

V. I. Lakshmanan
Arun Chockalingam
V. Kumar Murty
S. Kalyanasundaram *Editors*

Smart Villages

Bridging the Global Urban-Rural Divide



Springer

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In Memory of

*The Late Dr. A.P.J. Abdul Kalam
Former President of India*

and

*The Late Right Honourable John Turner
Former Prime Minister of Canada*

This book is dedicated to

*Swami Pramathananda
for his enduring faith
and constant encouragement*

and to

*Sarada Lakshmanan,
Shakuntala Chockalingam,*

and

*Usha Kalyanasundaram
for their infinite patience
and selfless lifelong support*

Foreword



Over the years, I have had the distinct pleasure to be professionally associated with Dr. V.I. (Lucky) Lakshmanan. In his most recent book on the smart village, he demonstrates his passion and expertise in understanding the development of connectivity, which includes infrastructure, knowledge and accountability.

Through this book, he describes in detail that government should not only concern itself with the well-being of people in communities but also promote relevant skills that must be considered when contemplating connectivity at times when disruptive technological changes affect countries like Canada. Further, he notes that government has an absolute obligation to protect the weakest and most vulnerable members of society, as I have always believed.

The smart village is a fascinating concept that clearly lays out an agenda for managing complexity. It was through Dr. Lakshmanan that I met President Abdul Kalam of India – at our meeting in Toronto, we discussed in detail his concept known as PURA and what it could do to develop rural and remote India. The concept as I understood it became a new development model for one of the world’s fastest-growing economies.

At the same time, President Kalam suggested that government must never deliberately or inadvertently extinguish the opportunity to work with the private sector to lay down pathways for innovation in connectivity. I have always believed that there is a role for government in the promotion of smart technologies, and it must be linked in tandem with the private sector whose investments and risk appetite are the engine of Canada's economy.

When I was an elected member of the House of Commons, I made it a habit to speak to students in whatever city or town I visited – I did this even when I became prime minister. Long after my career in politics, I take great pride in the fact that communities continue to welcome me to address students, and while there I strive to inform and inspire the next generation of Canadians about the role of an integrated Canada – through connectivity and knowledge transfer.

In my view, connected communities and the use of smart technologies are some of Canada's most unique selling propositions. Many men and women, even remote communities, throughout Canada – be they healthcare providers, operators and technicians, IT specialists and others who compete in global e-commerce – have enabled technology to link Canada from coast to coast to coast. My examples herein simply illustrate the extent to which their work and services are so vital to Canadian society and what is capable when we innovate effectively.

Throughout my professional and public life, I have maintained that for democracy to be effective it requires a diverse set of multi-skilled individuals. To be clear, a viable democracy is integrally linked to livelihood and without it economic decline is sure to follow.

In this book, I believe Dr. Lakshmanan and his colleagues set out to accomplish two objectives. The first is that they address complex regulatory issues that affect communities seeking to integrate through the use of smart technology. And the second is that they have correctly highlighted the need for public decision-making and accountability.

I have always been fascinated by the work of St. Augustine, who was the first to translate the Bible in the fifth century AD. In effect, his work and his writings supplanted the abuses of capitalism and power and emphasized the state's responsibility for those who are less fortunate. In effect, it was a call to action and the foundation for the reconstruction of society. This book modifies those tenets!

As I travel throughout this great country, I see that there are passionate, committed people, like Dr. Lakshmanan, who have taken up the challenge of complexity. I often compare what I see today with what I experienced when I was in public life, when I had the privilege to help shape society with some of the world's most prominent leaders, some of whose friendships I treasure to this day. I am delighted that Dr. Lakshmanan asked me to write a foreword in support of this important upcoming book – *The Smart Village*.

Preface

The idea of writing a book on smart villages that would serve as a reference and implementation guide for professionals involved in rural development and associated disciplines has been taking shape with the co-editors for several years. A decade of work focusing on smart villages, in addition to the individual professional experiences of the co-editors in associated disciplines, has prepared us for producing this book, with contributions from authors from Canada, India, Botswana and the USA. Contributors to the book have been chosen to represent the diversity of experience essential in the development of smart village conceptualization and implementation. Contributors include academics, senior government bureaucrats, public health experts, public policy experts, entrepreneurs, engineers and technologists, communications and information systems specialists, social activists and social workers, systems developers and – most importantly – solution implementers.

Books on smart villages are still a few in numbers, as the concept itself has not yet been analysed or promoted to the same extent as smart cities have been. Most of the information available is in the form of research papers on specific implementations of one or two dimensions of an ideal smart village, or results from funded projects. The purpose of this book is to create the necessary awareness and encourage more activities of this nature. This book takes a holistic approach to the smart village idea, by defining the need, identifying the enablers and delivery mechanisms and providing case studies from different parts of the rural world. In doing so, it offers a necessary complement to the literature available on smart cities focusing on the urban world and hopefully plays a role in bridging the widening urban–rural divide.

Inspiration for working in this area as a matter of common good and consequently for this book came from one of the most respected leaders in modern Indian history, the late Dr. A.P.J. Abdul Kalam, the 11th President of India. President Kalam first presented his vision for the development of rural India on the eve of India's 54th Republic Day in 2003. He called this vision, PURA (providing urban amenities to rural areas), which would comprise four elements of connectivity (physical, electronic, knowledge, and economic connectivity) in rural areas. Dr. Kalam was a passionate promoter of PURA as the means to develop rural

communities and shared his thoughts globally with government leaders, academics, public policy experts and general public, including the multiple visits that he made to Canada, coordinated by Dr. Lakshmanan – co-editor of this book – and the Canada India Foundation. A collection of his lectures in Canada were published in 2012 (*Prosperity and Peace in the Twenty-First Century*, A.P.J. Abdul Kalam with V. Ponraj, R. Swaminathan, V.I. Lakshmanan) to further the interest in rural development. This interest coalesced with the by-then prevalent interest in the smart cities concept and its implementation into a desire for creating a momentum for smart villages. Unlike smart cities, which involve the design and development of mega infrastructure (physical and electronic), including environmentally friendly transportation for efficient connectivity, smart villages put more emphasis on human resources development, healthcare, empowerment and equity. With nearly half the world's population living in villages, this topic cannot be ignored and will present a major challenge and an opportunity of our times.

A memorial arranged in Toronto in 2015 by Dr. Lakshmanan, to celebrate the legacy of Dr. Kalam, provided a venue for his initial meeting with Dr. Kumar Murty and discussion on the need to carry forward Dr. Kalam's legacy. The concept of a smart village, and the idea of organizing a conference on that theme, was conceived from follow-up conversations at the University of Toronto between Dr. Lakshmanan and Dr. Murty. The first Smart Villages Conference was held in March 2017 at the Fields Institute for Research in Mathematical Sciences located at the University of Toronto, co-chaired by Dr. Kumar Murty and Dr. Lakshmanan. While the beginning was modest with 4 talks and 20 participants from Canada, the USA and India, it led to a Connaught Global Challenge Award and facilitating two more smart villages conferences: one in April 2018 with 18 presentations and 80 international participants; and the other in June 2019, with 36 talks and 100 participants, with international participation from Asia, Africa, Europe and North America. The conferences enabled practitioners in the area of smart villages from around the world to share their experiences, challenges, results and recommendations. The conferences were very important in the development of the smart village idea, as they expanded the scope of smart villages beyond technology to a holistic development of villages including the preservation of cultural traditions and addressing the needs of the underprivileged. They also enabled sharing of multinational and multicultural perspectives on rural development. Discussions during the conferences convinced the co-editors that the next step in enhancing global awareness, leadership and expertise in the development of smart villages would be a reference book that addresses the multiple dimensions of a smart village, with descriptions of case studies around the world. This book is the result of those deliberations. It is hoped that it would also serve as a valuable reference for the next smart villages conference, scheduled to be held in Gaborone, Botswana, Africa, on April 11 and 12, 2021.

We are indebted to the late former prime minister of Canada, the Right Honourable John Turner, for writing the foreword for the book. When the book was initially conceived, the editors contacted Rt. Hon. Turner – through Mr. Marc Kealey, one of the book's contributors – and described the objectives of the book, requesting him to write the foreword. The former prime minister graciously agreed and sent the

document well before the requested date on August 20, 2021, while expressing his willingness to participate in the book's release in Spring 2021. Sadly, shortly afterwards, he passed away. We are sure that, if he were still with us, he would be proud of the book and optimistic about its impact on society. We would like to express our sincere gratitude to all the contributors to this book, who include Prof. Venkatesh Athreya, Mr. Vijay Shankar Chandrashekar, Dr. Suresh Kumar Chellian, Mr. Uday Gokhale, Dr. Barun Gorain, Dr. Richa Govil, Prof. S. Kanchana, Mr. Marc Kealey, Dr. Dinesh Krishna, Ms. Sulochana Krishnamurthy, Mr. T.S. Krishnamurthy, Ms. Brinda Muralidhar, Mr. Jacques NdoutouMvé, Ms. Monique Vanloo-Mvé, Dr. Annapurna Neti, Prof. Oathokwa Nkomazana, Dr. Ronika Paika, Mr. Prashant Pathak, Dr. V. Ponraj, Dr. Y.S. Rajan, Mr. Nirmalesh Sampath Kumar, Dr. Sebusang Sebusang, Mr. J. Simeon, Ms. Meena Singh, Ms. Sukarmina Singh Shankar, Mr. Howard Shearer, Prof. J.S. Thakur, Mr. Chocko Valliappa, Mr. Shinu Varghese and Dr. S.P. Viswanathan. Their contributions are particularly appreciated, given the challenges faced due to COVID-19 imposed restrictions. We also thank Padma Bhushan Prof. Mrityunjay Athreya and Prof. Sundar Bharadwaj for their consultation support regarding the contents of the book. The encouragement provided by members of the Canada India Foundation is also sincerely appreciated. Our thanks are due to Mr. Jonathan Chen for technical support and Ms. Savitha Ananth for administrative support. We are especially thankful to the team at Springer Nature, for its encouragement, guidance and support leading to the publication of the book.

In addition to the book, the co-editors are also involved in other smart villages-related activities, including the development of a scalable architecture which takes a holistic approach to technology, policy and institutional design, modelling of smart village domains, public health and education-focused initiatives and other rural economic and social development activities, serving the global community to seek ways to reduce the urban-rural divide.

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Introduction

The objective of the book, “Smart Villages: Bridging the Global Urban–Rural Divide”, is to provide a holistic understanding of the issues and challenges involved in the development of rural communities and also act as a guide for exploiting the opportunities made available through modern technology to convert rural communities into smart villages. The book is targeted at any organization or individual interested or active in the fields of rural planning and policy development, including governmental and non-governmental organizations, industrial solution providers, public healthcare professionals, public policy professionals and students, as well as rural communities around the world addressing rural development through tools available in this century.

While developing the contents of the book, the editors wanted to expand beyond the common perception of a smart village as one that can avail of the latest technologies being implemented in urban areas of the world. With that objective, the editors sought a diverse group of experts who, through their own career experience as well as academic research, have presented other dimensions of what would make a village “smart”, and by extension, enhance the quality of life of rural communities everywhere.

The book is divided into three sections, “Defining the Need”, “Building the Framework” and “The Enablers: Delivery and Case Studies”. In the first section, “Defining the Need”, the authors make a high-level case for the concept of “smart village”. Chapter 1, “Setting the Scene”, outlines the evolution of human development through early civilizations, colonization and industrialization to reach the current urban–rural unequal dichotomy. It describes the development of urban and rural civilizational communities, as well as events that contributed to the current state of the urban and rural world. The purpose of the chapter is to understand that we do not look at smart village development as an initiative unconnected with the continuum of human development through the ages. While developing the metrics of a smart village, it enables us to ensure that we do not forget the heritage and cultural dimensions of the community which is sought to be transformed into a smart village. Chapter 2 presents an overview of the concept of the smart village and its desired benefits. Some early and current smart village initiatives are also covered.

Chapter 3 provides a backgrounder on the divide between urban and rural demography and the consequences of that divide. The importance of being able to quantify and measure the impact of any smart village initiative is elaborated in Chapter 4. As the United Nations has highlighted, sustainable development has to be the key phrase of any initiative impacting humanity and the smart village is no exception, especially the rural communities who have been the last line of defense against environmental degradation. Chapter 5 highlights the importance of smart villages being an integral part of a sustainable ecosystem. While the above chapters address the material aspects of smart village development, it is the editors' view that the preservation of indigenous traditions is an aspect that should not be overlooked. This view is elaborated in Chap. 6, with examples from Canada, Africa and India, showing how indigenous traditions when not subsumed by modern technology – but nurtured instead – can not only ensure the local quality of life but also provide branding opportunities, global reach and economic advantage.

The second section “Building the Framework” describes in greater detail the many aspects associated with smart village development. Governance, whether at the national, regional or local level, is an essential part of any development. Governments conceive, facilitate, implement and finance development projects. They set and enforce rules and regulations. They create schemes with brand identity. Therefore, anyone considering smart village projects must understand the role government will play, the impact it will have on the project and how one can leverage government schemes and facilities to benefit the project. Chapters 7 and 8, written by authors with strong private sector and government services experience respectively, address the role of governments and governance in the context of rural development. Chapter 7 describes the North American governance scenario, and in Chap. 8, the Indian scenario. In the latter chapter, the author makes a strong case for decentralizing decision-making for better government at the grassroots. In addition to being a good idea, “smart village” can also be viewed as a science. The development of the science of smart villages requires an understanding of the attributes that make a village “smart”. Chap. 9 provides a detailed understanding of the components of an ontology for a smart village, with special emphasis on learning as a key component. Chapter 10 provides a blueprint for the development of a key element of smart village, healthcare, specifically primary public healthcare. The chapter also includes an item list for putting together a typical primary healthcare centre. Public health is the main indicator of the socio-economic environment of a rural community. Chapter 11 addresses the social mobilization that is required to achieve the key objectives of a smart village with examples, drawn from the author's personal involvement in successfully addressing two socio-economic issues, female infanticide and literacy. Chapter 12 describes the evolution of the smart village idea in India, starting from Mahatma Gandhi's championing of villages as the heart of India, to the PURA vision of India's former President Abdul Kalam of providing urban amenities in rural areas and to the SPMRM initiative of the current government. The realities and challenges associated with the development of smart villages in the Indian context are well laid out by the author who had been intimately involved with the development of the PURA concept. Chapter 13 addresses what

most people associate with “smart village”, namely providing physical, digital and knowledge connectivity. The author describes the technologies involved with implementation examples from Africa, India and Europe. Technologies adopted must be appropriate to suit local conditions and be capable of truly adding value for the smart village. This is particularly true for Indian villages. A comprehensive view of using appropriate technology for value addition in a rural setting is provided in Chap. 14, by the authors who draw from their personal involvement in initiating and implementing the value addition projects. The role of education, with a particular focus on skilling, in the development of smart villages is explored in Chap. 15. The authors draw upon their own academic research and that of other academics and integrate it with the experiences of grassroots practitioners to understand the role of skills development and challenges associated with it in the rural environment. The final chapter in the section, appropriately, is devoted to that aspect of a smart village project which – if not properly understood or applied – can guarantee failure of any project. The author, a reputed entrepreneur and investor, describes the conventional and innovative instruments to finance smart village initiatives and advises the project proponents that social and economic objectives of a project must be effectively communicated to attract the necessary capital needed to implement the project.

The third section, “The Enablers: Delivery and Case Studies”, provides several case studies of implementation of one or more smart village elements. These projects may not all have been pre-stamped with the “smart village” identification and terminology, but they all offer excellent case studies of rural development and examples to benefit from in any smart village project. One of the key themes of the section is the cross-fertilization of ideas on smart villages between countries and continents. For example, an idea like PURA from India could be superposed on a smart village implementation in an indigenous community in Canada. Chapter 17 does just that by showcasing two initiatives in Ontario, Canada, and they could be viewed as implementations of the PURA concept. Agriculture is the lifeline for most rural communities in India, and elsewhere, and farmers are the human face of agriculture. Chapter 18 shines the light on small farmer producer companies which can help farmers move beyond subsistence agriculture and indebtedness. Chapter 19 looks at natural resources and agriculture as two of the enablers of job creation in African smart villages, with success stories from Botswana and Mauritius respectively. Chapter 20 highlights the importance of clean water for any rural community and illustrates how an innovative water treatment solution developed in Canada has been implemented in Odisha, India. Another innovative and sustainable, technology-based, solution for providing drinking water for smart villages is presented in Chap. 21. It is a seawater desalination system utilizing solar and agro-waste biomass for producing high-quality drinking water, developed by an Indian company with guidance and funding from the Government of India. Several chapters are devoted to healthcare case studies from Africa and India. The importance of agriculture as an essential component of rural communities is known; however, its value as an entrepreneurial engine for the smart village is brought out by the author in Chap. 22. Chapter 23 describes a proposed rural healthcare case study in Botswana, Africa, which draws its inspiration from a similar initiative in India. Three other case stud-

ies on healthcare demonstrate the different ways in which healthcare can be incorporated in a smart village. Chapter 24 describes a healthcare case study and discusses the challenges inherent in sustaining an effective healthcare system in a rural community. The challenges of telemedicine in an Indian environment are presented in Chap. 25, and a case study of overcoming those challenges through a mobile hospital is described. Again, it is notable that this mobile hospital implementation in the state of Tamil Nadu, India, was funded by an organization and individuals from Canada. Chapter 26 describes a nurse-led healthcare initiative that also serves as an example of women's empowerment in a healthcare setting. Two cloud-based education solutions, both benefitting Africa, are presented in Chapters 27 and 28, one an indigenously developed solution whereas the other initiated and funded by the Indian government.

One of the main objectives of the book is to emphasize the social components of a smart village development. These are women's empowerment, inclusive development and indigenous traditions. These components are referenced in several chapters through the book but form the main theses in Chaps. 29, 30 and 31. In Chap. 29, the authors demonstrate through a comprehensive case study how technologies – not all of them leading edge – can be effectively adapted to provide meaningful employment for women. Chapter 30 provides a shining example of a unique organization which has successfully demonstrated that differently abled people can form their own smart village and is presented to make a case that no smart village can be classified as smart if it does not have a place for the differently abled. Chapter 31 uses the broad canvas of Africa to emphasize, using numerous examples, the necessity and value of incorporating indigenous traditions in any smart village project. The new normal that has gripped the world in the form of COVID-19 is the subject of Chapter 31, where the author – an epidemiologist and public health expert – describes the spread of the virus around the world in 2020 and offers his views on how smart village development will have to factor in the demographic and sociological changes brought about by the illness. The book concludes with recommendations for current and future practitioners in the field of rural and smart village development.

It is hoped that the book will be part of any toolkit for practitioners in the area of smart villages and help them develop a policy-based framework for smart village projects. It is also hoped that the general reader will appreciate the importance of smart villages-based rural development, importance of balancing development with social/gender equity and importance of cultural traditions and challenges in the implementation of smart villages. The book would be deemed to have achieved its objective if it results in an increase in the number of practitioners in the area of smart villages in particular and rural development in general contributing to the bridging of the urban–rural divide.



Elders of the village of Pilikwe, Botswana, at smart village discussions with co-editors V.I. Lakshmanan and Arun Chockalingam and contributing author Jacques NdoutouMvé

V. I. Lakshmanan
V. Kumar Murty
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About the Editors

V. I. Lakshmanan, Ph.D. is an internationally renowned teacher, scientist and innovator in the area of sustainable development. He has more than 40 years of hands-on experience in technology development, commercialization and skills development initiatives with both private and public sectors including the United Nations. He is co-founder, vice-chairman and CEO of Process Research ORTECH, a leading-edge technology development and commercialization company in the areas of process research and sustainable development. He has previously held prominent positions in the engineering/technology sector of Canada with companies such as Noranda, Eldorado Nuclear and ORTECH Corporation. His professional honours include Fellow of Canadian Academy of Engineering, Fellow of Canadian Institute of Mining, Metallurgy and Petroleum and many others. He also serves as an Adjunct Professor at the University of Toronto. He has published more than 150 papers and written/edited several books on science, process engineering and public policy. He has co-founded and/or led numerous community-oriented non-profit organizations, most notable Canada India Foundation, where he organized and chaired several public policy forums on themes, such as healthcare, agriculture, infrastructure, energy and mining. He has organized three visits to Canada by India's former President Dr. Abdul Kalam, who is the inspiration for his smart village initiatives, such as clean drinking water solutions and a mobile hospital in rural India, as well as co-chairing smart villages conferences at the University of Toronto. He was a recipient of the Queen Elizabeth Diamond Jubilee Medal in 2012.

Arun Chockalingam, Ph.D. is a Professor of Epidemiology, Medicine and Global Health at the University of Toronto, Canada. His experience encompasses a unique combination of global health research, policy, training and administration in addition to international leadership within the global health community. He is a co-author of the Institute of Medicine's 2010 report on "Promoting Cardiovascular Health in the Developing World" a key resource for the UN High-Level Meeting on Noncommunicable Diseases (NCD) Prevention and Control, 2011. He had been the Founding Director of Global Health at the following institutions: University of Toronto School of Public Health; the National Heart, Lung and Blood Institute

(NHLBI) of the US National Institutes of Health (NIH); and Faculty of Health Sciences at the Simon Fraser University Vancouver, BC. From 2005, He served as the Secretary General of the World Hypertension League for 9 years. He has over 200 scientific and medical publications and has edited 7 books. He is passionate about global health research, particularly on NCD prevention and control in low- and middle-income countries (LMICs). He is the recipient of several national and international awards, including the Simon Dack Award from the American College of Cardiology. He has established research collaborations in all six continents including countries like China and India. He is the Editor-in-Chief of the *International Journal of NCDs* (www.ijncd.org)

V. Kumar Murty, Ph.D is a Professor of Mathematics at the University of Toronto and Director of the Fields Institute for Research in Mathematical Sciences. His fields of research are number theory, algebraic geometry and their applications to Information Technology. He received his PhD from Harvard University and has held visiting positions at the Institute for Advanced Study (Princeton), the Tata Institute of Fundamental Research (Mumbai) and Concordia University (Montreal) before moving to Toronto. He has published over 120 scholarly articles and authored and edited seven books. His research has been recognized with many honours including election as a Fellow of the Royal Society of Canada, a Foreign Fellow of the National Academy of Sciences (India) and a Fellow of the Canadian Mathematical Society. He was also awarded the prestigious EWR Steacie Fellowship by NSERC and the Coxeter-James Prize by the CMS. Recently, he has embarked on a study of “smart villages” to mathematically understand the dynamics of communities and to derive the economic and social implications of various models of growth. This work has been recognized with a Connaught Global Challenge Award (together with Mariana Prado and Joseph Wong).

S. Kalyanasundaram is a former executive with Nortel Networks. He is an aerospace engineer by training and educated at the Indian Institute of Technology, Chennai, India, and Georgia Institute of Technology, Atlanta, USA. He spent nearly 25 years developing, product managing, implementing and marketing leading-edge technologies for digital telecommunication networks. For 7 years, he served as Executive Director of Canada India Foundation, a Canada-based public policy organization, promoting stronger relations between Canada and India, where he organized seven public policy forums on a range of strategic themes, such as healthcare, energy, mining, agriculture and infrastructure, as well as many other high-profile initiatives. He has been involved with several non-profit and charitable organizations over four decades and co-founded a venture, Grantx, to help such organizations apply for government grants. He serves as an advisor to Handi-Care International, an organization that has been raising awareness and funds for children, youth and adults with differing abilities in rural India and Canada. He also consults regularly on a variety of topics, including proposals for smart cities and smart villages.

About the Contributors

Venkatesh Athreya, Ph.D. earned a BTech degree in Chemical Engineering from the Indian Institute of Technology, Chennai, in 1969 and a Doctorate in Economics from the University of Wisconsin-Madison, USA, in 1975. After serving for three decades in the Bharathidasan University in Tiruchirapalli, India, he retired as Professor and Head, Department of Economics in 2008. His works include, besides over 100 published research papers and several monographs, the following books: *Barriers Broken* (Sage, 1990; co-authored with G. Djurfeldt and S. Lindberg), *Literacy and Empowerment* (Sage, 1996; co-authored with Sheela Rani Chunkath) and *Marxian Political Economy* (Tulika Books, 2013). He was the lead author of *The Report on the State of Food Insecurity in Rural India* (2008) and *The Report on the State of Food Insecurity in Urban India* (2010), both jointly published by the M.S. Swaminathan Research Foundation and the World Food Programme. He has worked and written on issues of rural and agrarian change, literacy, gender, female infanticide, food security and political economy, as both an academic and a social activist.

Vijay Shankar Chandrashekhar is a co-founder and secretary of the Learn and Uplift Foundation (LAUF). He is a former head of consulting at Price Waterhouse Coopers, Mumbai, India, and has managed and led large consulting projects for major multinational organizations. His experience in the non-profit sector includes organizations such as Parkinsons Society of Canada, Canadian Lung Association, the Ontario Association of Children's Aid Societies and many more. His role at LAUF includes networking with non-governmental organizations (NGO) and other institutions, coordinating with international stakeholders and technical leadership.

Suresh Kumar Chellian, Ph.D. is the Executive Vice-President of Emperal-KGDS Renewable Energy. He received a PhD degree from the Indian Institute of Technology, Chennai, India. He has played a leading role in developing various designs for solar thermal desalination and other applications, including flue gas-based desalination for recovering waste heat from chimneys in thermal power plants.

Uday Gokhale is a mechanical engineer who has been providing water treatment solutions for the past 30 years in India and other countries. After nearly a decade of working with Thermax Limited implementing water treatment plants, he started his own company Waterwings, which supplied more than 500 water treatment plants all over India and overseas, before merging with Eureka Forbes, one of the world's leading water treatment solutions providers. He was chosen to lead a new technology initiative within Eureka Forbes and worked on five to six potential technologies in filtration, membranes, sewage treatment, etc. Most recently, he successfully installed and commissioned one plant on automated variable filtration (AVF) technology for a rural supply scheme in Odisha.

Barun Gorain, Ph.D. is the managing director of ORE2METAL, based in Toronto Canada. He has more than 25 years of experience in precious and base metals plant operations, capital projects and technology and innovation roles. He has worked on various senior strategic roles spanning various global mining companies. Some of his key roles include Chief Technology and Innovation Officer for Hindustan Zinc (Vedanta Resources), Director of Barrick Gold based in Toronto and Group Leader at Teck in British Columbia. He has a PhD in Metallurgical Engineering from the JKMRRC, University of Queensland in Australia, and a BTech in Mineral Engineering from Indian School of Mines (now IIT, Dhanbad). Some of his recent accomplishments include underground mine digitalization and automation; building a world-class collaboration centre integrating multiple mines, mills, smelters and power plants; and enhancing ore to metal recoveries through milling excellence along with various patented metallurgical process innovations converting marginal ores into profitable operations.

Richa Govil, Ph.D. is the Director of the School of Development at Azim Premji University, Bangalore. Richa has been deeply engaged with issues related to education and development from her early years. She led Asha for Education, a large US-based volunteer-run non-profit organization focusing on the basic education of underprivileged children. She developed and implemented business strategies for small and large companies in the USA and India for many years. She co-founded Training Resources for Enabling Enterprises Society (TREE Society) to provide business management training for rural farmer and micro-enterprises. Her areas of interest include agriculture, nutrition, inclusive value chains, farmer producer companies, micro-enterprises and women's livelihoods. Richa has a PhD in Physics from the University of California, Berkeley, USA.

S. Kanchana, Ph.D. works as a Professor and Principal at Omayal Achi College of Nursing, and Coordinator of Omayal Achi Community Health Centre, Chennai, India. She is also the Research Director of International Centre for Collaborative Research in India. She has specialised in public health nursing, and her research interest is focussed on community-based participatory research. She is the editor and co-author of *Manual of Nursing Procedures and Practice* (second edition) by Omayal Achi College of Nursing.

Marc Kealey is the Principal and President of K&A Inc., a Canadian public affairs and project management company founded in 2007. The company has directed and developed some of the most effective public policy changes in Canada, including pharma care, healthcare delivery, energy, mining and gaming. The company operates in Canada, United States, Mexico, South America, Eastern Europe and Asia. Before his role at K&A, Marc Kealey was the CEO of Canada's largest pharmacy company for 5 years and helped bring prescription drug reform to Canada. Before this role, he spent 6 years at Atomic Energy of Canada as its general manager during the years when CANDU reactors were commissioned in China and Romania. He was a hospital administrator for 10 years in Durham region to the east of Toronto, where he helped to integrate the delivery of healthcare through a restructure of hospitals in the region into a system – the first such model in Ontario. He began his career in politics from 1984 to 1990 as an advisor to the late John N. Turner, former prime minister of Canada. He is a graduate of the University of Waterloo and attended Kent State University in Ohio. Marc is an expert in public policy and governance and sits on the board of several organizations.

Dinesh Krishna, M.D. is an Emergency Medicine Physician as well as Rehabilitation Consultation Physician and Postgraduate Education Director at North York General Hospital. He is also a lecturer at the University of Toronto. He obtained his medical degree at the University of Western Ontario and family medicine and emergency medicine residencies at the University of British Columbia in Canada. He was awarded the Anna Jarvis Award for Postgraduate Teaching Excellence in Emergency Medicine in 2015. He is also the Chair of the University of Toronto's International Centre for Disability and Rehabilitation, India. He is a volunteer Director of Handi-Care Intl., a registered Canadian charity focused on global disability rehabilitation and advocacy, and assists with fundraising, programme management and project development. He is also a consultant director of the early intervention/enabling inclusion programme at Amar Seva Sangam, which is a non-profit, non-government organization dedicated to disability advocacy and rehabilitation. He was recently awarded the MIT (Massachusetts Institute of Technology) Solver Award for his work towards this project.

Sulo Krishnamurthy is the founder and honorary President of Handi-Care Intl., a Canadian registered charity, established to serve the needs of people with differing abilities. She holds a master's degree in Chemistry and Microbiology and worked in pharmaceutical research for 19 years in Canada, before resigning her position to devote her full time to Handi-Care Intl., which she founded in 1992. Her inspiration to take on this initiative came from her parents, particularly her father, who shaped her vision and mission in life. She grew up with two siblings afflicted with degenerative muscular dystrophy, both of them achieved great success in their career and in serving others despite being rendered to wheelchairs at a young age. For more than 25 years, she has been active in raising funds as well as initiating and successfully implementing several public service projects in India and Canada, particularly at Amar Seva Sangam, a model smart village for people with differing abilities.

T. S. Krishna Murthy served as the 13th Chief Election Commissioner of India and had the responsibility to oversee the 2004 elections to the Indian Lok Sabha (lower house of the Parliament). He had earlier served in the Election Commission of India as a Commissioner from 2000 to 2004. A career officer with the Indian Revenue Service (IRS), he was the first officer from the IRS to become a Secretary to the Government of India as well as the Chief Election Commissioner of India. He served as an International Monetary Fund (IMF) advisor in Ethiopia and Georgia and was an observer to elections in Zimbabwe and the US Presidential elections in 2004. A gold medalist from Mysore University, he also completed a Master's in Fiscal Studies from the University of Bath, UK. He is the author of the book "Miracles of Democracy", published in 2008.

Brinda Muralidhar is an Indo-Canadian actor, writer, filmmaker and theatre practitioner. Her writings include 14 stageplays ranging from quirky one-acts to intense dramas, and musicals. Her first feature film *Knot Not!* explores the subject of domestic bullying at its core, while the treatment of the film keeps the audience thoroughly engaged and entertained. *Knot Not!* was very well received by the Canadian audience and went on to earn many accolades in several international film festivals including a Best Film Award. Brinda is developing content for a feature film and a web-series.

Jacques Ndoutoumvé is a Vice-President and Principal Adviser for Healthcare for the Canada-Africa Chamber of Business. He is also the founder and managing director of EL Consulting and Management LTD, a Toronto-based consulting firm focusing on project management and project integration in renewable energies, water and wastewater, CSR and economic development in mining and related infrastructure in Africa. Jacques is also the co-founder and CEO of the Sub-Saharan Africa Healthcare Initiative, an organization focusing on establishing and developing comprehensive state-of-the-art clinical and anatomic pathology as well as imaging services to deliver high-quality, efficient and affordable services to patients in Sub-Saharan Africa under standards that meet international accreditation expectations. He is a fervent advocate of UN SDGs and has previously addressed events of the UN such as COP, African Union, government level, international and regional conventions in the problematic of integration of WASH and adaptation of technologies to local realities.

Monique Vanloo-Mve is a Career Educator and Practitioner at the University of Toronto Scarborough, with a Bachelor of Arts in Interdisciplinary Studies that uniquely combines English, Communication and Africana Studies, and a Master of Arts in Education with post-graduate certificates in race and social policy as well as NGO and non-profit management. She has been involved with community education and employment for over 12 years in non-profit and public sectors, supporting both inner cities and suburban communities. Her expertise is in designing and developing curriculum for blended environments, project-based experiential learning solutions and career education programing. Her research interests focus on com-

munity development through an employment lens and finding innovative ways to incorporate experiential education to create a thriving workforce in developing nations.

Annapurna Neti, Ph.D. is an Associate Professor of the School of Development at Azim Premji University, Bengaluru. She has worked as a researcher and consultant to multiple organizations in the development sector. She has over 16 years of experience covering practice, research and teaching in the areas of MSMEs, microfinance, financial inclusion, women’s collectives and informal livelihoods in India, Nepal and Bangladesh. Her research interests include urban informal livelihoods, microfinance, producer companies and other organizational forms in the development sector. She serves as an expert director on the board of an all-women dairy producer company. She is a Fellow (PhD) of the Indian Institute of Management Bangalore.

Oathokwa Nkomazana, Ph.D. is a College of Ophthalmologists of South Africa certified ophthalmologist with a Masters in Community Eye Health (Public Health) from the University of London and a PhD in Family Medicine from the Stellenbosch University. Her professional goal is to improve the health of the people of Botswana through locally relevant implementation research, training healthcare professionals in a socially accountable manner and provision of sustainable high-quality accessible and affordable healthcare. She is currently Associate Professor of Public Health and Dean of the Faculty of Medicine at the University of Botswana.

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Prashant Pathak is the CEO of Ekagrata Inc., a business building-oriented principal investment and diversified holding company, and has served as a Principal of In Colour Capital Inc., an independent principal investment group, since April 2015. As part of his investments and ownership responsibilities, he sits on the boards of several private and publicly listed companies. He has been an appointee of the Government of Canada, for nearly a decade, on the Board of the Business Development Bank of Canada (BDC), Canada’s largest development finance institution with more than \$25 billion in assets. During this time, he was also the Chairman of the Investment and Venture Capital Committee of the BDC. Previously, Mr. Pathak was a Partner of McKinsey & Company Inc., where he was a leader of the North American Telecom Practice, the Financial Services Practices and a leader in the Strategy and Corporate Finance Practice. He has also been part of the start-up team and the Managing Partner of ReichmannHauer Capital Partners, a successful Canadian investment firm. Mr. Pathak has an MBA from INSEAD with Distinction

and a BTech degree in Electrical Engineering from the Indian Institute of Technology, where he was adjudged the Best All-round Graduating Student of his class. He also has a Diploma in Fuzzy Logic from IIT.

V. Ponraj, Ph.D. was closely associated with India's late former President Dr. A.P.J. Abdul Kalam from 1995 till 2015. After an early career in academic institutions as a programmer and information scientist, he joined India's Aeronautical Development Agency (ADA) in 1995 as a scientist in the design and development of India's indigenous light combat aircraft, Tejas. In 2003, he was deputed to the President's Secretariat as Director, Technology Interface, continuing with President Kalam as Advisor on science and technology and public policy. Following President Kalam's death in 2015, he resigned from ADA to devote himself to the realization of President Kalam's vision of bringing socio-economic and political awareness among the people and guiding the youth and preparing themselves as leaders. He is currently mentoring social and political movements named "Abdul Kalam Vision India Movement" and "Abdul Kalam Vision India Party".

Y. S. Rajan, Ph.D. has made major contributions to the management of science, technology and innovation in India as a pioneer in India's Space Programme (1964–1988). He was an elected member of International Academy of Astronautics (IAA) and led the Indian delegation to UN Committee on Peaceful Uses of Outer Space. He was a Vice-Chancellor Punjab Technical University (PTU) (2002–2004) and Scientific Adviser to the Chief Minister of Punjab. He was Chairman, Board of Governors of the National Institute of Technology (NIT), Manipur (2011–2015) and Dr. Vikram Sarabhai Distinguished Professor/Chief Mentor ISRO Strategy Group (2010–2011) He is a Fellow of the Indian National Academy of Engineering (1996–), Member International Law Association (ILA) – India Chapter and Fellow of World Academy of Art and Science (WAAS). He received the Padma Shri Award from the Government of India in 2012.

Nirmalesh K. Sampath Kumar is currently the Head of Knowledge Transfer and Valorisation at Sona College of Technology, Salem, India, and heads social impact initiatives within the Valliappa Foundation, India. He is one of the youngest persons to be both an Erasmus Mundus Scholar and a Marie S Curie Fellow. After having completed advanced degrees in quantum nanophysics and science and technology management, he founded his own technology start-up company "Connectdness" in Nice, France. This company was successfully acquired within a few months of its incubation. Following this, he ventured into the field of knowledge transfer, identifying R&D projects and ideas in the lab that can become potential start-up companies and has been responsible for the creation of at least six science and technology-based start-ups in Europe. On his return to India, he joined his alma mater and works with the Sona Group and Mr. Chocko Valliappa on solving social issues affecting the rural communities in India.

Sebusang Sebusang, Ph.D. is the Executive Director of Technologies at the Botswana Institute for Technology, Research and Innovation in Gaborone, Botswana. He holds PhD in Automatic Control Engineering from the University of Bristol, UK. He is also a partner and director at Motlabaseyo Integrated Management Systems, a research organization specializing in communications from strategy to crisis management. He is a champion of the need for rural communities of Botswana to gain access to information and communication technologies (ICT). He is also active in rural farming and is the Managing Director and Technical Officer for Sebusang farming.

Sukarmina Singh Shankar holds an Honours Bachelor of Science degree in Forensic Anthropology and South Asian Civilizations from the University of Toronto and is on her way to graduate school. In the intermezzo, she is working as a research assistant on the smart villages initiative co- founded by Dr. V.I. Lakshmanan and Dr. V. Kumar Murty. While pursuing a career in forensic pathology, she aims to continue working alongside Dr. Murty on the smart villages project to address the global problem of poverty through the development of smart communities internationally.

Howard Shearer is the Chief Executive of Hitachi Canada, having joined Hitachi in October 1984. Before his current role, he served in multiple roles such as Chairman Hitachi Power Systems Canada Ltd., President & CEO, Hitachi Canada Ltd., Vice-President & General Manager of HCL's Hitachi Canada's Semiconductor division. Before joining Hitachi, Mr. Shearer was employed by Texas Instruments as well as Murata Erie. Mr. Shearer holds a BEng degree in electrical engineering (McMaster University, Hamilton, Ontario and a Master of laws, LLM from the University of Toronto. He is currently a member of McMaster University's Dean of Engineering Advisory Board, and Executive in Residence. In 2019, he was inducted as a Fellow of the Canadian Academy of Engineering. Currently, he serves on the boards of Canadian Nuclear Laboratories, Canadian Nuclear Association, Energy Council of Canada, Japan Society and Canadian Nurses Foundation and has previously served on the boards of Metrolinx, University of Toronto, McMaster University, Independent Electricity System Operator (IESO), GE-Hitachi Canada Ltd., and Hitachi Canada Ltd.

J. Semeon is the Manager of Erections and Commissioning at Empereal-KGDS Renewable Energy. He has erected, commissioned and evaluated the performance of all solar thermal and desalination systems the company has built. He has focused on efficiency and reliability considerations, and has improved the company's products in National Thermal Power Corporation plants at Simhadri (Andhra Pradesh) and Vallur (Tamil Nadu), India.

Meena Singh is a co-founder and chair of the Learn and Uplift Foundation (LAUF), a Canada-based charitable organization working with underprivileged youth around the world. She is an international management consultant who has worked with over 95 for profit and non-profit organizations in transformation, assessment and development of people and strategy. Her experience includes consulting for large transnational corporations, medium and small enterprises and public sector organizations in Canada, India and the USA. She holds a master's degree in Physics from the University of Delhi, India, and an MBA from the Simon Business School at the University of Rochester, the USA, from where she is also a recipient of the Distinguished Alumnus Award. As an entrepreneur, she has served on Canadian and international juries assessing youth projects and volunteers as a guest speaker on youth issues on a multicultural radio programme.

J. S. Thakur, Ph.D.M.D. is a Professor in the Department of Community Medicine and School of Public Health, PGIMER, Chandigarh, India. He is an expert member of Mission Steering Group of National Health Mission, Ministry of Health and Family Welfare (MOHFW), Government of India. He is the Founder President of the World NCD Federation since 2015 and the Founder Editor of the *International Journal of Noncommunicable Diseases*, the official publication of World NCD Federation. He is a fellow of the Indian Association of Preventive and Social Medicine (IAPSM) and Indian Public health Association (IPHA). He is also an expert member of the COVID-19 Expert Group of MOHFW of India. He has been instrumental in developing the models of health-promoting districts, workplaces and schools, and is now developing a model for smart sustainable village in Punjab, India. He is a collaborator for global burden of disease study by the University of Washington; PURE study by McMaster University, Canada; and million death study in India by Centre for Global Health Research (CGHR), University of Toronto and One Health Global Governance Network, Canada. He has worked at WHO Country Office of India as Head for NCDs and Mental Health team (2009–2012).

Chocko Valliappa is a passionate social entrepreneur in pursuit of solving peoples' problems and democratizing solutions to make them more affordable. He founded Vee Technologies, a Fortune/IOAP 100 global services company working in health-care and engineering design services. His social enterprises, SonaYukti and HireMee, have a vision of skilling and enabling five million youth to embark on their first jobs by 2030. He is the Vice Chairman and Trustee of Sona Group of Institutions and has made strides in making those institutions more research focused. Chocko is also a keen researcher and heads a team of 200 PhDs with the quest of solving industrial and social problems. Anadhanam from Valliappa Foundation is his latest endeavour to reduce global hunger through the use of technology.

Shinu Varghese is the Vice-President of Technology at Empereal-KGDS Renewable Energy. He has received a master's degree from the Indian Institute of Technology, Chennai, India. He has designed many applications and has carried out detailed thermodynamic analyses to optimize various configurations in the solar desalination area for improved efficiency and reliability.

S. P. Viswanathan, Ph.D. is the President of Empereal-KGDS Renewable Energy Pvt. Ltd., Coimbatore, India. He has received a PhD degree from Georgia Institute of Technology in Aerospace Engineering and has worked for 33 years as a helicopter engineer for Bell. He co-founded the company in 2007 and has been a part of building solar thermal systems and solar desalination and other waste-recovery technologies.