

Implications of the 4th Industrial Revolution on Entrepreneurship Education

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Abstract

Changes in societal and technological economic systems indicate an industrial revolution. Any industrial revolution comes with implications on the education of its society. An interest in entrepreneurship education has grown since the beginning of the millennium 2000 mainly in institutions of higher education, incubators, development agencies and government in developing countries. The focus of entrepreneurship education has been on opportunity identification, attracting resources and managing risk in a new start-up enterprise. However, the 4th Industrial Revolution changes the narrative of how entrepreneurship education is understood and its future. The 4th Industrial Revolution means change in societal and technological economic systems. The nature of opportunities and how resources for businesses are deployed will also change, hence a need to understand the implications of the 4th Industrial Revolution on Entrepreneurship Education. In this research paper we use a theoretical framework that presents focal themes of Entrepreneurship Education and Industry 4.0. These are contrasted in this paper to derive the implications of Industry 4.0 on Entrepreneurship Education following the research design of this study. The design of this study is a desk review of 50 journal articles on which the derivation of the implications of Industry 4.0 on EE is based. A discussion, conclusion and a direction for future research is provided on this paper.

Keywords

4th Industrial Revolution, Entrepreneurship Education, Resources and Opportunities

1. Introduction

An industrial revolution is an inevitable occurrence caused by rapid and speedy changes in the design of solutions. An industrial revolution can be defined as a change in industrial, social, economic and technological systems driven by rapid growth in advanced intelligent-scientific solutions (Dombrowski and Wagner, 2014). Industrial revolution shapes work circumstances, life conditions and economic wealth. The notable developments of industrial revolution are traced to 1780 when the steam engine was invented and used, which then was followed by electricity generation in 1890 and the latest being Nano-technologies in 1990. These revolutions brought changes into consumer behavior through mass production and customization. However, throughout the developments there have been debates about mass production and automation replacing factory workers. Socio-technical production systems change when an industry is revolutionized but this happens inherently with no primary intention of laying-off labour. It is for this

purpose that trade union movements and employer organisations negotiate on mutual demands when industry changes and trends are adapted.

1.1 Understanding the 4th Industrial Revolution

The 4th industrial revolution is based on three (3) mutual interconnected factors which provide an understanding about this age of revolution (Zezulka *et al.*, 2016). These are:

- Digitisation and integration of any technical economical reaction to complex networks e.g. digital currencies
- Digitisation of products and services on offer e.g. smart products
- New market models e.g. virtual stores or reality

The 4th Industrial Revolution (IR) also known as 4.0 is a highlight of a new era of industrial revolution characterised by rapid changes in techno-social economic systems (Qin, Liu and Grosvenor, 2016). The 4th industrial revolution presents ideas of smart factories, full integration of business communication in all processes, smart products and investment in intelligence. The assessment of the state of readiness for the 4th IR is an important assignment that industry role players need to do in order to adjust dimensions such as organisational strategies, leadership skills, customer engagement methods, organisational practices, technology and governance (Schumacher, Erol and Sihni, 2016). The impact of technological developments also need to be given further attention by industries in order to cope with the heightened need to apply technological intelligence and automate through systems such as robotics (Kapoor, 2014). The role of industrial revolution has always been to facilitate human progress, ease the burden of production's dependence on human labour and this primary purpose is still the same in the 4th industrial revolution. The manner in which the 4th industrial revolution seeks to advance mankind and corporate entities is through flexibility in resource deployment that has a potential to fill gaps in the transformation of society (Bauer *et al.*, 2015). Resource flexibility deployment refers to the redevelopment of employee talents and skills for use in different activities and in areas where those add great value. The resource flexibility management would be powered through Internet-of-Things (IoT), Cyber-Physical-Systems (CPS), Information and Communication-Technologies. The flow of goods and services will also be supported by the stated resource flexibility management systems cutting down on slack time and poor quality. Corporations rely on sustainable and flexible supply chain systems; the 4th industrial revolution technologies will not only provide advanced and complex production systems but cyber physical systems with capacity to have the consumer, manufacturer and supplier joint together in real-time in a production process (Schuh *et al.*, 2015)

1.2 Entrepreneurship Education as an interdisciplinary field

Entrepreneurship education is described as the depth learning and teaching of the principles of opportunity identification, resourcing, envisioning and being catalyst for change (Kuratko, 2005). The teaching practices in entrepreneurship education vary from work-based learning to theoretical models (Schuh *et al.*, 2015). The subject of entrepreneurship is founded on other disciplines such as psychology, social studies, economics and finance (Faller and Feldmüller, 2015). The teaching and learning of this subject drives entrepreneurial action which rises from the intention of the recipients of the lessons to start new enterprises or to provide solutions. The first programme on entrepreneurship was first present in 1945 by Myles Mace at the Harvard Business School which was a pioneer programme that brought attention and interest in the entrepreneurship education (Samwel Mwasalwiba, 2010)(Kuratko, 2005).

1.3 Entrepreneurship Education and the 4th Industrial Revolution

Entrepreneurship education is interdisciplinary and has relied on this since the first entrepreneurship programme in 1945 to drive the entrepreneurial intention of the students of entrepreneurship. Business schools and universities have invested resources into the teaching and learning of this subject. Moreover, there has been industrial attention on entrepreneurship and innovation which set the subject to being among those which are of priority (Kuratko, 2005). Various governments view entrepreneurship as an important economic activity in driving the start-up of small enterprises which can create employment, new opportunities and provide access to affordable products and services to their communities. The teaching and learning of entrepreneurship aims to propel students to be confident and raise their intention to offer solutions that would result in viable businesses. However, the 4th Industrial revolution makes this purpose even complex to understand and deliver on. The 4th Industrial revolution opportunities look different and are driven by technological advancement. Entrepreneurship programmes are not designed to teach about technology and industrial activity but the generic principles of envisioning solutions (Kuratko, 2005). This presents the problem statement investigated by this study as on the next section.

1.4 Problem Investigated

The teaching and learning in entrepreneurship education focuses on generic principles of identifying opportunities and taking action on them. It also focuses on envisioning the future, developing entrepreneurial traits and running a new business. However, the 4th industrial revolution presents a new challenge to entrepreneurship education which can be described as the new look of opportunities and the heightened dependence of viable business opportunities on technological economic and social systems that are not adequately addressed in entrepreneurship education programmes.

2. Literature Review

Industrial revolution, education and sustainability are inseparable concepts as far as development and societal change is concerned (Trew, 2014). The change in natural environmental cycles and climate has sparked a great interest into trans-disciplinary teaching approaches to address complexities of achieving sustainability (Tejedor, Segalàs and Rosas-Casals, 2018). The rationale for the embedment of sustainability discussion in higher education are that students will develop a capacity to for global citizenship and engage in life-long learning and development of well thought solutions (Evans *et al.*, 2017). The dawn of the 4th Industrial Revolution also known as Industry 4.0 has made it become compulsory to promote sustainability among students in institutions of higher learning (Aleixo, Leal and Azeiteiro, 2018). Industrial revolution addresses humanity's challenges, it seeks to deliver societal transformation and development (Bürgener and Barth, 2018). There are three key factor-components on the literature of industrial revolution and these are sustainability, education and the cause of industrial revolution.

Causes of Industrial Revolution

Industrial revolution is caused by rapid increase and exposure of people to radical techno-economic solutions which can resolve their daily challenges (Trew, 2014). Industrial revolution is caused by solutions towards productivity, human capital, discovery of new ways to do challenging work and the acceleration in new scientific discoveries is another cause of industrial revolution (Grada, 2016). The main drivers of the third industrial revolution were discovery of new skills, critical thinking and working with complexity (Liu and Grusky, 2013). Industry 4.0 is based on the notion of social innovation, artificial intelligence and big data (Morrar, Arman and Mousa, 2017). This literature shows a pattern in the development of industrial revolution in that it is based on rapid change, skills, productivity and intelligence (Liu and Grusky, 2013).

Education and Economic Opportunities in an Industrial Revolution

Education faces challenges of being accessible to adults whose intentions are to learn about trends and changes in order to understand better the new outlook of economic opportunities (Moberg, 2014). Socio-economic and techno-economic development influence curriculum in institutions of higher education (Tejedor, Segalàs and Rosas-Casals, 2018). STEM (Science, Technology, Engineering and Mathematics) are subjects that provide a basis for industrial revolution curriculum (Warhuus and Basaiawmoit, 2014). Science focuses on sustainable planet solutions and other experimental projects of realizing the betterment of life for all species (Faham *et al.*, 2017). Entrepreneurs have been catalysts for bringing solutions and inventions onto a launch-pad for a long time because of their traits, skills and understanding of gaps in markets (Premand *et al.*, 2016). STEM solutions and industrial revolution takes place with a contribution of entrepreneurs whose role is to transform inventions into products or services that people are prepared to pay for while making their lives better (Jensen, 2014). The entrepreneurship education pedagogy is based on a four levels structure; on level one a student is engaged in a supplied with information (supply), on the second level there is engagement and questioning (demand), on a third level there is both supply and demand (competence) and on the fourth level the teaching pedagogy is set up to be a hybrid model which combines all levels of the entrepreneurship teaching pedagogy (Ismail, Sawang and Zolin, 2018). The teaching and learning of entrepreneurship is vital to understanding economic opportunities and to finding ways to best explore them (Jensen, 2014). The conceptual framework of this study is presented below. It is anchored on Entrepreneurship education elements and those of industrial revolution as already described in this literature.

Figure 1 Theoretical Research Framework

Entrepreneurship education is less accessible to adult members of society especially those who never had an opportunity to study this subject before hence their lack of understanding for economic opportunity changes (Moberg, 2014). The outcomes of entrepreneurship education are entrepreneurial intention (willingness to start a new business), actual start of a business (start-up action) and growing a business (Walter and Block, 2016). The industrial revolution era and entrepreneurship education are also linked by the concept of social entrepreneurship which focuses on the caring aspects of doing any kind of business (Wu, Kuo and Shen, 2013). Hands-on activities such as community projects they promote acts of kindness and responsible business (Ruskovaara, Hämäläinen and Pihkala, 2016). Entrepreneurship is instrumental to delivering solutions and envisioning future solutions along-side the strides of industrial revolution (Ellen Frederick, 2016). Entrepreneurship education provides long term benefits for its recipients, community and industries by developing creative ideas as well as giving directions about market access needed by inventors (Kirkwood, Dwyer and Gray, 2014). The theory-of-expansive-learning and cultural-historical-activity theories guide the idea of this study by providing and understanding that new fields of study can be integrated into older fields of knowledge to create beneficial interdisciplinary education (Morselli, Costa and Margiotta, 2014).

3. Research Design

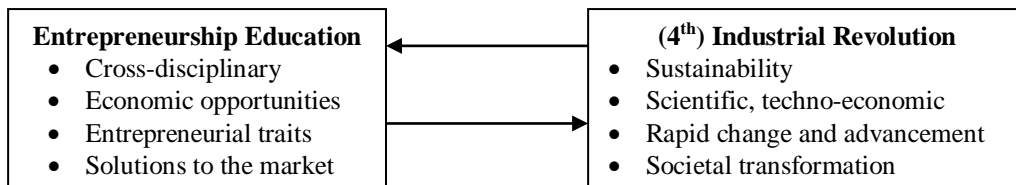
This research study follows an archival research study process. An archival research is a review of existing research studies within a certain period and based on specified criteria (Welman and Kruger, 2001). In this paper we use the archival study to explore an area of research which is fairly new and to develop underlying themes for further research about the implications of 4th industrial revolution on entrepreneurship education (EE).

Review of existing research

In this paper 50 journal articles are reviewed based on their relevance and detail they provide about the subject of 4th industrial revolution. These papers are split in two parts. The first 25 papers are on 4th Industrial revolution and its themes. The second batch is about entrepreneurship education and its dominant themes. These are tabulated to analyzing themes from the journal paper articles.

Criteria and Procedure

The research articles on the subject of the 4th industrial revolution are selected from high impact journal and also from key scholars in the field. The 4th industrial revolution drew attention from researchers in other fields other than



engineering from 2010 and to achieve the objectives of this research; research journal papers from 2010 to 2017 are considered on 4th industrial revolution as part of this review. On one hand the papers on entrepreneurship education are also sourced from a select set of journals and key scholars were considered. The field of entrepreneurship education is older than the new research on 4th Industrial Revolution; and has developed since early 2000s when the field of entrepreneurship received heightened amounts of attention. Journal papers from 2010 -2017 were reviewed in this research study about the implications of the 4th Industrial revolution on EE. Journal articles were sourced from online academic databases including Ebscohost, UJoogle and Mendeley and all articles underwent a quality

check to validate rigor and relevance to the criteria. The mentioned databases carried papers from SAGE, Elsevier and Emerald publisher journals.

Analysis and Quality Assurance

This is a guiding paper to further research into the implications of the 4th Industrial Revolution on entrepreneurship education and it is against this background that its analysis is to be of exceptional quality. The analyses of articles sourced for the purpose of this study are to be analysed based on archival research practices (Welman, Kruger and Mitchell, 2003). Themes, period of article and relevance are the standard bases for analysis. The quality assurance follows a step by step process which entails (1) sourcing relevant articles to both the subjects (4th industrial revolution and entrepreneurship education), (2) reviewing each of the articles, (3) qualifying or disqualifying article(s) as part of analysis (4) validating key information of the chosen (qualified) article and (5) tabulating the analysis based on all articles that passed the quality assurance of this research study.

Addressing the research problem investigated

This section explains how this chosen research design aims to address the research question of this study which is posed as a research problem being investigated. There are three ways in which this research design addresses its objectives and the problem under investigation. Firstly, quality validation is done to ensure that all papers selected are relevant and were published in the preferred or acceptable databases. Secondly, the timeframe selection ensures a broad coverage about the problem investigated to inform this paper’s findings and results. Finally, the use of tables, graphic representation and written analysis provides sufficient discussion about the papers focus on the 4th Industrial revolution and its implications on entrepreneurship education. It is based on these values that this paper can be considered reliable to provide ideas, findings and analysis about this subject for researchers, scholars, industry members and academics engaged in the multi-disciplinary subject of entrepreneurship.

4. Findings and Results

Entrepreneurship education dates back to 1945 when the first entrepreneurship programme was presented in Harvard Business School (Kuratko, 2005)(Nabi *et al.*, 2016). The increased attention for entrepreneurship as a subject in institutions of higher learning followed rapid industrial revolutions and the need to understand the people behind opportunity identification (Grada, 2016).

4.1. Entrepreneurship Education Focal Themes

The table below presents findings on the focal themes of entrepreneurship education. The ranking of themes based on this study’s review shows that (1) entrepreneurship is a cross disciplinary subject based on 18 of the authors; (2) entrepreneurship education focuses on development of entrepreneurial traits based on 15 of the articles; (3) the aim of entrepreneurship education (EE) is influencing entrepreneurial intention of recipients of EE based on 14 of the articles; (4) a total of 12 of the 25 studies found that entrepreneurship education helps the process of envisioning marketable solutions and finally (5) EE focuses on understanding and identification of viable opportunities according to 10 of the studies reported in the table below.

Table 1. Entrepreneurship Education Focal Themes

Themes Authors	Cross-Disciplinary Subject	Opportunity Identification	Entrepreneurial Traits Development	Marketable Solutions	Entrepreneurial Intention/Purpose
Marques et.al 2012			✓		✓
Premand et.al 2015		✓	✓		✓
Lin & Xu, 2016				✓	
Harhoff, Graevenitz & Weber, 2010		✓	✓	✓	✓
Oosterbeek, van Praag & Ijsselstein, 2010	✓				✓

Obschonka, Silbereisen & Rodermund, 2010	✓		✓		✓
Walter & Block, 2016	✓			✓	
Cacciotti et.al. 2016	✓		✓		✓
O'Connor, 2013	✓	✓		✓	
Fayolle, 2013	✓				
Walter & Dohse, 2013	✓		✓		✓
Lourenço, Jones & Jayawarna, 2012	✓			✓	
DeJaeghere & Baxter, 2014		✓		✓	✓
Fenton & Barry, 2011		✓	✓		✓
Allahar & Brathwaite, 2017	✓	✓	✓	✓	
Kakouris & Georgiadis, 2016	✓			✓	
Hoppe, 2015	✓				
Farny et.al. 2016	✓				
Johansen, 2014	✓		✓		
Pruett, 2012	✓	✓	✓		✓
Kazakeviciute, Urbote & Patraite, 2016	✓	✓	✓	✓	✓
Donnellon, Ollila & Middleton, 2014	✓	✓	✓	✓	✓
Kirkwood, Dwyer & Gray, 2014	✓		✓	✓	
Braun, 2012	✓		✓	✓	✓
Piperopoulos & Dimov, 2015		✓	✓		✓

4.2. Focal Themes on 4th Industrial Revolution

The 4th industrial revolution is also called Industry 4.0 (Morrar, Arman and Mousa, 2017). It is based on technological economical, societal transformation, rapid change, sustainability and application of data and artificial intelligence (Bauer *et al.*, 2015). The studies used in this analysis show that the driving priority of Industry 4.0 is (1) intelligence with 24/25 articles supporting this; (2) a total of 22 articles used in the analysis below support that Industry 4.0 is founded on the theme of technological and economic focus; (3) rapid change and advancement in manufacturing is the visible evidence of the influence that Industry 4.0 has on general factory operations in this paper this is supported by 18 articles studied as on the table below; (4) Industry 4.0, like the first industrial revolution (steam engine), mass production, Web 2.0 and 3.0, will have a massive impact on societal transformation as supported on this paper by 10 articles; (5) However, the reflection of sustainability in the thoughts and ideas about Industry 4.0 remains a concern with only 5 articles in the set used on this study focusing on sustainability. Developments and revolutionary industrial change has to embed sustainability practices and principles such as environmental, economic and social longevity (Gmelin and Seuring, 2014).

Table 2. Industry 4.0 Focal Themes

Themes Authors	Techo-economical	Societal Transformation (creative disruption)	Rapid Change and Advancement in Manufacturing	Embedment of Sustainability	Intelligence (IoT, Big Data, AI, Security, etc.)
Sung, 2017	✓		✓		✓
Agamuthu, 2017 (Editorial)	✓	✓		✓	✓
Müller <i>et.al.</i> , 2017	✓	✓	✓		✓
Roblek et.al. 2016	✓	✓			✓

Qin & Cheng, 2017	✓		✓		✓
Gotz & Jankowska, 2017	✓	✓	✓		✓
Scurati et.al. 2018	✓		✓		✓
Santos, 2017	✓		✓	✓	✓
Lu, 2017	✓				✓
Witkowski, 2017	✓		✓		✓
Omar, 2017			✓		✓
Zelzuka et.al. 2016	✓		✓		✓
Pereira & Romero, 2017	✓		✓		✓
Cohen et.al. 2017	✓				✓
Demartini & Benussi, 2017	✓	✓		✓	✓
Strange & Zucchella, 2017	✓		✓		✓
Chou et.al. 2017		✓			✓
Prause & Weigand, 2016			✓		✓
Sanders, Elangeswaran & Wulfsberg, 2016	✓		✓	✓	✓
Batista, Melicio & Mendes, 2017	✓	✓	✓	✓	✓
Ganzarain & Errasti, 2016	✓		✓		✓
Pfeipffer, 2016	✓	✓			✓
Sommer, 2015	✓		✓		
Fantini, Pinzone & Taisch, 2018	✓	✓	✓		✓
Müller, Kriel & Voigt, 2018	✓	✓	✓		✓

4.3. Implications of Industry 4.0 on Entrepreneurship Education

This paper provides insights on the implications of Industry 4.0 on Entrepreneurship education. Entrepreneurship is on top of global agendas about economic development and betterment of lives in emerging economies (Kirby, 2004). Considering Entrepreneurship Education and Industry 4.0 key themes as identified from 50 journal articles shown on the previous tables the following statements are developed as possible implications of Industry 4.0 on Entrepreneurship education.

- The design of the teaching and learning curriculum of the subject of entrepreneurship should be designed to enlighten students about the complex socio technological transformation issues.
- Student-recipients of entrepreneurship education will need to be rigorously taught about techno-economic opportunities to be able to develop competitive business ideas.
- In addition to the acceptable set of entrepreneurial traits there shall be a consideration of a new entrepreneurial trait referred to as “Technical ability”. This kind of a trait would address the knowledge of general use of technical resources in the entrepreneurship arena from computers to production technology awareness.
- Entrepreneurship education has to offer its recipients skills to apply intelligence when thinking and crafting business ideas or solutions.
- Sustainability practices are a fundamental emphasis that are not considered in Industry 4.0. However, the need for social, environmental and economically sustainable solutions is an essential consideration for Industry 4.0 and entrepreneurship needs to embed sustainability.

The table below presents a comparison and a direct contrast of EE and Industry 4.0 focal themes. These themes from EE and Industry 4.0 are used to describe the potential implications of Industry 4.0 on EE. These reflect the framework of this study as depicted on the literature review section.

Table 2. Entrepreneurship Education (EE) themes reflecting Industry 4.0 themes

Entrepreneurship Education Focal Themes (FT)	Industry 4.0 Focal Themes (FT)	Implications of Industry 4.0 on EE.
EE FT + Industry 4.0 FT = EE-Industry 4.0 FT		

Cross-Disciplinary Subject	Societal Transformation	Entrepreneurship that responds to complex socio-technological transformation issues
Opportunity Identification	Techno-Economical	Rigorous understanding of techno-economic opportunities
Development of Entrepreneurial Traits	Rapid Change and Advancement in Manufacturing	Entrepreneurial technical ability trait to deal with change and rapid advancement
Marketable Solutions	Intelligence (IoT, Big data, AI, Security etc.)	Application of intelligence techniques to device marketable solutions
Entrepreneurial Intention	Embedment of Sustainability	Consideration of the principles of sustainability when pursuing an entrepreneurial intent

The following sections present discussion, recommendations, conclusion and suggestions for future research. These sections provide further useful details on the implications of Industry 4.0 on EE.

5. Discussions and Recommendations

The development of industries depends on the competitiveness of role players and of those who envision the desired change (Liu and Grusky, 2013). The ability to understand and analyse tech opportunities is fundamental capability to be able to envision and act upon opportunities. Industry 4.0 opportunities are based on Artificial Intelligence technologies, Big Data, Internet-of-Things (IoT), Cyber-Physical-Systems (CPS) and security of all these. It is therefore important that industry practioners develop their own organisations to be able to cope with the rapid change and advancement in manufacturing, product distribution and sustainability practices. Industry 4.0 requires that the following be taken into consideration when developing EE curriculum in teaching and learning settings.

- Allocate curriculum time to hands-on training for students about technological advancements such as using databases, basic statistics and computer technologies.
- Cover content about sustainability with focus on ecological, social and economic aspects. This will help develop holistic entrepreneurs that care about society's wellbeing.
- Institutions that offer entrepreneurship programmes through teaching and learning may also invest resources to building an ecosystem that supports student's entrepreneurial intention by providing links to industry and incubators.

The impact of Industry 4.0 on EE is inevitable as entrepreneurs are regarded as catalysts of change and it is therefore important to develop skills to deal with the advancement posed by the new industry revolution.

6. Conclusion and Future Research

This research paper shares insights about the 4th Industrial Revolution which is upon the generations of this time (Xing and Marwala, 2017). In this conclusion it can be stated that Industry 4.0 has implications on Entrepreneurship Education. These implications include focusing on the nature of the techno-economic opportunities, developing EE that responds to intelligence and a curriculum that responds to understanding rapid change and advancements in manufacturing. These implications also propose a strong need for interdisciplinary approaches in the teaching of entrepreneurship as a subject. Our research design and protocol demonstrate the plan of this study's inquiry and it has guided the process of reviewing 50 articles on EE and Industry 4.0. Entrepreneurship Education can embrace Industry 4.0 when entrepreneurial ecosystems and industry collaborations are developed by institution providing this kind of education. Future research needs to address a specific area of this emerging topic. The area that requires further research is to study institutional readiness of business schools or university institutions in providing EE which addresses industry 4.0 implications.

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Biography

Michael S. Mkwanzani is a Research Associate in FEBE at the University of Johannesburg in South Africa. Mr. Mkwanzani holds a National Diploma in Entrepreneurship, Bachelor of Technology Degree in Operations Management, and Master of Technology Degree in Operations Management (Cum Laude) from the University of Johannesburg and a Postgraduate Diploma from North West University. In 2017 he was awarded the prestigious Rhodes scholarship to pursue an MSc Degree in Business Management – Entrepreneurship at Oxford Brookes University. He is also admitted to the University of Oxford to read for a DPhil. Education degree programme from October 2018 focusing on Entrepreneurship Education Ecosystems. In 2016 he was recognized as a runner up for the Queens Young Leaders Initiative which is managed by the Cambridge University Institute for Continuing Education. He has published some conference papers in the field of co-operatives and on system reliability under IEEM.

Charles Mbohwa Professor Charles Mbohwa is the Acting Executive Dean at University of Johannesburg’s (UJ) Faculty of Engineering and the Built Environment (FEBE). As an established researcher and professor in the field of sustainability engineering and energy, his specializations include sustainable engineering, energy systems, life cycle assessment and bio-energy/fuel feasibility and sustainability with general research interests in renewable energies and sustainability issues. Professor Mbohwa has presented at numerous conferences and published more than 150 papers in peer-reviewed journals and conferences, 6 book chapters and one book. Upon graduating with his B.Sc. Honors in Mechanical Engineering from the University of Zimbabwe in 1986, he was employed as a mechanical engineer by the National Railways of Zimbabwe. He holds a Masters in Operations Management and Manufacturing Systems from University of Nottingham and completed his doctoral studies at Tokyo Metropolitan Institute of Technology in Japan. Prof Mbohwa was a Fulbright Scholar visiting the Supply Chain and Logistics Institute at the School of Industrial and Systems Engineering, Georgia Institute of Technology is a fellow of the Zimbabwean Institution of Engineers and is a registered mechanical engineer with the Engineering Council of Zimbabwe. He has been a collaborator to the United Nations Environment Programme, and

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