (f)	Kenya	Agriculture	Weather-based index insurance is context specific and should reflect farmers' needs
2.1.2 (g)	Guatemala	Agriculture	It is difficult to create a reliable index insurance product, as it requires a strong correlation between the observed index and actual losses

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[4] Mookerjee, Agrotosh. Telephone interview. 1 March 2019.

Resource 2.1.2 (a) – Remote-sensing for index insurance: Findings and lessons learned for smallholder agriculture	
Reference information	*Publisher*: International Fund for Agriculture Development (IFAD) *Publication date*: October 2017 *Authors*: Coleman, E., Dick, W., Gilliams, S., Piccard, I., Rispoli, F. & Stoppa, A.
Resource link	https://reliefweb.int/report/ethiopia/remote-sensing-index-insurance-findings-and-lessons-learned-smallholder-agriculture
Line of business	Agricultural insurance
Type of resource	Report
Summary	*"Index insurance has a role to play in agricultural development and risk management, yet it faces operational and technical challenges to reach scale and sustainability. Limited availability, accessibility, quantity and poor quality of data on the ground are some of the primary technical constraints preventing scale-up and sustainability of index insurance. This publication details the project, which investigated overcoming issues with ground data by using* ***remote-sensing data*** *for index insurance."* (Excerpt, Executive summary, p. 9) *"The project developed and tested seven innovative remote-sensing methodologies over two crop seasons in Senegal." "Its overall goal was to contribute scalable and sustainable approaches to index insurance and to evaluate the feasibility of remote-sensing for index insurance to benefit smallholder farmers."* (Excerpts, Executive summary, p. 10)
Why should actuaries read it?	This is important for actuaries for **underwriting** and **product development.** Actuaries can refer to this report to better understand the different types of remote-sensing data that have been used to develop index insurance products, as well as the benefits and challenges of using each one. Section 3 describes the different types of remote-sensing systems that are used to develop earth observation estimates, and Section 6 describes how the insurance indices are designed. This reference could help actuaries with developing new index insurance products. The report raised the following conclusions that could be applicable for actuaries: • **Availability of expertise and dedicated service providers is a key challenge.** Index insurance indices are technical and require input from different experts in remote-sensing, agriculture, and insurance. There is demand for actuaries in developing indices for insurance and pricing the insurance product. • **Product design has a critical influence on performance. Basis risk remains the main concern to both insurers and insured farmers**. When actuaries are designing the index insurance product, it is important to think of ways the data can be used to more closely reflect the farmers' actual crop experience. Basis risk can lead to reputational risk for the insurer and decrease demand for the insurance product.
Special insight	*"This publication concludes that remote-sensing methodologies are operationally feasible for index insurance. However, it was a challenge for the indices developed to reflect local yield, and basis risk remains a key concern. Although remote-sensing data are increasingly available, and at no cost, local knowledge and data from the ground are still essential to design, calibrate and validate remote-sensing indices. The findings highlighted a very high variability of yields achieved by individual farmers, even in the same village in the same year. The potential for basis risk is strongly influenced by the size of the area set by the insurer under which all policyholders are grouped, the uniformity of local yield losses experienced in a loss event, and the ability of the methodologies to detect such yield losses. Performance analysis showed that whatever the methodology, product design has a critical influence on how accurately loss can be captured. In addition, limited availability of expertise to design indices is a challenge."* (Excerpt, Executive summary, p.10)

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Resource 2.1.2 (b) – Spatial Rice Yield Estimation Based on MODIS and Sentinel-1 SAR Data and ORYZA Crop Growth Model	
Reference information	*Publisher*: Remote-sensing 2018, 10(2), 293; doi:10.3390/rs10020293 *Publication date*: 2018 *Authors*: F.J., Boschetti, M., Busetto, Campos-Taberner, L., Collivignarelli, F., García-Haro, M., E.D., Gatti, Holecz, F., Khan, N.I. Quicho, L. & Setiyono, T.D.
Resource link	https://www.mdpi.com/2072-4292/10/2/293/htm
Line of business	Agricultural insurance
Type of resource	Journal article
Summary	*"This study is dedicated to demonstrating and validating the methodology of **remote-sensing and crop growth model-based rice yield estimation** with the intention of generating historical yield data for application in crop insurance."* (Excerpt, Abstract, p. 1)
Why should actuaries read it?	This is important for actuaries for **reviewing assumptions for pricing** and **modeling**. The project lists the types of data that were used and the methodology to interpret that data to develop a crop growth simulation model that can be used to price area-yield index insurance. It could be useful for an actuary to review the methodology to understand the limitations and overall quality of the results the crop growth model generates.
Special insight	Many sources of data were used in this study to develop the index. The remote-sensing data were obtained from MODIS and Sentinel-1 sensors. Non-remote-sensing data used in the study include "*meteorological, soil, and agronomic management data. Agronomic management information such as rice variety duration, crop establishment method, water management, and amount of inorganic nitrogen fertilizer was inferred for the study area based on interviews with farmers.*" (Excerpt, Section 2, p. 4)

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Resource 2.1.2 (c) – Satellite-based insurance protects farmers from destructive floods	
Reference information	*Publisher*: Geospatial World *Publication date*: June 2017 *Author:* Amarnath, G.
Resource links	https://www.geospatialworld.net/article/satellite-based-insurance-protects-farmers-from-floods/
Line of business	Agricultural insurance
Type of resource	Article with video
Summary	The International Water Management Institute (IWMI) has launched pilot projects in Bangladesh and India to offer index-based flood insurance to smallholder farmers there. They combine "***hydrological and hydraulic modeling** and newly available **10m-resolution satellite images** from the European Space Agency"* to calibrate the index. (Excerpt, Safety net section, para. 3) The claims payment is triggered "*when the pre-determined threshold of flood depth/duration is breached.*" (Excerpt, Raising resilience section, para. 1)
Why should actuaries read it?	This is important for actuaries for **product development** purposes. The article provides a pilot project case study of using satellite data as the input for a flood risk model that insures smallholder farmers against flooding of their crops. Insurance that covers flood risk may be suitable in these areas as flood is the main risk to their crops, yet it may not be suitable for other areas where drought or pestilence might be significant possible reasons for crop failure. It is important for actuaries to consider the risks farmers face when designing the insurance product.
Special insight	*"Rainfall data for a river catchment area is first added to the model, which shows how run-off will travel and collect. If a trigger water-level is reached (calculated using 35 years of hydrological data), satellite images are used to verify the depth and duration of the flood. This accurately identifies those farmers that are eligible for compensation."* (Excerpt, Safety net section, para. 3)

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Resource 2.1.2 (d) – Pula and Protecting Smallholder Farmers through Insurance	
Reference information	*Publisher*: Accion (podcast), Omidyar Network (blog) *Publication date*: June 2018 (podcast), April 2018 (blog) *Author*: Mante, Y. (blog) & Raj, V. (podcast)
Resource links	Podcast: https://www.accion.org/pula-protecting-smallholder-farmers-insurance Blog: https://medium.com/positive-returns/bringing-insurance-to-smallhold-farmers-2fe1ca21ffb
Line of business	Agricultural insurance
Type of resource	Podcast; blog post
Summary	An example is given of a weather-based index insurance product, which Pula bundles with fertilizer or seed, that the smallholder farmer purchases. Farmers can register for the insurance through their **mobile phones**, and agents who make field visits to the insured farms use **tablets** to collect KYC (know your client) data. **Satellite data** that provides information on cloud cover is used to develop the index that triggers a claims payout.
Why should actuaries read / listen to it?	This is important for actuaries for **product development**, **monitoring**, and **pricing** purposes. The article and podcast discuss how Pula, an agro-insurance-technology business, uses satellite data to develop an index-based crop insurance that offers financial protection from loss of investment in inputs in the event of drought. Pula also demonstrates an additional application of the data they have acquired from various sources. They provide agronomical information to their customers on activities that could increase their yield and recommend when they should conduct such activities. This could impact farmers' crop behavior and, ultimately, their yields, which could in turn impact pricing assumptions. It will be important to monitor and adjust the pricing model and its assumptions according to the farmers' crop experience going forward.
Special insight	Rose Goslinga, CEO and co-founder of Pula, describes the index insurance product features in the podcast: Pula combines the satellite data, which includes cloud cover data up to a resolution of 5km by 5km, with GPS coordinates collected by tablet during a field visit. This is done to more accurately pinpoint the pixel on the satellite that corresponds with the farm's location. The goal is to reduce basis risk. Pula is also able to advise farmers on when to conduct certain activities to increase yield based on the data they have gathered on cloud cover information from the satellites, the type of seed that the farmers purchased, and the GPS coordinates of the farm.

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Resource 2.1.2 (e) – CCRIF SPC (The Caribbean Catastrophe Risk Insurance Facility Segregated Portfolio Company) 2017-2018 Annual Report; *and* Understanding CCRIF: A Collection of Questions and Answers	
Reference information	*Publisher*: CCRIF SPC (The Caribbean Catastrophe Risk Insurance Facility Segregated Portfolio Company) *Publication date*: 2018 (annual report) and March 2015 (Book) *Authors*: Not available
Resource link	Annual report: https://www.ccrif.org/publications/ccrif-spc-annual-report-2017-2018 Book: https://www.ccrif.org/sites/default/files/publications/Understanding_CCRIF_March_2015.pdf (p. 14-20)
Line of business	Catastrophe insurance (property and agriculture)
Type of resource	Annual report; book
Summary	The CCRIF SPC annual report for the 2017-2018 season provides an update on how the insurance facility has performed for the season. Included in the section for the parametric insurance products is a description of the **weather data sources** and **risk models** used to develop the indices for their parametric insurance products that offer financial protection against tropical cyclones, earthquakes, and excess rainfall. The second resource, "Understanding CCRIF," refers to a book that describes the **hazard, exposure, damage, and loss modules** used by the CCRIF to calculate premium pricing and payouts should an event occur. It also describes the technology that acquires the data used in each module in great detail. "*CCRIF uses National Hurricane Center data to determine loss for hurricanes, United States Geological Survey (USGS) information for earthquake loss.*" (Understanding CCRIF excerpt, p. 17) For excess rainfall risk, "*public and internationally recognized precipitation datasets and meteorological models*" are used. (Annual report excerpt, p. 24) In addition to the weather data, the risk models are based on *"a geo-referenced database of buildings, infrastructure and crops that provides building count, replacement cost, expected crop production and vulnerability classification of the different assets. The exposure database provides the economic value of the exposed assets disaggregated by sector and by building class."* (Annual report excerpt, p. 23) This data is used to generate the loss distribution from the weather events, which is then used in the index for pricing and for reinsurance purposes.
Why should actuaries read it?	This is important for actuaries for **pricing** and **reinsurance** purposes. CCRIF SPC is an example of a sovereign risk pooling of developing countries for financial protection against extreme weather events. The payouts have gone to a variety of purposes, including providing aid to affected persons and repairing critical infrastructure. Amongst the beneficiaries are vulnerable families, including those who require medical attention. This financial protection for the vulnerable on such a scale requires many data sources for monitoring the various weather events, the geospatial spread of assets, and the economic value of the exposed assets. The risk models that actuaries have helped develop will use the data to calculate the expected losses for premium pricing and probable maximum losses (PMLs) for reinsurance purposes. There is a trade-off between the complexity of the methodology used to generate the probability distribution of losses for each country and each peril against the precision of the results generated. However, natural disasters do not occur frequently. Hence, there is much uncertainty in the risk profile generated with few historical data points for input. The actuary determining the loss distribution should take that into account, as it will eventually feed into the pricing model and drive management decisions.
Special insight	Development of the parametric insurance products with weather data as input allowed the CCRIF to provide rapid payouts shortly after an extreme weather event occurred in the Caribbean. "*During the 2017 Atlantic Hurricane Season, the Caribbean suffered devastation caused by two category 5 hurricanes – Irma and Maria – within two weeks of each other. CCRIF made payouts of approximately US$54 million to 9 of its member governments following the devastating impacts of these two hurricanes. CCRIF also made a payout to Trinidad and Tobago of approximately US$7 million after a severe rainfall event in October 2017. While these payments may seem relatively small compared to the overwhelming cost of rebuilding, all recipient governments expressed appreciation for the rapid infusion of liquidity, which they were able to use to address immediate priorities. The experience of CCRIF shows that quick liquidity after a disaster is critical."* (Annual report excerpt, p. 17)

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Resource 2.1.2 (f) – Rethinking agricultural insurance: Lessons learnt from the Agriculture and Climate Risk Enterprise (ACRE) Africa	
Reference information	*Publisher*: Microinsurance Network *Publication date*: 2017 *Author*: Ribeiro, P.C.
Resource link	https://www.microinsurancenetwork.org/groups/state-microinsurance-2017 (p22-23)
Line of business	Agricultural insurance
Type of resource	Article
Summary	ACRE Africa is a for-profit agricultural insurance company. In this article, they provide two examples of agricultural insurance sold and the adjustments they made to the products to better cater to the farmers' needs. The second example highlights an index insurance product and how **earth observation data** through satellite imagery and surface weather stations did not adequately cover the crop risks faced by farmers in Kenya.
Why should actuaries read it?	This is important for actuaries as background knowledge for **product development and management**, and **risk analysis.** ACRE Africa's example shows how there can be gaps in relying on technology to design a more automated insurance product. It is a reminder that, as actuaries delve into the data to develop an index that proxies the crop risk profile, they should also consider if the data accurately reflects the risks that the insurance product is trying to address. This comes back to the importance of the first step in the actuarial control cycle, which is to specify the problem.
Special insight	*"When a disease massively affected maize production in Kenya in 2013, the index-based insurance products did not adequately respond to the crisis, as they only protected farmers against weather-related losses."* (Excerpt, p. 23) *"ACRE decided to introduce a multi-peril hybrid product, combining the advantages of both index and indemnity-based insurance. Large scale losses related to weather are monitored through indexes, but for more local events, such as a pest, a disease, fire or hail, an assessment is conducted in the field. Operational costs are kept low as the main risk, drought, remains monitored remotely. Still, farmers get more value from the insurance as they are covered for a broader range of risks."* (Excerpt, p. 23)

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Resource 2.1.2 (g) – MiCRO: Bringing Insurance Solutions to Central America's Vulnerable Populations	
Reference information	*Publisher*: Actuaries Digital *Publication date*: May 2017 *Author*: Ling, J.
Resource links	https://www.actuaries.digital/2017/05/16/micro-bringing-insurance-solutions-to-central-americas-vulnerable-populations/
Line of business	Agricultural insurance
Type of resource	Article
Summary	*"The Microinsurance Catastrophe Risk Organisation (MiCRO) is a reinsurance company specializing in the design and implementation of natural hazard risk transfer solutions for low-income markets. In 2016, the organisation launched its first index insurance product in Central America, 'Esfuerzo Seguro', an index-based bundled earthquake, drought and excess rainfall insurance for low-income Guatemalans."* (Excerpt, para. 1) *"As an index insurance, payouts under MiCRO's product depend on the observed levels of a pre-defined index that utilize **satellite data** to measure rainfall and droughts, and **ground vibration measurements** to determine earthquake magnitude."* (Excerpt, para. 5)
Why should actuaries read it?	This is important to actuaries for **pricing** and **product development** purposes. In the article, Josh Ling, Senior Microinsurance Specialist for the International NGO, Mercy Corps advises that *"any single prediction of the future has a very small probability of occurrence. In the context of climate hazards that are difficult to model, one of the most significant jobs is the creation of a monitoring system that can assess the quality of the index design. If the index insurance is consistently over- or under-paying in a particular region, for a particular hazard, when compared to original assumptions, pricing and product design must be adjusted to ensure the product's long-term viability. Although microinsurance has clear social objectives, the price charged is sufficient to cover all claims and administrative expenses incurred by the product. This enables the product to continue to be offered into the market, and to be reinsured to minimize the capital strain on local insurers as the portfolio expands its scale."* (Excerpt, para. 7)
Special insight	*"Compounding the challenge of scant climate data with which to design and price the product, climate change suggests that future weather patterns are likely to be significantly different from those observed over the last 15 years…In fact, the complex modelling of Esfuerzo Seguro was performed by a hydroclimatologist, who developed indices based on observed monthly levels of vegetation, and three-day accumulated rainfall, both of which correlated with historical losses and are used to cover the risks of drought and excess rainfall respectively. MiCRO verified the correlation to actual losses by interviewing numerous potential clients living on small two hectare farms in various areas of rural Guatemala."* (Excerpt, para. 6)

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2.1.3 PRICING TOOLS

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Description of the technology: Pricing tools use the input provided, such as historical yield data, the cost of health services, and demographic distributions, to generate an indicative premium price for the designed microinsurance product.

How it supports microinsurance rating: The pricing tools—such as the web-based crop insurance pricing tool developed by CelsiusPro and the Excel-based health insurance toolkit developed by Milliman—can provide information on the possible insurance prices for insurers in emerging economies. They can help an insurer develop microinsurance products when they may not have access to a pricing actuary or someone with the technical knowledge to price it.

Applications for actuaries: Developing pricing tools is one way actuaries can offer technical assistance to insurers in developing economies who may not otherwise have access to the technical capacity needed to price microinsurance products. The limitations and risks of the pricing tool need to be explained to avoid misunderstandings about the results and how the tool is used. Furthermore, it should be made clear that the quality

of the pricing result depends on the data input into the tool. Attention should also be drawn to the fact that, if the premium calculated by the tool is only for illustrative purposes, it should not be used for determining the premium without other considerations.

When designing the tool, one should keep in mind that the intended audience may not understand if the language in the tool is too technical. This may lead to the tool being used incorrectly or people may be disinclined to use the tool altogether. The input interface and output design of the tool should also be kept simple to ensure clear communication for the intended user.

Resources:

Table 5

RESOURCES ON PRICING TOOLS

Resource	Location	Line of Business	Key Lesson
2.1.3 (a)	India	Agriculture	Pricing tool outputs must be easy to interpret
2.1.3 (b)	Global	Health	Pricing tools should be customized for microinsurance markets

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Resource 2.1.3 (a) – CelsiusPro launches new Crop Insurance Pricer for India	
Reference information	*Publisher*: CelsiusPro *Publication Date*: 2018 *Author*: Not available
Resource links	Press release: https://www.celsiuspro.com/pdf/2018/2018_01_09_PM_PMFBY_Pricer_F1.pdf Video: https://www.youtube.com/watch?v=ljucKRAXfO8
Line of business	Agricultural insurance
Type of resource	Press release; video
Summary	CelsiusPro, an Insurtech company that specializes in industrializing index insurance solutions, has developed a **web-based pricing tool** to calculate insurance premiums for India's national crop insurance scheme. The video provides a tutorial for the pricing tool.
Why should actuaries read it?	This is important for actuaries for **technical assistance** purposes. The app automates the pricing process of a crop insurance product based off of historical yield data as input for local insurers. This allows them to price and administer any crop insurance for India's government-sponsored crop insurance scheme, or the Pradhan Mantri Fasal Bima Yojana (PMFBY) scheme. The app could act as an informative tool on the premium cost. Still, the insurer's head of pricing, or someone with an understanding of the index insurance product and local insurance market, should have the final say on the premium cost. This is an example of how actuaries or people familiar with pricing insurance products may provide technical assistance to insurers in developing countries who may not otherwise have the technical capacity to design index insurance products. It is important that the portfolio inputs are simple yet flexible enough to accommodate the variables required to price the specific product. The dashboard needs to display the analysis in a way that the local insurer can understand and apply the results. The limitations of the pricing tool should also be clearly explained to ensure that the pricing tool is not just simply used without consideration for the risks.
Special insight	*"The PMFBY Portfolio Pricer consists of a database, portfolio and analysis dashboard. The database feature provides templates that help to upload data consistently in order to price crop insurance. Administrative units and crops can easily be selected and added to a portfolio, and the analysis tool allows for the individual setting of relevant parameters (such as the indemnity threshold) and the calculation of the expected loss – also on a granular level, e.g. by district, cluster or crop."* (Excerpt, para. 5)

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Resource 2.1.3 (b) – Health microinsurance instructional pricing tool	
Reference information	*Publisher*: Milliman *Publication Date*: October 2015 *Authors*: Borcan, A. M., Collins, J., Damler, R.M., Henry, D., Johnson, R. L. & Wright, A. S.
Resource links	http://www.milliman.com/insight/2015/Health-microinsurance-instructional-pricing-tool/
Line of business	Health insurance
Type of resource	Tool with user manual
Summary	Milliman, an actuarial consulting firm, has developed a model for pricing health microinsurance products
Why should actuaries read it?	This is important for actuaries for **pricing** and **technical assistance** purposes. The model highlights adjustments that a traditional actuary might have to consider for a microinsurance health product. For example, the pricing tool has an option for a budget scheme, which offers a limited selection of benefits. This is sometimes necessary in the microinsurance context to keep the product simple enough for the policyholder to easily understand. The pricing tool also offers assistance to insurers in emerging economies who are looking to underwrite health microinsurance products but lack the technical expertise to price it. The tool can provide management information on an illustrative premium that could, for instance, bolster their negotiations with reinsurers.
Special insight	*"This model illustrates key actuarial principles common to health scheme pricing and describes a number of important items to consider when using available data and applying adjustments in health scheme pricing. The concepts and mathematical principles used are examples of functional concepts related to health microinsurance and health insurance pricing and provide a valuable framework for actuaries and other health professionals as they develop and operate microinsurance schemes."* (Excerpt, para. 1)

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2.1.4 OTHER RATING-RELATED RESOURCES

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Additional technologies that can support microinsurance rating are being implemented by Skymet, a private company in India that offers weather forecasting solutions. They provide technology such as a **user interface platform** to display the data and **automated weather stations** that can be used to develop crop index insurance products and reduce their basis risk. More information can be found in the resource boxes below.

User interface platform for weather data. Weather Mine is a mapping and data visualization application for the weather data developed by Skymet. It provides data on rainfall and maximum and minimum temperatures for the different regions in India. This user interface tool *"provides easy visualization of data, quick analysis and tailor-made data downloads"* (Excerpt, para. 3) and *"is used by insurance and reinsurance companies to understand risk and calculate actuarial premiums for definite regions."* (Excerpt, para. 5) Resource link: http://indianweatherforecast.com:8080/corporate/weathermine-product.php
Automated weather stations. Skymet also builds automated weather stations with sensors that will record *"important farming parameters such as temperature, relative humidity, wind speed and direction, rainfall, solar radiation, leaf wetness, soil moisture, atmospheric pressure and evapotranspiration."* (Excerpt, Here's all you need to know section, para. 6) The data collected can be used to develop design indices for weather-based index insurance products that reflect the actual crop experience of nearby farmers. Resource link: https://www.indiatoday.in/education-today/gk-current-affairs/story/maharashtra-first-indian-state-to-use-automatic-weather-stations-974573-2017-05-01

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2.1.5 LESSONS LEARNED – RATING

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Technology is helping to address the lack of good quality data and the lack of rating technical expertise in the microinsurance space. The following paragraphs list three potential areas of interest that technology raises for actuaries interested in microinsurance rating.

Data for underwriting. Michael Weilant, a Principal and Consulting Actuary at Milliman who has experience pricing health microinsurance products, has commented that *"a lack of data makes it difficult for traditional actuaries to enter the microinsurance space."*[5] Through technology, data is being gathered that can be used to inform pricing insurance for low-income people. Satellites and other earth observation data sources are providing weather data that can be used as a proxy for weather-based or crop-yield risks faced by smallholder farmers. The challenge now is to develop models that can interpret the data to create indices that mirror farmers' actual crop experience. This will require actuaries to work together with remote-sensing and agricultural experts to minimize the basis risk in the indices that are complex and technical to develop.

Technology has also allowed us to collect risk data from unconventional sources. For example, machine-learning platforms can generate credit scores for those without access to formal financial products based off their mobile phone usage data. This technology can also provide actuaries with data that can be used as a proxy for risk profiles to calculate the risk premium of credit insurance. Going forward, this technology could be applied to insure other types of risk.

These data sources are new, and there is not much information on insurance experience in microinsurance markets. It is important for actuaries to closely monitor the sales and claims experience to see how the insurance product is faring against projections, as well as to recommend product design changes necessary for improving the performance of the insurance product.

Data analytics. Beyond pricing, actuaries can design machine-learning systems and other statistical models to inform other managerial decisions—such as product design or targeted customer acquisition—which lowers distribution costs. The data obtained for pricing can also be used to benefit the insurance customers. For instance, index insurance providers who have access to weather data can provide agronomical information to their customers on activities that could increase their yield and the best timing for such activities. Health data collected from telemedicine (see Section 3.2.2) services can also help insurance companies to offer health advice to their customers.

Given enough data, machine-learning could automatically price microinsurance products. This may raise the concern as to whether they will replace the need for an actuary. Victor Wang, actuary with Pula Advisors, posits that though technology can provide support for the backbone of actuarial work and reduce the need for an actuary, tackling new and unspecified challenges seems to, at least presently, be out of automations' grasp.[6]

Perhaps another point of view to consider is whether the technology actually meets the needs of the microinsurance company. According to Nigel Bowman, an actuary at Inclusivity Solutions—a microinsurance digital solutions provider—a simple descriptive analysis will give you a lot of information on how the customers engage with your platform. Going forward, however, there can be a lot of value in developing accurate predictive models to sell insurance, manage persistency, and select risk. [7]

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[5] Weilant, Michael. Telephone interview. 15 February 2019.
[6] Wang, Victor. Email interview. 20 March 2019.
[7] Bowman, Nigel. Telephone interview. 1 March 2019.

Communication. Actuaries can develop pricing tools to provide information on premium pricing for insurance companies in developing countries that may not have in-house technical expertise to do so. Clear communication is important to ensure that the tool will be correctly used to inform managerial decisions. This can be achieved through simple and straightforward instructions and a clean interface.

Being able to clearly communicate technical concepts is particularly important when working with index insurance. Actuaries should translate technical insurance principles to experts in other fields, such as remote-sensing experts or agronomists who may not be familiar with how insurance works. Actuaries might also need to work with the local insurer. Being able to express pricing issues simply and clearly will go a long way toward developing a high-quality index insurance product.

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2.2 DISTRIBUTION

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Distribution is one of the most significant challenges in delivering high-quality insurance products to low-income people. How does technology assist insurers in reaching clients in large numbers whilst addressing the constraints of low margins, minimal financial infrastructure, and the many other challenges in distributing microinsurance? In this section, several innovative distribution channels are discussed, including:

- **Mobile networks and devices**, which have become a major point of sale by facilitating access to significant volumes of clients and data
- **Mobile health (m-health)**, for which telemedicine has become a valuable service with which to bundle insurance
- **Digital marketing channels**, which facilitate client education and segmentation
- **Artificial intelligence and chat bots**, which can automate some customer service functions
- **Agent-led insurance platforms**, which provide a human touch, while still leveraging a digital platform to centralize information

2.2.1 MOBILE NETWORKS

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Description of the technology: Mobile devices are portable electronic devices using mobile voice or data communication over a network of cellular sites. Mobile microinsurance has, in turn, been defined as "*any type of microinsurance product which leverages the mobile channel, regardless of the existence of a mobile money platform, to improve a part of the insurance value chain which can include product design, pricing, marketing and sales, policy administration and claims payment.*"[8] As a result of its portability and wide acceptance, mobile devices, particularly applied in the context of mobile network operator (MNO) channels, have replaced smart cards and Point of Sale terminals as technologies in the last few years.

How it supports microinsurance distribution: In the last decade, MNOs have become a microinsurance distribution channel that have experienced rapid growth and continue to demonstrate great potential. The applications of mobile devices via an MNO's network in microinsurance include remote access to client information for enrollment and cashless transactions, such as the collection and payment of premiums. [9] With

[8] Leach J. "M-Insurance: The Next Wave of Mobile Financial Services?" (2011). https://www.cover.co.za/m-insurance-the-next-wave-of-mobile-financial-services/, Appendix.
[9] Gerelle E. & Berende M. "Technology for Microinsurance Scoping Study." Microinsurance Innovation Facility. (2008). https://microinsurancenetwork.org/sites/default/files/MIP2_technology_and_microinsurance.pdf, p. 12.

certain schemes, clients can also access coverage information and the claims process through mobile applications. More and more frequently, mobile usage data are utilized to generate an accurate risk profile or consumer behavioral persona.

MNOs have not been traditional players in distributing insurance. As a result, various business models in which the MNO plays different roles in the value chain have emerged. In an insurer-driven business model, the MNO typically manages only premium collection and claims payout. However, in a model which is led by the MNO, they may also take the lead with their branding. In some cases, the insurance is offered as a loyalty (free) product to their existing customer base, and the MNO pays the premiums. Technical Service Providers (TSPs) also play a significant role in the development of MNO-distributed microinsurance products. TSPs, like MicroEnsure, BIMA, Inclusivity Solutions, aYo, and OKO, have often been seen as the catalyst of mobile insurance products in the emerging markets. In 2017, GSMA estimated that the TSP-led business model accounts for more than 50% of existing MNO microinsurance products in the world.[10] With their strong positioning in the value chain of mobile-enabled microinsurance, significant investments made by global insurers have made them collaborative shareholders of the two major TSPs in the market.

Applications for actuaries: Being an integral part of the insurance world, the role of actuaries extends to the broader business and strategic decisions involving insurance players. The growth of mobile-enabled microinsurance has led to the emergence of complex and highly specialized ecosystems with the MNOs. Actuaries involved in managing an "m-insurance" product need to recognize the complexity involved at a partnership level, as well as the potential and risks it brings. While distribution through MNO partnership can penetrate the market at a rapid speed, these partnerships also run the risk of damaging an entire industry, as in the case of Ecolife in Zimbabwe. (see Resource 3.2.1 (c))

From a product development perspective, telecommunications companies have a very different perception of insurance than from a conventional insurer. Microinsurance products distributed via MNO are competing for consumer dollars against other tangible value-added services like ringtones or game downloads. Where high-speed competitions of the MNO environment drive product development, actuaries also need to act as gatekeepers in ensuring the quality of insurance products through regular and appropriate monitoring. The actuarial profession also carries the weight of ensuring that MNO microinsurance products are bringing value to customers. Moreover, actuaries working in this space are often involved in setting up the back-end systems by acquiring data to be used in future product development and pricing. While it does not appear to be a high risk in existing MNO insurance models, actuaries should continue to monitor and avoid adverse selection as part of the product management process. As products diversify and evolve for mobile-enabled insurance, risk bias may appear with particular insured populations.

As of 2017, there were more than 90 mobile-enabled microinsurance services across 27 emerging markets (details from Resource 2.2.1 (b)). While mobile-enabled insurance models have become prominent, regulations governing mobile-enabled products are not always mature. Actuaries also take on the role of providing guidance and advice from a regulatory perspective.

Furthermore, an enormous amount of data has been generated within the mobile-enabled insurance market. Yet, there are limited efficient channels for collecting and processing this information. Actuaries should be involved in designing optimal information systems for collecting data in a systematic manner while managing the budget.

[10] Raithatha R.& Naghavi N. "Spotlight On Mobile-Enabled Insurance Services." GSMA. (2018). https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/09/2017-SOTIR-Spotlight-on-mobile-enabled-insurance-services.pdf, p. 9.

Resources:

Table 6

RESOURCES ON MOBILE NETWORK OPERATORS

Resource	Location	Line of Business	Key Lesson
2.2.1 (a)	Asia	Cross-cutting	Development of meaningful mobile-enabled products is crucial
2.2.1 (b)	Global	Cross-cutting	Context is key for m-insurance partnership management
2.2.1 (c)	Zimbabwe	Cross-cutting	Risk management cannot be neglected for mobile-enabled products
2.2.1 (d)	Mali	Agriculture	Understanding end-customers problems is vital for product design

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Resource 2.2.1 (a) – Insights on Mobile Network Operators as a distribution channel for microinsurance in Asia	
Reference information	*Publisher*: Microinsurance Network *Publication date*: 2016 *Author*: Basix Consulting
Resource link	https://microinsurancenetwork.org/groups/insights-mobile-network-operators-distribution-channel-microinsurance-asia
Line of business	Cross-cutting
Type of resource	Research report
Summary	*This report provides an insight to MNOs as a distribution channel for microinsurance in Asia. The study shows that there are an estimated 2.6 billion SIM cards activated through various carriers in the Asian region. In Asia, both leading TSPs and their partner MNOs are not only providing a delivery channel but driving microinsurance development. They are increasingly taking an active role in branding, marketing, designing products, and managing front-end relationship with customers*. (Excerpt, p. 7)
Why should actuaries read it?	One of the greatest challenges around implementing mobile insurance initiatives is the **development of meaningful products** that meet customer needs. Actuaries are best placed in terms of balancing the cost and benefits of appropriate features at the product design stage. With the insights of the MNO microinsurance experience, actuaries should be involved in monitoring the performance of products (e.g. loss ratios) to ensure great customer value.
Special insight	Whereas most early microinsurance pilots were driven by insurers seeking new channels to expand their customer base, the "*recent wave of developments appears to be largely driven by MNOs seeking to build customer loyalty, improve average revenue per user (ARPU), and reduce churn in increasingly cut-throat markets.*" (Excerpt, p. 9) MNOs now appear to be taking the lead almost as often as insurers!

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Resource 2.2.1 (b) – Spotlight on mobile-enabled insurance services	
Reference information	*Publisher*: GSMA (Groupe Speciale Mobile Association) *Publication date*: September 2018 *Author*: Naghavi, N. & Raithatha, R.
Resource link	https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/09/2017-SOTIR-Spotlight-on-mobile-enabled-insurance-services.pdf
Line of business	Cross-cutting
Type of resource	Report
Summary	*This report provides an overview of the mobile-enabled microinsurance industry. It supports broader industry stakeholders to increase the utility and sustainability of mobile financial services. This publication is part of a series of deeper insights into selected topics based on the findings of the 2017 State of the Industry Report on Mobile Money*. (Excerpt, p. 3)
Why should actuaries read it?	This report includes several case studies, one of which is the case of JazzCash health insurance offered in Pakistan (offered in conjunction with MicroEnsure). This product is an example of the MNO distribution model in which customers are required to pay their premiums upfront and only via mobile money. In such a unique business model for insurance, actuaries are best put to use **designing products** that are valuable to customers. For example, what should the commission rate be for the product sold via this distribution channel? What disclosure is required for the terms and conditions? With premium collected up front, should there be an establishment and tracking of reserve by actuaries? At the same time, actuaries must understand the context and dynamics of the partnerships in order to apply their skills and judgment in designing mobile microinsurance products.

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Resource 2.2.1 (c) – Regulating m-insurance in Zimbabwe: Managing risk while facilitating innovation	
Reference information	*Publisher*: FinMark Trust *Publication date*: March 2014 *Author*: Leach, J. & Ncube, S.
Resource link	http://www.finmark.org.za/wp-content/uploads/2016/01/Rep_M_insurance_Zimbabwe_20142.pdf
Line of business	Life
Type of resource	Report (draft)
Summary	*Whilst some microinsurance initiatives have won awards from insurance supervisors for their innovation and value to consumers, there has also been dramatic failure. In this case from Zimbabwe, Econet (country's largest MNO) ceased to offer the insurance product following unilateral cancellation by Trustco (the technical service provider) during a partnership failure. It is estimated that 20% of the adult population of the country were impacted overnight due to the immediate cancellation of the mobile insurance product. This report draws lesson from this experience*. (Excerpt, p. 1)
Why should actuaries read it?	Actuaries are vital in assisting with **systemic risk** with regulators in insurance markets. By understanding the m-insurance failure in Zimbabwe (which is one of the most complex pricing models!), actuaries can gain an understanding of the mobile-enabled insurance model. This will help further identify, assess, monitor, and mitigate systemic risks.
Special insight	The short-term impact of the failure of Ecolife in Zimbabwe has caused more than 60% of the 1.6 million people insured by this model to rule out the use of similar products in the future. More than 4 out of 10 people also became dissatisfied with insurance. However, it is interesting to note that mobile insurance has recently been introduced again in Zimbabwe.

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Resource 2.2.1 (d) – OKO's pitch at the Youth Summit now on YouTube	
Reference information	*Publisher*: OKO *Publication date*: March 2018 *Author*: Not available
Resource link	https://www.oko.finance/single-post/2018/03/07/OKOs-pitch-at-the-Youth-Summit-now-on-YouTube
Line of business	Agriculture
Type of resource	Video
Summary	Tel Aviv-based OKO is a microinsurance company that uses mobile and satellite technologies to provide smallholder farmers in emerging markets with an affordable, paperless, and automated crop insurance solution. OKO was one of the six start-ups invited by the World Bank to pitch in front of an audience of young leaders and decision makers. This resource is a seven-minute pitch (and the Q&A session) done by OKO on video recording.
Why should actuaries watch it?	To ensure **appropriate product design**, actuaries need to understand the underlying problem and challenge what an insurance product is attempting to address. If a microinsurance product is designed for Martha in Mali with a low level of literacy skills, is it appropriate to provide 20 pages of terms and conditions for her to sign up for the product?
Special insight	There are 2 billion farmers who are dependent on rainfall, but less than 3% of them are protected by insurance!

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2.2.2 M-HEALTH (FOCUS ON TELEMEDICINE)

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Description of the technology: The World Health Organization (WHO) has defined telemedicine as "*the delivery of health care services (where distance is a critical factor) by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation.*"[11] Telemedicine also serves as the continuing education of health care providers. Typical services offered by "tele-doctors" include prescribing medicines, recommending appropriate clinics, and booking appointments with external partner doctors. In addition to telemedicine and insurance cover, some health packages also offer customers value-added services, such as daily health and nutrition tips via SMS or bill discounts at partnering hospitals and diagnostic centers. The types of underlying technologies used in telemedicine can include telephone landlines, mobile phone applications, SMS text, and video communication platforms.

Apart from providing convenience to customers, certain research also indicates that telemedicine improves health care quality and patient outcomes. This ultimately improves the health of patients. In general, telemedicine provides patients with low-cost health care opportunities, which they may not otherwise have access to. However, telemedicine providers generally have challenges in providing continuation of care, as patients do not always have access to the same doctor with each communication. [12]

How it supports microinsurance distribution: In facing a world of complex risks, insurance is increasingly less seen as a standalone solution. Instead, it is seen as a component of a holistic risk management package. Telemedicine serves as a health component of a bundled insurance package, with the components being linked to and reinforcing each other. (See example of Bima from Resource 2.2.2 (a)) Due to its tangibility, telemedicine is often perceived to make a bundled insurance package more attractive for customers. At the same time, telemedicine also serves as a distribution channel where insurance coverage is provided as a value-added

[11] WHO. "Telemedicine Opportunities and Developments In Ember States." (2010). https://www.who.int/goe/publications/goe_telemedicine_2010.pdf, p. 8.
[12] Avant Mutual Group. "Telehealth and Avant Issues and Discussion Paper." (2016). https://www.avant.org.au/telehealth-paper/, p. 3.

service for the existing customer case (i.e. customers who are currently subscribers to telemedicine are upsold health insurance products).

Applications for actuaries: As telemedicine is introduced in health microinsurance products, actuaries need to determine and monitor whether the use of telemedicine services is creating ultimate savings and providing greater accessibility to health care for customers. Considerations like cost of the service, the reliability of services, potential for misdiagnosis, and malpractice claims may also arise from these health models. These studies and their outcome should be fed into the plan design.

As the adoption, use, and coverage of telemedicine continue to grow, the health of the insured population should also improve due to increased accessibility to health resources. Not only should actuaries monitor the overall health of the population, analysis should also consider the health seeking behavioral change in insured populations. For example, will the provision of complimentary telemedicine as part of a subscription model increase the number of people in low-income populations seeking professional health assistance?

Resources:

Table 7

RESOURCES ON M-HEALTH (FOCUS ON TELEMEDICINE)

Resource	Location	Line of Business	Key Lesson
2.2.2 (a)	Global	Health	Insurance and m-health services can create a mutually reinforcing product bundle that protects financial and health risks
2.2.2 (b)	Global	Health	M-health can change health seeking behavior and thereby impact insurance product design

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Resource 2.2.2 (a) – How mobile microinsurance will impact the health insurance industry – Interview with Jose Martin, Global Health Manager at BIMA	
Reference information	*Publisher*: Research 2 Guidance (R2G) *Publication date*: 2018 *Authors*: Jie, Z.
Resource link	https://research2guidance.com/how-mobile-micro-insurance-will-impact-the-health-insurance-industry-interview-with-jose-martin-global-health-manager-at-bima/
Line of business	Health
Type of resource	Article with Q&A
Summary	*An article and Q&A interview with Jose Martin, the Global Health Manager at BIMA. Jose discusses how the development of digital technology—especially mobile communication and telehealth—have led to the emergence of microinsurance that covers the health risks of low-income families*. (Excerpt, introductory para.)
Why should actuaries read it?	Actuaries need to be aware of the drivers that impact **product development for microinsurance**, not only in relation to the insurance component of a package, but the entire bundled offering, inclusive of m-Health offerings. One of the top drivers of m-Health is regulation. The implementation of m-Health depends largely on the regulatory framework, which should be conducive to encouraging market entry of mobile health providers. This could include factors such as whether regulations allow medical professionals to write medical absent-from-work certificates or prescribe certain drugs via remote communication channels.
Special insight	*"Pure insurance offering will give way to integrated products and bundled services combining insurance and other elements such as healthcare. This convergence of products will deliver more customer value."* (Excerpt, para. 7)

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Resource 2.2.2 (b) – M-health: Remote access	
Reference information	*Publisher*: The Actuary *Publication date*: July 2015 *Authors*: Morgan, L. & Rogers, J.
Resource link	https://www.theactuary.com/features/2015/07/m-health-remote-access/
Line of business	Health
Type of resource	Article
Summary	*Morgan (microinsurance health actuary from the International Labour Organisation) and Rogers (health actuary from Clover Health insurance start-up) give an actuarial perspective on how mobile technology improves access to health insurance and healthcare, focusing on the underserved*. (Excerpt, introductory para.)
Why should actuaries read it?	In the actuarial control cycle, **external forces** influence actuaries' work. As a result, an actuary must be aware of new advances in technology and how these advances may affect the environment which they operate in, inclusive of m-health related technology. According to John Smith, founder of Pula Population Health Innovations and Technologies, the "*world is experiencing a paradigm shift in healthcare owing to the unprecedented confluence of a number of forces of change*." (Excerpt, para. 5) M-health is providing greater reach, efficiency, and productivity. In both emerging markets and developed economies, m-health is allowing customers to access health care in a more natural manner by fitting it into consumers' daily lifestyles.
Special insight	'Dial-a-doctor' programs are already reaching millions of members of large health microinsurance schemes. Aarogyasri (a large government-supported health microinsurance scheme in India) is even receiving up to 30,000 calls per day as of 2015!

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2.2.3 DIGITAL MARKETING CHANNELS

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Description of the technology: Digital marketing is the marketing of products or services using digital technologies, which include channels such as search engines, websites, social media, email, and mobile apps. As digital channels gain greater traction across developing markets, digital marketing also becomes crucial for microinsurance companies.

How it supports microinsurance distribution: When working with a low-income population where awareness is low, marketing and education become key components in the success of microinsurance products. The digital marketing channel is under-explored in microinsurance. Still, there are target marketing efforts through customer segmentation using mobile data that have led to increased customization.

Although online content for microinsurance players is typically devoted to sharing stories of its progress and future visions, there are also 'Life Stories' or 'Life Hacks' categories, which are aimed at informing and educating customers about insurance. In an increasingly competitive marketplace, content marketing has shifted to help customers understand the risks that they face and how to minimize them, as well as to occasionally entertain them. Rather than simply "marketing" their products, digital marketing for microinsurers also equips audiences with valuable resources and tools in order to build an ally and a trusted relationship.

Applications for actuaries: While actuaries do not typically create the content of a marketing campaign, they are often involved in reviewing the materials. Microinsurance product teams often work in low-resource environments, resulting in the actuary on the team becoming the gatekeeper to ensure that the product details disclosed are adequate and compliant with legislation. With a high level of credibility and professionalism, actuaries also hold the responsibility of preventing mis-selling in a digital marketing campaign.

Resources:

Table 8

RESOURCES ON DIGITAL MARKETING CHANNELS

Resource	Location	Line of Business	Key Lesson
2.2.3 (a)	Global	Cross-cutting	Data equips actuaries with significant customer insights
2.2.3 (b)	China	Health	Business retention is imperative

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Resource 2.2.3 (a) – Can technology push microinsurance further? Four reasons to say yes	
Reference information	*Publisher*: CGAP *Publication date*: May 2015 *Authors*: Mohan, R. & Noor, W.
Resource link	https://www.cgap.org/blog/can-technology-push-microinsurance-further-4-reasons-say-yes
Line of business	Cross-cutting
Type of resource	Blog post
Summary	Based on CGAP studies, the authors of this blog discuss four key opportunities across the microinsurance value chain which are underexplored, including digital marketing.
Why should actuaries read it?	Actuaries are among the earliest "data scientists" in history. In digital marketing distribution, **data analytics** provides marketers with solid evidence on what content resonates with customers and what does not. Moreover, through understanding data, actuaries can apply their skillsets to create a better understanding of customer insights and targeted marketing.
Special insight	Cignifi is a mobile data analytics firm that uses mobile data in tailoring microinsurance provisions. They analyze numerous mobile data variables, such as volume and duration of voice calls, mobile money transactions, and mobile savings to determine a premium appropriate for different customer segments. This allows microinsurance providers to adapt their SMS-based marketing campaigns through customer segmentation, thus ultimately increasing the chance of enrollment.

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Resource 2.2.3 (b) – The Development of WeChat Marketing & Distribution of Insurance Products in China	
Reference information	*Publisher*: Society of Actuaries *Publication date*: December 2018 *Authors*: Huang, W.
Resource link	https://www.soa.org/resources/research-reports/2018/wechat-marketing-distribution/
Line of business	Health ("micro-mutual assistance")
Type of resource	Report; podcast
Summary	Provides insights and research about how WeChat is the main force of online marketing for insurance products in China. With the popularization of WeChat communication technology, insurance companies should use this platform in their marketing, policy inquiries, and claim settlements.
Publisher	Society of Actuaries
Publication date	December 2018
Why should actuaries read it?	One important lesson for actuaries to understand is the importance of **business retention**. Despite the importance of integrating online mechanisms into the insurance value chain, in the case of "micro-mutual assistance" products, a short product cycle means that customers found little value to renewing a policy. It was further found that, while a majority of WeChat users were aware of health insurance, they did not understand how it worked and, as a result, did not purchase coverage.
Special insight	Whilst WeChat has been extensively adopted in the Chinese society, insurance distribution (particularly involving money transfer) via this channel still faces challenges of trust and product understanding. It was suggested that the provision of periodic free video lectures, inviting experts to answer questions and implementing small prize-winning quizzes, are good ways to promote the importance of insurance.

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2.2.4 ARTIFICIAL INTELLIGENCE AND CHATBOTS

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Description of the technology: Artificial intelligence (AI) refers to the "development of computer systems to perform tasks and decision making that have historically required human intelligence." (Willis Towers Watson) One application of this technology is chat robots (chatbot) for customer interaction. A chatbot is a service, typically powered by rules and sometimes artificial intelligence, that allows a person to interact via a chat interface. (i.e. Facebook Messenger, Slack, and text messages)

How it supports microinsurance distribution: The use of chatbots in microinsurance is a natural extension of the push for self-service capabilities. It is argued that the traditional face-to-face customer interaction experience—where customers often experience long wait times and multiple touchpoints for a single request—become more enjoyable by the use of chatbots. Chatbots can remove potential frustration in dealing with insurers and make customer servicing more accessible to customers at a lower cost. Chatbots can be used to facilitate online insurance purchases, answer questions on filing a claim, and address frequent inquiries about a product. Through the use of AI, chatbots can also deliver personalized recommendations that improve customers' quality of life through custom-made communications or advice.

Applications for actuaries: Whether it is applied in insurance customer servicing or automating driving, the very basis of AI is machine-learning. Some believe that as chatbots "learn," their application will ultimately take over the modelling and data analytical work in the actuarial space. In a world where algorithms can model risks better than humans, what role will the actuary of the future play? Actuaries are said to be the first "data scientists" in history; who is in a better position working in the field of data analytics to qualify the outputs of AI tools?

One might argue that the existence of artificial intelligence and predictive analytics is a threat to the actuarial profession. Yet, the value of the actuarial profession is clearly not a simple calculator. The value derives from good old-fashioned actuarial judgement, pricing in assumptions, and instigating the appropriate checks and balances that allow the profession to drive the insurance success story of tomorrow. It is only through a combination of AI tools and actuarial intervention that products and pricing can be taken to the next level.

Resources:

Table 9

RESOURCES ON ARTIFICIAL INTELLIGENCE AND CHATBOTS

Resource	Location	Line of Business	Key Lesson
2.2.4 (a)	Asia	Cross-cutting	Actuaries must embrace technology

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Resource 2.2.4 (a) – HeartiLab Blog	
Reference information	*Publisher*: Hearti (on Medium) *Publication date*: 2018 *Author*: Various
Resource link	https://medium.com/theheartilab (multiple blog posts)
Line of business	Cross-cutting
Type of resource	Blog posts
Summary	This blog page, hosted by Medium, features the work of HeartiLab and explores various topics on artificial intelligence and blockchain technology in the context of microinsurance in South East Asia. Some blog titles include: "Help the Unbanked and Uninsured Keep Up with the Economic Miracles in Asia," "Financial Inclusion Through Technological and Product Innovation," and "Microinsurance Is Insurance Evolved."
Why should actuaries read it?	The rise of a new, widely-adopted technology almost always addresses a challenge faced by humans. It is also unsurprising to see many insurers joining a global shift toward **digital and customer-centric strategies**. Actuaries can no longer work in silos to meet the demand for digitalization in insurance. Through data integration and analytics, actuaries can be involved in pricing customer behavior, understanding customer connectivity habits, automating cost/expense ratio, and de-duplication of tasks.
Special insight	*More than 60% of the adults in Asia do not have a bank account and many more do not have basic insurance protection in life, property, accident and health*. (Excerpt, post Part 1 – "Help the Unbanked and Uninsured Keep Up with the Economic Miracles in Asia") Consumers in Asia demand mobile solutions in buying insurance, and they want it to be simple, affordable, and on-demand. The rise of Insurtech players like Hearti demonstrates that insurers are increasingly looking to create microinsurance products that are innovative and can be easily understood by customers.

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2.2.5 AGENT-LED MOBILE INSURANCE PLATFORM

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Description of the technology: Agent-led mobile insurance business models are typically integrated through a mobile operator partnership. Through the use of call centers and face-to-face interactions, trained agents enroll customers with microinsurance products on a digital platform, such as mobile phones and tablets. The technologies used in this model are very similar to those discussed in Section 2.2.1 Mobile Networks, except an agent network is involved in face-to-face sales and customer education.

How it supports microinsurance distribution: Apart from enrollment and claims payment, technology is also used as part of customer education management in this distribution model. Selling insurance in an emerging market is tough, as it is typically new to the customer, and often has a bad reputation and complex product design. An agent-led distribution model is designed to overcome these challenges. However, it is also important to develop appropriate agent incentives and training to support product distribution.

Applications for actuaries: When working in an agent-led distribution model, the underlying business model is very different relative to conventional insurers. In particular, actuaries need to take relatively high distribution costs into consideration in the pricing model because of the salaries for agents. Commission rates for both the MNO partner and insurance agents can sometimes be as high as 50%[13], which makes the profitability of any insurance scheme very difficult. Moreover, with the sale of microinsurance as "low-ticket" items (occasionally in competition with selling policies of higher value), volume of sales become significantly important.

[13] IMF World Bank. "Will the Sun Shine On African Microinsurance?" https://microensure.com/wp-content/uploads/2017/09/MI144-147_BKR_0917-Sept-2017.pdf.

Actuaries need to regularly analyze and monitor the pricing in order to refine projection modelling which tracks the business model's sustainability.

Resources:

Table 10
RESOURCES ON AGENT-LED MOBILE INSURANCE

Resource	Location	Line of Business	Key Lesson
2.2.5 (a)	Tanzania	Life (accident) and health (hospitalization)	Distribution cost is one of the biggest expenses in an agent-led mobile insurance model

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Resource 2.2.5 (a) – Designing microinsurance products using mobile money in Tanzania	
Reference information	*Publisher*: Arcada *Publication date*: 2017 *Author*: Goshashy, C.
Resource link	https://www.theseus.fi/handle/10024/130579
Line of business	Life (accident) and health (hospitalization)
Type of resource	Master's thesis
Summary	This study looks at how microinsurance products can be scaled using mobile money in emerging markets, specifically Tanzania. The study further looks at the role of sales agents in marketing mobile microinsurance products in the BIMA business model.
Why should actuaries read it?	One important lesson for actuaries to understand is the importance of **distribution cost** in an agent-led mobile insurance model. It was found that, in an agent-led mobile microinsurance model, the biggest cost is typically salaries paid out to agents. While one can argue that the mobile microinsurance business model is only viable with an agentless system, it was found that agents play a significant role in customer education in low penetration markets like Tanzania. Moreover, agents also serve the purpose of preventing fraud. The author of this thesis suggests that, in reducing agent cost, agent services can be automated through following a standardized phone call script or a computer-based calling system where customers can dial and receive information. These insights into the business model are important for actuaries when designing an insurance product in the micro context.
Special insight	In an interview with a claims manager of BIMA, it was revealed that the adoption of social media channels to receive claims documents (e.g. WhatsApp and Facebook Messenger) will increase claims process efficiency. Moreover, it also serves as an important channel for promoting claims testimonials in building up trust between customers and insurers.

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2.2.6 LESSONS LEARNED – DISTRIBUTION

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Michael J. McCord, Managing Director of the MicroInsurance Center at Milliman, has previously commented that: "*Distribution drives microinsurance. Without it, the quality of the product is irrelevant.*"[14] For microinsurance to scale, distribution is arguably the greatest challenge insurers face. In servicing low-income markets, insurers must resolve the many associated problems: poor access to traditional financial service payment, irregular and unpredictable cash flows, living in remote locations, low trust with sales agents, and many others. In finding a cost-effective distribution channel, insurers need to think differently about microinsurance distribution. As a result, many

[14] Fulco, H. "Cracking the Distribution Challenge In Africa." Microinsurance Network (2016). https://microinsurancenetwork.org/community/blog/insights-and-perspectives/cracking-distribution-challenge-africa, para 2.

innovative distribution models have emerged. The MNO distribution channel—via freemium [15], paid, or a mix of methods—has been promising to many investors. A modified distribution method using an agent-led mobile insurance platform has also been widespread. More and more m-health services have been bundled with insurance coverage to provide a holistic risk management solution to customers. Digital marketing is also becoming more prominent in microinsurance advertisement. Examples of chatbots in self-servicing, including sales, Q&A, or simple customer interactions, are also developing in the microinsurance space.

Within a new and changing environment, actuaries cannot remain one-dimensional. Actuaries need to transfer their skillset into the innovative sphere of microinsurance. Being insurance experts, actuaries can bring value into the arena of microinsurance development with their risk management skills, commercial and creative problem solving, and strong analytic and financial training. Actuaries involved in m-insurance need to apply their risk management skills into a complex and ever-so-changing ecosystem. This may also include providing guidance and advice from a regulatory perspective. Actuaries can also be involved in the data analytics perspective—from setting up the back-end system to collecting the appropriate data to analyzing consumer behavior change with the implementation of new technologies. Pricing for microinsurance products is another important role that actuaries currently hold in the microinsurance industry. Last, but not least, with a high level of professionalism, actuaries also have the duty of whistleblowing when a microinsurance product is being mis-sold or public interest is not being protected. As demonstrated in the case of Ecolife in Zimbabwe (see Resource 2.2.1 (c)), systemic risk failures can occur in the microinsurance market.

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2.3 CLAIMS ADJUDICATION

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It is imperative to microinsurance that claims are processed quickly and transparently. Much effort has been put into making the claims process more efficient in order to instill trust in the customers about the insurance product. Trust, of course, is an important factor for product growth. Keeping operating costs low and reducing the cost of risk by increasing efficiency in fraud detection also enables the insurer to lower the premiums. This is especially important in microinsurance, where the product has to remain affordable for the lower-income demographic. A faster claims processing time also ensures that clients get their payouts when they need them to recover from the financial shock. Thus, they don't have to use costly coping strategies such as borrowing, restricting consumption, depleting savings, and selling off valuable assets at a discount. A number of technologies are being applied to microinsurance to improve how claims are processed, including:

- Claims administrative systems that facilitate a direct and smooth transaction between the different people required to process a claim.
- Smartphone applications that enable agents and even clients themselves to submit data required for claims processing. Similarly, claims agents may receive information through the app that will help them with claims processing. The applications leverage the internet or a cellular network connection to transmit data quickly from any location.
- Remote-sensing/Satellite technology. Section 2.1.2 explains the types of satellite data available and how they are being used to design and price index-based insurance products. Satellite data can also be used to

[15] Freemium is a business model which involves initially offering free insurance products for new customers as a reward for their loyalty to the provider (typically MNO). This model typically has a limited trial period where ultimately customers are upsold paid insurance products.

expedite claims processing for area-yield index insurance by reducing the labor involved in determining the average yield during loss assessment.

- Internet of Things (IoT) refers to physical sensors that are connected to a network and can transmit information required for processing claims. Possible applications are drones for fraud detection in crop insurance, heating sensors to detect fires for fire insurance, and RFID (radio-frequency identification) chips to uniquely identify livestock for livestock insurance.

- Blockchain technologies can help decentralize and automate claims processing so it can happen quickly and at low cost.

- Machine-learning and data mining can be applied to data the insurer already has to help detect fraud and automate claims data digitization.

2.3.1 CLAIMS ADMINISTRATIVE SYSTEMS

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Description of the technology: The claims administrative system can be set up to automate data collection from the customer. This reduces the claims processing time, as well as human error from data collection. It is important to integrate this claims administrative system with the insurer's IT system to facilitate a seamless transfer of claims data to the insurer and allow the insurer and other partners real-time access to claims data. To customize an insurer's IT system for microinsurance products, it might need to handle a large volume of frequent financial transactions for micro-premium payments and claims payouts.

How it supports microinsurance claim adjudication: *"The benefits of a good information technology (IT) system can include increased efficiency (and ultimately lower costs), more accurate and/or automated client verification, the ability to provide cashless benefits, real-time access to data within an organization, and access to data across organizations*." (see Resource 2.3.1(d), Section 6.1, p. 38). Stonestep is a technology service provider (TSP) that has developed a back office microinsurance platform that is customized for microinsurance products. (see Resource 2.3.1 (a)) It is described as able to handle frequent small incremental financial transactions, thus allowing for scaling of the microinsurance product. Stonestep also demonstrated how their claims submission platform is integrated with the core administrative system, which they expect will reduce the claims turnaround time. Britam MI, a microinsurance company, presents another example of this integration by providing partner hospitals with paperless claims systems. According to Britam MI, they can directly transfer the claims information to themselves, instead of having to wait for the claims to be delivered from the hospital before they can be processed. (see Resource 2.3.6(a))

Microcare was a health microinsurance provider that provides a positive example of how an integrated claims system can reduce the time taken to collect data for claims records. (see Resource 2.3.1 (b)) The claims system makes use of an automated rules-based system that processes straightforward claims. This reduces the number of claims that require manual processing by the claims staff. Connected terminals at the partner health care providers facilitated checking-in patients and tracking treatment, thus reducing time for data input and verification during patient treatment.

ICICI Lombard is a microinsurance provider with a case study that demonstrates the risks involved in relying on technology to facilitate claims processing. (see Resource 2.3.1 (c)) The government changed the biometric identification cards for clients so they were no longer compatible with existing devices in the outpatient clinics. The devices took months to replace and, in the meantime, the clinics were turning away the insurer's clients or asking them to pay for the health services out-of-pocket.

An integrated IT system or a claims administrative system can be a significant upfront cost for the insurer. However, a cost/benefit analysis must take into account *"not only the immediate returns from a technology investment, but also the impact on future business growth, efficiency and client value."* (see Resource 2.3.1 (d), p. 41) This impact can also go beyond claims. For instance, high quality claims data obtained from a digitized claims system may make claims data analysis easier and reveal patterns that could make pricing of risk more efficient. Or, they may provide customer segmentation information that could guide distribution efforts. The ILO paper (see Resource 2.3.1 (d)) also discusses instances when a cost/benefit analysis was conducted and, despite the potential benefits, microinsurance companies decided to not invest in IT systems. Yet, a lack of connectivity may render setting up a claims administrative system in rural areas ineffective. Such areas might be better served with mobile technology, which is discussed further in Section 2.3.2.

Applications for actuaries: A claims administrative system gives actuaries access to better quality claims data. This allows the actuary to generate timely financial reports, up-to-date analysis of claims experience for management decisions, and results that can drive the update of pricing and claims assumptions. Timely monitoring of the claims experience is valuable in microinsurance, where the market is generally unknown and there is uncertainty around the initial pricing of the product due to a lack of data.

Actuaries must also consider the data they require in the system for reporting and analysis, but there is a tradeoff. As Agrotosh Mookerjee advises, a data wishlist needs to be balanced.[16] If it is too detailed, acquiring the data may end up delaying insurance processes.

> *"Actuaries should be part of the conversations that create better IT solutions that are capable of handling the large volume of data generated in the provision of microinsurance. This will drive the design of suitable risk management plans, accurate sensitivity/stress tests and adequate reserving."* – Mildred Areeta, President, the Actuarial Association of Uganda. Email interview on 23 March 2019.

Resources:

Table 11

RESOURCES ON CLAIMS ADMINISTRATIVE SYSTEMS

Resource	Location	Line of Business	Key Lesson
2.3.1 (a)	Global	Cross-cutting	Back office systems for microinsurance products need to handle frequent small financial transactions
2.3.1 (b)	Uganda	Health	An integrated claims system reduces claims turnaround time
2.3.1 (c)	India	Health	Technology can delay claims processing
2.3.1 (d)	General	Cross-cutting	Investing in technology is not always the right choice

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[16] Mookerjee, Agrotosh. Telephone interview. 1 March 2019.

Resource 2.3.1 (a) – Stonestep – 'Microinsurance as a service' platform	
Reference information	*Publisher*: Digital Insurance Agenda *Publication date*: 2018 *Authors*: Not available
Resource link	http://www.digitalinsuranceagenda.com/pagina-dia-tv.php?keyword=stonestep
Line of business	Multiple insurance products
Type of resource	Video
Summary	Stonestep is a TSP that provides both **front-end and back-end systems** designed to bring microinsurance to the masses at an affordable cost. Their back-office system, Eiger, is customized for high-volume mass insurance business that can be transferred across countries and products.
Why should actuaries read it?	This is important for actuaries for **pricing** and **reserving** purposes. Stonestep's integrated platform automates many functions, but requires actuarial expertise in pricing the insurance product before the system can roll it out. Given the flexible nature of Stonestep's platform, actuaries may also need to adapt to pricing different insurance products within management's timeline. Microinsurance products tend to be short-term in nature with small payouts; this makes pricing straightforward. The challenge is obtaining high-quality data for pricing and working with partners, such as MNOs, that can provide access to such data. Despite the challenges, Stonestep's business model allows for large amounts of data collection from business partners, including MNOs, that can be used for predictive analytics and data mining to find patterns in data. This can be used by management to direct business decisions going forward.
Special insight	Eiger, as a back-office system tailored for microinsurance, allows for flexibility in product structure, coverage, pricing, services, insurers, and vendors. The system has a built-in customer-relationship management interface to allow the back office and agents quick access to the necessary information for efficient customer service and claims processing. It can also accommodate multiple currencies, languages, and calendars, which can facilitate communication with those in developing countries who may not speak English. Regarding small incremental premium billings in microinsurance, Stonestep claims their system is able to handle more transactions in a day than a traditional system could in a year.

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Resource 2.3.1 (b) – Microcare Insurance Uganda Case Study	
Reference information	*Publisher*: International Labour Organisation *Publication date*: 2013 *Author*: Greyling, L.
Resource link	http://www.impactinsurance.org/sites/default/files/mpaper24%20final.pdf (Section 7)
Line of business	Health
Type of resource	Case study
Summary	*"This case study examines the factors which contributed to both the success and failure of Microcare as a provider of health microinsurance."* (p. 9) This includes a section on the **health care and claims management software system** used by Microcare that enabled them to *"effectively deliver a specified range of medical services to a large group of people."* (p. 31)
Why should actuaries read it?	This is important for actuaries for **financial reporting** and **data analytics** purposes. One of the challenges in the claims management system was that the data between the claims system and financial accounting systems couldn't be reconciled. Another was that financial claims figures couldn't be obtained in real-time due to a limitation on the claims systems. *"The absence of accurate and timely financial reporting prevents effective tracking of the causes and interventions in claim trends."* (p. 33) Actuaries are not able to *"quickly identify if changes to underwriting practices and pricing were required"* (p. 24) and *"statutory and other reports cannot be provided within stipulated deadlines."* (p. 33)
Special insight	"*Health insurance claims administration involves very high volumes of transaction processing which can only be done efficiently within an automated rules-based system."* (p. 31) Microcare claims the management software system provided for *"automated claims vetting based on prescribed clinical treatment protocols and pre-determined contractual terms. This was designed to allow fast processing of compliant claims before involving medical staff in vetting claims which did not get past the automated stage."* (p. 31) Besides reducing operational costs and claims processing time, this rules-based system also reduces fraud, as manual claims processing can be easily manipulated. *"Another mechanism to facilitate claims management was the help desk at provider facilities, which facilitated checking-in patients and tracking treatment through connected terminals. This created a fast track to verify client identity and process claims at the point of treatment. It ensured that a large number of claims did not require further steps for data input and verification. The smart card technology used for patient identity verification ensured that Microcare membership identity cards could not be used by friends and neighbors."* (Excerpt, p. 32)

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Resource 2.3.1 (c) – Learning from Others' Mistakes	
Reference information	*Publisher*: International Labour Organisation *Publication date*: July 2015 *Author*: Dalal, A.
Resource link	http://www.impactinsurance.org/sites/default/files/MP42.pdf (pp. 22-23)
Line of business	Health
Type of resource	Research paper
Summary	This section in the paper discusses examples of how poor technological implementation can delay insurance processes, rather than improve them. With ICICI Lombard, a general insurance company in India, there were issues with the implementation of their **outpatient claims software** that led to a reduction in claims processed. This resulted in a loss of trust among their clients.
Why should actuaries read it?	This is important for actuaries for **risk management** and **financial reporting** purposes. ICICI Lombard's experience with claims monitoring software and biometric identification cards is an example of how operational risks from implementing new technology can instill distrust in insurance for the clients. This reputational risk impacts new business projections and distorts the claims experience while the system is down. This makes it difficult to set claims assumptions for the next year, impacting reserving and any pricing updates.
Special insight	The health insurance scheme used biometric identification cards to uniquely identify their clients, record their visits, and submit claims. The government changed the biometric identification cards for clients so they were no longer compatible with existing devices in the outpatient clinics. The hardware had to be replaced, and it took months to finalize the new software and then install it in the clinics. In the meantime, the clinics were turning clients away or asking them to pay for services out-of-pocket, thus reducing the number of claims processed and resulting in a loss of trust among their clients.

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Resource 2.3.1 (d) – The Moment of Truth: Claims Management in Microinsurance	
Reference information	*Publisher*: International Labour Organisation *Publication date*: January 2014 *Author*: Fonseca, C., Holtz, J. & Rendek, K.
Resource link	http://www.impactinsurance.org/sites/default/files/mp28.pdf (pp. 38-43)
Line of business	Multiple
Type of resource	Report
Summary	This section in the paper discusses the benefits and challenges of developing a good **information technology system** to streamline processes in microinsurance. It also lists examples of when it was better for the microinsurance company to not invest in the technology. Examples listed include: Fonkoze, a microfinance institution in Haiti that provided credit life insurance; Old Mutual, a South African commercial insurer with a group microinsurance business; and ICICI Prudential, which offered life insurance to rural tea farmers in India.
Why should actuaries read it?	This is important for actuaries for **financial reporting** and **risk management** purposes. Regardless of how claims are processed, whether manually or through an integrated system, a cost/benefit analysis should be conducted to see if the system works best for the specific context of the insurance company. In a microinsurance context where there may be a lack of understanding of the risks involved, this task may come to the actuary as it is an analysis on risks.
Special insight	*"A key concern is to ensure that the technology solution actually meets the needs of the programme and the process, rather than creating new processes or procedures that become bottlenecks."* (p. 39) *"Issues concerning connectivity, including the availability of electricity and/or Internet services, have plagued many of the systems used in the case studies."* (p. 39) *"Training requirements and user acceptance are other key issues that emerged from the case studies, particularly in rural areas."* (p. 39)

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2.3.2 SMARTPHONE APPLICATIONS

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Description of the technology: Smartphone apps allow claims agents and clients to directly send data to the insurer. They also allow insurers to send information to claims assessors to facilitate the loss assessment process. Data collected on the smartphone can include: client data that clients or their agents can key in so the data is digitalized, automatic data picked up by the phone that cannot be forged, such as GPS coordinates and time stamps, or data that can be photographed on the smartphone camera such as crop yield conditions or proof of claims documents (i.e. death certificates or hospital bills). Smartphones allow for quick and frequent transmission of data via the internet or a cellular network connection, which greatly reduces data delivery times—especially if there is a high volume of claims or the claims are coming from rural areas.

How it supports microinsurance claim adjudication: Firstly, mobile apps can allow clients and agents to submit claims. Clients can either submit a claim and the required supporting documents, if any, directly on the smartphone. This can be completed through WhatsApp, email, or SMS, or they can approach an agent who has the app to submit a claim on their behalf. The smartphone app enables quick digital recording of the claims data in the system with fewer data gaps and less opportunity for fraud.

TAGIC, a general insurer from India, developed a cattle insurance product with technology to reduce their claims turnaround time. They provided a smartphone to their tagging vendors with an app to capture and transfer claims data in real time. Instead of a manual delivery of paper documentation and photographs of the dead animal, claims data can now be transmitted instantly through the app, which reduced the claims turnaround time from 30 days to six days. (see Resource 2.3.2 (a), p. 5) IFPRI is a research center that piloted a project to base the claims assessment of crop insurance on photographs of the crops taken by the farmers on their smartphones. (see Resource 2.3.2 (b)) They found that crop damage from the smartphone pictures was quantifiable, and there was no evidence of fraud. Crop data accumulated from the pictures taken could also be used for more analysis on crop growth, which could lead to more efficient insurance pricing.

Secondly, smartphone apps can help claims agents quickly gather high-quality data that is required for claims processing. As well, they can quickly disseminate information for agents on the ground for loss assessment purposes. MALCOLM is a smartphone app being developed by Inclusivity Solutions, an insurance digital solutions company that aims to reduce motor insurance fraud by allowing anyone with the app and the right skills to step in as a claims assessor. (see Resource 2.3.2 (c)) This reduces the chance of the claims assessor receiving kickbacks. Thus, in conjunction with the GPS location and time-stamping functionality on the smartphone as well, it can prevent fraudulent claims. The CCE Agri app is developed for the government-sponsored crop insurance scheme of India. (PMFBY) (see Resource 2.3.2 (d)) It is expected to improve the quality of yield data collected, which reduces the turnaround time for claims processing. AgRISE is a smartphone app that delivers an impact assessment in the event of a natural disaster in India. It enables insurers and government agencies implementing PMFBY *"to estimate crop damage and overall insured losses quickly and reliably for all of India's major crops."* (see Resource 2.3.2(e), para. 2)

Applications for actuaries: Smartphone apps can reduce the time and effort required to process claims. They can also enable the collection of better quality data, which actuaries can use for claims reporting and other analyses for management or the reinsurer. In places where fraud detection is significant, they can reduce claims expenses. Coupled with reduction of operational costs, smartphone apps can also impact pricing considerations for microinsurance. Reducing claims processing time reduces the IBNR reserves required.

Resources:

Table 12
RESOURCES FOR SMARTPHONE APPLICATIONS

Resource	Location	Line of Business	Key Lesson
2.3.2 (a)	India	Agriculture	Giving the claims vendor a smartphone to transfer claims data significantly saves claims turnaround time
2.3.2 (b)	India	Agriculture	Regularly-taken pictures of crops from farmers' smartphones can be used to assess crop damage for crop insurance
2.3.2 (c)	Kenya	Property (Motor)	Smartphone apps can reduce fraud for motor insurance
2.3.2 (d)	India	Agriculture	Smartphone apps can help improve the quality of claims data
2.3.2 (e)	India	Agriculture	Smartphone apps can deliver information required for loss assessment

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Resource 2.3.2 (a) – Use of mobile technology in enrollment and claim settlement of cattle insurance -- Tata AIG	
Reference information	*Publisher*: International Labour Organisation *Publication date*: March 2015 *Author*: Prashad, P.
Resource link	http://www.impactinsurance.org/projects/lessons/mobile-technology-cattle-insurance
Line of business	Agriculture (Livestock)
Type of resource	Report
Summary	*"Cattle insurance in India faces both supply and demand side challenges which have affected the growth of the market. High claims ratios (due to adverse selection and fraud) and operational expenses (for identification and enrollment) affect the profitability of the portfolio."* (Excerpt, p. 1) In order to overcome some of these challenges, Tata AIG General Insurance Co. (TAGIC) *"developed a* ***mobile phone-based software application*** *for their tagging vendors to capture and transfer data and pictures from the field in real time."* (Excerpt, p. 1)
Why should actuaries read it?	This is important for actuaries for **data analytics, reserving,** and **pricing.** Digitizing claims data allows for actuaries to have access to data that can be directly downloaded from the system, making it easier for them to provide up-to-date reports and analysis. A significant decrease in the claims turnaround time reduces the Incurred But Not Reported (IBNR) reserves required. Actuaries can conduct the cost/benefit analysis to check how long before the initial costs incurred (i.e. setting up the system and training the vendors) will be offset by the benefits gained from the reduction in operating costs and potential increase in new business.
Special insight	TAGIC uses the smartphone app to approve and settle claims, rather than manually delivering paper documentation and survey reports back and forth. A photograph of the dead animal is sent from the tagging vendor directly to the central server, and the server sends the survey report to the claims team, who compare photos to verify the claim. *"Once the claim is approved, confirmation is sent to the client by SMS. This process has reduced the claims turnaround time from 30 days to 6 days."* (Excerpt, p. 5) *"Anecdotal evidence provided during interviews with the insurer suggests that this has also marginally reduced the impact of adverse selection and moral hazard. Back-end data management has also become more organized and efficient. Similarly, various costs such as photo storage, sharing and camera have been removed for the tagging vendor."* (Excerpt, p. 6) Technology in this study, however, was not able to help reduce loss ratios. Additional costs to implement this system include developing the software, purchasing mobile devices, translating the app into local languages for tagging vendors to use, and training the field staff to use the smartphone app. *"However, TAGIC believes that the additional expenses are worthwhile as the software will bring efficiency (in both time and costs) in the management of their cattle insurance portfolio over time."* (Excerpt, p. 6)

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Resource 2.3.2 (b) – IFPRI PBI Picture-based crop insurance: Is it feasible?	
Reference information	*Publisher*: IFPRI (International Food Policy Research Institute) *Publication date*: July 2017 *Authors*: Ceballos, F., Hufkens, K., Kramer, B., Mann, M., Melaas, E., Mishra, A., Robles, M. & Toor, M.S.
Resource links	https://www.ifpri.org/publication/picture-based-crop-insurance-it-feasible-using-farmers%E2%80%99-smartphone-pictures-minimize related: https://www.ifpri.org/publication/picture-based-insurance-it-sustainable-effects-willingness-pay-adverse-selection-and
Line of business	Agriculture
Type of resource	Research paper
Summary	Picture-Based Crop Insurance (PBI) makes use of regularly-taken pictures of crops to monitor crop growth and provide the index for crop insurance. Farmers take the pictures on their own phones using the **smartphone app** and send them to the insurer, thus minimizing loss verification costs.
Why should actuaries read it?	This is important for actuaries for **underwriting** and **data analytics** purposes. This technology provides a new source of data that is more strongly correlated with yields. This allows for more efficient pricing of crop insurance. Actuaries adept in machine-learning or data mining may be interested in working with the agronomic experts to develop the systems that can automate the crop loss assessments based off the pictures taken by the farmers. It will also be important to continue to monitor for fraud as farmers gain a better understanding for the PBI product as their behavior may adapt accordingly.
Special insight	Picture-based loss assessments are strongly correlated with yields and improve with weather index-based insurance in regard to basis risk. Crop damage is *"visible from smartphone pictures and can be quantified by agronomic experts. This paves the way for algorithms that automate loss assessment procedures, which reduces the claims processing time."* (Excerpt, Takeaway messages, p. 6) There was no evidence of fraud during the duration of the study. Of course, not having to check for fraud makes for a more efficient claims process.

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Resource 2.3.2 (c) – Using Insurtech to overcome barriers to non-life insurance	
Reference information	*Publisher*: Microinsurance Network *Publication date*: 2018 *Author*: Leach, J.
Resource link	https://www.microinsurancenetwork.org/groups/state-microinsurance-2018 (pp. 29-31)
Line of business	Property (Motor)
Type of resource	Report
Summary	*"Mobile Application Linked to Claims Operations and Learning for Microinsurance (MALCOLM), a joint venture between Inclusivity Solutions and Cocoon Network, combines a **cloud-based platform and GPS technology with a mobile application**. MALCOLM aims to reduce opportunities for fraud, whilst simultaneously creating greater efficiencies in the claim assessment process."* (Excerpt, p. 30)
Why should actuaries read it?	This is important for actuaries for **pricing** and **reserving** purposes. MALCOLM's efficiency can reduce expenses on claims assessment and reduce the claims ratio by reducing fraudulent claims. This impacts the pricing assumptions. It can also cut the claims processing time, reducing the IBNR reserves required. *"By digitising the claims process, insurers can also use data analytics to improve pricing as well as to tackle fraud."* (Excerpt, p. 30)
Special insight	MALCOLM allows anyone with the app, who has the right skills, and is in the right location at the right time, to step in as a claims assessor. An assigned assessor, coupled with the GPS location services and time stamps on the smartphone, can help prevent fraudulent claims.

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Resource 2.3.2 (d) – A Presentation on Crop Insurance Portal and CCE Agri Mobile App	
Reference information	*Publisher*: Department of Agriculture & Cooperation, Ministry Of Agriculture, Government of India *Publication date*: July 2016 *Author*: Not available
Resource link	http://www.ncfc.gov.in/downloads/Workshop_PMFBY_29july2016/Crop%20Insurance%20Portal.pdf
Line of business	Agriculture
Type of resource	Presentation slides
Summary	The **CCE Agri app** is a smartphone app that improves on the data quality of CCEs through photographing, geotagging, and time-stamping. Data can be entered into the app while the user is offline in rural areas. Afterwards, it can be uploaded into the centralized system when internet is available.
Why should actuaries read it?	This is important for actuaries for **data analytics.** Improved quality of digital data collected allows for actuaries to offer more insight into actual yields, which feeds into more informative reports and analysis on claims experience.
Special insight	The app is expected to significantly improve data speed (from harvesting to insurance loss estimation). Gains in data quality from geo-tagging ensures a field visit takes place, photos taken onsite mitigate manipulation risk, and data transfer through the internet greatly improves data consolidation/analysis. This results in reduced time in data collation and claim settlement. Though the app is available for all farmers who sign up for the Indian government-sponsored crop insurance scheme—PMFBY—reports on the impact of using the app could not be found on publicly-available resources.

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Resource 2.3.2(e) – Mobile phone app launched to strengthen new insurance scheme for India's farmers	
Reference information	*Publisher*: International Water Management Institute (IWMI) *Publication date*: September 2018 *Author*: Not available
Resource link	http://www.iwmi.cgiar.org/News_Room/Press_Releases/2018/press_release-mobile_phone_app_launched_to_strengthen_new_insurance_scheme_for_indias_farmers.pdf
Line of business	Agriculture
Type of resource	Press release
Summary	Relying on satellite data, climate data, and field data on crop yields, AgRISE (Agricultural Remote-sensing-based Insurance for Security and Equity) is a **smartphone app** that delivers *"a crop health card, which enables insurers and government agencies to estimate crop damage and overall insured losses quickly and reliably for all of India's major crops."* (Excerpt, para. 2)
Why should actuaries read it?	This is important for actuaries for **reporting on key performance indictors** and **reinsurance** purposes. During a natural disaster, actuaries may be asked to provide frequent updates on the claims impact, as the claims will need to be processed quickly to meet the needs of the clients. This report may also include how the actual loss impact compares against initial projections. Data from the app may allow actuaries to generate that type of report quickly for management or for the reinsurer.
Special insight	*"When natural disasters occur, the app will deliver an impact assessment in terms of reductions in crop area, yields and production. It will offer data as well as photos and videos from specific sites. The app will also provide weekly flood and drought severity maps to help policy makers plan relief efforts, based on estimates of expected crop losses."* (Excerpt, para. 4)

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2.3.3 REMOTE-SENSING / SATELLITE TECHNOLOGY[17]

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Description of the technology: The types of satellite data that have been used to proxy crop yield in the resources list in this section are described in the table below:

Table 13
APPLICATIONS OF SATELLITE DATA FOR CLAIMS PROCESSING

Dataset/Index	Type of Satellite Data	Application	Resource
Normalized Difference Vegetation Index (NDVI) (Voiland, A, para. 7)[18]	Infrared and visible light reflected from plant leaves	Index estimating density of chlorophyll in green leaves of vegetation	2.3.3 (a) – Satsure
Normalized Difference Wetness Index (NDWI) (JRC, p. 2)[19]	Near-Infrared and Short Wave Infrared channels	Index estimating the leaf water content of vegetation canopies	2.3.3 (a) – Satsure
Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) satellite dataset (Funk, C., Abstract)[20]	Infrared cold cloud duration observations	Combined with in-situ weather station data to create gridded rainfall time series	2.3.3 (b) - Pula

How it supports microinsurance claims adjudication: Satellite data can be interpreted through a risk model and used as a proxy for crop yield. This can improve the claims settlement process of area yield index insurance in the following two ways: through reducing the number of crop-cutting experiments (CCEs) that need to be conducted to measure average yield (see Box 2), and through developing crop growth models that can more precisely predict and reflect yield estimation. See Appendix B for a discussion of area yield index insurance.

CCEs incur significant costs in the claims assessment process of area-yield index insurance. As well, satellite data can help to reduce the number of CCEs that need to be conducted without increasing basis risk. Satsure, a satellite data analytics company, uses satellite data as a proxy for crop yield to stratify the insured area by crop health. This allows the insurer to focus their CCE efforts on low-yield areas, as claims payouts may be triggered there. Pula, an insurance and technology company, used machine-learning algorithms to rezone the insured area so that each zone has a homogenous yield distribution. (see Resource 2.3.3 (b)) In this way, fewer CCEs will be required to measure the average yield in each zone.

Satellites can provide data points on crop growth during the season. Together with weather, soil, crop data, images of actual crop growth at various stages, and geotagged CCE samples, crop growth simulation models can be developed to directly estimate crop yield with higher accuracy. Satsure suggests that the data from the crop growth model—which is now of better quality because of technology—can be used to settle disputes between insurance companies and the state in India's government-sponsored crop insurance scheme. (see Resource 2.3.3 (a)) Without room for disputes, the state will be able to provide the insurance companies with the yield data and premium subsidies for the farmers in a timelier manner.

[17] See Section 3.1.1 for definition of remote-sensing and satellite technology.
[18] Voiland, A. "NDVI: Satellites Could Help Keep Hungry Populations Fed as Climate Changes." (2009). Accessed 9 April 2019. https://www.nasa.gov/topics/earth/features/obscure_data.html.
[19] JRC. "Product Fact Sheet: NDWI – Europe." (2011). Accessed 9 April 2019. http://edo.jrc.ec.europa.eu/documents/factsheets/factsheet_ndwi.pdf.
[20] Funk, C. et al. "The Climate Hazards Infrared Precipitation With Stations—A New Environmental Record for Monitoring Extremes." Scientific Data vol. 2, Article number: 150066. (2015). Accessed 9 April 2019. https://www.nature.com/articles/sdata201566.

Applications for actuaries: Satellite data provides information on crop yield or factors that impact crop yield. Actuaries can use statistical models to analyze the data to detect patterns. These patterns could inform further actions that will reduce claims processing costs and support timely claim settlements. Using the actuarial control cycle to first clearly specify the problem will help to develop the models that could lead to improvements in the claims settlement process. The data gathered to improve the claims settlement process can also be used to better assess crop yield risks. This can be used to develop a more precise index, which will reduce basis risk. It can also be used to identify the risky areas that the insurance company may choose to transfer to a reinsurer.

Resources:

Table 14

RESOURCES ON REMOTE-SENSING AND SATELLITE TECHNOLOGY FOR CLAIMS ADJUDICATION

Resource	Location	Line of Business	Key Lesson
2.3.3 (a)	India	Agriculture	Satellite data can provide good quality information on crop yield
2.3.3 (b)	Nigeria and Kenya	Agriculture	Satellite data can feed into machine-learning algorithms to reduce claims processing costs

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Resource 2.3.3 (a) – Use of Satellite Data for Effective Implementation of Crop Insurance, Efficacy of Satellite Data Use in PMFBY (Pradhan Mantri Fasal Bima Yojana)	
Reference information	*Publisher*: Satsure *Publication date:* November 2018 *Author*: Basu, P. & Gunashekar, A.
Resource link	https://indd.adobe.com/view/0276eb4d-6a0e-4a89-b7ce-cb7bdaece5c2
Line of business	Agriculture
Type of resource	Newsletter
Summary	The two articles in this newsletter describe some of the issues faced in settling claims for the government-sponsored crop insurance scheme in India, PMFBY. High cost of CCEs and delay in claims settlements due to data disputes between state and insurance companies are two critical issues that contribute to the administrative costs. The articles then describe how Satsure, a satellite data analytics company, provides **satellite data** and data analysis that can play a key role in eliminating the data gaps that are causing the delay. This reduces operational costs and time taken to settle claims.
Why should actuaries read it?	This is important for actuaries for **data analysis, underwriting,** and **reinsurance**. Satellite data, which feeds into the crop yield estimation model, can be analyzed by actuaries to better understand crop growth. This could also help identify patterns that could lead to further actions that reduce claims processing costs and support timely claim settlements. The data can also be used to better assess risks that impede crop growth. This can then be used to develop a more precise index, which will reduce basis risk and identify the risky areas where the insurance company may choose to transfer those risks to a reinsurer.
Special insight	Satellite data that captures NVDI and NVWI can generate a crop map of the insured area that categorizes the crop area into a poor, medium, good, and very good crop health strata. This can identify areas of low crop yield where more CCEs could be conducted and use satellite data to proxy for CCE yield where there is good crop health. This guided stratified sampling method—which focuses efforts mainly on areas where a claims payout might be triggered—will reduce the number of CCEs that need to be conducted. Therefore, operational costs could be reduced without compromising on data collected. Satellites can provide data points on crop growth during the season. In comparison, CCEs can only measure crop yield data during loss assessment. The additional data points generated together with weather, soil, crop data, images of actual crop growth at various stages, and geotagged CCE samples can be used as input in crop growth models to directly estimate crop yield. This more objective and higher quality information on crop yield could reduce disputes between the insurance companies and the state. It will also allow the state and central governments to provide yield data and premium subsidies to insurance companies on time, which could reduce the time it takes to settle claims.

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Resource 2.3.3 (b) – Using Satellite Data to Scale Smallholder Agricultural Insurance	
Reference information	*Publisher*: CGAP *Publication date:* August 2018 *Author*: Goslinga, R. Hernandez, E. & Wang, V.
Resource link	https://www.cgap.org/sites/default/files/researches/documents/Brief-Using-Satellite-Data-Smallholder-Agricultural-Insurance-Aug-2018.pdf
Line of business	Agriculture
Type of resource	Report
Summary	This brief demonstrates a practical way that **satellite data** can be used to significantly reduce operational costs of area-yield index insurance offered to smallholder families in Africa. Precipitation data from satellites and yield data obtained on the ground were fed into a **machine-learning algorithm** to regroup the insured area into areas of land with more homogenous yield distributions. The brief also describes the challenges faced by Pula—the insurance and technology company who conducted the project—in using satellite data as a proxy for farm yields.
Why should actuaries read it?	This is important for actuaries for **claims processing** and **modeling**. This project gives an example of how actuaries can develop machine-learning algorithms for satellite and yield data to make loss assessment more efficient. The initial results from using satellite data to proxy farm yields on an individual farm level—or even average yield on a local government area level—were not good enough to be applied by the insurers and reinsurers. Further thought is needed about how to analyze the satellite data to reveal actionable information. Actuaries' technical expertise and data management skills can help with the process of developing statistical models that will solve the problem. In this case, specifying the problem—the first step of the actuarial control cycle—is important for developing an appropriate solution.
Special insight	A machine-learning algorithm was developed to use satellite data and yield data to define the borders of new and larger units of area to insure. The satellite data used was the precipitation variable within the CHIRPS satellite dataset. The data was allowed to reveal those areas where yields naturally followed a normal distribution, thereby showing only one mean. These areas were then used as units of area insured, as long as the distribution's variance was not too large. By aggregating the area units in this way, Pula sought to improve the ability to predict average yields in these areas while also reducing the total number of crop cuts or yield measurements required. Common yield distributions within these insured units could help maintain the basis risk levels already achieved in the current market. Over time, as more yield samples are gathered, basis risk could be further reduced. For the scope of this project, this methodology was found to reduce the total costs of yield sampling by about 43%.

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2.3.4 INTERNET OF THINGS (IOT)

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Description of the technology: The Internet of Things (IoT) is a network or system of interrelated computing devices, sensors, or other objects that have unique identifiers and can communicate with other devices in the network without human involvement. (see Resource 2 (a), p. 13) Examples of IoT technology include drones, heat sensors, and Radio Frequency Identification (RFID) tags.

Skymet is a weather-monitoring and agri-risk solutions company in India. They have attached sensors to drones to capture crop images with a granularity that satellite data cannot provide. Lumkani, an Insurtech start-up in South Africa, has developed a heat sensor to detect slum fires that occur often and spread quickly if left unchecked. The heat sensors are also connected to other sensors nearby to alert the community of the danger of fire. Finally, the sensor is also connected to Lumkani's system to alert them of the fire and its coordinates. (see Resource 2.3.4 (b)) IFFCO-TOKIO, a general insurance company in India, has used an identification device that can be implanted under

the skin of cattle for livestock insurance. The sensor can be read using RFID technology to uniquely identify the animal and potentially store information about the animal such as medical history. (see Resource 2.3.4 (c))

How it supports microinsurance claim adjudication: There are multiple ways drones can help make processing claims more efficient. Skymet uses drones to capture images of the actual crops being grown in the field. (see Resource 2.3.4 (a)) This can help verify that the crop grown matches the crop for which the insurance was purchased. Images from drones can also quickly show the extent of flooding, which can help determine if a flood insurance payout should be triggered. Images from drones give an aerial view of crop yield, which can streamline the loss assessment process for area-yield index insurance by targeting areas where the insurer should focus their yield assessment efforts.

Lumkani's heat sensor can accurately detect when a fire has occurred and can inform Lumkani of the GPS coordinates to kick-start the claims process. (see Resource 2.3.4 (b)) This enables Lumkani to pay out the claim for fire insurance within five business days. Lumkani takes pictures of the home at the time of registration for loss assessment, rendering a post-disaster visit to the client unnecessary.

Using RFID technology enabled IFFCO-Tokio to reduce fraud by preventing mis-identification of the insured cattle. (see Resource 2.3.4 (c)) This technology also makes claims processing more efficient. This technology was also adapted by other insurance companies for livestock insurance in India, with similar success.[21] The increase in cost in using the technology was expected to be offset by the decrease in expenses from scale and lowering of claims expense from fraud reduction.

Applications for actuaries: Use of IoT sensors can actually change the cost of risks that are being covered. Lumkani reduces the spread of fire, thus greatly reducing the claim severity of a fire event. RFID chips in cattle effectively reduced fraud, and the resulting data shows that claims expenses are lower than initially calculated. Drone imaging can provide real-time data on crop health, which could alert farmers to take immediate action to minimize crop loss. Actuaries will need to go back and update their assumptions as the insurance products are active.

IoT sensors can also be used to collect data that actuaries can use for data analytics. They can apply data-mining techniques to generate results that can inform additional preventive measures. With data on where and when fires most frequently occur, Lumkani can advise their clients on targeted preventive behavior. RFID chips can store medical history for the specific cattle, which allow farmers to provide better targeted care for the animal. Drones provide a resolution of crop data that was not previously accessible, which can be used to develop more precise indices for index insurance.

[21] Hart, E.K. "Understanding the Gap Between the Supply of and Demand for Cattle Microinsurance at the Base of the Pyramid In Rural India." BoP Innovation Center. Accessed 9 April 2019 https://thesis.eur.nl/pub/11432/Hart,%20Kim%20't%20(314024).pdf), p. 88.

Resources:

Table 15
RESOURCES FOR INTERNET OF THINGS

Resource	Location	Line of Business	Key Lesson
2.3.4 (a)	India	Agriculture	Drone images can identify crop and prevent insurance fraud
2.3.4 (b)	South Africa	Fire and life	Heat sensors can prevent the spread of slum fires and provide insurance protection
2.3.4 (c)	India	Agriculture	RFID chips can uniquely identify cattle and prevent insurance fraud

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Resource 2.3.4 (a) – Uprooting Uncertainty – UAVs for agricultural insurance sector	
Reference information	*Publisher*: Federation of Indian Chambers of Commerce and Industry (Report), Geospatial World (article) *Publication date:* February 2018 (report); September 2016 (article) *Authors*: Not available
Resource links	Report: http://ficci.in/spdocument/22946/Agri-Insurance-book.pdf (pp. 24-25) Article: https://www.geospatialworld.net/article/uavs-agricultural-insurance-sector/
Line of business	Agriculture
Type of resource	Report; Article
Summary	**Drones** or unmanned aerial vehicles (**UAV**s) can fly at about 200m above ground level, and the sensors attached to them are able to capture earth images with a granularity that satellite data cannot provide. (Report, p. 24) Drones can also fly below the cloud cover. Therefore, unlike satellites, which may have their optics hindered, drones can still gather data during the monsoon season in India when crops are grown. (Article, para. 2)
Why should actuaries read it?	This is important for actuaries for **data analytics** and **product development** purposes**.** Drones can provide evidence that prevents fraud by being able to check if the crop sown matches the crop that the field was insured for. This impacts the cost of insurance, as well as provides a reduction in claims processing time, which also impacts the IBNR reserves. Purchasing drone images have also shown to be economical relative to satellite data if the area is small, which is the case for smallholder farmers.[22] When considering if the cost of the technology is worth it, one must also take into account that the additional data the drone images provide can also be used to make the index the insurance product is based on more precise.
Special insight	Drones are able to identify if the crop a farmer has sown actually matches the insurance coverage he purchased for it, improving fraud detection. Drones can quickly tell if there is a loss—i.e. a flood—and then reduce the time required for loss assessment by providing flood data that was not previously accessible. Drones can also help streamline the loss assessment process for area-yield index insurance by targeting areas where the insurer should focus their yield assessment efforts. By providing field-level data for a more precise yield estimation that satellites cannot provide that is also quicker and cheaper than obtaining the information on the ground manually, drones can help to develop a quicker, more precise trigger that can reduce the time it takes to pay out a claim in the event of a loss. (Report, p. 25)

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"In Rajkot, Gujarat, there are many instances where farmers have taken insurance for the groundnut crop, which is a risky and vulnerable crop, but sowed cotton. Since the harvesting time of both the crops is different, drone surveys were carried out to get a clear picture on the ground." - Rajeev Chaudhary, Chief Risk Officer at Agriculture Insurance Company of India. (https://www.thehindubusinessline.com/economy/agri-business/insurers-deploy-drones-to-check-claims-by-farmers/article9583909.ece)

[22]Gamaya. "Use of Drones or Satellites In Agriculture." (2017). Accessed 9 April 2019. https://gamaya.com/blog-post/use-of-drones-or-satellites-in-agriculture/, para. 4.

Resource 2.3.4 (b) – Lumkani uses Fire Insurance to Protect Families in South Africa	
Reference information	*Publisher*: Venturekast (Podcast); Global Innovation Exchange (Report) *Publication date:* January 2019 (Podcast); March 2018 (Report) *Authors*: Gluckman, D. (Report) & Raj, V. (Podcast)
Resource links	Podcast: https://www.accion.org/lumkani-uses-fire-insurance-to-protect-families-in-south-africa Report: https://www.globalinnovationexchange.org/innovation/lumkani-fire-detection
Line of business	Fire/life
Type of resource	Podcast; Report
Summary	*"Lumkani has built the world's 1st off-the-shelf,* ***networked early warning device & system*** *designed for people living in dense urban slums [to protect them from fire]. In a fire situation, the device will ring alerting the family inside enabling them to be proactive before the fire becomes unmanageable. After 20 seconds the device transmits a signal to all devices in neighboring homes up to 60 metres away creating a community-wide response to the fire."* (Report, para. 1) The heat sensor device also signals Lumkani that a fire has occurred.
Why should actuaries read it?	This is important for actuaries for **data analytics** and **underwriting** purposes. The sensor has been effective in reducing the extent of damages from a fire, thus reducing the cost of insurance. This reduces the correlated risk of having one fire resulting in many claims in the same geographical region, which will impact how expected claims are modeled. Instead of cash, payouts are also given in the form of a card with credit stored on it for the purchase of damaged things. This should also reduce the moral hazard effect. (Resource 1 excerpt, audio interview) Data collected from the sensors during fire incidences—such as the frequency and time of day/year of the fire—can also be used to further develop the fire risk profile. (Resource 1 excerpt, audio interview)
Special insight	A large benefit of the technology is that the system alerts the community when there is a fire, which prevents extensive damages. Yet, the sensor is also able to alert Lumkani in the event of a fire and provide the exact GPS coordinates. This enables Lumkani to start processing the claim sometimes even before the homeowners themselves realize there has been a fire. This allows them to make the claims payment at most 5 days after the fire has occurred. (Resource 1 excerpt, audio interview)

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Resource 2.3.4 (c) – Cattle insurance through electronic identification chip technology -- IFFCO-Tokio	
Reference information	*Publisher*: International Labour Organisation *Publication date:* September 2012 *Authors*: Not available
Resource link	http://www.impactinsurance.org/projects/lessons/cattle-insurance-through-electronic-identification-chip
Line of business	Agriculture
Type of resource	Report
Summary	IFFCO-Tokio General Insurance Co. Ltd. piloted a cattle insurance project that places an identification device under the hide of the animal. *"The identification device is based on* ***RFID*** *(Radio Frequency Identification) technology."* (Excerpt, p. 1) The note describes the project and lists the lessons learned from the impact of the technology on reducing moral hazard and fraud and increasing claims efficiency.
Why should actuaries read it?	This is important for actuaries for **data analytics** and **underwriting** purposes. The technology has proven effective in reducing fraud and moral hazard, thus reducing costs of insurance that impact the actuarial pricing assumptions. The potential of scaling this technology and reducing expenses per policyholder needs to be weighed against the cost of implementing this technology to determine financial feasibility of the livestock insurance product.
Special insight	*"Using RFID technology enabled IFFCO-Tokio to reduce fraud through more accurate identification of animal and changing business processes for livestock insurance."* (Excerpt, p. 5) *"RFID helped to understand risks and adverse selection in the context of livestock insurance."* (Excerpt, p. 5) *"RFID chips and related processes improved claims experience of cattle insurance clients."* (Excerpt, p. 6) Going forward RFID chips can also be used to store health information about the insured cattle. (Excerpt, p. 1) This could be used to monitor the health of the cattle, reducing mortality risk.

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2.3.5 BLOCKCHAIN

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Description of the technology: Blockchain technology allows for person-to-person transfer of digital assets without an intermediary like a bank. (see Resource 2.3.5 (a), slide 8) Blockchain technology enables transactions to be recorded in a decentralized ledger in the form of "smart contracts." These "smart contracts" can store information and automatically execute functions when certain conditions are met. (see Resource 2.3.5 (a), slide 11) The decentralized nature of blockchain technology means that no centralized authority is required. The information stored on the "smart contracts" is open to the community of stakeholders who validate the transactions. (see Resource 2.3.5 (b), para. 23)

How it supports microinsurance claim adjudication: In the case of index insurance, the "smart contract" can store the index contract so that when satellite data indicates that a payout has been triggered, the claims payment can automatically be made to the smallholder farmer. (see Resource 2.3.5 (a), slide 17) This essentially removes the claims process, thus reducing operational costs. The automatic payment trigger also allows for a large number of small microinsurance premium payments and claims payouts to be operationally feasible. (see Resource 2.3.5 (a), slide 13) Since the trigger cannot be influenced by the insured, there is no incentive for moral hazard.

IBISA is a blockchain start-up that offers financial protection from crop loss to smallholder farmers. (see Resource 2.3.5 (b)) IBISA explains that the decentralized ledger in blockchain systems allows the project to involve anyone worldwide with an internet connection to interpret the satellite data and determine the payouts to the farmers (a process IBISA calls "crowd-watching").[23] This methodology reduces processing time and promotes an efficient loss verification process.

Applications for actuaries: Going forward, blockchain may change the way we think about the insurance contract, depending on the microinsurance products that are developed to be sold using blockchain. This will impact pricing methodology and reserving requirements. For instance, pricing assumptions will be impacted if the blockchain system can completely remove insurance fraud. Blockchain allows for global risk pooling, which diversifies weather-based risks and further reduce the cost of risk. However, this might also require customized pricing for each region since each area might have to use different triggers to determine a loss event.

Data stored in the "smart contracts" might be limited, which will affect the data available for monitoring and reporting. On the flip side, a decentralized ledger may give an actuary access to all insurance contracts sold through blockchain, building a data repository which could be used with machine-learning algorithms for more efficient premium pricing.

[23] IBISA. Telephone interview. 11 March 2019.

Resources:

Table 16
RESOURCES ON BLOCKCHAIN

Resource	Location	Line of Business	Key Lesson
2.3.5 (a)	Global	Agriculture	Blockchain "smart contracts" can store insurance information
2.3.5 (b)	Global	Agriculture	Blockchain can access "wisdom of the crowd" to assess crop loss

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Resource 2.3.5 (a) – Blockchain technology for inclusive finance: Can it add value to microinsurance organisations?	
Reference information	*Publisher*: Microinsurance Network *Publication date:* October 2016 *Authors*: Berende, M., Day, K. & Houtekamer, A.
Resource link	https://microinsurancenetwork.org/civicrm/event/info?reset=1&id=132
Line of business	Agriculture
Type of resource	Presentation Slides
Summary	This expert forum discusses how **blockchain technology** can add value to microinsurance organizations. It discusses what the technology is, how it can be beneficial for microinsurance, and what the costs of implementing the technology can be.
Why should actuaries read it?	This is important for actuaries for **financial reporting** and **pricing** purposes. Using blockchain as the structure behind the insurance product might change how actuaries develop the pricing models. Assumptions required for pricing and claims experience might be different under this structure, as there are different risks to consider and different data available. Blockchain changes the way actuaries have access to the insurance contract. Until there is an interface developed, actuaries may need to learn how to read the "smart contracts" on blockchain. As well, they may need to understand the type of data available from the blockchain system so that it can be extracted when needed to assess up-to-date claims experiences. The "smart contract" can only store a limited amount of data, so actuaries can help to determine the data that will need to be included to generate financial reports, experience analyses, and data for other reporting and monitoring functions.
Special insight	Using blockchain technology to sell microinsurance products involves using "smart contracts" to store insurance contract information on a decentralized ledger. On the contract, claims can be triggered to be paid out automatically when certain conditions are met, such as after a specific number of days of drought as determined by objective satellite data. (Excerpt, slide 17) Automating the claims monitoring and processing on the blockchain system reduces operational costs and processing time, as additional paperwork or loss assessment is not required. It favors microinsurance products as it makes small, frequent financial transactions for premium and payouts feasible and scalable. (Excerpt, slide 13) Relying on a decentralized ledger and an objective claims trigger determined by satellite data can also minimize the potential problem of disputes and fraudulent claims. This keeps claims processing costs low.

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Resource 2.3.5 (b) – This autonomous insurance from space is an agricultural risk game-changer	
Reference information	*Publisher*: Widgetlabs *Publication date:* June 2018 *Authors*: Agudo, A.
Resource link	https://medium.com/widgetlabs/this-autonomous-insurance-from-space-is-an-agricultural-risk-game-changer-527c0917bfbc
Line of business	Agriculture
Type of resource	Blog post
Summary	This blog post contains an interview with Maria Mateo, IBISA's project lead, who describes their business model. IBISA is a risk-sharing service that offers crop index coverage to smallholder farmers. Accessing **satellite data** allows for a transparent index to be set up, so the claims process can be automated and independent of the farmer's input. **Mobile money technology** allows for disbursement of small monthly claims to smallholder farmers. **Blockchain technology** ties it all together by providing the system to perform peer-to-peer (P2P) micro-transactions at a reasonable cost. As well, it allows one to use the "wisdom of the crowd" to improve accuracy and reliability of claim evaluations.
Why should actuaries read it?	This is important for actuaries for **underwriting** and **product development** purposes. The blog post describes IBISA's method of using blockchain technology to offer affordable and efficient agricultural insurance to smallholder farmers. In a separate interview, IBISA's lead actuary, Jean-Baptiste Pleynet, explains that IBISA is a mutual risk-sharing service, as it takes a fixed fee and the remaining gains and losses are divided among the members. This means that there are no capital requirements for an actuary to monitor. Even though the data management process for pricing and solvency checks are similar to that in the traditional insurance market, actuaries will need to learn to be familiar and comfortable with different types of data and target market needs. Pleynet also advised that being flexible and hands-on is important for an actuary working in a start-up.[24]
Special insight	IBISA leverages on the blockchain network to employ "watchers" to interpret their satellite data. Interested parties with a computer and internet connection can sign up to assess the satellite images of the areas covered by the crop insurance. The average outcome taken as the "wisdom of the crowd" is the index level for the month.[25] High-frequency satellite data enables this process to be repeatable monthly, and blockchain technology enables the small payouts in the event of a triggered index to take place at low cost. (Excerpt, para. 20)

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2.3.6 MACHINE-LEARNING / DATA MINING

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Description of the technology: Machine-learning is a method of data analysis that automates analytical model building. It is a branch of artificial intelligence based on the idea that systems can learn from data, identify patterns, and make decisions with minimal human intervention.[26] Data mining is defined as the discovery of interesting, unexpected, or useful patterns within large datasets. (see Resource 2.3.6(c), Section 2.3.3, p. 21)

How it supports microinsurance claim adjudication: Machine-learning can be used to process a large number of claims in a short amount of time to facilitate fraud detection and loss assessment. An example of how this can be done is demonstrated by Etherisc, which builds blockchain platforms for decentralized insurance. (see Resource 3.3.6 (b)) Data mining can also be applied to identify patterns that represent fraudulent claims. The Principle Component Analysis of RIDIT Scores (PRIDIT) method is a statistical data-mining method that could be applicable for microinsurance. Claims fraud *"increases the average cost of providing insurance because*

[24] IBISA. Telephone interview. 11 March 2019.
[25] IBISA. Telephone interview. 11 March 2019.
[26] SAS. Accessed 9 April 2019. https://www.sas.com/en_us/insights/analytics/machine-learning.html, para. 1.

more claims are paid" and *"reduces the stability and predictability of the claims experience because it distorts the random statistical process underlying the claims experience."* (see Resource 2.3.6 (c), Section 2.3, p. 12) Fraud also reduces policyholders' trust in the insurance product, ultimately reducing new business and renewals.

Britam MI, a microinsurance company in Kenya, uses automated bots to capture information from scanned documents submitted for health claims processing. *"The system leverages machine-learning, so that the quality of the data captured by the bots improves over time, gradually minimizing the need for manual intervention.*" (see Resource 2.3.6 (a), para. 11) This significantly reduces the overall claims turnaround time and improves the quality of the data collected, which was previously susceptible to human error.

Applications for actuaries: These resources give detailed examples of how actuaries can combine their knowledge of insurance together with their understanding of statistics to design the machine-learning and data-mining models required for insurance processes, including fraud detection and data acquisition. If effective, the actuary doesn't need to be the one operating these models. Still, the experience from employing these models should be monitored to see if claims expenses are reduced, as well as if pricing assumptions need to be updated to reflect the new claims experience. It is important to monitor the implementation of new technology to better understand its limitations and weaknesses to see how it can be improved upon. While the ability to design and implement these models are not limited to an actuary (others with statistical knowledge can also do the job), an actuary has the expertise to uniquely add value to this process through their familiarity with the insurance industry.

Resources

Table 17

RESOURCES ON MACHINE-LEARNING AND BIG DATA FOR CLAIMS ADJUDICATION

Resource	Location	Line of Business	Key Lesson
2.3.6 (a)	Kenya	Health	Machine-learning can digitize data on paper documents
2.3.6 (b)	Global	Property (Motor)	Machine-learning only requires a few hundred images to learn fraud detection
2.3.6 (c)	Global	Cross-cutting	Statistical models can detect fraud from claims data

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Resource 2.3.6 (a) – i-Buka -- Britam	
Reference information	*Publisher*: International Labour Organisation *Publication date:* Last updated January 2019 *Authors*: Not available
Resource link	http://www.impactinsurance.org/practitioner-lessons/fsda/britam
Line of business	Health
Type of resource	Case study
Summary	Britam MI is the microinsurance business unit of Britam, a financial services group in Kenya. The case study describes how Britam MI conducted a systematic diagnostic review of the claims process to pinpoint the specific activities that were delaying the process. *"The two main bottlenecks identified were the time taken for claims documents to reach Britam MI from the hospitals, and the time spent on data entry from physical documents into the IT system."* (Excerpt, para. 7) The technological solutions to reduce claims turnaround time were a **paperless claims system** in partner hospitals that can directly transfer the claims information to Britam MI, and a **machine-learning system** through which automated bots digitize data from paper claims documents and load the data in the IT system. (Excerpt, para. 11)
Why should actuaries read it?	This is important for actuaries for **data analytics** and **financial reporting** purposes. This case study demonstrates how data diagnostics on the existing claims process can reveal where efforts to reduce claims turnaround time should be focused on. This is one way actuaries can help with claims processing, given their expertise in data management. The two technological solutions in this case study help to digitize claims data, which further analysis and make claims reporting easier and quicker for actuaries.
Special insight	Britam is leveraging a system already implemented in their conventional health insurance process for their health microinsurance line of business. *"The second bottleneck identified was data entry from physical documents into the core IT system. Some manual intervention is needed to capture information from scanned documents such as hospital invoices and patient reports. Britam has therefore introduced Intelligent Process Automation (IPA), through which automated bots extract data from documents submitted via the partner portal. The system leverages machine-learning, so that the quality of the data captured by the bots improves over time, gradually minimizing the need for manual intervention. In addition, data captured through this method is five times faster than manual intervention and is therefore expected to bring further efficiencies."* (Excerpt, para. 11)

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Resource 2.3.6 (b) – Optimizing Insurance Policies with Machine-learning	
Reference information	*Publisher*: Decentralized Insurance Developer Conference *Publication date:* October 2018 *Author*: Etherisc
Resource link	https://blog.etherisc.com/optimizing-insurance-policies-with-machine-learning-ml-cc44ee33a3b2
Line of business	Property (Motor)
Type of resource	Blog post with video
Summary (technology)	The presentation demonstrates how a decentralized insurance model made possible through blockchain makes the insurance market more efficient. They then explain and demonstrate how **machine-learning** functionalizes the business model through facilitating ratemaking, fraud detection, and loss assessment.
Why should actuaries read it?	This is important for actuaries for **modeling** purposes. Actuaries can combine their insurance knowledge together with their statistical expertise to design the machine-learning algorithm, as well as test and understand the robustness of the model.
Special insight	Machine-learning enables insurance companies to process a large number of claims efficiently at a low cost—a necessity for microinsurance. Machine-learning now only requires smaller datasets to calculate pure premiums, determine fraud, and assess loss. Even a few hundred images can be used to teach and configure the model for fraud detection. (Excerpt, Enter machine-learning section, para. 4) This can make the technology more applicable for microinsurance products that have yet to achieve scale.

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Resource 2.3.6 (c) – The significance of claims fraud in microinsurance and a statistical method to channel limited fraud identification resources	
Reference information	*Publisher*: Actuarial Society 2014 Convention, Cape Town *Publication date:* October 2014 *Authors*: Agostinho, P.J.F. & Cherry, C.J.
Resource link	https://actuarialsociety.org.za/convention/convention2014/assets/pdf/papers/2014%20ASSA%20Agostinho.pdf
Line of business	Cross-cutting
Type of resource	Paper
Summary	This paper *"highlights the problem of claims fraud in low-income markets and explains how fraud makes microinsurance unsustainable."* (Excerpt, p. 7) With a worked example, it then proceeds to demonstrate a **statistical data-mining method** known as Principle Component Analysis of RIDIT Scores (PRIDIT). It has been shown to effectively identify fraudulent claims without the need for a training sample, which may not be available in microinsurance. (Excerpt, p. 7)
Why should actuaries read it?	This is important for actuaries for **modeling**, **data analysis,** and **risk management** purposes. This is an example where someone with statistical knowledge and an understanding of insurance claims—such as an actuary—could come in to set up the model. The actuary could also test its accuracy in correctly identifying fraudulent claims in the specific context of the microinsurance product before the fraud detection model is implemented.
Special insight	The PRIDIT method is a relatively simple low-cost model that doesn't require a high level of expertise to run and can be done on Excel. This is important as microinsurance doesn't typically allocate resources to complicated technical expertise. One challenge with the method is the *"subjectivity that is used to select the predictor variables and the criteria for assigning values to them."* Therefore, someone with technical expertise might need to test the model before implementation. (Excerpt, p. 50) Another challenge is that the type of claims data that the model requires as input might not have been previously recorded in a microinsurance context and, thus, wouldn't be available. (Excerpt, p. 50)

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2.3.7 LESSONS LEARNED – CLAIMS ADJUDICATION

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This section has listed a variety of ways technology is helping to reduce claims processing costs and turnaround time in microinsurance. The technology has helped to lower expenses, reduce fraud, and equip insurers for achieving scale. These are ways to lower premiums but still allow the microinsurance product to add value to low-income policyholders. Actuaries can also contribute to these goals and leverage the technology employed in claims processing in the following ways:

Enabling new processes to improve claims processing. Many microinsurance providers, being new entrants to the industry, may not be hindered by legacy systems. Actuaries can leverage their experience working with data in the insurance industry to assist in the set-up of new systems that are customized for microinsurance processes. They can take the lead in determining what data is required in a new claims administrative system. With blockchain technology, they can recommend what data needs to be stored in the "smart contracts" for reporting and monitoring purposes. Actuaries can also conduct the cost/benefit analysis to inform the managerial decisions on the new technology implementation.

Actuaries can use their technical skills to develop machine-learning models that reduce claims processing costs. From the examples listed in this section, actuaries have used machine-learning algorithms on satellite and crop-yield data to update the parameters of a crop insurance product, thus significantly reducing claims processing costs. Actuaries can also work with agronomic experts to use machine-learning to develop a system to automate crop damage detection based off farmers' pictures of their insured crops. This streamlines the loss-assessment process.

Data analysis. Microinsurance is sold to low-income customers who typically have not had access to formal financial services. There is a lack of data on this target market, which makes pricing, product development, and other strategic business decisions difficult to implement. Technology, such as IoT, smartphone apps, and claims administrative systems, not only streamline claims processes, but can also pick up high-quality digitized data from the client. Then, they can deliver the data to a centralized system where actuaries get real-time access to it. This can improve the quality of actuarial reporting. With this improvement in data quality and access to claims data, actuaries can produce up-to-date claims reports on claims ratios and performance indicators that enable management to make informed decisions. Data analysis on process data, such as claims settlement times or other workflow productivity measures, is important in order to improve efficiency of claims management and manage growth. (see Resource 2.3.1(d), Section 6.4, p. 42)

Data analytics can also be applied to this data in order to inform decisions on other insurance processes. Drones, for instance, can provide more data on crop growth, which can be used to improve the precision of the index for index-based crop insurance. Claims data for health microinsurance can provide insight into the health services used, which can inform product-design decisions. Actuaries can also be involved in designing the machine-learning systems or other statistical models that automatically detect fraud from claims data, thus reducing operating costs to detect fraud and reducing the cost of risk.

Pricing. Technology that improves on the claims processes impacts assumptions used by actuaries in pricing the microinsurance product. Actuaries should be aware of the potential impact and monitor the claims experience accordingly in order to price the microinsurance product more efficiently. For example, IoT can change policyholder behavior, which impacts the insured risks. As shown in some of the above resources, IoT can reduce the spread of fire, which impacts the loss distribution for fire insurance and reduces fraud. This lowers the loss ratios. Smartphone apps can take pictures with geotags and time-stamps and can also be used to reduce the number of fraudulent claims. In these examples, technology lowers the premium price. The sooner the actuary updates the pricing calculations and recommends the decrease in premium, the sooner the insurance product will appear more attractive while remaining profitable for the insurer. The updated premium price can also impact negotiations with reinsurers.

Blockchain technology plans to improve on the microinsurance claims process by fully automating it. Part of further streamlining insurance processes to use with blockchain is to use machine-learning to automate the calculation of an efficient price. The benefits of machine-learning will be maximized here as blockchain achieves scale in microinsurance. Actuaries can develop the system and do periodic reasonableness checks to ensure the model is behaving as expected, especially when the model is new, or a new type of data has been introduced and manual intervention is necessary.

Reserving. Integrated claims administrative systems, smartphone apps, and remote-sensing technology have been used to reduce the claims turnaround time in microinsurance from months to days. This impacts the IBNR reserving assumptions. Actuaries should monitor this and recommend adjustments accordingly to help management make efficient use of their capital.

2.4 PAYMENT FACILITATION

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There are numerous obstacles that insurers must overcome to be able to offer high-quality microinsurance products. One of the primary stumbling blocks is the significant cost associated with facilitation of payments. In servicing low-income households, insurers incur high-transaction costs in collecting frequent premiums from persons who may not have bank accounts and in paying out claims of low value. However, the recent emergence of technologies for payment facilitation has enabled rapid scaling of microinsurance. Technologies discussed in this section include:

- Mobile money, which has shown to be a viable substitute for banks to allow quick, convenient, and relatively lower-cost payments of premiums and claims
- Airtime, which is another prominent technology enabling microinsurance payments (premiums and claims)
- Emerging technologies like blockchain, which facilitate payments in microinsurance via e-commerce platforms or remittance applications

2.4.1 MOBILE MONEY

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Description of the technology: In the last decade, mobile money has experienced incredible growth. According to GSMA, mobile money is defined as being "a *service in which the mobile phone is used to access financial services.*"[27] Types of transactions within the mobile money ecosystem include: airtime top-up or transfer, bill payment, bulk disbursement (such as claim payments), international remittance, merchant/retail payment (including transactions for insurance premium payments), Peer-to-Peer (P2P) transfer, and savings or money storage. Certain providers also provide over-the-counter mobile money payment points that allow customers to make deposits and withdrawals ("cash-in" and "cash-out"). Mobile money has been rapidly deployed across emerging markets as a key tool to enhance the goal of financial inclusion, including the provision of microinsurance.

Mobile money services are typically owned and operated by either a Mobile Network Operator (MNO) or a financial institution (typically a bank). Whilst MNOs have the benefit of owning the cellular network with physical customer touch points in the communities, they often lack the regulatory ability to distribute financial services. In situations like these in which the money service is operated by a non-bank, a regulated bank is also used at the back-end as the fund custodian. [28]

How it supports microinsurance payment facilitation: Undoubtedly, mobile money continues to play a vital role in financial inclusion and the development of microinsurance. Mobile money typically supports the mobile-enabled microinsurance value chains at the stage of premium collection and claims payout.

In a MNO-led business model, premium is typically collected by the MNO through the payment mechanisms of the mobile money wallet. Many MNO-led business models allow daily deductions or "micro-payments" in premium for

[27] GSMA. "Mobile Money for the Unbanked Mobile Money Definitions." (2010). (https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/06/mobilemoneydefinitionsnomarks56.pdf), p. 3.
[28] Lal R., Sachdev I. "Mobile Money Services—Design and Development for Financial Inclusion." Harvard Business School. (2015). (https://www.hbs.edu/faculty/Publication%20Files/15-083_e7db671b-12b2-47e7-9692-31808ee92bf1.pdf), p. 5.

customers. A case in point is the insurance product offered by Zong in Pakistan where daily deductions are made for an annual cover.[29]

Claim processes are generally split into two parts. When a claim is submitted, the insurer or TSP typically takes charge of claim assessment in determining whether the claim should be paid. The physical mechanism of paying out claims is usually facilitated by the telco, with the compensation landing into customer's mobile money wallet. At scale, this model enables large-cost savings, providing end-customers with fast and accessible claim payments.[30]

Applications for actuaries: Access to mobile money transactional data can provide significant opportunity for data mining and, as a result, improved pricing and sales models. MNOs currently control access to this treasure trove of data and employ their own actuaries or data scientists. Yet, in strong partnerships, anonymized data could be made available to TSPs or underwriters. While actuaries may not have been involved in all the powerful data-mining case studies, performing data analytics on payment data can reveal an immersive amount of insights on consumer behavior and spending patterns. In the application of health microinsurance schemes, understanding each of the health expense items will undoubtedly provide better assumptions for pricing models. Furthermore, the use of mobile money to reduce transaction costs can help to shift the payment structure, from lump sum upfront premiums to monthly premiums or even shorter durations. This may allow for alternative pricing schemes to be developed.

There is an application example where predictive analysis was performed on pre-paid customer payment data in predicting the chance of customers buying microinsurance products. Inclusivity Solutions, for example, has performed randomized experiments in predicting the chance of insurance purchase using mobile money transactional data. However, in certain circumstances, predictive analysis was not able to increase the chance of insurance purchase through client segmentation. In an interview with Nigel Bowman, he stated that it is of the utmost importance to understand data from simple analytics before applying the knowledge to a more complicated algorithm.[31]

Resources:

Table 18
RESOURCES ON MOBILE MONEY

Resource	Location	Line of Business	Key Lesson
2.4.1 (a)	Global	Cross-cutting	Mobile money opens a critical payment channel for microinsurance
2.4.1 (b)	Kenya	Health	Better data quality is a key to improving viability
2.4.1 (c)	Ghana	Life	Mobile money payment can change pricing assumptions significantly

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[29] Tellez C. "Emerging Practices In Mobile Microinsurance." GSMA. (2012). https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/07/MMU_m-insurance-Paper_Interactive-Final.pdf, p. 8.
[30] Naghavi N. & Raithatha R. "Spotlight On Mobile-Enabled Insurance Services." GSMA. (2018). https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/09/2017-SOTIR-Spotlight-on-mobile-enabled-insurance-services.pdf.
[31] Bowman, N. Telephone interview. 1 March 2019.

Resource 2.4.1 (a) – State of the industry report on Mobile Money in 2018	
Reference information	*Publisher*: GSMA (Groupe Speciale Mobile Association) *Publication date:* 2019 *Authors*: Not available
Resource link	https://www.gsma.com/mobilefordevelopment/resources/2018-state-of-the-industry-report-on-mobile-money/
Line of business	Multiple financial services, including insurance
Type of resource	Report
Summary	Provides landscape of mobile money across emerging economies and how important it is in designing financial products for low-income populations in these markets. In particular, the "Credit, savings, and insurance" section mentions how almost half of the mobile money providers currently offer an insurance service or intend to launch one in the next year.
Why should actuaries read it?	This is important for actuaries as background knowledge for **product development** and **management**.
Special insight	Did you know that the customer activity rate among mobile network providers offering a credit, savings, or insurance product is 46%? In comparison, there is a 26% customer activity rate among providers who do not. (Excerpt, figure 9, p. 31) Meaning, the offering of additional financial services makes customers more active by almost two-fold.

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Resource 2.4.1 (b) – Linda Jamii -- Changamka Microhealth Ltd	
Reference information	*Publisher*: International Labour Organisation *Publication date:* January 2015 *Authors*: Matul, M., Merry, A., Oloo, Z. & Omotto, S.
Resource link	http://www.impactinsurance.org/projects/lessons/linda-jamii
Line of business	Health
Type of resource	Case Study
Summary	Microinsurance products typically collect premiums and pay claims via the M-Pesa (mobile money) payment channel in Kenya. Linda Jamii is a microinsurance product which was rolled out at national scale, but was terminated after the pilot period. This case study provides a summary and lessons learned in the development of the Kenyan Linda Jamii product.
Why should actuaries read it?	An actuarial review of this product highlighted the importance of **pricing and modelling** with recommendations on better **data management**. In particular, it was important to track the registration of initial policy purchases, as well as renewals, per client—including tracking of dates of registration, policy activation, and medical diagnoses and treatment. Could actuaries have made use of the payment data from the M-pesa system to further understand both the differing health expense items paid to clients? What about the customer's journey through their payment patterns?
Special insight	High-loss ratios associated with concentration in maternity coverage was also a factor which impacted the viability of Linda Jamii. This demonstrated the importance of reviewing pricing assumptions regularly. In this case study, maternity coverage represents 4% of all visits by patients but 45% of claims cost. High adverse selection! (Excerpt, Section "On Viability") External consultants recommended to the insurer that there should have been an introduction of a nine-month waiting period for antenatal coverage and deliveries.

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Resource 2.4.1 (c) – Emerging Practices in Mobile Microinsurance	
Reference information	*Publisher*: GSMA *Publication date:* July 2012 *Authors*: Téllez, C.
Resource link	https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/07/MMU_m-insurance-Paper_Interactive-Final.pdf
Line of business	Life
Type of resource	Research paper
Summary	This paper provides a case study on a microinsurance product that typically collects premiums and pays claims via the MTN Mobile Money platform in Ghana. "Mi-Life" provides users with the opportunity to buy life insurance via their mobile phones on the USSD technology. This paper provides insights into emerging practices in mobile microinsurance with "Mi-life" mentioned, where mobile money is used as the premium collection technology.
Why should actuaries read it?	This research demonstrates how technology changes the way a microinsurance product can be managed, making premium collection much more efficient. In turn, expense-related assumptions need to be refined during the **pricing process**.
Special insight	Microinsurance products, particularly those sold via MNO channels, are often sold on a monthly basis. Customers will typically be reminded via an SMS to make premium payments via mobile money on a monthly basis.

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2.4.2 AIRTIME

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Description of the technology: According to Verizon, one of the world's leading wireless phone providers, airtime is defined as the time you are connected to your mobile phone network.[32] This typically refers to a pre-paid mobile credit that can be used within a mobile network to make calls, retrieve messages, use data, and purchase value-added goods or services offered by the MNO. In many countries, mobile airtime minutes serve as a de facto currency that can be transferred between phones and exchanged for cash.[33] The use of airtime as money in certain countries is partly a result of regulators making it difficult for banks to offer mobile money.

How it supports microinsurance payment facilitation: Airtime in the microinsurance value-chain is typically used as a form of "currency" for making premium payments. According to GSMA, in 2017, two-thirds of mobile-enabled microinsurance products used airtime deductions for premium collection.[34] While it is less common to see claims payment made using airtime, there are reported cases.

Insurers have also used airtime as transactional data to model risk and price policies. The real-time rendering of insurance and mobile transaction information (inclusive of airtime usage patterns) can dramatically improve the pricing and product development process. This reliable data allows insurers to find the patterns necessary for better understanding customers' risk profiles and spending patterns, ultimately enabling product managers to create more customer-centric products.[35]

[32] Sigafoos, S. "What is Mobile Airtime? It Still Works." https://itstillworks.com/mobile-airtime-7441418.html, Definition Section.
[33] The Economist, "The Other Type of Mobile Money – Airtime is money." (2013.) https://www.economist.com/finance-and-economics/2013/01/19/airtime-is-money, para 1.
[34] Naghavi, N. & Raithatha, R. "Spotlight On Mobile-Enabled Insurance Services." GSMA. (2018.) https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/09/2017-SOTIR-Spotlight-on-mobile-enabled-insurance-services.pdf, p. 7.
[35] Tellez, C. "Emerging Practices In Mobile Microinsurance." GSMA. (2012.) https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/07/MMU_m-insurance-Paper_Interactive-Final.pdf, p. 6.

While it is not a direct application of the technology, airtime dealers are often involved in the retail sales and client enrollment part of the microinsurance value chain as well.

Applications for actuaries: Collecting premiums via airtime can be relatively costly, as the initial airtime purchase is subject to distribution costs, sales tax, and value-added tax. (see Resource 3.4.2 (c)) This changes the pricing assumptions and costing models for actuaries. In some cases, when airtime deduction is the only premium payment option, these charges may be passed on to the client. (see Resource 3.4.2 (b) on Cover2Go) In other cases, the provider absorbs the cost, collecting lower actual revenue after the airtime deduction is monetized.

While airtime payment data reveals much less detail than mobile money transactions, it typically serves as a stepping-stone toward mobile money payments. Once customers see the benefits of their microinsurance policies, there is an opportunity for providers to collect premiums via mobile money. Thus, actuaries need to understand the consumer behavior on using airtime vs. the mobile money payment method on premium deductions. For example, data analytics can be performed to understand whether deducting premium via airtime channel is more efficient on particular days of the week or times of the month.

Resources:

Table 19

RESOURCES ON AIRTIME

Resource	Location	Line of Business	Key Lesson
2.4.2 (a)	Ghana	Life	Payment data can reveal the best time in collecting premiums
2.4.2 (b)	South Africa	Life (Accidental death)	Airtime payment as a channel can be expensive
2.4.2 (c)	Global	Cross-cutting	Watch out for tax implications for airtime payments

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Resource 2.4.2 (a) – Scale: Thinking big – case studies: Tigo/Bima: Tigo Family Care Insurance life (Ghana)	
Reference information	*Publisher*: International Labour Organisation & Cenfri *Publication date:* 2013 *Authors*: Fonseca, C., Gray, J., Muller, Z., Prashad, P., Solana, J.M., Tappendorf, T., Thom, M. & Zafar, S.
Resource link	http://www.impactinsurance.org/ckfinder/userfiles/files/MP30%20case%20studies.pdf (Tigo/Bima: Tigo Family Care Insurance life (Ghana))
Line of business	Life
Type of resource	Case study
Summary	This study includes eight case studies of microinsurance products around the world with a focus on the drivers of product scaling. In particular, the case study relating to the Tigo Family Care Insurance Life product in Ghana provides great insight into the use of airtime deduction as a premium payment channel. This product was offered as a free loyalty cover for prepaid mobile customers who used a certain amount of airtime on their mobile phones during the course of a month. The greater the amount of airtime added, the greater the amount of free coverage for the policyholder and an additional insured life.
Why should actuaries read it?	With a holistic understanding of insurance and the ability to perform **business analysis**, actuaries are well-placed to monitor and refine the business model to track the amount of "loyalty" the freemium is bringing to the MNO. According to Bima, with claims ratios exceeding 40 percent, the microinsurance product appears to be viable to the company, as well as provides value to the clients it serves. (Excerpt, p. 35) Although lapse rates are not publicly available, a number of policies can be expected to expire each month due to insufficient airtime usage. Through data analytics, actuaries can gain insights into the airtime usage of customers, ultimately finding the best timing for airtime deduction for re-enrollment.
Special insight	In the case of Tigo Family Care Insurance, the number of registered users grew from 0 to over 0.5 million over 1.5 years. (Excerpt, p. 32) The capability to register remotely (with premium payments made via airtime deduction) is just one of the many ways in which mobile technologies have played a key role in reaching scale. Whether it be by tapping into the MNO's large existing customer base, by using airtime for premium collection, by focusing marketing through call centers, or by using Tigo Cash for claims payments, the product has leveraged mobile technology to reach clients at scale in a cost-effective manner.

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Resource 2.4.2 (b) – Case Study: Metropolitan Cover2go	
Reference information	*Publisher*: FinMark Trust & Cenfri *Publication date:* July 2010 *Authors*: Smit, H. & Smith, A.
Resource link	https://cenfri.org/wp-content/uploads/2018/01/Metropolitan-Cover2go-case-study_Cenfri-FinMark-Trust_July-2010.pdf
Line of business	Life (Accidental death cover, under Section "Cell phone-based distribution")
Type of resource	Research paper
Summary	This case study forms a part of a larger study titled, "Update On Innovative Microinsurance Models and Products In South Africa." This case study reviews the success and development of various microinsurance models that have been launched during the last few years in South Africa—including Metropolitan Cover2go via cell phone-based distribution.
Why should actuaries read it?	Though insurance sales using airtime as payment for policy premiums is an attractive and simple distribution mechanism, this model has proven rather costly. This is due to two factors. Firstly, a high level of consumer education is needed, which can often only be pursued through extensive marketing. Secondly, airtime-based premium collection has proved to be very expensive, with a 40% fee charged on each transaction to collect the airtime and convert it to currency. (Excerpt, p. 4)
Special insight	While the technology was allowed for the automation of processes, the lack of face-to-face interaction through the mobile channel may have been a cause of the low take-up.

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Resource 2.4.2 (c) – Designing Mobile Microinsurance Products: Premium Payment Methods	
Reference information	*Publisher*: CGAP *Publication date:* February 2014 *Authors*: Saunders, D. & Tappendorf, T.
Resource link	https://www.cgap.org/blog/designing-mobile-microinsurance-products-premium-payment-methods
Line of business	Multiple
Type of resource	Blog post
Summary	This blog posts looks into the factors of consideration for insurers and MNOs when deciding how and whether to use airtime or mobile money as a payment mechanism. With self-payment models where premiums can be collected via mobile money wallet or prepaid airtime balances, there is potential to create huge savings in the operations of microinsurance distribution.
Why should actuaries read it?	As payment channels expand beyond the conventional banking system, actuaries need to understand changing consumer behavior with the different payment mechanisms as part of **product management**. Moreover, as a whistleblower to insurance regulations, actuaries need to understand tax and systemic risk implications to payment channels.
Special insight	While this may differ by national regulations, purchases made via airtime are often taxed. (Insurance premiums are typically not.) Usually a value-added tax (VAT), sales tax, or excise tax is built into the cost of airtime. A case in point is in Tanzania: In 2012, insurance distributors needed to pay an excise tax of 12% alongside a 18% VAT with local and regulatory charges. As a result, an ultimate duty of 32% was included in each airtime purchase. (Excerpt, para. 3) In many cases, these taxes can make airtime a commercially unsustainable payment mechanism for insurance products, which otherwise wouldn't need to price taxes into their premiums.

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2.4.3 OTHER PAYMENT-RELATED RESOURCES

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New business models are emerging beyond mobile operators with various social platforms and commercial players entering into the mobile payment landscape. It is not uncommon in Asia to see ride-hailing applications expanding into mobile-payment services. Payment mechanisms have also been built into e-commerce retail platforms with offerings of insurance products. Below are a few examples of groups that have recently introduced microinsurance products on their platforms allowing for mobile payments:

Payments via multi-purpose payment terminals. Yastas, originating from the Mexican banking group, Gentera, is known for their innovative payment facilitation in Latin America. This correspondent network allows customers to purchase microinsurance products via their payment platform. More information can be found on the resource below: https://www.yastas.com/wps/themes/html/YastasOrg/media/Yastas/index.html
Payments linked to remittances. Remittance transfer channels, making premium payment simple, are also an emerging form of technology platform where microinsurance products are distributed. AXA Malaysia has recently started selling a mass market insurance product which targets foreign workers through remittance: https://www.insurancebusinessmag.com/asia/news/breaking-news/axa-to-offer-migrant-worker-insurance-solutions-in-malaysia-107427.aspx
Payments via e-commerce platforms. Argentina-based Mercado Libre has become the most popular e-commerce platform in the region and offers a range of payment services, inclusive of premium payment: https://www.mercadolibre.com/
Payments via other retail e-platforms. Singapore-based ride-hailing giant, Grab, first expanded into mobile payment services in 2017 with the launch of GrabPay. In early 2019, they have also entered into the arena of microinsurance: https://www.entrepreneur.com/article/330486
Payments linked to remittances using blockchain technology. Saldo.mx, mobile payments platform, launched Consuelo, a blockchain enabled life and health microinsurance product for Mexican migrant workers in the US: https://medium.com/@montesneri/saldo-mx-and-its-mission-to-hack-poverty-68c8a8c070fe

2.4.4 LESSONS LEARNED – PAYMENT FACILITATION

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For microinsurance to reach the unbanked, an accessible payment facilitation channel has historically been a big hurdle. The bustle of mobile money has moved rapidly beyond M-Pesa in Kenya and continues to develop in many emerging economies around the world. Other technologies facilitated by telcos like airtime also allow insurers to collect premium payments and disburse claims for microinsurance products. While "cash is king" continues to hold true in many developing nations, these payment technologies are unquestionably disrupting the financial inclusion market. New transformative technologies like blockchain and other online platforms (including e-commerce platforms and remittance applications) are also emerging within the space of microinsurance.

While actuaries don't typically work in the payment arena, it is of the utmost importance that the profession understand the impact of these technologies within the insurance landscape. The actuarial analytics skillsets working with big payment datasets will provide a greater understanding about customer behaviors and details relating to their risk profiles. Furthermore, actuaries need to capture appropriate payment facilitation costs into their expense model for microinsurance products.

3. Conclusions

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What is the role of actuaries in microinsurance? The underlying assumption is that actuaries are necessary in many areas of the microinsurance arena. Some actuaries argue that microinsurance has typically been simple and short-term in nature—namely credit life and hospital-cash products. Thus, as long-term risk managers, actuaries have a limited or even no role to play.[36] On the flipside, practitioners like Veronique Faber (former Executive Director of the Microinsurance Network) believe that "*most microinsurance services are developed without proper actuarial experience, which can put millions of clients at risk of inadequately priced products and broken contracts. Actuaries, who deal with business risk, are the pillar of insurance companies worldwide.*"[37] Nigel Bowman, chair of the IAA's Microinsurance Working Group, argues that the key to the role of actuaries in microinsurance lies in the word "proportionality." That is, the level of actuarial skills required depends on the level of risk inherent on the insurance product offered, as well as the extent to which product providers can manage potential risks.[38] In microinsurance, where insurance needs to be re-invented to serve the needs of the low-income population, what roles do actuaries play? Moreover, what are the technological innovations within this space at this moment, and how must actuaries as a profession embrace the advancements in technology?

Microinsurance is broadly defined in this paper as risk pooling products that are intentionally designed—in terms of costs, coverage, distribution, and marketing—for low-income individuals, families, and businesses. Actuary, on the other hand, has been defined by Chris Daykin in his 1994 Institute of Actuaries (IoA) Presidential address as: "*Someone who is qualified to evaluate the risks and probabilities and their financial consequences. They apply those skills in the solution of business and social problems particularly those involving future uncertainties*." (Andrew Brown, Section 4.9)[39] If this definition of actuary is assumed, the profession brings significant value to the space of microinsurance. Not only does actuaries' high level of technical insurance knowledge come into play, the profession also contributes to commercial strategic planning. Actuarial functions should not be purely compliance or regulatory driven. Instead, the profession needs to continue to add value as real problem solvers within broad business problems. As experienced microinsurance actuary Denis Garand commented: "*[Actuaries] should be part of the big picture on operational efficiency and reaching clients; actuaries should be present and develop a big picture and strategic mindset to help improve operational results considering the risk to the organization.*"[40] As a profession, actuaries need to continue to "transform" themselves in applying logical thinking and analysis to real-life problems in the ever-changing world.

What is the role of actuaries in microinsurance within the new world of cutting-edge technologies? As technology grows immensely, its use has become vital in every field of work. The focus on a customer-centric business model further drives insurers toward embracing emerging technologies. As a result of the data-intensive nature of the industry—from operations to pricing—more and more technologies are being adopted in insurance. In overcoming the challenges of microinsurance, many innovative technologies have been developed in the market. In this paper, various technologies have been discussed as they apply to the key insurance processes of rating, distribution, claim adjudication, and payment facilitation. The use of technologies improves operations and customer experience, thus driving business success in microinsurance. From the use of airtime balance in premium payment, to chatbots in

[36] Garand, Denis. Email interview. 4 April 2019.
[37] Blacker J. & Yang M. "Actuaries In Microinsurance Managing Risk for the Underserved." ACTEX. (2015) Introduction.
[38] Bowman, N. "The Role of Actuaries In Inclusive Insurance." Inclusivity Solutions. http://inclusivitysolutions.com/the-role-of-actuaries-in-inclusive-insurance/.
[39] Brown, A. "The Eight Habits of Highly Effective Actuaries." Institute of Actuaries of Australia. (2005). https://actuaries.asn.au/.
[40] Garand, D. Email interview. 4 April 2019.

servicing customers, it is obvious that technologies must be part of the tools applied for the success of microinsurance.

While many resources relating to technologies in microinsurance were easily found during this research, very little were from the perspective of actuaries. This is perhaps a reflection on the small number of actuarial practitioners working in this space. Yet, in commenting on the demand for actuaries in microinsurance, Craig Churchill from the ILO's Impact Insurance Facility noted: "*One of the constraints inhibiting the expansion of better insurance services for more low-income households is sufficient technical expertise.*"[41] How is the actuarial profession keeping up with the technological disruption in microinsurance?

Below are a few key areas identified from this research where actuaries can (and do) apply their skillsets within the microinsurance technological space:

- Data analytics. When describing the role of actuaries within microinsurance technologies, Victor Wang from Pula Advisors commented that, "*actuaries working in microinsurance seem to be rather close to data scientists*."[42] Through analyzing various datasets, actuaries can price premiums better through understanding clients' risk profiles. Big data has allowed insurers to tackle fraudulent claims through profiling. Through better client segmentation and understanding customer behavior through data, marketing and customer servicing can be improved.

- Data collections/setting up back-office systems. One of the greatest challenges confronting microinsurance is the limitation in data and past experience. The few actuarial entrepreneurs in microinsurance have been creative about data sources and assumptions. New technologies like satellite, IoT, mobile platforms, and tablets are also contributing to collecting better datasets. It is very important that actuaries are involved when systems are built to collect data for future development. If actuaries are the insurance experts, this profession plays an important role in ensuring that systems constructed are capturing key data points. In an interview with Mildred Areeta, President of The Actuarial Association of Uganda, commented that "*actuaries are a key part of the teams that must design technology solutions to provide automation and flexibility for partners who serve the unique customers targeted in the microinsurance space*."[43]

- Application of new technologies. Insurtech, such as blockchain, and AI applications, such as chatbots and machine-learning, have entered the microinsurance space. With a high level of technical expertise, actuaries are in an advantageous position to ensure that the technologies are functioning in the expected manner. Machine-learning has historically produced unreasonable results when calculating premiums during the initial stage of implementation. Actuaries can leverage their pricing experience in performing reasonableness checks on the premiums generated. Actuaries can also monitor if insurance distributed through chatbots may change the consumers' behavior.

- Capacity building in technical skillset. One of the key areas where actuaries have been involved in microinsurance is technical skill-building. As many practitioners within the microinsurance industry come from a development background, actuaries are often involved in training partners on the basic technical skills required for microinsurance. This may include topics like how to calculate mortality rates or analyze claims history. Agrotosh Mookerjee also noted that technical capacity in the insurance industry is often in demand in emerging economies.[44] Initiatives like Actuaries Without Borders (AWB) have also been set up

[41] Blacker, J. & Yang, M. "Actuaries In Microinsurance Managing Risk for the Underserved." ACTEX. (2015). Introduction.
[42] Wang, Victor. Email interview. 20 March 2019.
[43] Areeta, Mildred. Email interview. 23 March 2019.
[44] Mookerjee, Agrotosh. Phone interview. 1 March 2019.

by the International Actuarial Association (IAA) to develop the actuarial profession in countries that lack actuarial resources.

- **Regulatory and risk management**. In the relatively young industry of microinsurance, actuaries also take on the role of providing guidance and advice from a regulatory perspective. With disruptive technologies introduced, new complex ecosystems may also emerge. Being sound risk managers, actuaries are in a good position to identify, assess, monitor, and mitigate the systemic risks associated with new technologies. Furthermore, actuaries also have the duty of whistleblowing when a microinsurance product is being mis-sold or public interest is not being protected.

With tremendous advancements in technology, particularly with machine-learning, the future role of actuaries has often been questioned. The role of actuaries in microinsurance is no exception. As machines continue to "learn," will they ultimately take over the modelling and data analytical work from actuaries? Undoubtedly, the work of actuaries will be advanced or made more efficient with technologies like machine-learning or predictive analysis. However, actuaries bring greater value than acting as a simple "calculator." While the profession is often perceived to offer technical skills, it is the blend of high technical capabilities, ethics and integrity, effective communications, and qualitative judgment that makes this profession valuable. At the same time, actuaries must embrace, intervene, and interface with technology in order to stay relevant in this changing world. As technology grants access to quality data, actuaries can help with developing models that translate the data to actually inform business decisions. Experience has further shown that even with technology, a customer-centric approach is important in combination with methodologies that are actuarially-sound. As new products and new environments continue to emerge—inclusive of the microinsurance industry developing alongside innovative technologies—actuaries must continue to evolve in their ability to serve all aspects of the insurance market.

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Appendix A: List of Key Interviewees

Organisation	Organisation Description	Interviewee/s Position	Interviewee/s
Global Insurance Consulting	Independent actuarial consultant in microinsurance	Consulting actuary	Jeff Blacker
Denis Garand Associates	Actuarial consultants who have worked in microinsurance	President	Denis Garand*
Etherisc	Decentralized insurance protocol to collectively build insurance products	Inclusive insurance lead	Michiel Berende
IBISA	Blockchain-enabled, global risk sharing platform for small scale farmers	Architect, Actuarial lead	Vu Tien Khang, Jean-Baptiste Pleynet
Inclusivity Solutions	Digital insurance solutions provider for emerging consumers	Executive Product, Actuarial and Analytics	Nigel Bowman
MicroInsurance Centre at Milliman	Microinsurance consulting firm	Actuary – microinsurance consultant	Clemence Tatin-Jaleran
Milliman	Actuarial consulting firm	Principal and Consulting actuary	Michael Weilant
Milliman Advisors Sdn Bhd	Actuarial consulting firm	Consulting actuary	Natasha Su Sivarajah
Pula	Technology and agricultural insurance advisory firm	Actuarial and analytics lead	Victor Wang*
Risk Shield Consultants Ltd.	Specialist insurance service provider with work in microinsurance	Managing director and Chief actuary	Agrotosh Mookerjee
The Actuarial Association of Uganda	Actuarial association	President	Mildred Areeta*

* Interviews were conducted via email

Appendix B: Index Insurance

According to the Global Index Insurance Facility, **Index-based insurance—**also known as parametric insurance—is an "*innovative approach to insurance provision that pays out benefits on the basis of a predetermined index (e.g. rainfall level) for loss of assets and investments, primarily working capital, resulting from weather and catastrophic events. Because index insurance doesn't necessarily require the traditional services of insurance claims assessors, it allows for the claims settlement processes to be quicker and more objective*." (https://indexinsuranceforum.org/faq-page#n84)

Types of risks and target markets. Index insurance products can cover risks at the micro level (i.e., crop losses faced by small scale farmers due to drought), at the meso level (i.e., protecting the portfolios and maintaining liquidity of microfinance banks after a natural disaster), and at the macro level (i.e., covering liabilities and facilitating relief efforts for governments in the wake of natural disasters).

Basis risk. Designing insurance products in this way creates the risk that index measurements do not reflect the insured's actual loss experience. For example, a farmer may, in fact, lose his crop due to drought, but the rainfall measurements captured by the index do not meet the pre-determined level to trigger the payout. This situation creates distrust in the farmers and will impact the new business and persistency rates for subsequent farming seasons.

Area yield index insurance: Crop insurance is meant to offer financial protection to smallholder farmers in the event of low crop yield. Weather-based index insurance can only protect against weather-based reasons for a low yield, such as drought or excess rains. Yet, this exposes the farmer to basis risk, as it does not protect the farmer against other entities that destroy crops, such as pestilence and disease.

Area-yield index insurance is another index-based product where a payout is triggered when the average yield of the insured area falls below a pre-determined level, whatever the reason. Part of the process of determining the average yield of the area involves agents being sent to randomly-selected farms to conduct crop-cutting experiments (CCEs). There, they estimate the yield in a region during a given cultivation cycle. Although CCEs create additional costs, the costs incurred through area-yield index insurance are still lower than indemnity insurance, as not every field that has experienced crop loss has to be assessed. Insurers are still protected against adverse section and moral hazard since the payout trigger is based on an index. At the same time, farmers are also protected against any situation that might cause a low yield, not just weather-based events.

More information:

- Website: Global Index Insurance Facility, Index Insurance Forum FAQs: https://indexinsuranceforum.org/faq-page
- Paper: "Innovations and Emerging Trends in Agricultural Insurance." Prepared for the G-20 Round Table on Innovations in Agricultural Finance. Antalya, Turkey. (2015.) Gives an overview and global landscape of index-based insurance products. This includes weather-based index insurance, area-yield index insurance for agriculture coverage, and macro-level insurance for natural disaster coverage. https://www.researchgate.net/publication/283089244_Innovations_and_emerging_Trends_in_Agricultural_Insurance

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The Society of Actuaries (SOA), formed in 1949, is one of the largest actuarial professional organizations in the world. It is dedicated to serving more than 30,000 actuarial members and the public in the United States, Canada, and worldwide. In line with the SOA Vision Statement, actuaries act as business leaders who develop and use mathematical models to measure and manage risk in support of financial security for individuals, organizations, and the public.

The SOA supports actuaries and advances knowledge through research and education. As part of its work, the SOA seeks to inform public policy development and public understanding through research. The SOA aspires to be a trusted source of objective, data-driven research, and analysis with an actuarial perspective for its members, industry, policymakers, and the public. This distinct perspective comes from an association of actuaries who have a rigorous formal education and direct experience as practitioners as they perform applied research. The SOA also welcomes the opportunity to partner with other organizations in our work where appropriate.

The SOA has a history of working with public policymakers and regulators in developing historical experience studies and projection techniques, as well as individual reports on health care, retirement, and other topics. The SOA's research is intended to aid the work of policymakers and regulators, and follow certain core principles:

Objectivity: The SOA's research informs and provides analysis that can be relied upon by other individuals or organizations involved in public policy discussions. The SOA does not take advocacy positions or lobby specific policy proposals.

Quality: The SOA aspires to the highest ethical and quality standards in all of its research and analysis. Our research process is overseen by experienced actuaries and non-actuaries from a range of industry sectors and organizations. A rigorous peer-review process ensures the quality and integrity of our work.

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Quantification: The SOA leverages the diverse skillsets of actuaries to provide research and findings that are driven by the best available data and methods. Actuaries use detailed modeling to analyze financial risk and provide distinct insight and quantification. Further, actuarial standards require transparency and the disclosure of the assumptions and analytic approach underlying the work.

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