Proceedings
Green & Digital Cities Conference 2019
Wroclaw, Poland

Wrocław University of Economics

Roger Williams University

icn business school ARTEM

The Global Interdisciplinary Conference
Green & Digital Cities
Business, Engineering, Art, Architecture,
Design, Political Science, & Technology
June 26 - 29, 2019, Wroclaw, Poland
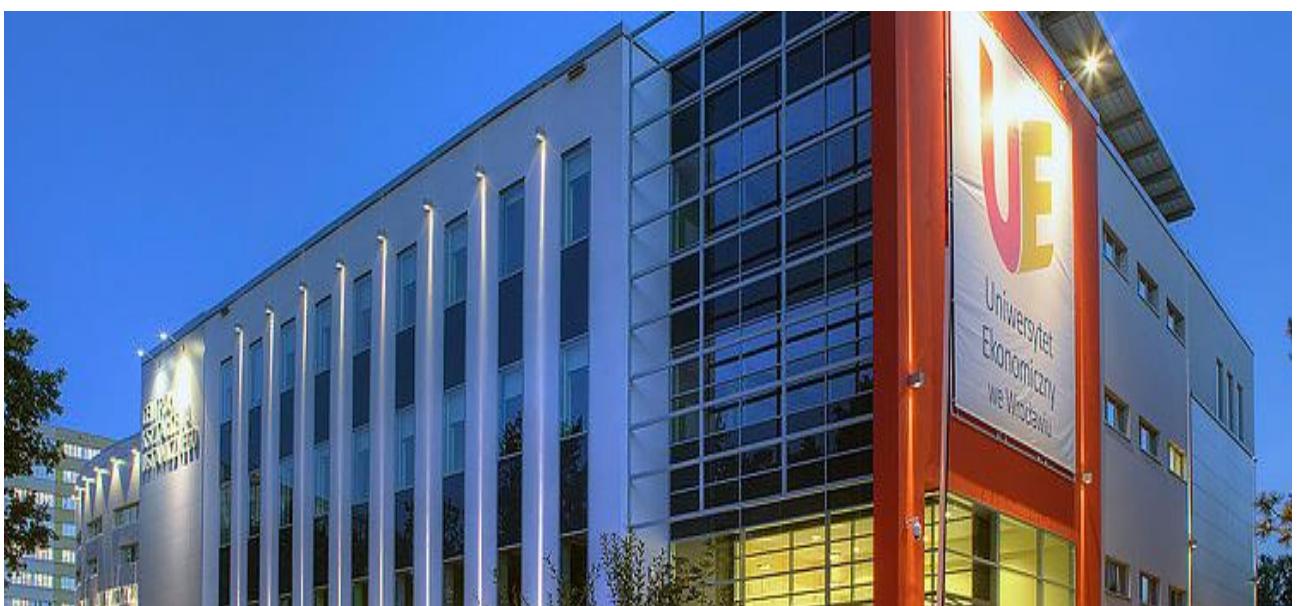
Wroclaw University of Economics

Table of Contents

Welcome Message from the Dean of the Faculty of Management, Computer Science & Finance

It is my great pleasure to welcome you all to The Global Interdisciplinary Conference Green & Digital Cities Business, Engineering, Art, Architecture, Design, Political Science, & Technology in Wroclaw, Poland!

Through our meeting in Wroclaw, we continue to improve our intellectual capital, whereas through networking, we continue to increase our social capital. The major goal of our conference is to provide engaging opportunities both for academics and practitioners to learn from each other. Our conference delivers a forum for building intense collaboration between generations of people with shared affinity for global interdisciplinary studies.

Our planning team along with all track-chairs have worked with tremendous energy and enthusiasm to ensure a great conference experience. My sincere thanks go to the Program Chairs, Dr. Minoo Tehrani, Dr. Nuon Guimarães da Costa, Dr. Laura Franco-Garcia, Dr. Natalia Szozda and Dr. Artur Swierczek, for their leadership and guidance throughout the program planning process.

Again, welcome to The Global Interdisciplinary Conference Green & Digital Cities Business, Engineering, Art, Architecture, Design, Political Science, & Technology! We look forward to seeing you in Wroclaw, Poland, and wish you an enjoyable and productive conference.

Prof. Ewa Stańczyk-Hugiet
Dean of the Faculty of Management, Computer Science & Finance
Wroclaw University of Economics, Poland

Roger Williams University

Welcome Message from Dr. Robert Cole, Acting Provost
Roger Williams University
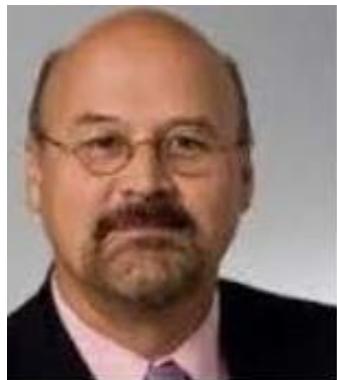
I believe you will agree that the array of research to be presented at The Global Interdisciplinary Conference Green & Digital Cities Business, Engineering, Art, Architecture, Design, Political Science, & Technology is indeed quite impressive.

The intellectual discourse promises to challenge all of us to leave thinking in fresh and refreshed ways about the natural and built worlds that we both inhabit and sustain. I wish to personally thank all the people who have put the conference together, and I hold in high esteem the focused efforts of the conference's scholars. Most of all, I am grateful for the audience without whom any scholarly endeavors would be meaningless, because it is only in the dialogue with each other that we come to know something.

Sincerely,
Dr. Robert Cole
Acting Provost
Roger Williams University

Green & Digital Cities Conference Program Chairs
Welcome to the Green & Digital Cities Conference
Wroclaw, Poland
June 26 - 29, 2019

Greetings to all:
We would like to take this opportunity and thank you for participating in the Green & Digital Cities Conference 2019, Wroclaw, Poland.

We are delighted to report that we have 82 authors of the accepted submissions representing 15 countries and 42 universities and organizations. In addition, our 39 tracks have 78 track chairs representing 11 countries across three continents.

With the diversity of countries, universities, organizations, and academic disciplines represented in this conference, we will have a fantastic opportunity to share our knowledge.

We look forward to meeting you and wish you a great time in Wroclaw.

Best,
Minoo, Natalia, Nuno, Artur, Laura

Green Cities Conference Program Committee

Dr. Stańczyk-Hugiet
Dean
Wroclaw University of Economics
Wroclaw

Dr. Workman
Interim President
Roger Williams Univ
USA

Dr. Carol Leary
President
Bay Path University
USA

Dr. Caprio
President
Western New England Univ
USA

Dr. Florence Legros
General Director
ICN Business School
France

Mr. Jean-Pol Mura
CEO, Saudi Arabia Mobility Division
Siemens Ltd

Dr. Charles Manz
Chaired Prof of Leadership Isenberg School of Mgt University of Massachusetts
USA

Dr. Arthur Chen
 Dean
College of Management National Yunlin Univ of Science & Tech
Taiwan

Dr. Maling Ebrahimpour
Dean, College of Bus Admin
University of Rhode Island
USA

Green Cities Conference Organizing Committee

 Dr. Marek Wąsowicz
Vice-Dean, Strategy & Dev
Wroclaw Univ of Economics
Poland

Dr. Robert Cole
Acting Provost
Roger Williams Univ
USA

Prof. Alan Cutting
Web Design
Roger Williams Univ
USA

Dr. Surendra Gupta
Director of Lab- Manfg
College of Mech & Industrial Engineering
Northeastern University
USA

Dr. Guy Deloffre
Director, MSC Intl Bus Dev
ICN Business School
France

Dr. H. Cheraghi
Dean, College of Eng
Western New England Univ
USA

Mme. Estelle Durand
Head of Research Activities
ICN Business School
France

Dr. John McIntyre
Exec. Director, GT CIBER
Georgia Tech University
USA

Dr. Eldon Li
University Chair Professor
National Chengchi University
Taiwan

Dr. Shahid Al Baluchi
Sultan Qaboos University
Oman

Dr. Tetsuo Yamada
The University of Electro-Communications
Japan

Green & Digital Cities 2019 Conference Track Chairs

Accounting

May Lo……………………………………..…….…Western New England University

Cristiane Benetti………………………………………….………....**.**ICN Business School

Asian Studies

Arthur Cheng-Hsui Chen………....…National Yunlin University of Science & Technology

Yuh-Yuan Tsai………………………………..……..….…National Dong Hwa University

Behavioral Operations Management

Mohsen Ahmadian…………………….…..………..University of Massachusetts - Boston

Beata Skowron-Grabowska……………..…..…… Czestochowa University of Technology

Big Data & Business Intelligence

Manouch Tabatabaei……………………….………...…....Georgia Southern University

Krzysztof Kania ………………….…….…..…..… University of Economics - Katowice

Branding & Luxury Management

Maxime Koromyslov………………………….…….………..ICN Business School

Miao Zhao…………………………………….……..Roger Williams University

Business Law, Ethics, & Corporate Social Responsibility

Ben Franta…………………………….………….………….……… Stanford University

Thomas Langdon………………….……………....…..Roger Williams University

Case Studies

Kula Maria ………………………………….………..Roger Williams University

Betty Woodman………………………….......……..……University of New Hampshire

Corporate Communication

Amiee Shelton……………….………….…………………Roger Williams University

Patricia Tehami……………….…………………………..University of Strasbourg

Design & Smart Buildings

Patrick Charles……………………………...……….…Roger Williams University

Uwe W. Schulz…………..………….……Lucerne University of Applied Science & Arts

e-Commerce

Carol Lee……………………………………… University of Massachusetts - Boston

Suhong Li……………………………..……….…………...Bryant University

Economics

Luis Rivera-Solis…………………………..….………...Capella University

Patrick Dümmler……………………………….………………………Avenir Suisse

Energy

Don Jankins………...……………………….... University of Massachusetts - Boston

Adrian Altenburger…………………..…Lucerne University of Applied Science & Arts

Entrepreneurship
Jean-Claude Tagger …………………………………..…..…..Skema Business School
Stanislas Eyrames………………………………….....................ICN Business School

Finance & Financial Management
John Malindretos……………………………….....………..William Paterson University
T. Homer Bonitsis…………………..……………....New Jersey Institute of Technology

Financial Engineering
Mark Wu……………………….……………………...………Roger Williams University
Emily Xu…………………………………………………...…University of New Hampshire

Health Care Management
Lawrence Fulton…………………………………………...…………….Texas State University
Kostas Nikolopoulos.……………………….…………....………Bangor University

Healthy Cities & Suburbs
Suzanne Lanyi Charles.……………………………….....……….Cornell University
Gary Graham…….……………………………….....…..Roger Williams University

Hospitality Management & Tourism
Tung-Shan Liao…………………………………..….…….….…Yuan Ze University
Katarzyna Czernek-Marszalek……………….…..…. University of Economics - Katowice

Human Resource Management
Krista Finstad-Milion……………………….………………….…..ICN Business School
Brendan D. Bannister………………………………..………...Northeastern University

Innovative Education
Susan Bosco……….…………………………………...Roger Williams University
John Weber…….…………………………………………....………DeVry University

Information Technology & Enterprise Security
Doug White……….…………………………….....…………Roger Williams University
Issa Ramaji…….…..…………………………………… Roger Williams University

International Business
Gayatree Siddhanta.…………………………………….…………...Linfield College
Martins Priede…………………………….………...….……Estonia Business School

Knowledge Management
Jann Hidajat.……………………………….....................Bandung Institute of Technology
Shouhong Wang.………………….……………….…University of Massachusetts-Dartmouth

MS/OR: Techniques, Models & Applications
Russell Beauchemin.…………..Roger William University
Carolyn LaMacchia.…………………………………….……Bloomsburg University

Green & Digital Cities 2019 Conference Track Chairs (Cont'd)

Manufacturing Management
Aya Ishigaki…………………………………………......Tokyo University of Science
Jiahua Weng………………………………………….…...…….Waseda University

Marketing: Theory, Application & Practice
Maciej Mitrega …………………………………….... University of Economics - Katowice
Gilles Nakhle……………………………………...…….……....INSEEC Business School

Negotiation
Elizabeth Volpe…………………………………….…….…..Roger Williams University
Guy Deloffre……………………………….…….………....ICN Business School

New Product Development & Project Management
Andreas Rathgeber…………………………………………….…… Universität Augsburg
Irem Ozkarahan……………………………….…….……..........…..Fordham University

Organization Behavior & Leadership
Deseré Kokt………………………………….…......Central University of Technology
Alexander Knights…………………………...…….…..……….Roger Williams University

Political Science/International Relations
June Speakman……………………………….…….…......Roger Williams University
Joseph Roberts……………………………….…….…...…….Roger Williams University

Quality & Productivity
Natalia Szozda………………………………….…..... University of Economics - Wrocław
Artur Swierczek……………………………….…....University of Economics - Katowice

Service Management
Mahour Mellat-Parast……………………….…...…….... North Carolina AT&T University
Silvester Ivanaj………………….………………….…..……….. ICN Business School

Social Media
Sharmin Attaran…………………………………….…….……...……….Bryant University
Robin Saunders………………………………….…….…...…….…Bay Path University

Sport & Entertainment Management
Xiangrong Liu……………………………...……….……..……Bridgewater State University
Theo Stengelhofen……………………………...……………ICN Business School

Statistics & Business Analysis
Josephine Namayanja……………………………. University of Massachusetts-Boston
Fatemeh Poromran……………………….……………..…….…..Northeastern University

Strategy
Tamym Abdessemed…………………………………...…......ICN Business School
Robert Fiore………………………….……….…….…...…….......…….Springfield College

Green & Digital Cities 2019 Conference Track Chairs (Cont'd)

Supply Chain Management

Hossein Safizadeh……………………………………………….… Boston College

Yu Cui……………………………………………………….Otemon Gakuin University

Sustainability

Bilge Çelik…………………………………………...……Roger Williams University

Amine Ghanem…………………………………………....Roger Williams University

Transportation

Ellie Fini……………………………………………...…...……Arizona State University

Joseph Sarkis……………………………………….....Worcester Polytechnic Institute

Green & Digital Cities Conference Best Paper Award Winners

Best Paper Award in Contribution to Theory

The Impact of Financial Speculation on Commodity Prices: A Meta-Granger Analysis
Andreas Rathgeber, Universität Augsburg
Jerome Geyer-Klingeberg, Universität Augsburg
Marie Hütter, Universität Augsburg
Florian Schmid, Universität Augsburg
Thomas, Wimmer, Universität Augsburg

Best Paper Award in Application of Theory

A Multi-attribute Utility Decision Support System for Strategic Sustainable Energy Purchases
Donald Jenkins, University of Massachusetts – Boston
Jeffrey Keisler, University of Massachusetts – Boston

Statue called Professor, City Center, Worlcaw, Poland

Green & Digital Cities Conference Best Presentation Award Winners

Best Presentation Award Winner, Ph.D. Student Categoy

A Multi-attribute Utility Decision Support System for Strategic Sustainable Energy Purchases
Donald Jenkins, University of Massachusetts – Boston
Faculty Supervisor: Jeffrey Keisler, University of Massachusetts – Boston

Best Presentation Award Winners, Undergraduate Student Categoy

New NAFTA, USMCA: Anything Green?
Dari Tavekelian, Roger Williams University
Faculty Supervisor: Minoo Tehrani, Roger Williams University

&

Paris Accord: Goals & Objectives
Yasmin Hernandez, Roger Williams University
Faculty Supervisor: Minoo Tehrani, Roger Williams University

Sponsors

 Roger Williams University

 Wroclaw University of Economics

 ICN Business School
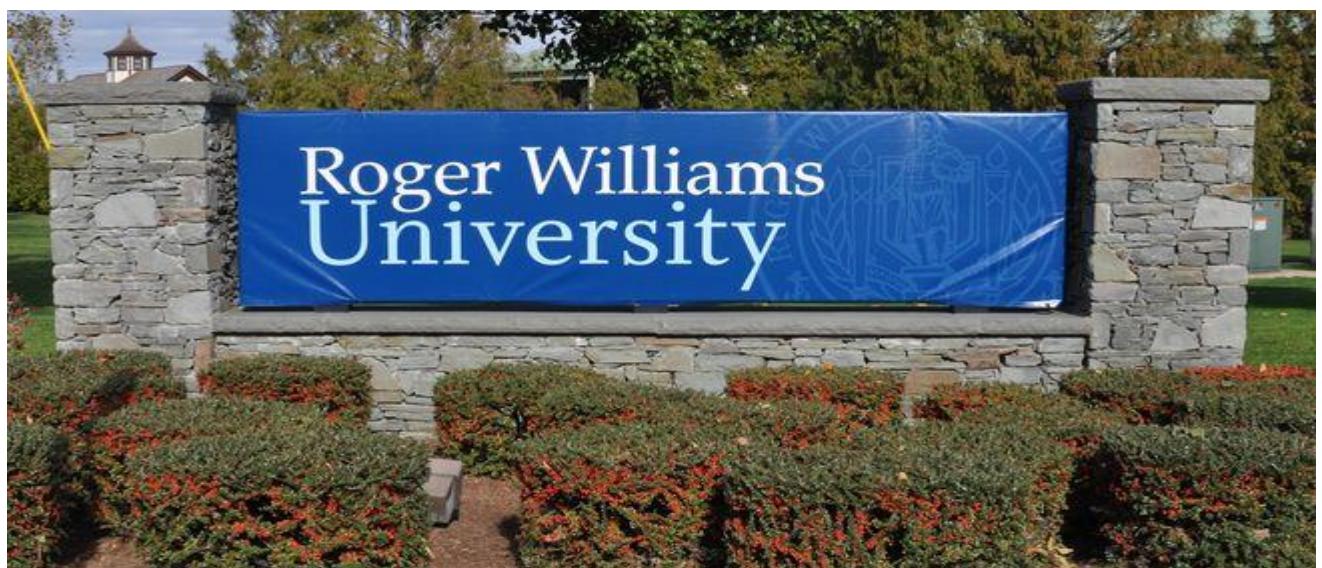
Reviewers

Ahmadian, Mohsen…………………………………………...……University of Massachusetts-Boston

Charles, Patrick……………………………………………….. Roger Williams University

Cui, Yu…………………………………………………..……..Otemon Gakuin University

Fini, Ellie……………………………………………………………Arizona State University

Fulton, Lawrence……………………………………………….....Texas Tech University

Ghanem, Amine…………………………………………………...Roger Williams University

Jenkins, Donald………………………………………………… University of Massachusetts-Boston

Knights, Alexander………………………………………...……….. Roger Williams University

Kula, Maria………………………………………………………… Roger Williams University

LaMacchia, Carolyn…………………………...….………….…………Bloomsburg University

Lee, Carol………………………………………………………. University of Massachusetts-Boston

Lo, May……………………………………………………........Western New England University

Mackey, Scott……………………………………...…………………………….. Roger Williams University

Matos, Geraldo……………………………………………...…. Roger Williams University

Ozkarahan, Irem……………………………………………...………..Fordham University

Rivera-Solis, Luis…..………………………………………….…………..Capella University

Roberts, Joseph………………………………………….…...……… Roger Williams University

Safizadeh, Hossein.…………………………………….……...………...Boston College

Sarkis, Joseph………………………………………………...…...Worcester Polytechnic Institute

Siddhanta, Gayatree…………………………………………….……………Linfield College

Swierczek, Artur…………………………………………………University of Economics-Katowice

Szozda, Natalia……………………………………………....Wroclaw University of Economics

Tabatabaei, Manuch…………………………………...…………….....……Georgia Southern University

Tehrani, Minoo…………………………………………………….…..Roger Williams University

Wang, Shouhong…………………………………..…...…………University of Massachusetts – Dartmouth

Weber, John…………………………………………………………DeVry University

Zhao, Miao…………………………………………………….…………… Roger Williams University

Alphabetic Index of Authors

Alphabetic Index of Authors & Session Chairs (Cont'd)

Alphabetic Index of Authors & Session Chairs (Cont'd)

Alphabetic Index of Papers and Special Session Titles

Alphabetic Index of Papers and Special Session Titles (Cont'd)

The Impact of Financial Speculation on Commodity Prices:

A Meta-Granger Analysis[*]

(Best Paper Award in Contribution to Theory)

Jerome Geyer-Klingeberg[a], Marie Hütter [a], Andreas Rathgeber[a], Florian Schmid[a], Thomas Wimmer [~a]

[a] Professorship for Finance, Information & Resource Management, Institute of Materials Resource Management, University of Augsburg, 86135 Augsburg, Germany, ~Correspondence:thomas.wimmer@mrm.uni-augsburg.de, Phone: +49 821 598 – 3058

Address: Universitätsstr. 2, 86135 Augsburg, Prof. Rathgeber, MRM

Abstract

We analyze 3,183 estimates from Granger causality tests on the impact of financial speculation on commodity markets obtained from 67 prior studies. Our results reveal that there is no aggregated price effect of speculation across the literature as a whole. However, when breaking down the effect by certain aspects of data and study design, speculation might have a price distorting effect. Moreover, our meta- regression shows that the heterogeneity in the speculation effect can be largely explained by the commodity type under examination, the source of speculation data, the measurement of speculation, the publication status of a paper, as well as the affiliation of the authors. These findings help to disentangle the previous contradictions in empirical results and provide an aggregated picture of the literature.

Keywords: speculation, commodity prices, non-commercial trader, meta-analysis

JEL Classifications: G13, Q02, C58, C83

This version: February 2019

---

1. Introduction

The market environment of commodities trading has undergone substantial changes over the last decades. Often termed as "financialization of commodity markets," commodities have become an increasingly attractive asset class for investors. In this regard, financial speculation, amplified by the emerging popularity of index related financial products, is associated with increased trading activity in commodity futures markets (Tang and Xiong 2012). The surging commodity prices and volatilities, especially in the 2000s, have been frequently attributed to this increased speculative activity, sparking a still ongoing public debate (e.g., Masters and White 2009, U.S. Senate 2009, Bode 2011, Greely and Currie 2008).

From a theoretical perspective, the influence of speculation on commodity prices can be analyzed via three potential channels (Cheng and Xiong 2014). (i) According to the theory of storage (Kaldor 1976; Working 1948, 1949), spot and futures prices are directly linked via an arbitrage process. This channel contains an impact on spot prices since the higher level of demand for commodities increases the futures prices and subsequently the convenience yield increases and the implied volatility declines.

(ii) According to Keynes (1923) or Hicks (1939), risk sharing leads to hedging pressure for commodity producers or long position traders. In this channel, spot and futures prices are directly linked via balanced long and short positions (Keynes 1930; Blau 1944). If this deviates from the equilibrium, the spot price can rise or fall dependent on which a trader gets an overweight. (iii) Following information discovery, futures prices react faster on new market information. This can be seen as a trend factor for spot prices (Grossman and Stiglitz 1980; Hellwig 1980). Therefore, informed traders can speed up the pricing process. This also includes a volatility increase (Harris 1989).

Similar to the public debate and academic theory, also empirical literature is ambiguous about the effect of speculation on commodity prices. Despite an extensive literature base, there still is considerable controversy surrounding the causal relationship between non-commercial trading and commodity prices. One strand of empirical analysis finds limited or no evidence for a causal

relation (among others, Brunetti et al. 2011; Büyükşahin and Harris 2011; Dimpfl et al. 2017). Other authors conclude that speculators cause commodity prices to deviate from their market fundamentals (among others, Bohl et al. 2018; Pradkhan 2017, Huchet and Fam 2016, Mayer 2012). In addition, the third branch of academic research reports rather balanced evidence for either side (among others, Sanders et al. 2004, Alquist and Gervais 2013; Mayer et al. 2017, Fujihara and Mougou 1997, Ciner 2002; Peri et al. 2013; Babalos and Balcilar 2017). Besides mixed empirical results, previous findings vary in terms of their study design, especially sample composition, the configuration of empirical testing, and diverging notions on the concepts of the influencing parameter (financial speculation) and the response variable (commodity market behavior). Thus, it is challenging to directly compare previous evidence without accounting for this heterogeneity.

Previous literature already contains several review articles using narrative approaches or vote count procedures to aggregate the inconclusive results of the research body. Boyd et al. (2018), Grosche (2012), Shutes and Meijerink (2012), and Will et al. (2013) conduct qualitative literature reviews on research articles on commodity index speculation, whereas the last two papers explicitly focus on agricultural commodities. As an overall result, these reviews document inconclusive evidence for speculation to raise commodity prices or amplify its volatility in the mid-term to long-term. Indeed, Shutes and Meijerink (2012) observe an increase in short-term price volatility and Grosche (2012) detects that causal effects most often appear within a one day time lag. The paper closest to this study is Haase et al. (2016), who apply a vote counting approach to summarize the distribution and apparent disagreement among 100 studies on the effects of financial speculation. They use an integer scale from -2 to 2, dependent on direction and strength of the impact of speculation on commodity markets, to categorize previous empirical findings. Furthermore, they apply this categorization to subgroups of results, based on the examined speculation measure, economic response variable, and paper quality as well as the commodity type within food commodities. The authors find that within their total sample of 100 studies, and

evidence is equally distributed among weakening effects (-2 and -1), no impact (0), and reinforcing effects (+1 and +2).[1] For specific subsamples, the authors report clearer results, such as for the use of direct speculation measures where weakening effects dominate.

Within this meta-analysis, we extend previous reviews by aggregating 3,183 reported estimates from Granger causality tests for the relation between speculation and commodity markets reported in 67 studies. By collecting and aggregating data from previously published studies, meta-analysis provides a powerful method to improve our understanding of why reported study results are so diverse. This approach extends previous reviews in the field (Boyd et al. 2018.; Grosche 2012; Haase et al. 2016; Shutes and Meijerink 2012; Will et al. 2013) and contributes to the literature in several ways: (i) We provide a statistical integration of the accumulated research and explore whether the literature as a whole or certain subgroups show an impact of speculation on commodities. (ii) We apply the meta-regression model for Granger causality testing by Bruns and Stern (2018) to investigate the presence and impact of publication selection bias and overfitting via lag selection in primary studies. (iii) Within this regression model, we explicitly test the joint impact of various aspects of study design, such as the analyzed commodity type, measurement differences, and methodological characteristics of the primary study models. The findings of this meta-study may have implications for policy makers and related organizations to figure out under which conditions speculation really impacts commodity markets.

The remainder of the article is structured as follows: Section 2 describes the construction of the meta- dataset. Section 3 presents the methodology of meta-regression analysis. Section 4 explains the sources of heterogeneity among primary study results. Section 5 presents and discusses the empirical findings. Section 6 concludes.

---

[1] A further group contains papers where the impact direction could not be determined.

2. Literature Search and Data Construction

The literature search process and the subsequent meta-analysis are in line with the reporting guidelines for meta-regression research by Stanley et al. (2013). To find the sample of relevant studies, a systematic database search[2], a forward search with Google Scholar's cited-by-option, as well as a backward search of the reference lists of all previously identified studies was conducted. The search strategy is based on relevant keywords and frequent synonyms for 'speculation' and 'commodity markets.'

To construct a homogenous set of primary research articles, we use three predefined selection criteria: (i) A study reports results for Granger causality tests between a measure of financial speculation and a measure of commodity prices. Granger testing was found to be the most prevalent empirical method among the research on this topic and ensures the comparability of collected statistics. (ii) Since our study is an empirical investigation on the speculation-price-nexus, it was further required that the associated F-statistics, X^2-statistics, and/or p-values from the causality tests are reported in the study.

(iii) The number of lags used for the Granger causality testing must be available from the study. This information is required to analyze the impact of overfitting on the reported Granger results, which is discussed in detail in Section 3. If no lag orders or empirical test statistics were provided within a relevant primary study, we requested the missing information from the study authors. Filtering the results from the literature search against the selection criteria, left us with a total of 67 studies. The full list of studies is available in Appendix A.

From the sample of studies, we manually extract the Granger test results in the form of p-values and the respective test statistics (F or X^2). If possible, missing values are re-calculated from the other reported statistics. As studies usually report multiple results, e.g., for different commodities, lags, or method choices, we collect all reported findings. In this regard, we follow established practice in meta-regression analysis (among others, Feld et al. 2013; Kysucky and Norden 2015, Rusnak et al. 2013). This procedure maximizes the amount of retained information,

avoids subjectively selecting individual estimates, and retains the natural variability within primary studies occurring from differences in model design and subsample selection. In the subsequent meta-regression models, we explicitly account for the within- study dependencies arising from multiple estimates collected from the same article.

3. Methodology

Meta-regression analysis is a form of meta-analysis designed to analyze empirical research in economics and business (Stanley 2001; Stanley 2007). It covers statistical methods to condense information from a sample of studies and is capable of providing insights into why empirical outcomes vary or even contradict on a certain phenomenon. Studies in economics and business research typically exhibit large variation in terms of the analyzed time periods, sample composition, applied methods, and model specification. This heterogeneity creates demand for reviews examining the sources of this variation among the reported results for a specific relation and identifying the central tendency of the literature. Unlike narrative reviews, meta-analysis allows testing for such potential moderating effects across papers, to reconcile conflicting evidence, and to draw the big picture of piecemeal findings. In general terms, meta-regression analysis uses effect sizes collected from primary studies as the dependent variable and regresses them against a set of study-level moderators to encode the drivers of heterogeneity.

As mentioned before, we identified Granger causality testing (Granger 1969) as the most common empirical method among the research on the price impact of the speculative activity. According to this approach, financial speculation Granger-causes commodity prices when past information on speculation improves the prediction of prices compared to a prediction solely based on past information on prices. Originally, the test employs an autoregressive distributed lag (ADL) model:

$$y_t = \phi + \sum_{j=1}^{p} \lambda_i y_{t-j} + \sum_{k=1}^{q} \theta_k x_{t-k} + \varepsilon_t$$

---

[2] We searched in ABI/Inform Complete, EconLit, Google Scholar, ScienceDirect, and the Social Science Research Network.

where in our context y_t refers to the commodity price, x_t refers to speculative activity and (p, q) refers to the applied lag structure. The relevant test statistic is an F or χ^2-test with $H_0: \theta_k = 0$ $\forall k \in (1, \ldots, q)$, testing for granger non-causality. If the null hypothesis can be rejected, speculative activity is said to Granger-cause commodity prices. Owed to the nature of Granger causality that focuses on the presence of an effect instead of its size or direction, we treat p-values from F or χ^2-tests reported in prior studies as effect sizes in our meta-regression analysis. However, reported tests might be subject to so called p-hacking, i.e. primary studies might (consciously or unconsciously) only present a subset of estimated model specifications that deliver a p-value of F or χ^2-tests below the common threshold levels of statistical significance. Consequently, a potentially substantial number of model specifications might remain unreported (Simonsohn et al. 2014), resulting in publication bias and uncertainty about genuine effects. In the context of Granger causality testing, p-hacking might be especially based on sampling errors and overfitting (Bruns and Stern 2018). The former arises e.g. from varying periods under investigation until a p-value below a certain level of statistical significance is detected (Bruns 2017). Similarly, the latter might arise by increasing the lag length of speculative activity, potentially leading to reported false positive findings, most notably in small samples. Bruns and Stern (2018) developed a meta-regression model that tests for genuine Granger causality by controlling for p-hacking based on sampling errors and overfitting. Since the larger body of the existing literature on price effects of speculation activity reports the absence of effects, suggesting that this is a widely accepted finding for publication, we test for p-hacking in both directions. Hence, we do not only investigate potential bias in significant, but also in non-significant test results. In our meta-regression model we extend the model by Bruns and Stern (2018) by additionally testing for the genuine lack of Granger causality besides testing for genuine Granger causality:

$$\tilde{p}_i = \alpha + \beta_1 \sqrt{df}_i \cdot I_{p \geq 0.05} + \beta_2 \sqrt{df}_i \cdot I_{p < 0.05} + \gamma_1 lags\_y_i + \gamma_2 lags\_x_i + \varepsilon_i \qquad \text{Eq. (1)}$$

$$\text{with } \tilde{p} = \Phi^{-1}[p_i]$$

where we use the inverse cumulative distribution function of the standard normal distribution, Φ^{-1}, to convert p-values p_i from Granger causality tests i reported in prior studies to probit-

transformed p- values $\tilde{p}$. Degrees of freedom, df_i, are split up into two terms, referring to test results denying Granger causality $(p_i \geq 0.05)$ and asserting Granger causality $(p_i < 0.05)$ from speculative activity to commodity prices. As Bruns and Stern (2018) demonstrate, in the case of reported p-values less than 0.05, p-values decrease with an increase in the degrees of freedom $(\beta_2 < 0)$ in the presence of genuine Granger causality. However, if prior studies report significant Granger causality while there is no genuine effect, p-values should be unrelated to df_i or even increase as df_i increases $(\beta_2 \geq 0)$. As selective publication of model specifications might not only lead to biased false positive findings we additionally try to test for false negatives by investigating the relationship between p-values larger than 0.05 and the degrees of freedom in the corresponding model specifications. In the case of a genuine lack of granger causality, p-values should be uniformly distributed between 0.05 and 1, independent of df_i, leading to $\beta_1 = 0$. In contrast, if non-significant test results are biased due to false negatives, we expect $\beta_1 \neq 0$. Additionally, we include lag lengths of primary models to control for overfitting. Especially in small samples, overfitting might even occur if information criteria are used (Bruns and Stern 2018). If lags of speculative activity, $lags_{x_i}$, are overfitted, test results might over-reject the null of no Granger causality. Analogously, overfitted lags of the commodity price variable, $lags_{y_i}$, might lead to less significant findings of Granger causality from speculative activity to prices, potentially leading to false negatives. So far, we investigate the genuineness of speculation effects or of the lack thereof by testing the presence of p-hacking in primary studies. Using this approach as a base model to control for publication bias, we extend equation (1) by including moderating variables that potentially drive the apparent variety in primary test results, resulting in an extended meta-regression model:

$$\tilde{p}_i = \alpha + \beta_1 \sqrt{\overline{df_i}} + \beta_2 \sqrt{\overline{df_i}} \cdot I_{p<0.05} + \gamma_1 lags\_y_i + \gamma_2 lags\_x_i + \sum_{l=1}^{L} \delta_l Z_{l,i} + \varepsilon_i \qquad \text{Eq. (2)}$$

where $Z_{l,i}$ is the variable referring to moderator l of Granger causality test i. In the following chapter, we present details about primary tests' characteristics that we modelled through

moderating variables $Z_{l,i}$.

4. Sources of Heterogeneity

Eq. (2) incorporates variates to control for the sources of heterogeneity which we identified to determine the differences among the primary studies and subsequently potentially influence the empirical results at the primary study level. To adequately account for this variation, we use explanatory variables as presented in Table 1.

Table 1. Description and summary statistics of primary Granger causality tests' characteristics

Variable	Description	Mean	Std. Dev.
Sample and data characteristics			
Average time	Average of start and end year of sample data	2004.47	4.73
Degrees of freedom	Square root of the difference between sample size and no. of included covariates	21.83	32.09
Commodity class			
Industrial metal	= 1 if industrial metals are examined	0.05	0.22
Precious metal	= 1 if precious metals are examined	0.18	0.38
Energy	= 1 if energy commodities are examined	0.12	0.33
Agricultural and other*	= 1 if agriculturals only or commodity mixes incl. agriculturals are examined	0.65	0.48
Granger causality test			
# lags X	Number of lagged values of independent variable	3.21	5.00
# lags Y	Number of lagged values of the dependent variable	3.13	3.10
Modified Granger	= 1 if a modification of granger causality testing is used	0.14	0.35
Traditional Granger*	= 1 if traditional granger causality testing is used	0.86	0.35
Measurement of the response variable			
Price*	= 1 if the effect of speculation on commodity prices is examined	0.58	0.49
Volatility	= 1 if the effect of speculation on commodity price volatility is examined	0.40	0.49
Other focus variable	= 1 if the effect of speculation on price spreads or spillover is examined	0.02	0.13
Nearby futures	= 1 if nearby futures contracts are examined	0.32	0.47
Other futures	= 1 if any other futures contracts are examined	0.10	0.30
Spot price*	= 1 if spot prices are examined	0.58	0.49
Logs	= 1 if the focus variable in logarithms is examined	0.48	0.50
Levels*	= 1 if the focus variable is examined in levels	0.52	0.50
First differences	= 1 if the focus variable is examined in first differences	0.48	0.50
Speculative activity			
Relative	= 1 if the speculative measure is scaled by another dimension	0.14	0.35
Flow	= 1 if the change in speculative activity is examined	0.27	0.44
Absolute*	= 1 if the level of speculative activity is examined	0.59	0.49
Report and hedge fund data	= 1 if speculative measures are constructed with CFTC data or data provided by hedge funds, 0 otherwise	0.55	0.50
Publication characteristics			
Published	= 1 if the paper appeared in a peer-reviewed journal, 0 otherwise	0.51	0.50
High impact	= 1 if the Scimago journal rank of the publication outlet ≥ 1, 0 otherwise	0.12	0.32
No. of citations per year	Number of average Google Scholar citations per year (as of July 2018)	1.70	1.29
Author affiliation			
NGO/IGO	= 1 if one (co)-author is affiliated to a non- or inter-governmental organization	0.39	0.49
Corporate	= 1 if one (co)-author is affiliated at a commercial corporation	0.06	0.23
Academia*	= 1 if all authors hold an academic position	0.56	0.50

Notes: This table presents the definition and summary statistics of the variables measuring data-related and methodological heterogeneity across studies. All variables are manually collected from primary studies. (*) marks the omitted base category in the meta-regression analysis.

Sample and data characteristics. We include the average of the start and end year of the period under investigation in primary Granger causality tests as moderator to capture time effects. Those might arise as the effect of speculation might change over time or only be present in certain periods. Especially since the early 2000s, financialization lead to a change in commodity markets (Tang and Xiong 2012), possibly also having an influence on the presence of speculation effects. Furthermore we control for the degrees of freedom, as illustrated in section 3.

Commodity classes. Data on 46 commodities is collected and grouped into one of the four categories: industrial metals, precious metals, energy or agricultural commodities. Granger causality tests that analyze a basket of commodities at once, all happen to include agricultural commodities, are assigned to one dummy variable 'Agriculturals and others'.

Granger causality test. While traditional Granger tests establish causality in the mean, modified versions of the test are e.g. able to detect causality in the quantiles or in higher moments of the response variable (Bell et al. 1996). Such non-linear or non-parametric types might produce test results that may differ from that of traditional tests. We account for this variation by incorporating a binary variate that is 1 for traditional Granger causality tests and 0 otherwise. Further controls regard the number of lags as outlined in section 3 as well as the method according to which lag orders were determined. High lag orders deplete the degrees of freedom and favour spurious findings of causality (Bruns and Stern 2015, 2018). While the use of information criteria is more accurate than an arbitrary selection, certain criteria can still lead to overfitting bias and thus facilitate false positive findings (Bruns and Stern 2018).

Measurement of the response variable. Primary tests greatly differ in various dimensions regarding the dependent variable that captures the commodity price. We implemented a set of dummy variables trying to disentangle speculation effects on various forms of commodity prices, e.g. price returns or price volatilities. Most primary studies investigate spot prices while others focus on futures markets that are more directly subject to speculation, potentially resulting in more

significant findings. Furthermore, results might be influenced whether response variables enter Granger causality tests in logs and/or levels or first differences.

Definition and measurement of speculation activity. Heterogeneous empirical findings might stem from dissimilar concepts of financial speculation and different notions as to which types of traders count as non-commercial. We add a dummy variable that is one if official data issued by the CFTC or proprietary hedge fund data is used for constructing the speculation proxies. Hedge fund data used in primary studies and CFTC data work towards distinguishing commercials from non-commercial traders and, additionally, allow to analyze possible price effects for different subgroups of non-commercials. Further controls account for the trading position (short, long, net-long) which are analyzed for the specified group at the primary study level. This exposes in more detail what trading behaviour is associated with price effects. In our view, using position and trader type-specific data permits to generate more reliable empirical results than other proxies, such as trading volume or the futures price level. Those latter proxies are not able to distinguish between types of traders and trading positions and produce results that might be biased by price effects of commercial traders. Furthermore, primary studies differ regarding the measurement of the proxy for speculative activity that enters the Granger causality test. Therefore, we introduce dummies, since level variables should exhibit more vulnerability to spurious findings compared to first differenced or rescaled variables.

Author affiliation. The professional background might presumptively have an influence on the research outcome selected for publication. The process of selecting moderators, designing the study as well as the weighting and reporting of results is not immune to bias (even unconsciously) arising from an institutional affiliation or financial assistance and therefore controlled for (Lexchin 2012; Krimsky 2013). We differentiate between studies where all authors are affiliated with an academic institution, studies where at least one author is affiliated to a commercial firm as well as studies where at least one author is affiliated to a non-or inter-governmental organization.

Publication characteristics. Differences in publication quality are captured threefold: First, a dummy variable that is one, if the primary study is published in a peer-reviewed journal, as well as a continuous moderator with the Scimago Journal Rank (SJR), are introduced. In addition to that, a control variable with the number of google scholar citations normalized by the study's age serves as an indicator for the study's academic impact.

5. Empirical Results

We start our analysis by investigating the graphical distribution of the 3,183 p-values, extracted from 67 primary studies. Figure 1(a) depicts the distribution of all p-values included in our meta-data set and reveals that results are strongly right skewed. Almost 30 % of the *p*-values are significant at the 5% level (see Figure 1(b)), and half of the p-values have values below 0.2. We further observe that for p-values between 0 and 0.5, the relative frequency of occurrence is strictly decreasing while it remains at a constant fraction for *p*-values between 0.5 and 1. Hence, the graphical representation highlights that our extracted data is rather uniformly distributed for *p*-values larger than 0.5 while the relative frequency rises strongly for *p*-values smaller than 0.1.

Figure 1. Distribution of p-values from Granger causality tests

(a)   (b)
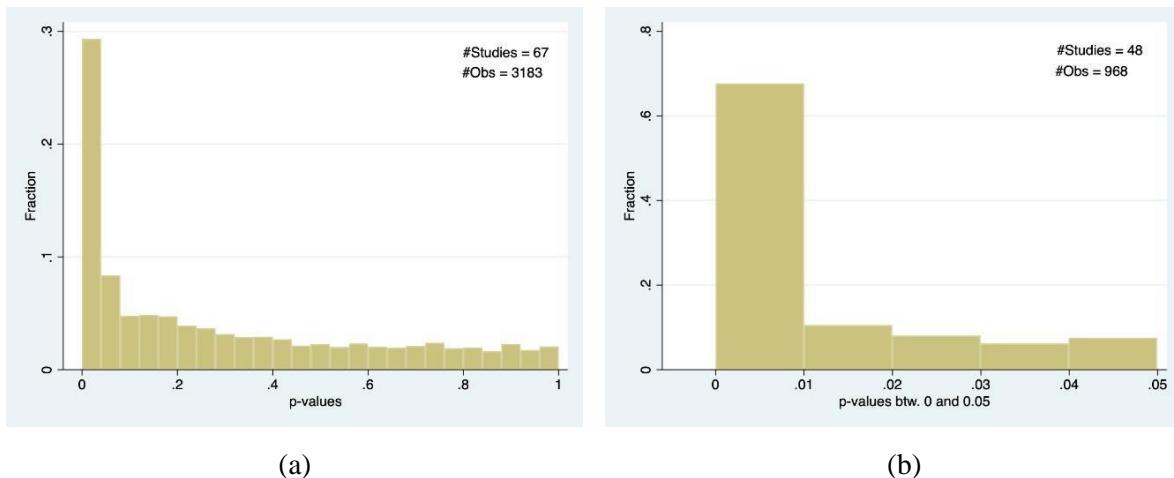
Notes: The figures show the histogram of p-values from Granger causality tests reported in primary studies: (a) the full sample and (b) the subsample of p-values between 0.00 and 0.05.

To further investigate significant findings, Figure 1(b) visualizes the distribution of the subsample of

p-values between zero and 0.05. Likewise, the data exhibits a significant right-skew with a median of 0.07.

While the distribution of *p*-values larger than 0.01 is almost evenly distributed, we observe a dominance of *p*-values which are significant at the 1%. The apparent pattern and the absence of a noticeable bump just below the common threshold of statistical significance, 0.05, suggest that overall, significant results do not stem from p-hacking. This finding indicates genuine Granger causality from speculation to commodity prices in those cases where primary tests report statistical significance.

Overall, a first graphical investigation of our meta-data set exhibits strong heterogeneity among previous research findings. For *p*-values smaller than 0.05, a clear majority (70%) lies well below 0.01 while insignificant *p*-values are approximately uniformly distributed with slightly more probability mass to the left.

Basic Meta-Granger Analysis. As the second set of analysis, we employ the Meta-Granger model from Eq. (2) as a test for publication bias and overfitting. The baseline model shown in the first column in Table 2 includes the complete meta-data set and is inversely weighted by the number of estimates per study to give equal weight to each primary study and clustered at primary study level to account for study inherent effects. The regression coefficient β_1 of $\sqrt{df} \cdot I_{p \geq 0.05}$ is nearly zero, suggesting that p- values above 0.05 are independent of the degrees of freedom, indicating that overall, results are not biased by false negatives.

Table 2. Analysis of publication selection and overfitting bias

|	(I) Full sample	(II) Full sample	(III) Full sample	(IV) Agricultural	(V) NGO/IGO	(VI) Top journals	(VII) Price as speculation measure	(VIII) Report based data
Clustering	Study	Study, author	Study	Study	Study	Study	Study	Study
Weighting	[1/#est.]	[1/#est.]	$[1/\sqrt{df}]$	[1/#est.]	[1/#est.]	[1/#est.]	[1/#est.]	[1/#est.]
Constant	-0.734***	-0.734***	-0.972*	-0.660***	-0.182	-0.815***	-0.811***	-0.708***
	(-4.19)	(-4.24)	(-1.87)	(-3.00)	(-0.69)	(-2.98)	(-4.38)	(-5.16)
$\sqrt{df} \cdot I_{p \geq 0.05}$	0.010	0.010	0.025	0.003	0.011	0.024**	0.016	0.011**
	(1.08)	(1.06)	(1.61)	(0.27)	(1.04)	(2.04)	(1.64)	(2.05)
$\sqrt{df} \cdot I_{p<0.05}$	-0.074***	-0.074***	-0.093***	-0.068***	-0.159***	-0.062***	-0.079***	-0.083***
	(-9.07)	(-8.98)	(-3.07)	(-6.97)	(-2.90)	(-8.59)	(-5.94)	(-7.70)
#lags Y	-0.016	-0.016	-0.151**	-0.023	-0.174***	0.004	-0.020	0.017
	(-1.04)	(-1.08)	(-2.35)	(-0.75)	(-3.89)	(0.15)	(-1.14)	(1.07)
#lags X	-0.001	-0.001	-0.013	-0.001	(omitted)	-0.047***	0.004	-0.004*
	(-0.05)	(-0.05)	(-0.68)	(-0.17)		(-2.73)	(0.67)	(-1.77)
#Obs.	3183	3183	3183	2075	1236	367	1857	1599
#Studies	67	67	67	51	6	11	55	39

Notes: This table reports the results of Eq.(1): $\tilde{p}_i = \alpha + \beta_1\sqrt{df_i \cdot \overline{I_{p \geq 0.05}}} + \beta_2\sqrt{df_i \cdot \overline{I_{p<0.05}}} + \gamma_1 lags\_y_i + \gamma_2 lags\_x_i + \varepsilon_i$, where $\tilde{p}_i$ is the probit-transformed p-value and df_i the degrees of freedom of the corresponding Granger causality test i. The variables $lags\_y_i$ and $lags\_x_i$ refer to the lag length of the commodity price y_i respective of the speculation activity measure x_i. Models I, II and IV-VII are estimated by weighted least squares using the inverse of the number of estimates as weights. Model III uses the inverse of the square root of the degrees of freedom as weights. In Model V the coefficient for #lags X is omitted, since #lags X = #lags Y for all observations in that subset. The t-statistics of the regression coefficients reported in parentheses are based on standard errors adjusted for within-study and across-study correlation. *p<0.1,**p<0.05,***p<0.01

Similarly, we detect no bias by false positives, as p-values significantly decrease with the degrees of freedom in the case of significant primary findings ($\beta_2 < 0$), as expected in the presence of genuine Granger causality. Furthermore, controlling for overfitting has no effect, as coefficient of the lag lengths are near zero. Hence, we may conclude that significant as well as non-significant results do not suffer from publication bias and/or model overfitting in general. These findings mainly hold if we additionally account for author-specific effects (Model II) or apply a weighting scheme based on the inverse of the degrees of freedom (Model III). The subsequent Models (IV -VIII) investigate the sources of heterogeneity within our meta-data sample by conducting a regression for specific subgroups based on the weighting scheme and clustering technique applied in Model I (for further details see chapter 4). Model V regards research findings that have been published, endorsed or conducted by a non-or intergovernmental organization. As we can see from the coefficient on the lag length of primary models (#lags X = #lags Y for all observations in that subset), overfitting seems to be a prevalent issue in that subset.

Nevertheless, the negative relation between p-values < 0.05 and degrees of freedom persists after controlling for overfitting, and thus still indicates genuine Granger causality. On the contrary, findings from Models VI and VIII might be interpreted in that way that decreasing the lag length of the speculation measure increases p-values, leading to false negatives implied by $\beta_1 > 0$. In the case of a genuine lack of Granger causality, p-values > 0.05 should be unrelated to the degrees of freedom which is not the case for test results of the subsets 'Top journals' and 'Report-based data'. In general, we observe that overfitting bias, although not visible for the data set as a whole, is present for subgroups and appears to affect research findings. Based on the meta-granger approach we show that there is genuine granger causality within our meta-data set, while the genuine lack thereof is in some cases unclear due to false negatives.

Further graphical analysis of the observed heterogeneity can be found in Figure 2. Figure 2(a) depicts a subsample of primary studies where at least one (co)-author is affiliated to a non- or intergovernmental organization (NGO/IGO). This is contrasted with Figure 2(b) where all other studies not belonging to the first category were included.

Figure 2. Distribution of p-values from subsamples of Granger causality tests

(a)

(b)

(c)

(d)
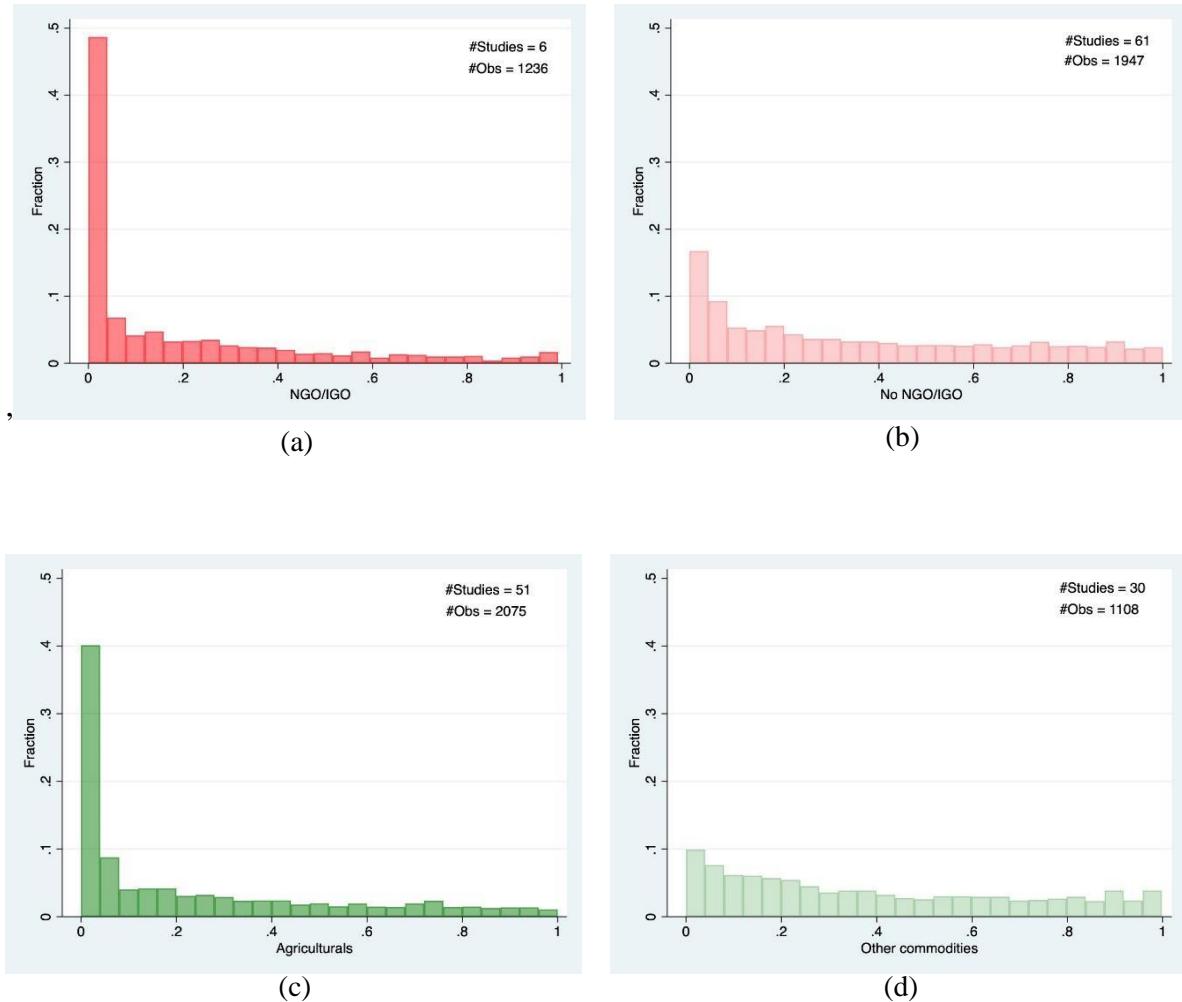
Notes: The figures show the histogram of p-values from subsamples of Granger causality tests reported in primary studies: (a) studies with at least one author who is affiliated to a non- or inter-governmental organization, (b) studies with no author who is affiliated to a non- or inter-governmental organization, (c) Granger causality tests that examine agricultural commodities and (d) Granger causality tests that examine non-agricultural commodities.

This visual comparison illustrates the extent to which we are able to explain the existing heterogeneity within our data set by the researchers' background. While almost 50% of all research findings belonging to the group of NGO/IGO-affiliated researchers are significant at the 10% level, merely 18% of the *p*-values stemming from the second group are smaller or equal to 0.1. Apart from the frequency of significant results, another apparent difference is presented by the overall distribution of research findings: Figure 2(b) exhibits an almost even frequency distribution over the interval of insignificant *p*-values (p>0.1) whereas Figure 2(a) displays a

strong right-skew and negligible frequencies for *p*-values above 0.5. In a similar fashion, Figures 2(c) and 2(d) compare the distribution of *p*-values for the subgroup of tests that investigate Granger causality from speculation to agricultural commodities (c) and a sample excluding those test results (d). Yet again, the charts deviate the most for the interval of significant values (<0.1) where 40% of all research outcomes reside for agriculturals compared to only 10% for all other commodities. While Figure 2(c) again features a notable right-skew with diminishing frequencies for the interval > 0.8, Figure 2(d) is only slightly right-skewed with a rather uniform distribution from 0.4 to 1. From these graphical illustrations, we infer that there is vast significance of Granger causality tests regarding agricultural commodities and of those conducted by researchers affiliated to NGOs/IGOs.

Extended Meta-Granger Analysis. In Table 3, further moderator variables are added to the regression model in order to statistically explore the drivers of heterogeneity within our meta-sample. Analogous to the regression output in Table 2, coefficients of the degrees of freedom for the subgroup of significant p-values are significant and negative in all models, still indicating the lack of false positives and hence, implying the presence of genuine Granger causality. Analogously, since $\beta_1 \approx 0$, non-significant findings from prior studies are not biased by false negatives. Therefore, significant as well as non-significant results reported in the primary literature apparently do not suffer from publication bias in any direction. Consequently, heterogeneous findings can be largely explained by moderator variables that we included in our extended meta-granger model of Eq. (2). Models I and II of Table 3 are estimated by weighted least squares using the inverse of the number of estimates as weights. In both cases, we observe that an affiliation of at least one author to an NGO/IGO is associated with a significantly smaller reported *p*-value. A second driver of variation within our meta-sample is given by the publication status of the primary study. Interestingly, peer-reviewed journal articles are less likely to present significant *p*-values compared to unpublished studies. Since the publication process ensures the compliance of academic research with certain standards in conducting, reporting and interpreting

37

scientific outcome, we regard published papers as more trustworthy. However, if the weighting is altered to the inverse of the square root of the degrees of freedom, such as in Model III, the significant influence of the publication status vanishes albeit a positive coefficient remains.

Table 3. Analysis of heterogeneity

Clustering Weighting	(I) Study [1/#Est.]	(II) Study, author [1/#Est.]	(III) Study [1/df]
Constant	26.813	26.813	72.769**
	(0.93)	(0.93)	(2.08)
$\sqrt{df} \cdot I_{p \geq 0.05}$	0.005	0.005	0.011
	(0.57)	(0.55)	(1.33)
$\sqrt{df} \cdot I_{p < 0.05}$	-0.076***	-0.076***	-0.166***
	(-5.71)	(-5.69)	(-3.43)
#lags Y	-0.013	-0.013	-0.004
	(-1.08)	(-1.15)	(-0.39)
#lags X	-0.002	-0.002	-0.005
	(-0.61)	(-0.63)	(-1.13)
NGO/IGO	-0.457**	-0.457**	-0.395*
	(-2.05)	(-2.10)	(-1.70)
Corporate	0.142	0.142	0.327*
	(0.75)	(0.83)	(1.85)
Published	0.349**	0.349**	0.261
	(2.03)	(2.13)	(1.47)
High Impact	-0.017	-0.017	-0.226
	(-0.07)	(-0.07)	(-0.69)
No. of citations	-0.109*	-0.109*	-0.172**
	(-1.89)	(-1.86)	(-2.33)
Average Time	-0.014	-0.014	-0.037**
	(-0.99)	(-0.99)	(-2.13)
Industrial metal	0.710***	0.710***	0.601***
	(3.06)	(5.25)	(3.24)
Precious metal	0.929***	0.929***	0.680***
	(5.01)	(5.11)	(3.59)
Energy	0.285	0.285	0.401*
	(1.41)	(1.47)	(1.96)
Mod. Granger	0.053	0.053	0.468
	(0.20)	(0.19)	(1.22)
Relative	-0.065	-0.065	-0.104
	(-0.33)	(-0.34)	(-0.61)
Flow	0.370**	0.370**	0.295**
	(2.43)	(2.30)	(2.22)
Report data	0.480***	0.480***	0.009
	(2.58)	(2.70)	(0.08)
Price	0.303	0.303	-0.010
	(1.16)	(1.13)	(-0.03)
Volatility	0.727*	0.727*	1.091*
	(1.77)	(1.72)	(1.89)
Nearby futures	0.804***	0.804***	0.944***
	(3.24)	(3.30)	(3.35)
Other_futures	0.737***	0.737***	1.002***
	(2.89)	(2.98)	(3.16)
First differences	-0.210	-0.210	-0.118
	(-1.19)	(-1.21)	(-0.74)
Logs	0.293	0.293	0.092
	(1.10)	(1.12)	(0.34)
#Obs.	3183	3183	3183
#Studies	67	67	67

Interestingly, the results are reversed once we consider the impact of the primary study among academic researchers as measured by the average number of citations per year. All three models indicate that researchers are able to attract more attention with smaller, that is, more significant p-values. The respective coefficients (-0.109) are significant at the 10% level for Models I and II and more pronounced for Model III (-0.172). Researchers who are able to reject the null hypothesis of no effect gather more recognition among academia which might be attributed to a general fondness of researchers as well as publishers towards significant results.

An association of at least one of the researchers to a bank or a commercially-run company does not generate results significantly different from academic researchers and appears to be a negligible determinant for the within-sample heterogeneity. Results are only statistically significant at the 10% (0.327) in case of the third regression model and insignificant for the remaining two.

Moreover, the regression analysis suggests significant differences between types of commodities for all three models. Primary studies which analyze speculation effects on the subgroup of industrial metals find significantly higher p-values (0.701) than for agricultures. The effect is even more pronounced for precious metals where we observe (probit-transformed) p-values which are, on average, larger by 0.929 compared to agricultural commodities. Energy commodities such as minerals and processed oil exhibit no (Models I and II) or a less significant effect of 0.401 at the 10% level compared to agriculturals. Following our findings, we may conclude that agricultural and energy commodity prices are significantly more affected by speculation activity than metal prices.

We further observe that the data source constitutes an important driver of heterogeneity as indicated by a positive and significant coefficient on the control variable for report-based data. Primary studies which accessed data on traders' positions are less likely to reject the null hypothesis and report probit- transformed p-values that are higher by 0.480 at the 1% level. Yet, once we weight by the inverse of the primary studies' degrees of freedom, we fail to find a statistically significant effect compared to tests including other proxies for speculation such as the futures price level, the overall volume of open interest or trading volume.

Second, to last, Table 3 suggests that causal effects from speculation to commodity prices are less likely to be found for price volatilities than for price returns. The correlation coefficient on price volatility suggested by Model III is very high in absolute terms (1.091) but only significant at the 10% level. That is, we may partially explain the existing heterogeneity in research findings by the researchers' choice of measuring the dependent variable. Our results provide evidence that suggests that using returns is more likely to induce significance in Granger causality tests whereas levels appear to be unrelated to the level of significance.

Lastly, we note that using futures prices are associated with higher, less significant p-values compared to using spot prices as response variable in Granger causality tests. This effect is significant at the 1% level for all three models and remains valid irrespective of whether researchers study nearby futures or futures with a later expiration date. This is an interesting finding as financial speculation in fact usually takes place in futures markets.

6. Conclusion

We applied meta-granger analysis to systematically analyze 67 primary studies on the impact of financial speculation on commodity prices. In our base model, we could not detect overall publication bias. Although controlling for overfitting that occasionally is present in primary studies, most of our model specifications show that reported Granger causality test results are neither biased by false positives nor by false negatives. Exceptions are studies that are published

in journals we classified as top journals in our sample and studies that use report based data on speculation activity. Results from those studies might be slightly biased by false negatives, leading to uncertainty on the genuineness of the reported lack of Granger causality. Nevertheless, our results do not show that there is an aggregated speculation effect on commodity prices. Using an extended meta-regression model with moderator variables capturing primary study and test characteristics we could largely contribute to explaining contradictory findings in the existing literature. In summary, we find that significance in research findings is induced by a researcher's affiliation with a non- or intergovernmental organisation, agricultural and energy commodities as well as highly cited research studies. Insignificant test outcomes, on the other hand, are more likely observed if research is published in a peer-reviewed journal, examines industrial or precious metals, uses futures prices of commodities (instead of spot prices) as dependent variables and utilizes official data from the CFTC or proprietary data from hedge funds.

However, drawbacks remain, as our meta-analysis is only able to consider previous findings from Granger causality tests that might also suffer from omitted variable bias next to the biases investigated in our study. Furthermore, we do have to rely on p-values as an effect size due to the nature of Granger causality testing. Consequently our (and most prior) research has to focus on the presence of speculative effects instead of their size or direction. Further research might address these issues and draw attention to other methods of detecting and aggregating speculation effects while drawing attention to economic next to statistical significance.

References

Alquist, Ron; Gervais, Olivier (2013): The role of financial speculation in driving the price of crude oil. In *The Energy Journal*, pp. 35–54.

Babalos, Vassilios; Balcilar, Mehmet (2017): Does institutional trading drive commodities prices away from their fundamentals: Evidence from a nonparametric causality-in-quantiles test. In *Finance Research Letters* 21, pp. 126–131. DOI: 10.1016/j.frl.2016.11.017.

Bell, David; Kay, Jim; Malley, Jim (1996): A non-parametric approach to non-linear causality testing. In *Economics Letters* 51 (1), pp. 7–18. DOI: 10.1016/0165-1765(95)00791-1.

Blau, Gerda (1944): Some Aspects of the Theory of Futures Trading. In *The Review of Economic Studies* 12 (1), p. 1. DOI: 10.2307/2296011.

Bode, T. (2011): Die Hungermacher. Wie Deutsche Bank, Goldman Sachs & Co. auf Kosten der Ärmsten mit Lebensmitteln spekulieren. Foodwatch-Report.

Bohl, Martin T.; Siklos, Pierre L.; Wellenreuther, Claudia (2018): Speculative activity and returns volatility of Chinese agricultural commodity futures. In *Journal of Asian Economics* 54, pp. 69–91. DOI: 10.1016/j.asieco.2017.12.003.

Boyd, Naomi E.; Harris, Jeffrey H.; Li, Bingxin (2018): An update on speculation and financialization in commodity markets. In *Journal of Commodity Markets* 10, pp. 91–104. DOI: 10.1016/j.jcomm.2018.05.005.

Brunetti, Celso; Buyuksahin, Bahattin; Harris, Jeffrey H. (2011): Speculators, Prices and Market Volatility. In *SSRN Journal*. DOI: 10.2139/ssrn.1736737.

Bruns, Stephan B. (2017): Meta-Regression Models and Observational Research. In *Oxford Bull Econ & Stats* 79 (5), pp. 637–653. DOI: 10.1111/obes.12172.

Bruns, Stephan B.; Stern, David I. (2015): Meta-Granger Causality Testing. In *SSRN Journal*. DOI: 10.2139/ssrn.2619478.

Bruns, Stephan B.; Stern, David I. (2018): Lag length selection and p-hacking in Granger causality testing: prevalence and performance of meta-regression models. In *Empir Econ* 1 (1), p. 18. DOI: 10.1007/s00181-018-1446-3.

Büyükşahin, Bahattin; Harris, Jeffrey H. (2011): Do speculators drive crude oil futures prices? In *The Energy Journal*, pp. 167–202.

Cheng, Ing-Haw; Xiong, Wei (2014): Financialization of Commodity Markets. In *Annual Review of Financial Economics* 6 (1), pp. 419–441. DOI: 10.1146/annurev-financial-110613-034432.

Ciner, Cetin (2002): Information content of volume: An investigation of Tokyo commodity futures markets. In *Pacific-Basin Finance Journal* 10 (2), pp. 201–215. DOI: 10.1016/S0927-538X(01)00037- 3.

Dimpfl, Thomas; Flad, Michael; Jung, Robert C. (2017): Price discovery in agricultural commodity markets in the presence of futures speculation. In *Journal of Commodity Markets* 5, pp. 50–62. DOI: 10.1016/j.jcomm.2017.01.002.

Feld, Lars P.; Heckemeyer, Jost H.; Overesch, Michael (2013): Capital structure choice and company taxation: A meta-study. In *Journal of Banking & Finance* 37 (8), pp. 2850–2866. DOI: 10.1016/j.jbankfin.2013.03.017.

Fujihara, Roger A.; Mougou, Mbodja (1997): An examination of linear and nonlinear causal relationships between price variability and volume in petroleum futures markets. In *J. Fut. Mark.* 17 (4), pp. 385–416. DOI: 10.1002/(SICI)1096-9934(199706)17:4<385::AID-FUT2>3.0.CO;2-D.

Granger, C. W. J. (1969): Investigating Causal Relations by Econometric Models and Cross-spectral Methods. In *Econometrica* 37 (3), p. 424. DOI: 10.2307/1912791.

Greely, David; Currie, Jeffrey (2008): Speculators, Index Investors, and Commodity Prices. In *Goldman Sachs Commodities Research*.

Grosche, Stephanie (2012): Limitations of Granger causality analysis to assess the price effects from the financialization of agricultural commodity markets under bounded rationality.

Grossman, Sanford J.; Stiglitz, Joseph E. (1980): On the impossibility of informationally efficient markets. In *The American economic review* 70 (3), pp. 393–408.

Haase, Marco; Seiler Zimmermann, Yvonne; Zimmermann, Heinz (2016): The impact of speculation on commodity futures markets – A review of the findings of 100 empirical studies. In *Journal of Commodity Markets* 3 (1), pp. 1–15. DOI: 10.1016/j.jcomm.2016.07.006.

Harris, Lawrence (1989): S&P 500 Cash Stock Price Volatilities. In *The Journal of Finance* 44 (5), pp. 1155–1175. DOI: 10.1111/j.1540-6261.1989.tb02648.x.

Hellwig, Martin F. (1980): On the aggregation of information in competitive markets. In *Journal of Economic Theory* 22 (3), pp. 477–498. DOI: 10.1016/0022-0531(80)90056-3.

Hicks, J. R. (1939): The Foundations of Welfare Economics. In *The Economic Journal* 49 (196), p. 696. DOI: 10.2307/2225023.

Huchet, Nicolas; Fam, Papa Gueye (2016): The role of speculation in international futures markets on commodity prices. In *Research in International Business and Finance* 37, pp. 49–65. DOI: 10.1016/j.ribaf.2015.09.034.

Kaldor, N. (1976): Speculation and Economic Stability. In B. A. Goss, B. S. Yamey (Eds.): The Economics of Futures Trading. London: Palgrave Macmillan UK, pp. 111–123.

Keynes, John Maynard (1923): A tract on monetary reform: London,

Macmillan. Keynes, John Maynard (1930): Treatise on money.

Krimsky, Sheldon (2013): Do Financial Conflicts of Interest Bias Research? In *Science, Technology, & Human Values* 38 (4), pp. 566–587. DOI: 10.1177/0162243912456271.

Kysucky, Vlado; Norden, Lars (2015): The Benefits of Relationship Lending in a Cross-Country Context: A Meta-Analysis. In *Management Science*. DOI: 10.1287/mnsc.2014.2088.

Lexchin, Joel (2012): Sponsorship bias in clinical research. In *The International journal of risk & safety in medicine* 24 (4), pp. 233–242. DOI: 10.3233/JRS-2012-0574.

Masters, M.; White, A. (2009): The 2008 commodities bubble. Assessing the damage to the United States and its citizens. In *Masters Capital Management and White Knight Research and Trading*.

Mayer, Herbert; Rathgeber, Andreas; Wanner, Markus (2017): Financialization of metal markets: Does futures trading influence spot prices and volatility? In *Resources Policy* 53, pp. 300–316. DOI: 10.1016/j.resourpol.2017.06.011.

Mayer, Jörg (2012): The Growing Financialisation of Commodity Markets: Divergences between Index Investors and Money Managers. In *Journal of Development Studies* 48 (6), pp. 751–767. DOI: 10.1080/00220388.2011.649261.

Peri, Massimo; Baldi, Lucia; Vandone, Daniela (2013): Price discovery in commodity markets. In *Applied Economics Letters* 20 (4), pp. 397–403. DOI: 10.1080/13504851.2012.709590.

Pradkhan, Elina (2017): Financial activity in agricultural futures markets: evidence from quantile regressions. In *Aust J Agric Resour Econ* 61 (4), pp. 610–625. DOI: 10.1111/1467-8489.12222.

Rusnak, Marek; Havranek, Tomas; Horvath, Roman (2013): How to Solve the Price Puzzle? A Meta- Analysis. In *Journal of Money, Credit and Banking* 45 (1), pp. 37–70. DOI: 10.1111/j.1538-4616.2012.00561.x.

Sanders, Dwight R.; Boris, Keith; Manfredo, Mark (2004): Hedgers, funds, and small speculators in the energy futures markets: an analysis of the CFTC's Commitments of Traders reports. In *Energy Economics* 26 (3), pp. 425–445. DOI: 10.1016/j.eneco.2004.04.010.

Shutes, Karl; Meijerink, Gerdien W. (2012): Food prices and agricultural futures markets. A literature review, hrsg. von der Wageningen School of Social Sciences (WASS).

Simonsohn, Uri; Nelson, Leif D.; Simmons, Joseph P. (2014): P-curve: a key to the file-drawer. In *Journal of experimental psychology. General* 143 (2), pp. 534–547. DOI: 10.1037/a0033242.

Stanley, T. D. (2007): Meta-Regression Methods for Detecting and Estimating Empirical Effects in the Presence of Publication Selection. In *Oxford Bull Econ & Stats* 0 (0), 070921170652004-??? DOI: 10.1111/j.1468-0084.2007.00487.x.

Stanley, T. D.; Doucouliagos, Hristos; Giles, Margaret; Heckemeyer, Jost H.; Johnston, Robert J.; Laroche, Patrice et al. (2013): META-ANALYSIS OF ECONOMICS RESEARCH REPORTING GUIDELINES. In *Journal of Economic Surveys* 27 (2), pp. 390–394. DOI: 10.1111/joes.12008.

Stanley, T.D (2001): Wheat From Chaff: Meta-Analysis As Quantitative Literature Review. In *Journal of Economic Perspectives* 15 (3), pp. 131–150. DOI: 10.1257/jep.15.3.131.

Tang, Ke; Xiong, Wei (2012): Index Investment and Financialization of Commodities 68, pp. 54–74. DOI: 10.3386/w16385.

U.S. Senate (2009): Excessive speculation in the wheat market. In *Majority and Minority Staff Report. Permanent Subcommittee on Investigations* 24, pp. 107–108.

Will, Matthias Georg; Prehn, SSren; Pies, Ingo; Glauben, Thomas (2013): Is Financial Speculation with Agricultural Commodities Harmful or Helpful? A Literature Review of Current Empirical Research. In *SSRN Journal*. DOI: 10.2139/ssrn.2333076.

Working, Holbrook (1948): Theory of the Inverse Carrying Charge in Futures Markets. In *Journal of Farm Economics* 30 (1), p. 1. DOI: 10.2307/1232678.

Working, Holbrook (1949): The Theory of Price of Storage 39 (6), pp. 1254–1262.

Appendix A: Studies included in the meta-analysis

Abba Abdullahi, Saada; Kouhy, Reza; Muhammad, Zahid (2014): Trading volume and return relationship in the crude oil futures markets (31).

Algieri, Bernardina (2016): Conditional price volatility, speculation, and excessive speculation in commodity markets. Sheep or shepherd behaviour? (30).

Alquist, Ron; Gervais, Olivier (2013): The role of financial speculation in driving the price of crude oil. In: Energy J., pp. 35–54.

Amann, Stefan; Lehecka, Georg, Schmid, Erwin (2013): Does speculation drive agricultural commodity spot prices? In: Jahrbuch der Österreichischen Gesellschaft für Agrarökonomie 22 (1), pp. 131–140.

Antonakakis, Nikolaos; Chang, Tsangyao; Cunado, Juncal; Gupta, Rangan (2018): The relationship between commodity markets and commodity mutual funds: A wavelet-based analysis. In: Finance Research Letters 24, pp. 1–9. DOI: 10.1016/j.frl.2017.03.005.

Aulerich, Nicole; Irwin, Scott; Garcia, Philip (2010): The Price impact of Index Funds in Commodity Futures Markets: Evidence from the CFTCs Daily Large Trader Reporting System.

Aulerich, Nicole M.; Irwin, Scott H.; García, Philip (2014): Bubbles, food prices, and speculation. Evidence from the CFTC's daily large trader data files. In: The economics of food price volatility. Chicago, Ill. [u.a.]: Univ. of Chicago Press, pp. 211–253.

Babalos, Vassilios; Balcilar, Mehmet (2017): Does institutional trading drive commodities prices away from their fundamentals. Evidence from a nonparametric causality-in-quantiles test. In: Finance Research Letters 21 (2017), pp. 126–131.

Baldi, Lucia; Peri, MassimoM; Vandone, Daniela (2011): Spot and Futures Prices of Agricultural Commodities: Fundamentals and Speculation. 110 - 125 Pages / Proceedings in Food System Dynamics, Proceedings in System Dynamics and Innovation in Food Networks 2011. DOI: 10.18461/PFSD.2011.1110.

Bohl, Martin T.; Siklos, Pierre L.; Wellenreuther, Claudia (2018): Speculative activity and returns volatility of Chinese agricultural commodity futures. In: Journal of Asian Economics 54, pp. 69–91. DOI: 10.1016/j.asieco.2017.12.003.

Borin, Alessandro; Di Nino, Virginia (2012): The role of financial investments in agricultural commodity derivatives markets. Roma: Banca d'Italia (Temi di discussione / Banca d'Italia, 849).

Bos, Jaap W. B.; van der Molen, Maarten (2012): A bitter brew? Futures speculation and commodity prices. Maastricht (METEOR / Maastricht research school of Economics of Technology and Organizations).

Brunetti, Celso; Buyuksahin, Bahattin (2009): Is Speculation Destabilizing?

Brunetti, Celso; Büyükşahin, Bahattin; Harris, Jeffrey H. (2016): Speculators, Prices, and Market Volatility. In: Journal of Financial and Quantitative Analysis 51 (5), pp. 1545–1574. DOI: 10.1017/S0022109016000569.

Bu, Hui (2011): Price dynamics and speculators in crude oil futures market. In: Systems Engineering Procedia 2, pp. 114–121. DOI: 10.1016/j.sepro.2011.10.014.

Büyük̦ sahin, Bahattin; Harris, Jeffrey H. (2011): Do speculators drive crude oil futures prices? (32).

Capelle-Blancard, Gunther; Coulibaly, Dramane (2011): Index Trading and Agricultural Commodity Prices: A Panel Granger Causality Analysis1. In: International Economics 126, pp. 51–71.

Chakraborty, Ranajit; Das, Rahuldeb (2013): Dynamic relationship between futures trading and spot price volatility. Evidence from Indian commodity market (19).

Ciner, Cetin (2002): Information content of volume. An investigation of Tokyo commodity futures markets (10).

Coleman, Les; Dark, Jonathan (2012): Economic significance of non-hedger investment in commodity markets.

Ding, Haoyuan; Kim, Hyung-gun; Park, Sung Y. (2014): Do net positions in the futures market cause spot prices of crude oil? (41 (2014)).

Ederer, Stefan; Heumesser, Christine; Staritz, Cornelia (2013): The role of fundamentals and financialisation in recent commodity price developments: An empirical analysis for wheat, coffee, cotton, and oil (Österreichische Forschungsstiftung für Internationale Entwicklung (ÖFSE) / Austrian Foundation for Development Research, 42).

Etienne, Xiaoli L.; Irwin, Scott H.; Garcia, Philip (2017): New Evidence that Index Traders Did Not Drive Bubbles in Grain Futures Markets. In: Journal of Agricultural & Resource Economics 42 (1).

Fagan, Stephen; Gençay, Ramazan (2008): Liquidity-induced dynamics in futures markets. Brussels, Belgium, EERI research paper series.

Fujihara, Roger A.; Mougoué, Mbodja (1997): An examination of linear and nonlinear causal relationships between price variability and volume in petroleum futures markets. In: Journal of Futures Markets 17 (4), pp. 385–416.

Ghalayini, Latife (2011). In: European Journal of Economics, Finance and Administrative Sciences 32 (32), p. 149.

Ghalayini, Latife (2017): Modeling and forecasting spot oil price. In: Eurasian Bus Rev 7 (3), pp. 355– 373. DOI: 10.1007/s40821-016-0058-0.

Gilbert, Christopher (2010a): Speculative Influences on Commodity Futures Prices 2006-08. 197. Aufl. Hg. v. UNCTAD Discussion Papers. United Nations Conference on Trade and Development.

Gilbert, Christopher (2010b): Commodity Speculation and Commodity Investment. In: Department of Economics Working Papers (0820).

Gilbert, Christopher L. (2010c): How to Understand High Food Prices. In: Journal of Agricultural Economics 61 (2), pp. 398–425. DOI: 10.1111/j.1477-9552.2010.00248.x.

Gilbert, Christopher.; Pfuderer, Simone (2014): The Role of Index Trading in Price Formation in the Grains and Oilseeds Markets. In: Journal of Agricultural Economics 65 (2), pp. 303–322. DOI: 10.1111/1477-9552.12068.

Girardi, Daniele (2015): Financialization of food. Modelling the time-varying relation between agricultural prices and stock market dynamics. In: International Review of Applied Economics 29

(4), pp. 482–505. DOI: 10.1080/02692171.2015.1016406.

Gupta, C. P.; Sehgal, Sanjay; Wadhwa, Sahaj (2018): Agricultural Commodity Trading: Is it Destabilizing Spot Markets? In: Vikalpa 43 (1), pp. 47–57. DOI: 10.1177/0256090917750263.

Haase, Marco; Zimmermann, Yvonne Seiler; Zimmermann, Heinz (2018): Permanent and transitory price shocks in commodity futures markets and their relation to speculation. In: Empirical Economics, pp. 1–24.

Hannesson, Rögnvaldur (2012): Does speculation drive the price of oil? In: OPEC Energy Review 36 (2), pp. 125–137. DOI: 10.1111/j.1753-0237.2011.00207.x.

Hernandez, Manuel; Torero, Maximo (2009): Examining the dynamic relationship between spot and future prices of agricultural commodities. In: IFPRI discussion papers (988).

Huchet, Nicolas; Fam, Papa Gueye (2016): The role of speculation in international futures markets on commodity prices. In: Research in International Business and Finance 37, pp. 49–65.

Irwin, S. H.; Garcia, P.; Good, D. L.; Kunda, E. L. (2011): Spreads and Non-Convergence in Chicago Board of Trade Corn, Soybean, and Wheat Futures: Are Index Funds to Blame? In: Applied Economic Perspectives and Policy 33 (1), pp. 116–142. DOI: 10.1093/aepp/ppr001.

Irwin, Scott H.; Sanders, Dwight R. (2010): The impact of index and swap funds on commodity futures markets. In: 1815-6797.

Irwin, Scott H.; Sanders, Dwight R. (2012): Testing the Masters Hypothesis in commodity futures markets. In: Energy Economics 34 (1), pp. 256–269.

Malliaris, A. G.; Urrutia, Jorge L. (1998): Volume and price relationships: Hypotheses and testing for agricultural futures. In: Journal of Futures Markets 18 (1), pp. 53–72. DOI: 10.1002/(SICI)1096-9934(199802)18:1<53::AID-FUT3>3.0.CO;2-A.

Mathur, Kritika; Kaicker, Nidhi; Gaiha, Raghav; Imai, Katsushi S.; Thapa, Ganesh B. (2013): Financialization of food commodity markets, price surge and volatility. New evidence. Kobe (Discussion paper series / Research Institute for Economics and Business Administration, Kobe University, 2013,22).

Mayer, Herbert; Rathgeber, Andreas; Wanner, Markus (2017): Financialization of metal markets: Does futures trading influence spot prices and volatility? In: Resources Policy 53, pp. 300–316. DOI: 10.1016/j.resourpol.2017.06.011.

Mayer, Jörg (2012): The growing financialization of commodity markets. Divergences between index investors and money managers (48).

Merino, Antonio; Albacete, Rebeca (2010): Econometric modelling for short-term oil price forecasting. In: OPEC Energy Review 34 (1), pp. 25–41. DOI: 10.1111/j.1753-0237.2010.00171.x.

Mukherjee, Kedar Nath (2011): Impact of Futures Trading on Indian Agricultural Commodity Market. Pune, India.

Naderian, Mohammad Amin; Javan, Afshin (2017): Distortionary effect of trading activity in NYMEX crude oil futures market: post crisis. In: OPEC Energy Review 41 (1), pp. 23–44. DOI: 10.1111/opec.12092.

Obadi, Saleh Mothana; Korecek, Matej (2018): The Crude Oil Price and Speculations: Investigation Using Granger Causality Test. In: International Journal of Energy Economics and Policy 8 (3), pp. 275–282.

Often, Einar M.; Wisen, Craig H. (2013): Disaggregated commitment of traders data and prospective price effects (29).

Peri, Massimo; Baldi, Lucia; Vandone, Daniela (2013): Price discovery in commodity markets (20).

Pfuderer, Simone; Gilbert, Christopher (2013): Index funds do impact agricultural prices. In: 53rd Annual Conference, Berlin, Germany, September 25-27, 2013 (156220).

Prokopczuk, Marcel; Symeonidis, Lazaros; Verlaat, Timo (2014): Rising and Volatile Food Prices: Are Index Fund Investors to Blame?. DOI: 10.2139/ssrn.2450397.

Sanders, Dwight R.; Boris, Keith; Manfredo, Mark (2004): Hedgers, funds, and small speculators in the energy futures markets: an analysis of the CFTC's Commitments of Traders reports. In: Energy Economics 26 (3), pp 425–445.

Sanders, Dwight R.; Irwin, Scott H. (2011): New evidence on the impact of index funds in US grain futures markets. In: Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie 59 (4), pp. 519–532.

Sanders, Dwight R.; Irwin, Scott H. (2011): The impact of index funds in commodity futures markets: A systems approach. In: Journal of Alternative Investments 14 (1), pp. 40–49.Sanders, Dwight R.; Irwin, Scott H. (2014): Energy futures prices and commodity index investment: New evidence from firm-level position data. In: Energy Economics 46, pp.57-68.

Sanders, Dwight R.; Irwin, Scott H.; Merrin, Robert P. (2009): Smart money: the forecasting ability of CFTC large traders in agricultural futures markets (34).

Sassi, Maria; Werner, Harald A. (2013): Non-commercial actors and the recent futures prices of wheat. In: Economia e Diritto Agroalimentare 18 (3), pp. 309–330. DOI: 10.14601/EDA-13861.

Sehgal, Sanjay; Rajput, Namita; Dua, Rajeev Kumar (2012): Futures Trading and Spot Market Volatility: Evidence from Indian Commodity Markets. In: Asian Journal of Finance & Accounting 4 (2). DOI: 10.5296/ajfa.v4i2.1990.

Sen, Sunanda; Paul, Mahua (2010): Trading in India's Commodity Future Markets. Institute for Studies in Industrial Development (3).

Shanker, Latha (2017): New indices of adequate and excess speculation and their relationship with volatility in the crude oil futures market. In: Journal of Commodity Markets 5, pp. 18–35. DOI: 10.1016/j.jcomm.2016.11.003.

Shanmugam, Velmurugan; Armah, Paul (2012): Role of Speculators in Agriculture commodity price spikes during 2006-2011. In: Academy of Accounting and Financial Studies Journal (16), pp. 97–114.

Sharma, Dinesh Kumar; Malhotra, Meenakshi (2015): Impact of futures trading on volatility of spot market-a case of guar seed (75).

Sharma, Tanushree (2016): The impact of future trading on volatility in agriculture commodity. A case of pepper.

Stoll, Hans R.; Whaley, Robert E. (2011): Commodity index investing. Speculation or diversification? (14).

Tse, Yiuman; Williams, Michael (2013): Does index speculation impact commodity prices? An intraday analysis (48).

Yang, Jian; Balyeat, R. Brian; Leatham, David J. (2005): Futures Trading Activity and Commodity Cash Price Volatility. In: Journal of Business Finance & Accounting 32 (1-2), pp. 297–323. DOI: 10.1111/j.0306-686X.2005.00595.x.

Measuring the Impact of the Sustainability Accounting Standards Board on Climate Change Risk Disclosures

A J Stagliano, Saint Joseph's University

Abstract

Sustainability concerns and the financial risks associated with environmental liabilities prompted the U.S. Securities and Exchange Commission (SEC) to issue interpretive guidance for registrants regarding disclosures related to these matters. The SEC's 2010 document is focused on four main themes: (1) impacts from existing regulation and legislation, (2) effects generated by international accords, (3) expected indirect results of new environmental protection alteration. Disclosures from these four areas are likely to create many questions and rules, and (4) risk consequences on business activities connected with the physical effects of uncertainties about the materiality of sustainability financial risks.

Environmental

The Sustainability Accounting Standards Board (SASB) has developed a wide array of measurement methods and reporting guidelines with respect to major industrial and service sectors in the U.S. economy. The SASB's efforts complement regulatory reporting as firms comply with mandatory SEC filings.

One of the most significant financial elements related to threats such as global warming is the risk that these phenomena might add costs to operating a company and reduce the firm's economic outcome. The empirical research described here is focused on disclosures about sustainability risks that a selected group of SEC registrants, those in the health services sector, made in connection with SEC disclosure guidance and the SASB's reporting standards.

This study seeks to determine whether firms in a high-profile sector of growing importance disclose their efforts at furthering sustainability. Data are gathered from the years 2008 through 2017 Form 10-K filings of every publicly traded SEC registrant in two cognate SIC Major Groups: #80—Health Services and #83—Social Services. All of the firms selected for study have a fiscal year ending date that would have made them subject to the new SEC guidance starting with financial reporting for year 2010. All of these firms are especially focused on a "business" that is imbued with the public interest in a unique way.

Unpacking 25 Years of "Reel" Leadership: A Review of Leaders and Leadership in Bestselling Films

Alexander Knights, Roger Williams University

Abstract

Scholars have long argued that one of the main imperatives for studying leadership lies in the fact that it pervades much of our everyday lives. One area of everyday life where leadership has proven inescapable, but gone largely unstudied, is in bestselling films. A comprehensive review of the 250-bestselling films in the last 25 years will be undertaken for the purposes of unpacking these films' portrayals of leaders and leadership, providing general conclusions, as well as temporal trends.

Keywords:

Leadership, Leader Traits, Leader Behaviors

Resisting Trump on Twitter
Exploring Themes and Messages of the #Resistance

Amiee Shelton, Roger Williams University

Abstract

Millions of Americans are protesting policies and/or communication style of the current American White House. These resistance activities can be viewed in large part as facilitated through the microblogging platform of Twitter. After identifying 1000 users who follow #Theresistance, we analyzed 15,000 tweets, using the framework of the framing theory. This study specifically investigated how self-proclaimed members of the resistance frame their messages, by analyzing the tone, rationality, and media components of each tweet. We were able to determine themes, and persona (type of user) and the apparent motivation for posting. Our analysis revealed that participatory action is cultivated in the #Theresistance, yet Habermas's idea of a public sphere is not fully realized, despite wide demographic and geographic usage. Overall, our findings support the argument that Twitter increases political participation and social movements. This exploratory study sets a foundation from which other studies can investigate if Twitter enhances the public sphere and the role of Twitter in social movements.

Key Words: Twitter, Political Communication, Resistance, Public Sphere, Framing Theory

Flipped Classroom Application
In an Introductory Business Information System Course

Bahadir Akcam, Western New England University

Purpose

The purpose of this research is to describe a flipped classroom application in an introductory business information system course at the undergraduate level and report student satisfaction results with the course components.

Methodology

End of the semester surveys were used to collect data on the student satisfaction with the twelve course components. A five-point Likert scale from strongly dissatisfied (1) to strongly satisfied (5) was used in the survey. 77 students in three sections in two semesters participated in the surveys. Survey results are analyzed using descriptive statistics, t-test and ANOVA methods.

Key Findings

Flipped classroom approach dramatically changed the course activities. This change resulted with different learning experiences for students.

Students had varying satisfaction levels with different components of the course. They are satisfied with 11 out of 12 course components. While course activities such as class exercises (3.94), group collaboration (3.87) and assignments (3.69) in class resulted with high satisfaction, pre-recorded lectures (3.39) and quizzes at the beginning of each chapter (3.10) resulted with lower satisfaction levels. Textbook (2.57), as a traditional course component, did not satisfy students.

Conclusions

Given the positive student satisfaction levels with 11 out of 12 course components indicate the promise of the flipped classroom approach in this type of course.

Flipped classroom approach mainly adopted to provide ample opportunity to have hands-on class exercises. Students reported high satisfaction level with these components such as SAP Case Study Exercises (4.08), Class Exercises (3.94), and Group Collaboration (3.87).

Students are more satisfied with the Posted Lecture Presentations (3.99) than the Prerecorded Lectures (3.39) that are explaining the concepts in these presentations. Quizzes (3.10) designed to measure student understanding from the Prerecorded Lectures and the Posted Lecture Presentations resulted with low satisfaction. The Textbook (2.57) did not satisfy the students despite its good quality.

Key Words: **Flipped Classroom, Introductory Business Information Systems Course, Teaching Methodology**

Social Approaches of Enterprises and Innovativeness

Beata Skowron-Grabowska
Czestochowa University of Technology
Management Faculty
Ul. Armii Krajowej 19b
42-200 Czestochowa, Poland

Abstract

In the herein paper the problematic issues of the social approaches of the process of the functioning of enterprises have been presented. The context of reference is that of the innovativeness of enterprises. The globalization and competitiveness of enterprises has led to the fact that society, by appreciating the positive effects of business activities, conducted a revaluation of the results and categories of the assessment of business entities. The financial parameters are one of the most important categories of evaluation, yet it is the social nature of enterprises that is becoming an increasingly noted and appreciated approach of business entities. In the herein paper, the strategic conditioning of the social approaches of enterprises and entrepreneurs has been presented. Likewise, the pro-innovative activities have been indicated in a social aspect.
Key words: social enterprise, entrepreneur, strategy, innovations

Introduction

The execution of the tasks of enterprises in circumstances of the dynamically progressing processes of globalization and competitiveness is becoming an issue that is increasingly intricate. On the one hand, there is absolute pressure within an enterprise in order for their activities to fulfil the criteria of efficiency. However, on the other hand, society increasingly assesses the results of business activity more profoundly, particularly those that have a direct impact on mankind and the environment in a negative sense. Enterprises when faced by social pressure verify their business activities in the direction of social approaches. This approach is the consequence of the publication of reports and social audits. The increase in the level of social awareness exerts significant influence on the processes of management, particularly in a strategic context. The afore-mentioned facts have led to the creation of social enterprises, as well as the categories of enterprises and managers of a social approach. The essence of the activities of enterprises and entrepreneurs however results in the necessity to implement innovations due to the competitiveness of the market. The problems of the innovativeness of enterprises also requires the perception of social aspects.

1. Strategic conditioning of social approaches of enterprises

The processes of globalization and competitiveness cause the pursuit of development among enterprises. The development of enterprises is a positive effect of the activities of mankind. Unfortunately, development is also accompanied by the negative consequences for mankind in both direct and indirect ways by means of the degradation of the natural environment.

The strategy of the choices of our planet is an interesting subject matter for research. In multi-paged analyses, it is emphasized that a strategic choice is a very intricate problem and relates to the space in which the boundary conditions are separated by significantly different concepts. One of these comes down to the necessity of moderation in terms of the utilization of non-renewable resources. In the second one, it is claimed that the problems of the degradation of the environment, while also other areas that threaten the ecological and social balance may be resolved as a result of innovativeness, as well as the broad perception of progress in the development of science and the economy. (Martin, Kemper, 2012)

The growth trend of globalization and competitiveness has led to the fact that firms have undertaken the challenge of realizing the concepts of social engagement. With relation to the

aforesaid information, social reports are published, social and ethical audits are conducted in firms, while furthermore, the process of adjustment to the standards created over the last few years exists. The growth of the level of social awareness has not failed to leave its mark on the processes of management. In the modified and improved strategies of firms within the context of a social dialogue, aspects associated with environmental protection, recycling and the rationalization of the use of resources are first and foremost to the forefront. (Kwiecińska, 2014) Hence, there is significant evidence of the creation of social values. The intricacy of this issue has led to the fact that it is justifiable to view social values in varying concepts.

In the area of information relating to the social responsibility of enterprises (CSR), there is a growth trend in terms of the range and scale of this problem. J. Adamczyk emphasizes that there are no legislative regulations with relation to information about CSR, thus the business entities create their own standards and guidelines. (Adamczyk, 2013)

In the standard working conditions an ethical report and social report are displayed, as well as sustainable growth in the context of the development of GDP. The guidelines however, encompass responsible behaviour and good practices.

In emphasizing the significance of CSR in terms of the basic sphere of the economy, it is necessary to emphasize the debatable nature of this issue. This does not arise from questioning the justification of CSR, but the form and workability of the undertakings initiated.

In the arguments of the proponents of CSR the following aspects are first and foremost illustrated (Sokołowska, 2014):

- shaping the new socio-economic reality within the framework of which, models based on a pro-social approach are defined,
- responsibility of enterprises within the framework of the freedom of management,
- pro-market mechanisms that should constitute an important decision-making element of the market due to its restricted regulatory nature,
- opportunities of enterprises in realizing the principles of CSR over a long-term perspective are higher in the area of additional financial results. As a result of the radical changes to the social expectations with relation to enterprises, it is necessary to balance their economic and social aims as follows:
- public opinion creates the image of an enterprise from the viewpoint of ethical and empathic approaches,
- an enterprise of really great economic significance simultaneously bears a high level of corporate responsibility,
- CSR illustrates the close ties between the correlative and complementary behaviour and organizational culture,
- indicating social responsibility by an enterprise is a result of the essence of this concept itself.

Activities aimed at changes in the relations in terms of behaviour in enterprises focused on developing undertakings of a pro-ecological and social nature are worth mentioning here (Nitkiewicz, 2013).

The following claim is also made: "that human activity within the framework of an organization determines the moral responsibility in a decisive manner" (Sokołowska, 2014). By way of justification, the following positions are presented: (Fudaliński, 2013)

- In a liberal approach to results, an enterprise only expects profit, whereas other areas are not important.
- The principles of the market economy lead to the fact that the only responsibility of an enterprise is concentrated on the efficiency of the utilization of resources.
- The evaluation of CSR is of a superficial and minimalistic nature due to the lack of possibilities to conduct a profound analysis.
- CSR is identified in a more methodological way with resolving the problems of society in a more comprehensive manner than the multi-dimensional concept of the business activities of enterprises.
- There is a lack of appreciation for long-term social benefits concentrated around the social balance of the improvement of the image of an enterprise, the growth of social capital.
- The concept of M. Friedman associated social responsibility with charitable activity and omitted very valuable initiatives of a local nature created by business and first and foremost executing social aims.
- An enterprise does not assign itself responsibility due to a lack of unequivocal ranges and relation of the tasks executed, while also their effects with regard to the particular employees.

The concepts of the proponents of the social approach to business create the basis for the category of the social enterprise.

In the notion of a social enterprise there is therefore an accumulation of a certain type of antinomy. Its source constitutes a category of an enterprise identified with business activities with the simultaneous reference to the social nature of the tasks executed. Likewise, the problems of social management in their basis concentrate on the self-realizing society as an entity creating the abilities of self-organization. (Fudaliński, 2013)

R. Krupski emphasizes the fact of the difficulty of measuring the intangible resources, which may include CSR. This resource requires qualitative evaluation, while also being subject to the process of subjective verification. From the viewpoint of the usefulness of CSR, an enterprise is becoming the subject of quantitative analysis. It is also necessary to underline the difficulty of identifying them in this notion. (Krupski, 2011)

By referring to the research results in the sphere of intangible values, it is necessary to emphasize the importance of social values within the framework of which the relation to the environment and approach of the enterprise towards the environment is defined. The leading values have become the processes of sharing, protection, social responsibility, sustainable growth and the environment. The research was conducted by availing of the analysis of the variants. The comparison of the level of social values in the strategies of Polish enterprises with relation to international enterprises results in the fact that Polish enterprises are featured by a decisively lower level of social values on the market (approximately 30%). (Rzemieniak, 2013)

On the basis of the afore-mentioned results, as well as the deliberations conducted, it is necessary to emphasize the social approach of enterprises.

Hence, the process of the growth of trust with regard to the realization of the business activities of enterprises takes place. This is confirmed by the number of respondents who respond to the positive impact of the social approach of enterprises towards trust with regard to this type of entities (almost 80%). (Malara, Kroik, 2011) Thus, an important problem in an enterprise of a social approach is the perception of organizational changes that accompany business entities.

Hence, the social approach of enterprises is required in an increasingly broader area of activity. The strategic problems of the circumstances influencing the illustration and perception of the social approaches of enterprises and entrepreneurs are becoming more important.

2. Concepts of functioning of social entrepreneurs

The category of a social enterprise remains in direct relations with human resources by creating various approaches. In human resources, a key role is played by entrepreneurs who display an increasing level of social attitudes.

In the social definition, entrepreneurs are illustrated by activity involving the reconfiguration of the resources held for the realization of the social aim. With regard to the scope of the problem, it is justifiable to conduct a classification of social entrepreneurs. (Zając, 2014)

In the group of social entrepreneurs, the following are distinguished: local social initiators, social constructors and social engineers. Each of these groups are given a scale, scope and area of activity. Furthermore we identify the motive of activity and social significance, together with the evaluation of the impact on the social balance. As a consequence, the source of the advantage of social entrepreneurs is emphasized, assuming that the data of the European Commission (KOM 2011/682) indicates that one fourth of enterprises in Europe are of the nature of social enterprises. (Kurczewska, 2012) Hence, the continued propagation of the importance of social enterprises is significant.

The social nature of entrepreneurs is indicated by the aspect of the variety of the economic sphere and trends in the behaviour of society. (Grabowska, 2014)

It is possible to distinguish managers in the group of entrepreneurs by defining their role and social approaches in an enterprise.

An interesting research project on the scope of the role and functions of a manager in organizations was conducted by J. Niemczyk, R. Trzaska. (Niemczyk, Trzaska, 2014) In the first stage, the identification of the features of the analysed managers from Europe and the USA was conducted (Fig. 1).
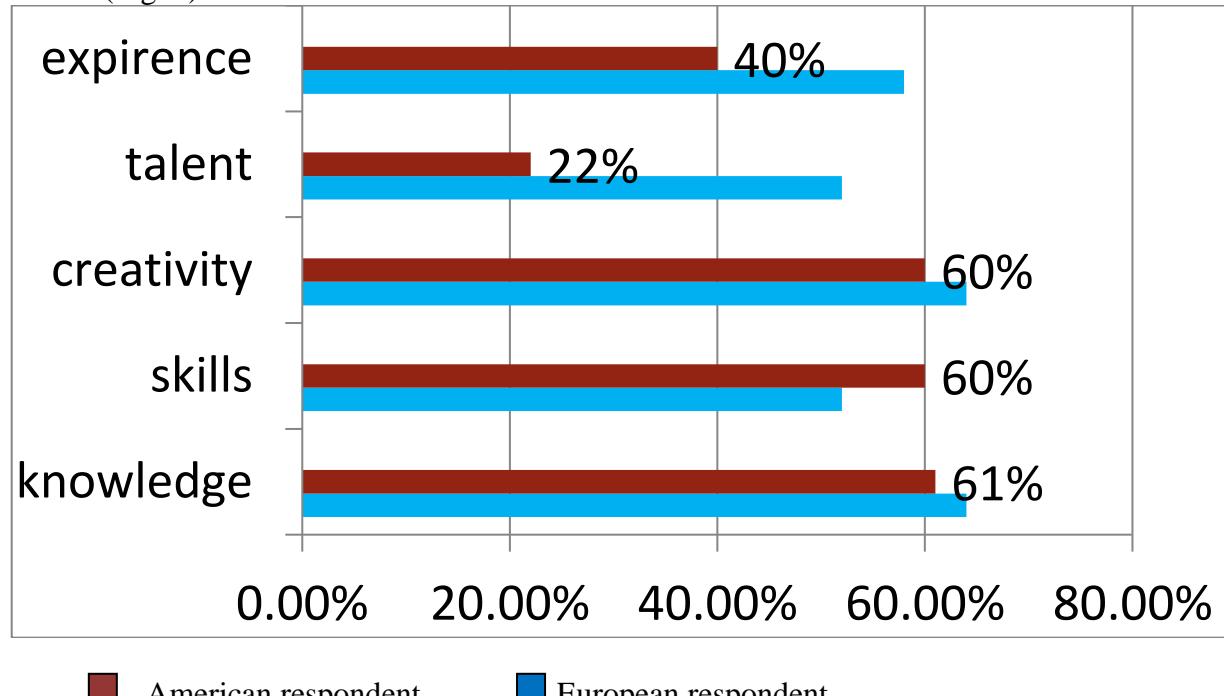
Fig. 1. Structure of the indications of the source of advantage of network managers over other managers in network organizations.
Source: (Niemczyk, Trzaska, 2014)

Managers from Europe and the USA acknowledge the following in terms of building competitiveness: creativity, skills and experience. Few indications related to talent as the source of competitive advantage. It is worth referring to the following statement in this sphere: The talent of managers constitutes one of the most important elements in terms of creating the development of

enterprises. (Chodorek, 2013) In general terms the aforesaid dependence may be stated as the fact that the talent of managers of enterprises creating networks is decisive with regard to the potential for the development of a network, as well as the particular enterprises in the network.

In the subsequent stage, the area of the responsibility of managers in an international network was defined (Table 1).

Table 1. Structure of responses to questions relating to the area of the responsibility of a manager in an inter-organizational network

As a manager, you are responsible for, among other things:	Percentage of indications of European managers	Percentage of indications of American managers
mobilizing knowledge	55	60
acquiring innovations and knowledge	52	60
stability of organization in network	52	80
building trust	79	100
coordinating and harmonizing	82	60
creating ties between participants of organization	64	60
ensuring support in sphere of management	55	100
perceiving the contexts of activities of participants	42	80
concentrating on significant issues of activities	52	100
defining organizational roles	64	80

Source: (Niemczyk, Trzaska, 2014)

Analysis of the data reveals that the approximate level of responses for European and American managers refers to such areas as follows: mobilizing knowledge, the acquisition of innovations and knowledge, shaping the ties between the participants of organizations, while also defining the organizational roles. A significant advantage in terms of these indications is featured by the American managers over their European counterparts in the sphere of the following: the stability of an organization in the network, building trust, ensuring support in the sphere of management, perceiving the context of the activities of the participants of the organization, concentrating on the significant issues of the activities and defining the organizational roles. A contrasting nature of dependencies exists between the European and American managers, namely the percentage of indications of the European managers is higher with relation to the American managers only in the area of coordination and harmonization.
The authors of this research in terms of summing up the interpretation indicate that the afore-mentioned differences are determined by cultural circumstances. The notion of the behaviour of an American manager comes down to the perception of the problem of management, while the European manager pursues the realization of an aim and significantly restricts analysis of its past. (Niemczyk, Trzaska, 2014)

Nevertheless, it is essential to underline the change in the approach of the manager and entrepreneur. This approach is clearly evolving in a pro-social direction by taking account of the innovative aspect.

3. **Pro-innovative activity of enterprises. Social aspect**

The activities of enterprises of an unequivocal social nature requires taking the aims of the market economy into account. With relation to these, competitiveness is of fundamental importance in terms of which category is determined by a greater sphere by the innovativeness of enterprises.

Each of the areas of competitive potential is served by pro-innovative activities. The sphere of research and development activities that create pro-innovative activities has been displayed.

Furthermore, in the activities distinguished production, quality management, logistics, marketing, finance and employment may be found. The afore-mentioned areas encompass practically the whole sphere of the activities of an enterprise, which are directed at the social nature of the tasks executed. Hence, it is possible to state the relation between the social nature of an enterprise and its pro-innovative activities. Likewise, it is necessary to refer to the correct view of R. Krupski who summed up the relations of the environment, open innovations, while also cooperation and competitiveness. A new sense of purpose creates new competitive potential. A new paradigm of management is created that is based on the creation of an environment of competitive cooperation and open organizational solutions. (Krupski, 2014) The aforesaid deliberations of cooperation directly refer to the social nature of the activities of an enterprise.

The context of the social nature of enterprise and innovativeness directly corresponds with social innovations. The aspect of social innovations is perceived in terms of the aspect of the enterprise at hand, while also the category of activity, effects, as well as the ability to create this type of innovation.

In order to illustrate the problem, it is possible to refer to empirical research on such enterprises as the following: AVNA, CEMEX, CLIFFORD-Chance, Deloj, TTE, Żywiec SA, Lotos. In the case of the particular enterprises, a type of category of activity was defined, as well as the benefits of the simultaneous display of social innovations.

It would seem that from the viewpoint of management, the projects of CLIFFORD-Chance and Lotos Group are deserving of mention. The project of CLIFFORD-Chance provides aid for students of law of low incomes. The aim of the project is to break through the stereotypes, and as a consequence change the social structure of the legal environment. The project of the Lotos Group was directed at transferring information relating to new strategic aims to all the employees. By means of improving the internal communication, it is assumed that the growth of the integration of employees shall occur, who increasingly identify with the strategic aims of the Lotos Group. (Kroik, Malara, Skonieczny, Swida, 2014) A better perception of strategies would enable the improvement of interpersonal relations and motivation of employees. The afore-mentioned examples confirm the pro-innovative activities of enterprises. Furthermore, their nature indicates the social direction of the functioning of enterprises.

Summary

The changes of the conditioning of the functioning of enterprises have a significant impact on the scope, function and first and foremost the nature of the activities of business entities. Globalization and competitiveness lead to the fact that the strategies of enterprises take account of not only financial parameters, but in multi-criteria analyses there is an increasing presence of the category of the social approach of enterprises. In terms of competition, this type of approach must also represent entrepreneurs and managers. This type of activity favours the conditions of the functioning of enterprises, which involves the possibilities of preparing and implementing the appropriate projects of the European Union. Analysis of the subject for analysis in terms of the scope of the projects of the European Union reveals that those preferred are ones that are characterized by the innovativeness and social tendencies of enterprises. Projects of this nature shall constitute a significant motive that guides an enterprise towards a social approach. However, regardless of projects, the general attitude of society is towards the creation of the pro-social approach of enterprises functioning in the market economy.

Literature

1. Adamczyk J., Raportowanie społecznej odpowiedzialności przedsiębiorstw. Przegląd organizacji Nr 4/2013.

2. Chodorek M., The role of talent management in creating pro-developmental outcomes of positive organizational potential. in: Positive Management. Managing the key areas of

positive organizational potential for company success. Edited by M. J. Stankiewicz, Dom Organizatora ,TNOiK, Toruń 2013.

3. Duraj J., Determinanty trwałości i wartości działania przedsiębiorstw społecznych. W: Restrukturyzacja. Teoria i prakty6ka w obliczu nowych wyzwań. ed. A. Jaki, J. Kaczmarek, T. Rojek, Uniwersytet Ekonomiczny w Krakowie, Kraków 2011.

4. Fudaliński J., Koncepcja zarządzania społecznego organizacjami trzeciego sektora (zarys problematyki): Przegląd Organizacji 1/2013.

5. Glińska-Newes A., Rola kapitału społecznego organizacji w kształtowaniu jej kapitału intelektualnego. [in:] Nowe kierunki w zarządzaniu przedsiębiorstwem – wiodące orientacje, ed J. Lichtarski, S. Nowosielski, G. Osbert –Pociecha, E. Tobaszewska-Zajbert. Prace naukowe Uniwersytetu Ekonomicznego we Wrocławiu Nr 340, Wrocław 2014.

6. Grabowska M., Percepcja i motywy przedsiębiorczości w Polsce i w wybranych krajach. [in:] Przedsiębiorczość. Strategie i metody. ed N. Duraj i A. Pieloch-Babiarz, Wydawnictwo Uniwersytetu Łódzkiego, 2014.

7. Kroik J., Malara Z., Skonieczny J., Swida A., Innowacje społeczne z perspektywy wartości ekonomiczno-społecznej. [in:] Potencjał intelektualny i innowacyjny w zarządzaniu organizacją. Ed. by: J. Dudzik-Lewicka, H. Howaniec, J. Klisiński, W. Waszkiewicz, Akademia Techniczno-Humanistyczna, Bielsko-Biała 2014.

9. Krupski R., Innowacje wartości i innowacje otwarte w kontekstach odpowiednich dla nich strategii. W: Kreatywność, Innowacyjność, Przedsiębiorczość. Zarządzanie operacyjne w teorii i praktyce organizacjach biznesowych, publicznych i pozarządowych. ed. L. Kowalczyka, F. Mroczko. Prace naukowe WSZiP T.30 Wałbrzych 2014.

10. Krupski R., Strategiczna użyteczność zasobów. Koncepcja i wyniki badań. Wyd. Restrukturyzacja. Teoria i praktyka w obliczu nowych wyzwań. Red. A. Jaki, J. Kaczmarek, T. Rojek, Uniwersytet Ekonomiczny w Krakowie, Kraków 2011.

11. Kwiecińska M.: Koncepcje społecznego zaangażowania przedsiębiorstw CCJ (Corporate Cominumity Invodrement). Teoretyczne i praktyczne podstawy zmiany w postrzeganiu roli przedsiębiorstwa w otoczeniu, [in:] Nowe kierunki w zarządzaniu przedsiębiorstwem – wiodące orientacje, ed J. Lichtarski, S. Nowosielski, G. Osbert –Pociecha, E. Tobaszewska-Zajbert. Prace naukowe Uniwersytetu Ekonomicznego we Wrocławiu Nr 340, Wrocław 2014

12. Kurczewska A., Przedsiębiorczość społeczna jako nowy kierunek rozwoju świata. Przegląd Organizacji 12/2012

13. Malara Z., Kroik J., Odpowiedzialność społeczna przedsiębiorstwa. Znaczenie i wpływ CSR na problemy restrukturyzowanych przedsiębiorstw. [in:] Restrukturyzacja, Teoria i praktyka w obliczu nowych wyzwań. ed A. Jaki, J. Kaczmarek T. Rojek. Uniwersytet Ekonomiczny w Krakowie, Kraków 2011.

14. Martin R., Kemper A., Saving the Planet: A Tule of Two Strategies, „Harvard Business Review", April 2012, followed by J. Polowczyk: Ratowanie planet: Opowieść o dwóchstrategiach. Przegląd Organizacji 5/2012.

15. Nitkiewicz T., Ekologiczna ocena cyklu życia produktu w procesach decyzyjnych przedsiębiorstw produkcyjnych, Politechnika Częstochowska, Częstochowa 2013.

16. Niemczyk J., Trzaska R.: Zarządzanie w sieciach międzyorganizacyjnych z perspektywy ról i funkcji menedżera. [in:] Nowe kierunki w zarządzaniu przedsiębiorstwem wiodące orientacje. Ed. J. Lichtarski, S. Nowosielski, G. Osbert - Pociecha, E. Tabaszewska - Zajbert, Prace naukowe Uniwersytetu Ekonomicznego we Wrocławiu nr 340. Wrocław 2014.

17. Rzemieniak M., Zarządzanie niematerialnymi wartościami przedsiębiorstw. Dom Organizatora, TNOiK, Toruń, 2013

18. Sokołowska A., Teoretyczno-metodologiczne dylematy związane ze społeczną odpowiedzialnością przedsiębiorstwa. [in:] Nowe kierunki w zarządzaniu przedsiębiorstwem wiodące orientacje. ed: J. Lichtarski, S. Nowosielski, G. Osbert - Pociecha, E. Tabaszewska - Zajbert, Prace naukowe Uniwersytetu Ekonomicznego we Wrocławiu nr.340. Wrocław 2014.

19. Zając Cz., Procesy integracyjne w warunkach przejęć i fuzji przedsiębiorstw- Aspekty organizacyjne i społeczne. [in:] Nowe kierunki w zarządzaniu przedsiębiorstwem – wiodące orientacje, ed. J. Lichtarski, S. Nowosielski, G. Osbert –Pociecha, E. Tobaszewska-Zajbert. Prace naukowe Uniwersytetu Ekonomicznego we Wrocławiu Nr 340, Wrocław 2014.

Net Zero Energy City: Prospects of Microalgae Architecture

Kyounghee Kim, University of North Carolina Charlotte

Abstract

Net zero energy practice has gained a global trend in the past few years in response to climate change design imperatives. To that end, buildings are required to balance its energy consumption and self-sufficiency by integrating multifunctional building enclosures, energy efficient building service systems, and on-site renewable energy production potentials. The study therefore aims to assess the prospect of microalgae architecture as a way to achieve net zero energy buildings. A multidisciplinary investigation on understanding the feasibility of microalgae architecture is proposed, focusing on sustainability and technological issues to support a net zero energy city vision.

Keywords: climate change design imperatives, net zero energy city, microalgae architecture, multifunctional building enclosures, energy efficiency

1. Introduction

Urbanization is expected to continue. It is estimated that world's urbanization rate has reached 50% as of 2010 and six billion urban residents are expected to live in cities by 2050 (UN, 2014). Rapid urbanization and population growth has increased building, industry, and transportation sectors, aggravating climate change and environmental quality. The building sector worldwide is a primary contributor of global energy use, raw material consumption, and pollution emissions. Urban development is typically accompanied by the loss of green areas. As a result of increased urbanization and loss of nature in urban settings, people living in dense cities have a higher risk of respiratory and cardiovascular sickness compared to less urbanized areas (WHO, 2016). As both urban population and buildings will increase, it is imperative to find ways to reduce resource consumption and environmental impacts.

Net zero energy practice has become a global trend in the past few years. The building industry around the world aims to adopt more stringent building regulations and voluntary actions for energy conservation. For example, US Department of Energy targets to attain marketable net zero energy residential buildings by 2020 and net zero energy commercial buildings by 2025 (DOE, 2016). EU aims a "zero energy goal" for all new buildings by 2020 while UK is committed to cut carbon emissions by 80% by 2050 (Recast, 2010). To that end, there requires an integrative design approach

where building energy required for operation and maintenance of a building is equal or less than the renewable energy supplied through on- site renewable energy resources. Building energy could be reduced by good building envelope design and the integration of energy efficient building service system. Renewable energy systems in situ should be tied to buildings and communities to expense energy consumption by building service systems. The local weather characteristics such as temperature, solar radiation, relative humidity, wind rose, rainfall and so on should be incorporated in designing building enclosures, the selection of HVAC systems, and on-site energy production system.

Recently, microalgae architecture have also drawn the attention of the building industry in the field of
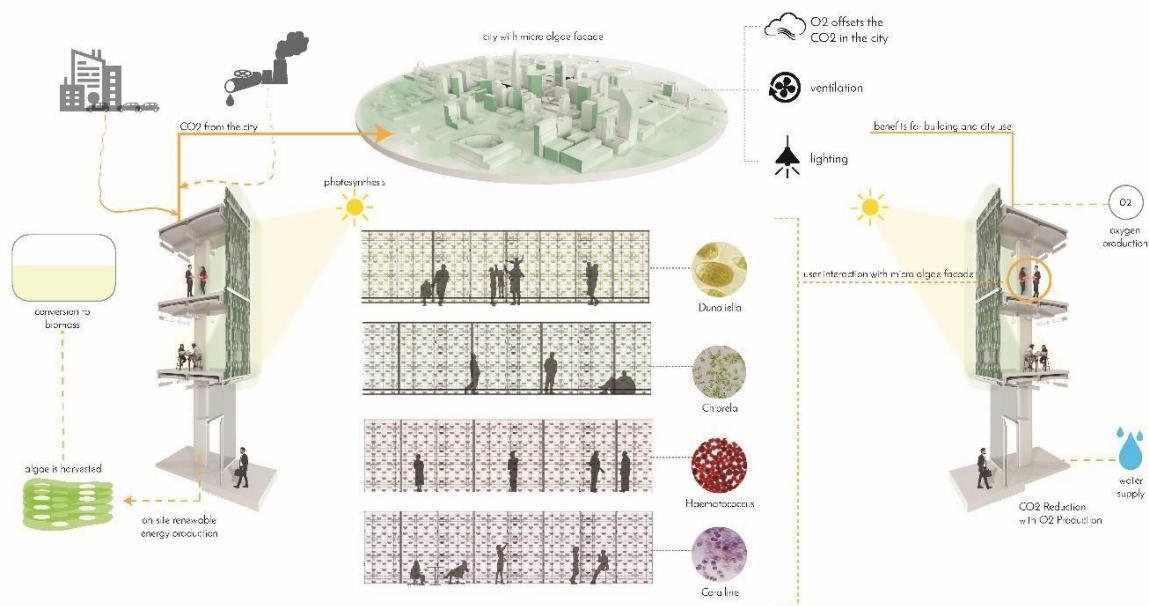
net zero architecture practice due to their potential role in building energy conservation and on-site renewable energy production (Figure 1). The microalgae architecture as symbiosis between microalgae and the built environment use CO2 from buildings and inhabitants to produce O2 and biomass. In return, photosynthetic microalgae benefit the building and occupants by providing good air quality and energy efficiency. The dynamic shading efficacy of microalgae, depending on the seasons, keep out summer solar gain while maximizing winter solar penetration. The biomass of microalgae adds insulative attributes of building enclosure. The integration of a viewing system within microalgae building enclosures offers good daylighting potentials for occupants. All environmental performance from microalgae architecture aims to reduce building energy consumption of heating, cooling, ventilation, and artificial lighting while biofuel production on site can offset such energy use.

Figure 1 Lifecycle performance of microalgae architecture toward net zero energy city; Energy conservation, on-site renewable energy production, and CO2 fixation as well as O2 generation from microalgae architecture

2. Why Microalgae Architecture?

Microalgae, or planktonic algae, are aquatic, single-celled microorganisms that contain chlorophyll A. These photosynthetic microorganisms use light energy to convert water and CO2 into biomass. Different algae species contain various colors such as green, cyan, brown, orange, blue, and so on. Energy producing microalgae are typically green (Elrayies, 2018). A considerable amount of research on microalgae biofuel has been conducted and emerging technologies have led to the development of biofuel production using microalgae. Microalgae could contribute to a sustainable and economical alternative to fossil fuel due to their high growth rate, reduced land requirement and high production rate for biomass and fuel. Corn, for example, requires an area twice the size of the United States to harvest 210B gallons of biofuel gallons while algae only requires an area the size of North Carolina (around 50,000 sq. miles) to grow an equivalent amount of biofuel (DOE, 2012; Niblick & Landis, 2016).

In addition to biofuel production, microalgae are known to offer ecological sustainability by improving water quality, air quality, and soil quality while encouraging biodiversity and minimizing greenhouse gas emissions. For example, microalgae serve as a cost-effective and sustainable means for domestic wastewater treatment and water sanitation due to their ability to provide oxygenation by photosynthesis (Spolaore, et al., 2006). Likewise, microalgae's photosynthesis and fast growth rate could effectively offset anthropogenic CO2 emissions. Scientific data indicate that microalgae produce 60% of the oxygen on Earth while using up CO2 (Elrayies, 2018). Another potential use of microalgae is the bioremediation of soil pollution. Research suggests that microalgae can fixate pesticides, heavy metals, and toxic pollutants in soil. Moreover, they serve socioeconomic sustainability by offering social well-being (e.g. employment, food security), energy security, and resource conservation (Elrayies, 2018).

Microalgae architecture has potential to harvest on-site biofuel and therefore, reduce our dependence on non-renewable resources to operate buildings and cities. Currently the microalgae biofuel industry is growing remarkably with investments from government and private companies. Microalgae as photocatalyst can help remediating contaminated soil, waste water, and polluted air in

the built environment. Furthermore, microalgae buildings could serve as a primary sink for anthropogenic pollutants, providing a great potential to promote physical and psychological well-being. We have developed a series of prototyping for microalgae building enclosure application, and in the process of evaluating biological performance such as O2 reduction and biofuel production potential.

3. Toward Net Zero Energy City

The concept of net zero energy city can be defined as the reduction of site energy and the generation of renewable energy in situ to offset the primary energy consumption. In other words, net zero energy city balances its energy consumption with renewable energy production in situ such as a photovoltaic system and wind turbine system. The primary energy consumption in cities consist of the building, transportation, and industry sectors where higher energy demand of cities is concentrated in buildings. The integration of renewable energy systems in buildings and communities is therefore a way to achieve self-sufficiency of cities, fueling the primary energy need and lowering CO2 emissions. Energy efficiency and self- sufficiency of buildings are key design strategies toward net zero cities. Microalgae system in various architectural applications could help both energy efficiency and energy self-sufficiency. Benefits of microalgae architecture include reduced building energy consumption, renewable energy production, reduced environmental impacts, biodiversity, as well as occupants' physical and psychological well-being. Energy efficiency of microalgae architecture is achieved through good R-value, dynamic solar heat gain coefficient (SHGC), daylight transmission, and O2 generation. Self-efficiency of microalgae architecture could be determined by biomass and biofuel production rate.

A key to achieving a net zero energy city is to improve the energy efficiency of old urban buildings by retrofitting obsolete building enclosures with high performance microalgae integrated building enclosures. In comparison to new construction, building enclosure retrofitting is a cost effective option that provides economic benefits and ecological sustainability, while at the same time improving occupants' well-being and contemporary images of a building to the city context. The microalgae building enclosure as an alternative to old buildings is expected to more energy-efficient buildings due to improved U-factors, good shading efficacy, and daylighting performance. While costs in the short term may appear to favor traditional window façade systems, the long-term implications for microalgae building enclosures include reduced natural resource usage and building operational costs with good air quality for the built environment.

The new development of microalgae building enclosures builds on earlier results with the aim of further developing the microalgae building enclosure into a prefabricated curtainwall unit with cost-effective constructability and long-term durability for tall building application in a dense urban site. The presence of microalgae in constructed environments may be perceived negatively, and it is important to improve specific user perceptions with an emphasis on interactive features that can reduce negative perceptions, enhance creativity and cognitive performance, and improve an occupant's well-being. The microalgae curtainwall system aims the compliance of building codes and national industry standards for scalable industrialization in the building industry.

4. Conclusions

The building sector requires environmental stewardship in relation to energy conservation and climate change. Microalgae architecture could be part of net zero energy practice and has pushed the boundaries for new development and architectural application. One such development would retrofit the low energy efficient building stocks with microalgae building enclosures where energy conservation and user comfort can be achieved due to its energy efficiency, on-site biofuel production potentials as well as CO_2 fixation and O_2 generation. This paper identifies some prospects of microalgae architecture in achieving net zero energy city vision.

Bibliography

1. Dincer, I., Colpan, C. & Kizilkan, O. (Eds.). (2018). Exergetic, energetic and environmental dimensions. London, UK: Elsevier.
2. Elrayies, G. (2018). "Microalgae: prospects for greener future buildings", *Journal of Renewable and Sustainable Energy Reviews*. 81, 1175-1191.
3. International Energy Agency. (2018). CO2 emissions form fuel combustion 2018 highlights. Last modified in November 2018. https://webstore.iea.org/co2-emissions-from-fuel-combustion-2018- highlights
4. International Renewable Energy Agency. (2017). Renewable power generation costs in 2017. Last modified in Jan 2018. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Jan/IRENA_2017_Power_Costs_2018.pdf
5. Kim, K. (2013). A feasibility study of an algae façade system", Proceeding of International Conference in Sustainable Buildings, 333–41

6. Niblick, B. & Landis, A. (2016). Assessing renewable energy potential on Unite States marginal and contaminated sites. Renewable and Sustainable Energy Reviews, 60, 489-497

7. Recast, E.P.B.D. (2010). Directive EU of the European parliament and of the council on the enrgy performance of buildings. Last modified in May 2010. https://umanitoba.ca/faculties/engineering/departments/ce2p2d/alternative_village/media/1_eceee_bu ildings_policybrief2010_rev.pdf&gt

8. Spolaore, P., Joannis-Cassan, C., Duran, E., & Isambert, A. (2005). Commercial Applications of Microalgae. *Journal of Bioscience and Bioengineering,* 101(2), 87-96.

9. United Nations, Department of Economic and Social Affairs, Population Division. (2014). World Urbanization Prospects. Last modified in 2014. https://esa.un.org/unpd/wup/publications/files/wup2014-highlights.pdf

10. U.S. Department of Energy. National Algal Biofuels Technology Review. Last modified in June 2016. https://www.energy.gov/sites/prod/files/2016/06/f33/national_algal_biofuels_technology_revie w.pdf

11. U.S. Energy Information Administration (EIA). (2015). Annual energy outlook. Last modified in April 2015. https://www.eia.gov/outlooks/aeo/pdf/0383(2015).pdf

Pattern Recognition and Sentiment Analysis in Social Internet of Things

Carol Lee, University of Massachusetts -Boston
Carol.Lee002@umb.edu

Abstract

Social Internet of Things (SIoTs) can be used to understand the social relationships between connected devices and people to explore patterns in their actions and behaviors. SIoTs can be considered as "a universal framework to combine users, devices and services and the interactions among them" and may lead to the creation of novel services and applications due to the interactivity, recommendation and filtering, and services composition capabilities (Ortiz et al., 2014). There are many types and characteristics of the social relationships, such as co-location object and ownership object relationships, that have been statistically analyzed to understand the probability distributions of the distance between nodes (Nitti et al., 2015).

Social media can be a way to diffuse information, especially during natural or industrial disasters (Segault et al., 2017). Smart devices that incorporate social media can help understand the sentiment of the textual content within the social networks as "objects may have a social consciousness and may exhibit social behaviors allowing them to build their own social network of objects" (Gil et al., 2016). An experiment was used to automatically analyze Twitter tweets to sense home care functions, such as when someone finished a meal or entered or left the room (Kranz et al., 2010). Furthermore, a new framework for dynamic SIoT services discovery was developed to understand users' situational needs, preferences, and other social aspects based on a cognitive reasoning approach. However, there are limited studies investigating the social media capabilities of SIoTs and how they can be used to understand the social relationships.

This research will provide an exploratory analysis for pattern recognition in social media in the context of SIoTs. The use of smart device and social media data from Twitter will be conducted to answer the following the research question: What are the individuals' sentiment patterns exhibited in the networks of social internet of things? The potential contribution of this study is to discover users' actions, behaviors and their patterns in SIoTs. Practically, this study may help improve applications in home care, medical settings, and disaster recovery using location and context aware capabilities.

Keywords: social internet of things, smart devices, sentiment analysis, network analysis

REFERENCES

Gil, D., Ferrández, A., Mora-Mora, H., and Peral, J. 2016. Internet of things: A review of surveys based on context aware intelligent services. *Sensors*, 16(7): 1069.

Kranz, M., Roalter, L., and Michahelles, F. 2010. Things that Twitter: Social networks and the internet of things. In *The Eighth International Conference on Pervasive Computing* (Pervasive 2010), 1-10.

Nitti, M., Atzori, L., and Cvijikj, I. P. 2015. Friendship selection in the social internet of things: Challenges and possible strategies. *IEEE Internet of Things Journal*, 2(3): 240-247.

Ortiz, A. M., Hussein, D., Park, S., Han, S. N., and Crespi, N. 2014. The cluster between internet of things and social networks: Review and research challenges. *IEEE Internet of Things Journal*, 1(3): 206-215.

Segault, A., Tajariol, F., and Roxin, I. 2017. Tweets from Fukushima: Connected sensors and social media for dissemination after a nuclear accident. *Internet of Things: Evolutions and Innovations*, 4: 169-187.

Developing Analytic Skills in Higher Education through Sports-related Project

Carolyn LaMacchia, Bloomsburg University of Pennsylvania

Abstract

This research addresses the need to develop a skill set in analytics in higher education through the development of an interesting analytics project. Predictive analytics involves the study of historical data to identify potential trends that may be used to support decision making efforts. There is much interest in the topic of sport analytics and quantitative methods in both academics and industry. Sports analytics has been adopted and integrated into decision-making processes of both college and professional sport teams since it was first introduced about 15 years ago. In addition, research supports the use of hands-on activities as a successful technique to motivate learners. Hands-on activities which address personal interests and develop a competitive spirit have been shown to increase student engagement. This study develops an exercise for students to apply analytics techniques, competing against one another, to the predict outcomes in the NCAA Basketball Championship Tournament. Students determine and collect appropriate data then work with technology to develop the model. To emphasize the appropriate learning objectives, the exercise will also include discussion about personal and societal impact of sports wagering.

Digital Transformation at LSPs: Barriers, Success Factors, and Leading Practices

Marzenna CICHOSZ, Ph.D.*

SGH Warsaw School of Economics, Poland

Marzenna.Cichosz@sgh.waw.pl

Prof. Carl Marcus WALLENBURG, Ph.D.

WHU – Otto Beisheim School of Management, Germany

Carl.Wallenburg@whu.edu

Prof. Thomas J. GOLDSBY, Ph.D.

Fisher College of Business, Ohio State University, US

goldsby.2@osu.edu

Prof. A. Michael KNEMEYER, Ph.D.

Fisher College of Business, Ohio State University, US

knemeyer.4@osu.edu

 *Corresponding author

"Digital technologies can now become just as important to society and the economy as the steam engine once."
Brynjolfsson and McAfee (2014, p. 19).

Abstract

The rapid advancement of digital technologies has fundamentally changed the competitive dynamics of industries, including the logistics service industry. To cope with an increasingly unstable environment and fully leverage the opportunities opened by new technologies, logistics companies need to transform their businesses. However, many of them still struggle to drive their digital transformation (DT) forward. This study aims to help logistics service providers (LSPs) understand the underlying factors that hinder or even stop DT, and identify success factors and leading practices for accomplishing digital transformation in the logistics service industry. The analysis is based on a two-stage effort to offer deeper insight into LSPs' understanding of what shapes success. Stage 1 is devoted to a literature review. Stage 2 analyzes multiple case studies utilizing semi-structured interviews with experts from five global LSPs and data from additional sources. The findings allowed to formulate the definition of DT in the logistics service industry, and revealed important barriers, as well as success factors and leading practices observed in the case companies to overcome these barriers. The results contribute to the emerging field of the DT of logistics and supply chain management literature and provide insight for practitioners how to implement DT more effectively.
Keywords: technology, digitalization, digital innovation, success, logistics service provider (LSP)

A Multi-attribute Utility Decision Support System for Strategic Sustainable Energy Purchases

(Best Paper Award in Application of Theory)

Donald J. Jenkins
Management Information Systems, University of Massachusetts, Boston
donald.jenkins@umb.edu

Jeffrey M. Keisler, PhD
Management Information Systems, University of Massachusetts, Boston

Abstract

The procurement of energy for global companies continues to become more challenging with improved sustainable energy opportunities, increasing greenhouse gas compliance reporting, electricity market regulatory changes, and customer pressure for companies to be sustainable. With so many dimensions to the challenge, it is difficult to simultaneously weigh the options and make a fully informed decision. This situation calls for applying multiple tools from the decision analyst's toolkit to create a framework that will both clearly inform the decision maker, while providing an opportunity to incorporate the non-monetary values such as improved brand recognition or corporate sustainability. We evaluate such a framework in this paper by leveraging strategy tables and multi-attribute utility theory on an energy purchasing case study and build the model in the Analytica decision modelling software. The result is a holistic framework that can be replicated in many similar energy purchasing situations for decision-makers trying to balance the many complex dimensions.

1. Introduction

Energy procurement for global companies continues to become more challenging because of new corporate sustainability initiatives, increasing greenhouse gas compliance reporting, decreasing renewable energy costs, and continual electricity market regulatory changes, all compounded by companies trying to control costs as international competition grows (Google, 2011). Company executives, sustainability leaders, procurement professionals, and energy managers are faced with numerous objective decision-making situations requiring significant effort to make an optimal decision (Esty & Winston, 2009). Many companies find they don't have adequate decision-making frameworks in place for proper tactical decision-making at the facility or regional level, let alone ensuring company strategic initiatives and objectives are met more broadly. Ample literature exists in academia and industry that spells out challenges of integrating renewable energy and sustainability initiatives on a regional or country level. There is very little research covering the challenges from the perspective of a multi-national company looking to optimize energy purchasing strategies through a combination of achieving energy cost savings, managing volatile energy market risks, and meeting greenhouse gas reporting compliance requirements. Companies must balance these needs while aiming to optimally run their organization and improve their brand recognition. In this report, we will be applying multi-attribute utility theory decision-making along with strategy development methodologies to build a decision model that helps corporate decision- makers pick the optimal strategy based on anticipated energy usage combined with their applied utility function for energy cost, sustainability requirements, and brand prestige. We will incorporate best practices from similar

efforts in decision analysis and energy related journals to introduce a decision support framework, enabling holistic sustainable energy procurement management for global companies.

1. Background

A search for published research on multi-criteria decision-making (MCDM) in sustainable energy results in hundreds of articles, with several holistic reviews of articles published on MCDM in the energy decision space. The first holistic paper evaluated (Wang, Jing, Zhang, & Zhao, 2009) conducts a thorough review of more than 100 studies involving multi-criteria decision analysis aids in sustainable energy decision-making. This paper conducts a breakdown of criteria for what constitutes sustainable energy, methods for criteria selection, weighting methods, multiple MCDM analysis methods, and aggregation methods. Another holistic review paper (Kumar et al., 2017), also conducts a thorough review of MCDM application in sustainable renewable energy development. The authors evaluate sustainable and renewable energy for electrification of rural areas along five dimensions of sustainability indicators: Economic, Technical, Environment, Social/Ethical, and Organizational/Institutional. The authors also conduct a complete breakdown of the differing types of MCDM methods applied from eight possible MCDM methodologies, including the one we will apply in our framework – multi-attribute utility theory. Venturing a bit more afield in sustainability, the third comprehensive review paper (Ibáñez-Forés, Bovea, & Pérez-Belis, 2014) evaluates literature applicable to assessing and selecting optimal technology alternatives from a sustainability perspective. The authors similarly walk through the literature, bucketing selection criteria along five dimensions: Economic, Technical, Environmental, Social, and Political. These three review articles evaluated more than 300 papers, conducting thorough reviews of the application of decision-making methods for choosing sustainable material or energy from multiple criteria.

There is a gap in the research highlighted by the growing need for companies to also capture value from their demonstrated commitment to sustainability. In (Galbreth & Ghosh, 2013), the authors highlight the increasing importance of consumer awareness on sustainability and that consumers are deciding among competitors based on a company's focus on sustainability. In a recent study conducted from a company perspective, (Mydock III, et. al., 2018) evaluate how branding products as "made with renewable energy" will positively affect Australian consumers impression of a company. There is a dearth of articles that focus on developing decision support systems which allow companies to manage energy purchasing strategies which balance the competing priorities of short- and long-term energy costs with sustainability reporting requirements, while also enhancing brand prestige as a sustainability-focused company. Some papers do approach the challenge from a strategic perspective of defining corporate energy policy and strategy to achieve carbon emissions reduction targets (Finnerty, Sterling, Contreras, Coakley, & Keane, 2018), while others get to a more tactical decision support framework to support prioritizing energy efficiency projects in an industrial organization (Sterling, Coakley, Contreras, Keane, & Finnerty, 2017), but none tie all of the strategic needs together.

Sustainable energy choices are being made by global companies every day. In conducting this analysis, we had access to an Energy Solutions company that helps guide customers through the complicated process of developing and executing on sustainable energy purchasing strategies. We spoke with the facilitator of a recent strategic energy purchasing workshop held for a global company operating in Mexico. From that interview, we used the workshop information as a case study to better understand what the customer's priorities were and how the Energy Advisory team could help guide the customer to the "best" decision based on customer provided criteria. We then took that framework to evaluate creating a more structured and formal method to concisely capture, analyze, and present the possible

strategic options and outcomes. In the following, we will walk through the specifics for this particular case study, but the framework we create is generalizable to many situations where companies are making similar decisions.

2. Methods

In this research, we used the Lumina Decision Systems Analytica 5.0 decision support modeling tool to build, explore, and share the quantitative decision model presented in this research (Analytica, 2018). After evaluating the case study mentioned above, we synthesized the key elements discussed in the workshop and broke them down for creating a generalizable framework. We applied several decision support methodologies to the problem of balancing short/long term energy costs with the need to meet green reporting requirements and the strategic value of being able to leverage the purchase of more sustainable energy for building a better brand image. We will next discuss the multi-criteria decision-making tools included in this analysis, including the following: Strategy Table, Multi-attribute Utility Theory, and Sensitivity Analysis.

3.1. - Strategy Table Model Development

Many decisions come into play when weighing the type of energy to purchase. Based on the previously mentioned case study, we assigned five possible decisions that the decision-maker will need to make as they plan for their energy and sustainability needs. These decision points are shown in *Table 1*. *Table 1* represents an important subset of the decision points for this customer but is not a complete set of possible decisions that any firm may need to make. In *Table 1* there are $2^3 * 4^2 = 128$ possible combinations of decisions in just this relatively small table of choices. Not all of those options are feasible (e.g. "No Renewable Energy" should not be paired with "Own Green"), but there is still a non-trivial amount of complexity to the choices facing the decision-makers. To that end, the first tool used in mapping out the decision process was to apply a Strategy Table (McNamee & Celona, 2007) to enable reducing the decision set to feasible combinations of the decision points. In evaluating the case study, we synthesized five possible strategies that are different enough to ensure the alternatives are distinct. These five strategies are broken down as:
   1. Install, use, and maintain own green generation supply
   2. Purchase cheapest retail energy (assumed it is not green)
   3. Purchase green energy from supplier on a short-term basis, without a CAPEX investment
   4. Purchase green energy from supplier on a long-term basis, without CAPEX investment
   5. Offset non-green retail energy purchases with Renewable Energy Credits

Build or Buy	On or Off Site	Renewable Energy Strategy	Purchase Strategy	Equipment Type
Build Energy Supply	On-Site	Buy Green Energy	Retail Green	Existing
Buy Energy Supply	Off-Site	Buy Renewable Energy Credits	Own Green	New
		No Renewable Energy	Power Purchase Agreement	
		Use Own Energy	Retail Any	

Table 1 - Decision Options and Associated Options

Combining these strategic options with the decision choices in *Table 1*, and applying the appropriate option for each decision, we end up with the strategy table shown in *Table 2*.

Strategy Alternatives	Build or Buy	On or Off Site	Renewable Energy Strategy	Purchase Strategy	Equipment Type
Install own Green Gen	Build	On-Site	Use Own Energy	Own Green	New
Cheapest Retail Energy Cost	Buy	Off-Site	No Renewable Energy	Retail Any	Existing
No CAPEX w/ Green short-term	Buy	Off-Site	Buy Green Energy	Retail Green	Existing
No CAPEX w/ Green long-term	Buy	Off-Site	Buy Green Energy	PPA	Existing
Offset with RECs	Buy	Off-Site	Buy RECs	Retail Any	Existing

Table 2 - Strategy Table with Strategy Alternatives and Associated Decision Points

3.2. - Multi-attribute Utility Model Development

As seen in the literature review, there are many different methodologies to approach a multi-criteria decision analysis. For the purposes of our modelling, we choose the multi-attribute utility theory (MAUT) approach (Keeney & Raiffa, 1993) because of its relative simplicity. Its simplicity is important for explaining the inputs and results to decision-makers who may not have the background, time, or patience to understand the more mathematically complex approaches. In this model, we highlight three key attributes that come into play during the decision to select a strategy: Energy Cost, Green Value, and (Brand) Prestige Value.

3.2.a – Energy Cost

We use an Energy Cost calculation that is relatively straightforward based on expected energy usage, price rates for various parameters of usage, and time covered. We use this simplified method as a starting point, but acknowledge that electricity charges are often as unique as the utility tariff, country, utility, etc., as the customer will be using, so this model could get overly complicated quickly if we tried to replicate all possible charges (Capehart, Turner, & Kennedy, 2006). *Table 3* shows at a high level the cost factors that were used in this model broken down into two columns, those factors that were used across all strategies, versus factors unique to each strategy.

For all types of electricity, the data is ultimately summed up to evaluate the total cost over a twenty-year period. By looking over twenty years, we are able to estimate expected annual rate increases (e.g. Retail Elevator, PPA Elevator, Inflation Rate) for each scenario. Including these rates helps show the value of long-term contracts or potential risk of not locking-in rates in potentially volatile markets. Finally, for some types of electricity, in the model there are unique costs evaluated by applying a probability distribution to reflect each strategy's specific costs (e.g. CAPEX and OPEX for Install Own Green Gen).

3.2.b – Green Value

While most traditional business decisions are made with regard to cost, due to the introduction of sustainability regulations, greenhouse gas reporting, and science-based goals, there is now more focus on being green within companies (Esty & Winston, 2009). This value can be captured through economic means (e.g. selling renewable energy credits), utility value (e.g. greenhouse gas reporting requirements), or other numeric means (e.g. science-based targets for actual greenhouse gas reductions). For purposes of simplicity for this project, we treat Green Value as a utility value on a scale of 0 to 5. Although 0 to 1 is typically used in Decision Analysis, the scale of 0 to 5 was found to be more intuitive to the Energy Advisors and decision makers in this case study.

Strategy Alternatives	Cost Factors Used in Cost Calculations for Individual Strategies	Cost Factors Applied to all Strategies
Install own Green Gen	CAPEX and OPEX for installing and maintaining Green Energy Generaton	Energy usage by type (base, intermediate, peak) Peak demand for prior period Price rates (base, intermediate, peak, demand) Value added tax (VAT) Inflation rate Adder charges rate
Cheapest Retail Energy Cost	Retail Elevator and Possible Fines for failing to meet green regulations	
No CAPEX w/ Green short-term	Retail Elevator	
No CAPEX w/ Green long-term	PPA Elevator for contracted annual rate increases	
Offset with Renewable Energy Credits	Cost of Renewable Energy Credits	

Table 3 - Cost Factors Applied to Strategy to Determine 20-year Energy Cost

3.2.c – Prestige Value

Every company is always trying to get ahead of their competition (Porter, 1998). Energy purchasing has not been on the forefront of improving the corporate brand as energy was simply a commodity the procurement team worked to get as cheaply as possible. With the advent of increasing green energy opportunities, significant news coverage on climate change, and the changing regulatory environment, there are now significant opportunities for companies to leverage their energy purchasing strategy for improving the prestige of their brand (Winston, Favaloro, & Healy, 2017). For the purposes of this research, we treat Prestige Value as a utility value on a scale of 0 to 5, using similar reasoning for the Green Value index.

3. Model Design

For this analysis we used the software Analytica Optimizer 5.0 (Lumina, 2018) to map out the complexity, breaking the analysis down into five main modules.

As seen in ***Error! Reference source not found.***, at the highest level of the model we had one module each for the Strategy Table, the three attributes (Energy Cost, Green Value, and Prestige Value), and the MAUT Scores. The analytical output of the model is also available at this level of the model, including Outputs and Sensitivity Analysis (Tornado Charts) for Energy Costs and the Multi-attribute Utility Scores. There is one additional MAUT Score Importance node for an alternative sensitivity analysis using the variable importance functionality of Analytica. The Green Value, Prestige Value, and Energy Cost modules house all the inputs, variables, indices, and calculations necessary to provide outputs for each strategy alternative to act as the necessary inputs into the MAUT Score calculations.

Figure 2 shows the structure for the Strategy Table representation for *Table 2*. The Strategy Index node represents the strategy alternatives and the Decision Index node represents the decisions from the *Table 2* columns. The table is replicated in an array in the Strategy Table node, and the strategic decisions flowing throughout the model are based on the green Strategy Selection decision node. The five variable nodes representing the five decisions create individual arrays that are used for further calculation triggering throughout the rest of the model.
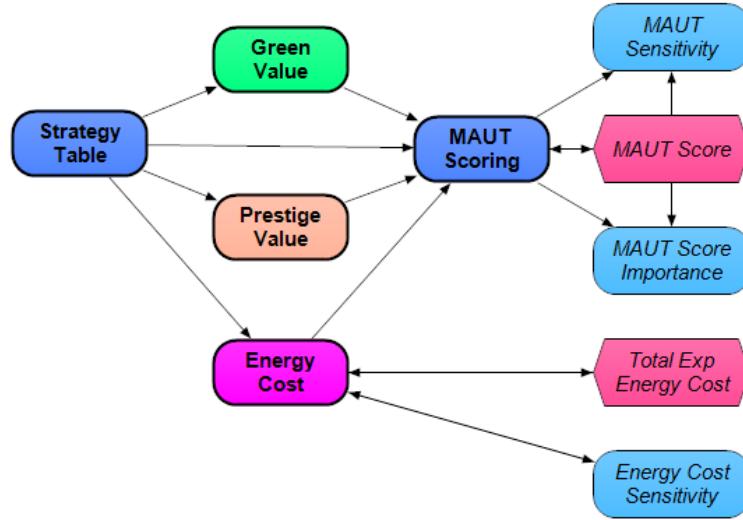
Figure 1 - Analytica Top Level of Decision Model
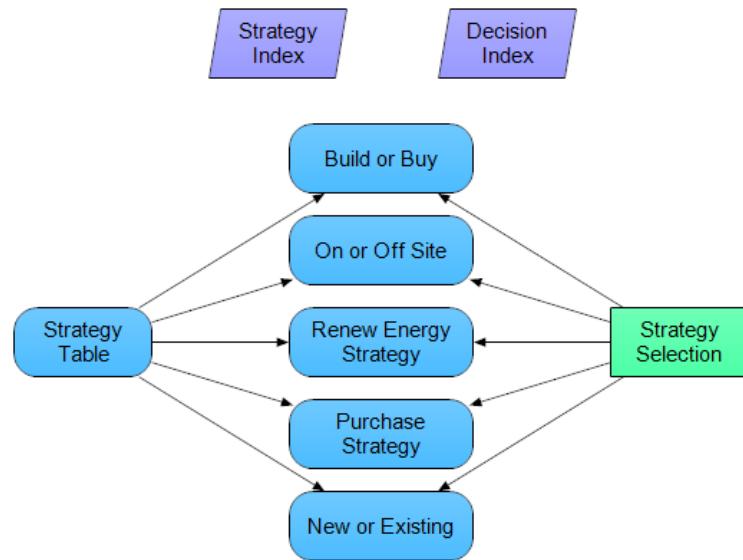
Figure 2 - Analytica Model Strategy Table Diagram

Figure 3 shows the model development within the Energy Cost module, the most complex of the three attributes represented in this model. All strategies for Electricity Rates and Electricity Costs are represented therein. Because different strategic alternatives have different costs, we also capture those unique costs in some of the other modules below. If a decision results in building and maintaining Green Gen equipment, those costs are modelled in the Cost to Build/Own module. If a strategy requires Renewable Energy Credits, then those costs are modelled in the Cost for RECs module. If the energy is from a non-green source and there is possible regulatory and penalty risk, those costs are modelled in the Cost for Fines module. All of the information from the different modules is brought back together in the Combined Costs by applying applicable costs to each of the strategic alternatives Energy Cost, which provides the final result in the Energy Cost Measure node.

Figure 4 shows the inner calculations for the Prestige Value and Green Value modules. For the purposes of this analysis, we used a simple combination of utility values (Utility Raw variables) for both the additive (Good) and detrimental (Bad) strategies and shaped them with probabilistic

distributions (Util Uncertainty variables). These values were combined into the attribute values to be passed on to the MAUT calculations as Prestige Measure and Green Measure. We believe keeping these modules simple for this analysis is appropriate given the very complicated nature of these attributes for potential companies who would all be evaluating these utility values differently based on their own individual corporate needs.
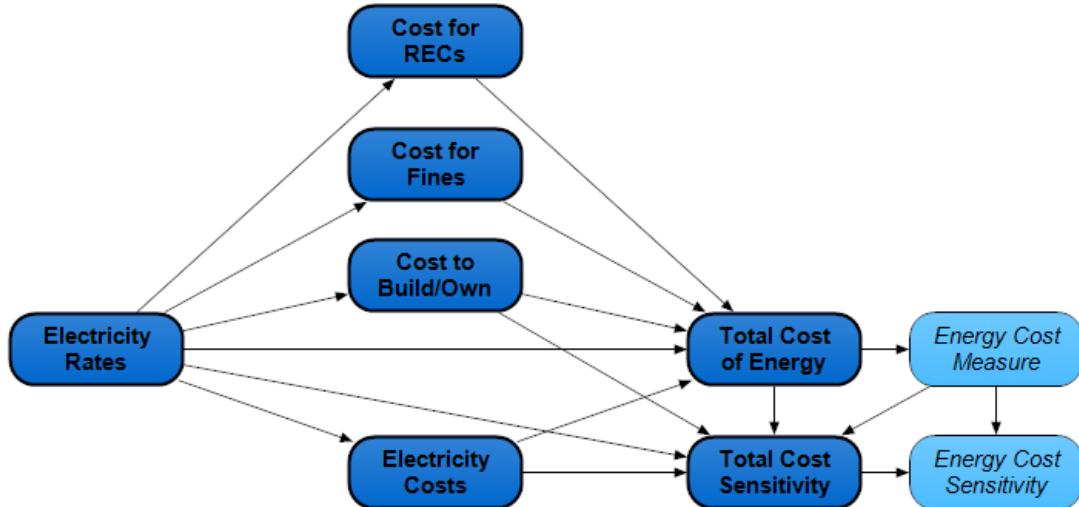
Figure 3 - Energy Cost Module Diagram
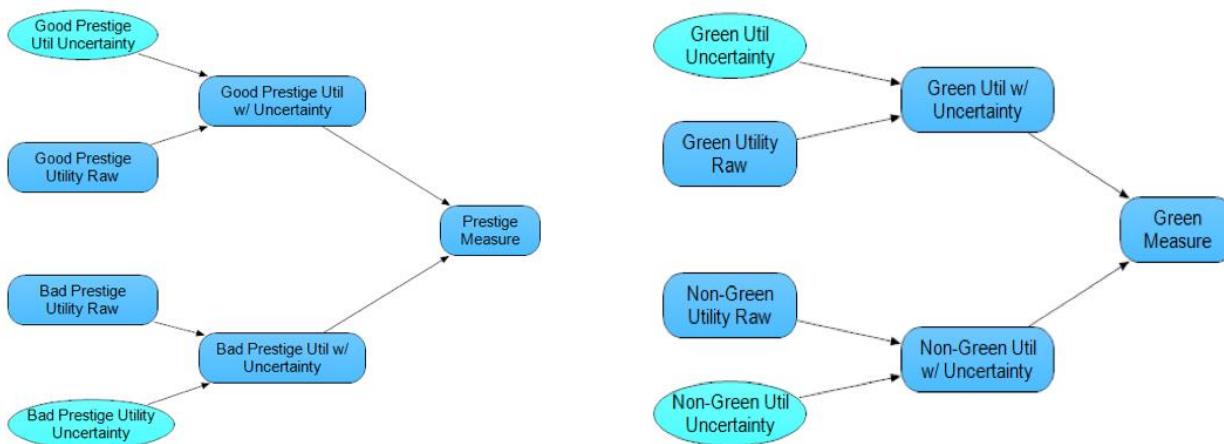
Figure 4 - Prestige and Green Value Model Diagrams

Figure 5 represents the multi-attribute utility scoring methodology. On the left are the raw score outputs from the Energy Cost, Green Value, and Prestige Value modules. Those raw scores are combined into a single table of values (Measures node) that are normalized to a 0 to 1 scale (Normalized Measures node). The next step converts the normalized measures into an exponential utility function (Exponential Utilities node) to account for risk tolerances of the decision-maker (Risk Exponents node). The scores are then weighted (Weighted Utilities node) based on their relative importance by multiplying each attribute's score by a weight (Weight Determination module) that is determined by the decision-maker or energy advisor. The final step is to sum up the attribute scores for all three attributes for each strategic alternative to give a resulting MAUT Score. There are a few other nodes as the MAUT module also houses the nodes used to calculate the Weights and MAUT

Sensitivity Analysis outputs.
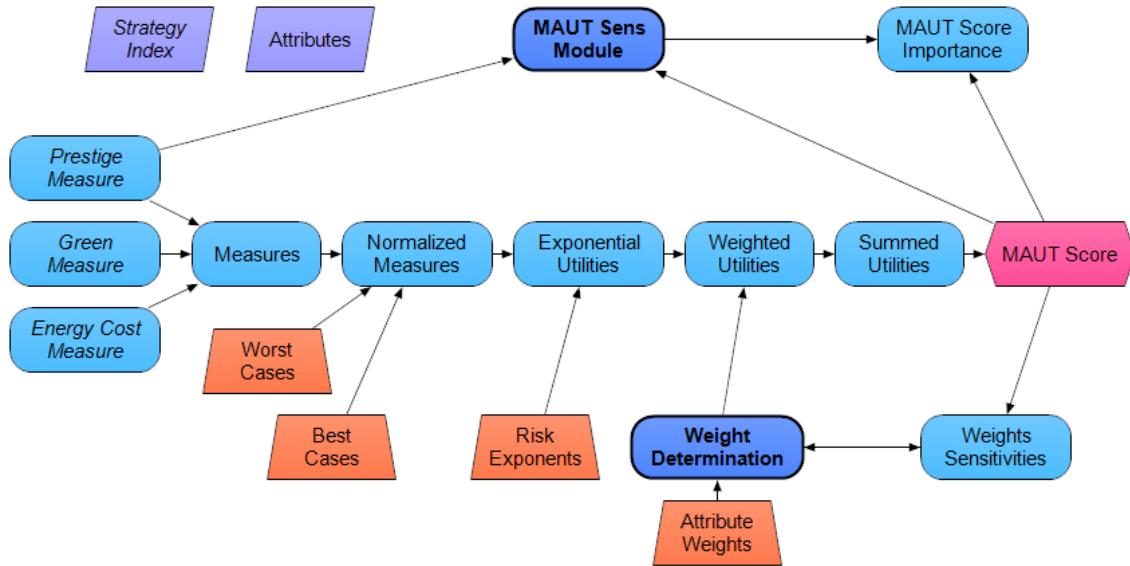
Figure 5 - Analytica Model Multi-attribute Utility Score Diagram

4. Data Summary

Next, we provide a discussion of the key data feeding the model and analysis, focusing on the three main attributes previously discussed. Understanding the data is an important element of understanding the decision model. This discussion will focus on explaining the data used in the case study, but the model framework is generalizable to numerous similar situations with different data formats and inputs.

For the Cost of Energy, we use a combination of actual values from the case study and estimates where necessary. The actual data used is historical energy usage and demand from the preceding 12 months, associated types of charges for that usage and demand, and Value Added Tax (VAT). This actual usage data feeds all the calculations for the different types of electricity, with the assumption that the customer's usage will be consistent regardless of electricity type procured. Using the retail cost rates, we built rate estimates for the other types of electricity. The Adder Rate is estimated by determining the percentage of historical bill expenses that were due to non-core charges, and then used that percentage as the baseline for the Adder Rate. The remaining inputs are all estimated based on energy advisor input, including PPA Elevator, Retail Elevator, Inflation Rate, CAPEX, OPEX, cost of Renewable Energy Credits, and possible Fines for not mitigating greenhouse gases.

The data used for both the Green Value and the Prestige Value are estimated utility values based on input from case study, with the caveat that the utility values will likely change based on the customer, the decision-maker's risk tolerance, and an individual company's strategy for energy procurement. We use a static number from 0 to 5 for the utility for each of the strategies, with 0 being least utility to 5 being highest utility. We make the utility values probabilistic by applying distributions that are skewed towards higher values if the strategy adds to the sustainability, or skews towards a lower value if the strategy does not. To achieve what we believe to be representative skews we use a Beta distribution for the Green Value and a Log-Normal distribution for the Prestige Value. Again, these distributions are representative of possible decision-makers inputs and could just as easily be represented with other distributions based on the scenario.

Finally, for the multi-attribute utility calculations we introduce additional shaping variables to properly calculate the final MAUT score. To start, we use upper and lower bounds to enable normalizing each attribute's measure to a value from 0 to 1. We use weights that allow each attribute to contribute to the overall score based on the value the decision-maker will provide to the advisory team. The weights must sum to 1 in order to keep the overall utility score bounded between 0 and 1. Finally, we provide a mechanism to apply the risk tolerance to each attribute through designated exponents that shape the utility value (McNamee & Celona, 2007). *Table 4* shows the representative shaping values for each of the attributes, and *Figure 6* shows the risk tolerance shaped curves for each attribute.

Attributes	Normalizing Lower Bound	Normalizing Upper Bound	Exponent (Risk Tolerance)	Weights
Energy Cost	$2.0B	$3.0B	1	0.7
Green Value	0	5	0.5	0.2
Prestige Value	0	5	-0.5	0.1

Table 4 - Multi-attribute Utility Shaping Values
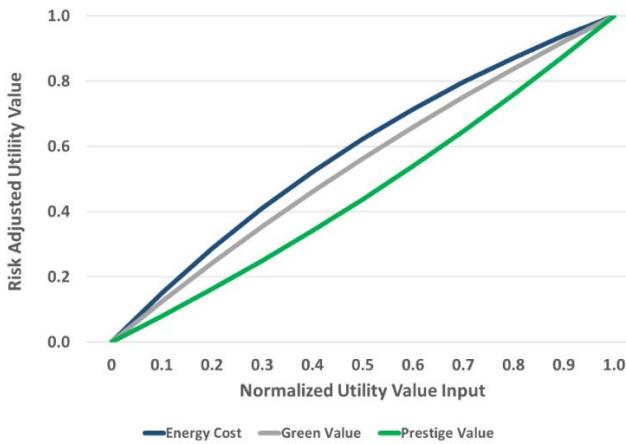
Figure 6 - Exponential Utility Functions for the Three Attributes

5. Results and Interpretation

In this section, we will present and interpret the results of the Analytica model run. Of interest, is that we introduced a number of probabilistic variables in the model, which allows for a Median Latin Hypercube Sampling (McKay, Beckman, & Conover, 1979) method to run many sample simulations. In this case we used 1,000 simulations as a reasonable bound. The simulation functionality of Analytica provides a range of results that help model and analyze uncertainties such that we can evaluate more than just a static expected value result (Analytica, 2018).

We first present the results of the 20-year total cost determination with expected cost and statistics by strategy in *Table 5*, followed by the Cumulative Distribution of those total costs in *Figure 7*. The results show that the strategy most likely to give us the lowest cost option over 20 years, at an expected cost of $2.21B, is the "No CAPEX w/ Green long-term" strategy. This option entails working with a supplier to contract rates for a long-term Power Purchase Agreement with known contracted annual increases. This option also appears to be the least volatile as its standard deviation is less than half the next nearest strategy of "Install Own Green Gen" and is 5x smaller than that of the largest standard deviation for the "Cheapest Retail Energy Cost" strategy. The most expensive option is "Offset with Renewable Energy Credits, at an expected cost of $2.69B over 20 years, which is nearly $500M more than the PPA option.

The next summary information provided below is the output of the multi-attribute utility score calculations, which takes the utility value of the cost information above and combines it with the utility values for Green Value and Prestige Value. *Table 6* provides the expected utility value and summary statistics by strategy alternative. Once again, the best strategy score for utility is the "No CAPEX w/ Green long-term" strategy, with a utility value of 0.83. This strategy also has a small standard deviation of 0.01, meaning it stays within a fairly tight band of outcomes. The utility score for the "Install Own Green Gen" strategy closes some ground on the leader due to higher Green Value and Prestige Value utility values, coming in at an expected utility of 0.80. More interestingly, the max value of "Install Own Green Gen" actually is larger than that of the leader. That overlap is seen clearly in *Figure 8*, with the red line surpassing the yellow near the top of the probability curves. Also, note that "Cheapest Retail Energy Cost" has lost ground on all other strategy alternatives as its expected utility value of 0.36 is the smallest, even though its expected value for cost was in the middle of the pack. This is attributable to this option having limited utility for both Green Value and Prestige Value.

Strategy Alternatives	Mean ($B)	Min ($B)	Median ($B)	Max ($B)	Std. Dev ($M)
Install own Green Gen	$2.38	$2.21	$2.38	$2.56	$52.98
Cheapest Retail Energy Cost	$2.60	$2.29	$2.59	$3.53	$133.47
No CAPEX w/ Green short-term	$2.60	$2.30	$2.60	$2.94	$94.79
No CAPEX w/ Green long-term	$2.21	$2.13	$2.21	$2.29	$25.12
Offset with Renewable Energy Credits	$2.69	$2.40	$2.68	$2.99	$93.26

Table 5 – Statistics for Total Energy Cost over 20 years by Strategy Selection
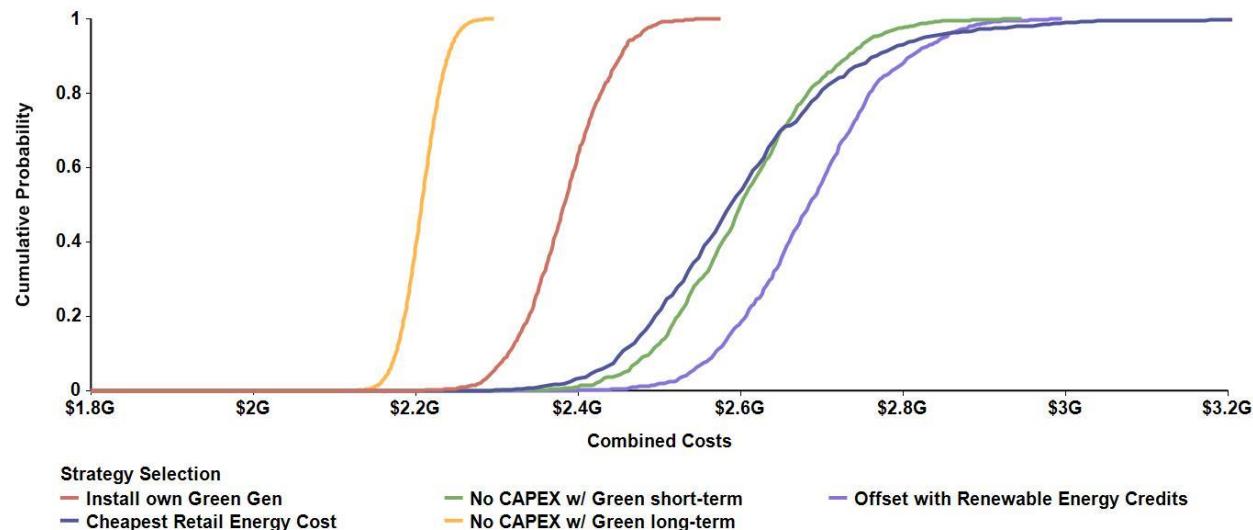
Figure 7 - Cumulative Distribution of Total Costs by Strategy

Strategy Alternatives	Mean	Min	Median	Max	Std. Dev
Install own Green Gen	0.80	0.68	0.80	0.90	0.03
Cheapest Retail Energy Cost	0.36	0.00	0.38	0.58	0.11
No CAPEX w/ Green short-term	0.50	0.21	0.51	0.70	0.07
No CAPEX w/ Green long-term	0.83	0.78	0.83	0.86	0.01
Offset with Renewable Energy Credits	0.44	0.15	0.44	0.64	0.08

Table 6 - Statistics for Multi-attribute Utility Scores by Strategy Selection
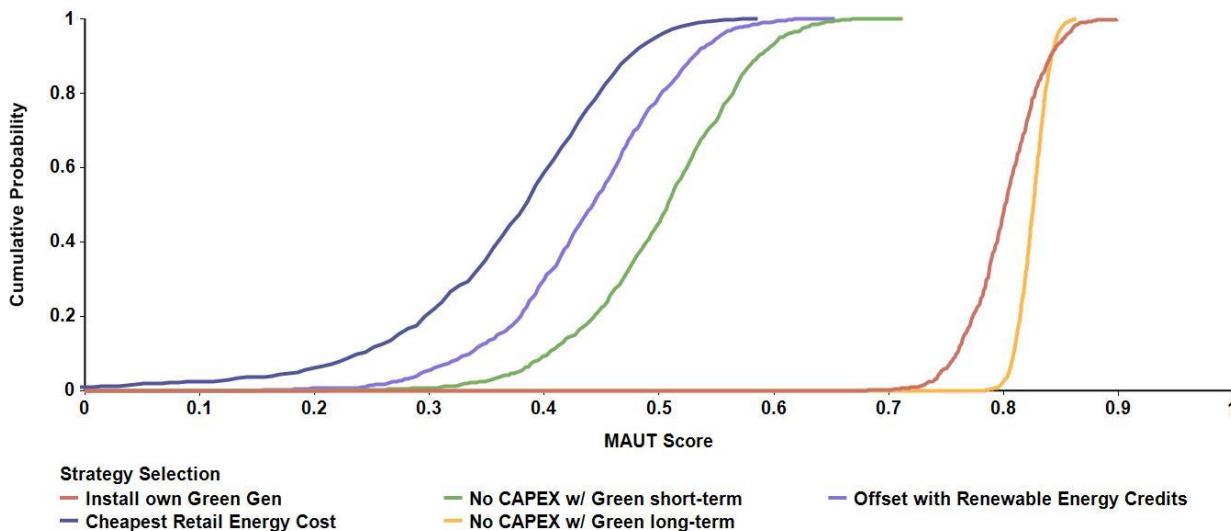
Figure 8 - Cumulative Distribution of Multi-attribute Utility Scores by Strategy

6. Discussion

The results of the model output provide us with the best choice to pursue a sustainable energy strategy based on more than just the cost, by incorporating multiple utility values for non-cost attributes. There appears to be one winning strategy of "No CAPEX w/ Green long-term", with a close runner up in the "Install Own Green Gen" strategy being well within range of sensitivity analysis. The remaining strategies were sufficiently far away on both the Energy Costs and MAUT Scores that we would not recommend pursuing them under these particular conditions.

There are limitations to our model that require more development before taking this model to the level of making real business recommendations to company decision-makers. Many of the energy cost input variables are based on estimates or simplified distributions to provide uncertainty bands around the estimates. We would need to apply it to an actual situation in an energy market with a history of energy prices, forecasted future prices, rate structures, known rates, and a band of expected values for other variables that are tied to the location and customer needs. These values are all key contributors to the determination of energy cost and need to be more closely aligned with an actual customer situation. For the Carbon Value and Prestige Value utility value development, we simplified the scoring to a scale from 0 to 5 and assigned values to those based on our assessment of the case study. In reality, every decision-maker will have their own utility functions that would need to be elicited and codified through the techniques available to decision analysts. Additionally, the shaping variables for the MAUT calculation are all values assumed from experience, when in reality each decision-maker will have their own risk tolerances, weights, and expected bounds for the measures being normalized. These limitations do not take away from the framework applied but should be used to set expectations around the need to delve deeper on the input parameters and improve precision on developing the values that feed into this model. Another addition to be made to the model is to output a digestible summary of the sensitivity analysis to help decision makers see how sensitive the output is to changes to various inputs. Finally, one major area of improvement in a future version would be to capture the time value of money. For the purposes of developing this version of the model and not overly complicating it, we do not use traditional methods of applying Net Present Value or Return on Investment for costs like CAPEX for new gens or OPEX to maintain the equipment. The model can be improved to include these methods in future versions.

The application of Analytica to this decision support model proved to be very effective. The Analytica user interface presented some challenges at times, but there is ample supporting documentation and video examples to support the analyst who is willing to invest the time. The complexity of this model could be replicated in a spreadsheet but would take numerous tabs that are not intuitively easy to walkthrough with energy experts or decision-makers. Analytica's object-oriented approach, indexing of arrays, and visual / tabular outputs makes it simple to walk through the model and explain how it works to non-technical individuals.

7. Conclusion

The aim of this project was decision model development to apply to the challenge of making sustainable energy strategy decisions that help navigate complex decisions entailing multiple attributes and decision objectives. Much literature exists showing the application of multi-criteria decision-making in the sustainable energy space. There is limited applied research tying out the challenge for global companies to effectively manage costs while evaluating the utility of meeting sustainability requirements and capturing added brand prestige. We built a functioning model in Analytica that incorporated reducing the numerous decision combinations into a few distinct strategies that will be easier to explain to a time-strapped executive decision-maker. Additionally, we used a proven version of MCDM, multi-attribute utility theory, to help capture the risk tolerance of the decision-maker as well as the weight of the three key attributes of Energy Cost, Green Value, and Prestige Value. Combining these two decision analysis methods into a functioning model with useful summary visualizations and output, we have created a toolkit that can be used to support company executives in evaluating their decisions. This methodology provides a framework that helps evaluation of the utility value of decisions in a more cohesive and comparable manner. Having laid out this model for this project, we believe that this framework is easy to improve upon and expand to include in use in the field of sustainable energy procurement strategic decision-making.

References:
Analytica. (2018). Expressing Uncertainty - Analytica Wiki. *Wiki.Analytica.Com.* Retrieved from http://wiki.analytica.com/index.php?title=Expressing_Uncertainty.
Capehart, B. L., Turner, W. C., & Kennedy, W. J. (2006). *Guide to energy management*: The Fairmont Press, Inc.
Esty, D., & Winston, A. (2009). *Green to gold: How smart companies use environmental strategy to innovate, create value, and build competitive advantage*: John Wiley & Sons.
Finnerty, N., Sterling, R., Contreras, S., Coakley, D., & Keane, M. M. (2018). Defining corporate energy policy and strategy to achieve carbon emissions reduction targets via energy management in non-energy intensive multi-site manufacturing organisations. *Energy, 151*, 913-929. doi:10.1016/j.energy.2018.03.070
Galbreth, M. R., & Ghosh, B. (2013). Competition and Sustainability: The Impact of Consumer Awareness. *Decision Sciences, 44*(1), 127-159. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1540-5915.2012.00395.x. doi:10.1111/j.1540-5915.2012.00395.x
Google. (2011, September 17, 2013). Google's Green PPAs: What, How, and Why. Retrieved from http://www.google.com/green/pdfs/renewable-energy.pdf
Ibáñez-Forés, V., Bovea, M. D., & Pérez-Belis, V. (2014). A holistic review of applied methodologies for assessing and selecting the optimal technological alternative from a sustainability perspective. *Journal of Cleaner Production, 70*, 259-281. doi:10.1016/j.jclepro.2014.01.082
Keeney, R. L., & Raiffa, H. (1993). Decisions with multiple objectives : preferences and value tradeoffs. Retrieved from http://dx.doi.org/10.1017/CBO9781139174084.

Kumar, A., Sah, B., Singh, A. R., Deng, Y., He, X., Kumar, P., & Bansal, R. C. (2017). A review of multi criteria decision making (MCDM) towards sustainable renewable energy development. *Renewable and Sustainable Energy Reviews, 69*, 596-609. doi:10.1016/j.rser.2016.11.191

Lumina. (2018). Analytica Optimizer Software (ver 5.0). California, USA: Lumina Decisions Systems, Inc.

McKay, M. D., Beckman, R. J., & Conover, W. J. (1979). A Comparison of Three Methods for Selecting Values of Input Variables in the Analysis of Output from a Computer Code. *Technometrics, 21*(2), 239-245. Retrieved from http://www.jstor.org/stable/1268522. doi:10.2307/1268522

McNamee, P., & Celona, J. N. (2007). *Decision analysis for the professional*: SmartOrg, Incorporated.

Mydock III, S., Pervan, S. J., Almubarak, A. F., Johnson, L., & Kortt, M. (2018). Influence of made with renewable energy appeal on consumer behaviour. *Marketing Intelligence & Planning, 36*(1), 32-48. Retrieved from https://www.emeraldinsight.com/doi/abs/10.1108/MIP-06-2017-0116. doi:10.1108/mip-06-2017-0116

Porter, M. (1998). On Competition (A Harvard Business Review Book). *Boston: Harvard Business School Publishing*.

Sterling, R., Coakley, D., Contreras, S., Keane, M. M., & Finnerty, N. (2017). *A systematic decision support framework and prioritization method for energy projects in industrial organisations.* Paper presented at the 10TH International Conference on Sustainable Energy and Environmental Protection.

Wang, J.-J., Jing, Y.-Y., Zhang, C.-F., & Zhao, J.-H. (2009). Review on multi-criteria decision analysis aid in sustainable energy decision-making. *Renewable and Sustainable Energy Reviews, 13*(9), 2263-2278. doi:10.1016/j.rser.2009.06.021

Winston, A., Favaloro, G., & Healy, T. (2017). Energy strategy for the c-suite. *Harvard Business Review, 95*(1), 139-146.

Climate Change: Politics and Policies

Douglas Nelson, Douglas C. Nelson, P.C.

Abstract

On the crowded stage of environmental challenges, many of them are gathered under what is called "climate change." No topic draws more interdisciplinary attention than does climate change. It is webbed in all branches of science—physical, chemical, astronomical, geological, biological, oceanographical, ecological, architectural, mathematical, logical, social, economic, political, and others.

The subject of climate change spans the globe. It spreads across nation-states, from all levels of governments to the level of each individual. The topic of climate change reaches many classrooms whether or not the subject is the primary focus. The search for facts in climate change can be challenging.

In this study, climate change is explored in a historical context focusing on politics in regards to the climate change and policymaking perspective. In addition, the United States' role in the international platform of climate change is studied.

Several recommendations are made with respect to knowledge-making and knowledge-transfer of the climate change in an attempt to highlight the facts about climate change.

Sustainable Bio-based Construction from Lab to Market Transition

Ellie Fini, Arizona State University
Mahour Mellat-Parast, North Carolina A&T State University

Abstract

To promote sustainable engineering practices in construction, repeated recycling using reclaimed asphalt pavement (RAP) has been promoted; repeated recycling has led to the second and third generation of reclaimed materials containing severely aged asphalt binders. To facilitate recycling and reuse of these resources, there is a need to synthesize sustainable chemicals and modifiers, which can truly rejuvenate severely aged asphalt binder. This paper investigates mechanisms of true rejuvenation and introduces the ability to deagglomerate asphaltene nano-aggregates as a measure of true rejuvenation. Molecular dynamics simulations followed by rheometry and chemical characterization is used to evaluate the effect of a Bio-Rejuvenator (BR) made from bio- mass on asphalt binders aged for 60 hours and 100 hours in the laboratory as surrogates for highly aged asphalt binders found in the 2nd and 3rd generation of RAPs, respectively. Introduction of BR is found to be effective to disturb the nano-aggregates formed during oxidation due to the increased polarity of oxidized molecules. Some of the BR molecules are found to be more effective than others to interact with the oxidized asphaltene molecules causing deagglomeration, whereas others play as dispersant agents to promote separation of nano-aggregates. Chemical characterization of the aged asphalt binder doped with BR shows that the colloidal stability of the systems increases and the large molecule size decreases when the BR is introduced to the aged asphalt binder. It is further observed that addition of 10% and 30% Bio-Rejuvenator to the aged asphalt binder reduces its complex modulus by 34% and 76%, respectively, bringing it closer to that of the neat binder. Overall, the study results show that the ability to de-agglomerate oxidized asphaltenes can be used as a measure of true rejuvenation. Such findings can

help manufacturers develop effective rejuvenators to facilitate recycling and promote sustainability of construction practices.

Customer Similarities and Helpful Online Reviews

Fatemeh Pouromran, Northeaster University
Mohsen Ahmadian, University of Massachusetts – Boston

Abstract

Accompanying with the growth of Internet and e-commerce, online reviews have become an important source of information assisting consumers in making purchase decisions. Despite many studies in this area, there is no study of the helpfulness of the online reviews based on similarity of the consumers. Drawing upon the customer similarity concept, we develop a research model to explain how customer similarity affect the review helpfulness, which in turn helps the customers to make better purchase decisions. We use data from Amazon.com to test our model empirically. The results show that customer similarity moderates the effect of both review- and reviewer-related determinants on the review helpfulness in a way that reviews from a customer who is more similar to a new customer have been evaluated more helpful by the new customer. We also find that the moderating role of the customer similarity is stronger for the experience products. Our findings can help us in better understanding of the consumers' purchase behavior. This research contributes to the marketing literature, specifically literature of the online review helpfulness, by studying a new factor that can affect customers' perceived helpfulness of the product reviews, which in turn can influence their purchase decision. Findings of this study have managerial implications too. Online intermediaries provide the customers with lots of information about available product, which helps the customers to reduce their uncertainty and make better purchase decisions. However, customers should spend their time on gathering this information, which has its own cost in consumers' view. Hence, online retailers can help the new customers in finding opinions about a product that might be closer to their own opinion by indicating the product reviews written by similar customers. Providing customers with the more customized information can help them to make their purchase decisions faster and more confidently while spending less time.

Keywords: Consumer Purchase Behavior; Online Review; Review Helpfulness; Customer Similarity

A Conceptual Data Model for Managing Relationships between Program Objectives to Course Objectives in a BSBA Curriculum

Jerzy Letkowski, Western New England University

Abstract

The AACSB accreditation standards for business programs rely heavily on outcome assessment efforts, expecting that the accredited schools formulate specific learning goals and perform direct assessments of the learning outcomes in order to improve their curricula. The program learning goals are typically mission driven and they spawn appropriate competencies that are to be addressed by offered courses. This paper attempts to develop and analyze a data model that would better assist program managers (dean, department chair, and faculty) in managing the curriculum. At the high level, the model has the following semantics: Mission has Program Goals which are realized by specific Competencies. The Competencies are developed by Courses, implementing definite Learning Objectives, which are assessed by Assignments, contributing to the development of particular Competencies. If the model gets accepted by the educational community, its initial implementation will be developed in SQL. The ultimate model might be constructed, using formal classes and properties expressed in RDF/OWL.

Keywords: Data model, AACSB, program, goal, competency, assessment, relationship.

Dow Jones Sustainability Index: Impact of the Firms' Financial Performance

Bryan Schmutz, Western New England University
Minoo Tehrani, Roger Williams University

Abstract

Dow Jones Sustainability World Index (DJSI World) that started in 1999 highlights the largest global companies that are considered the leaders in sustainability practices across sixty different industries. The DJSI World publishes the" Largest 10 Additions" and the "Largest 10 Deletions" annually (RobecoSAM, 2018). This study concentrates on the companies under textiles, apparel and luxury goods industry that appear on the additions and deletions lists of DJSI World indices for the past five years. The research examines the impact on the financial performance of these companies that are placed on the addition versus the deletion lists of the DJSI World.

RobecoSAM, 2018. https://www.robecosam.com/en/media/press-releases/2018/robecosam-publishes-the-sustainability-yearbook-2018.html

Decision-making: Water for Sustainability of Urban Areas

Douglas Nelson, Douglas C. Nelson, P.C.

Abstract

Water and sustainability of urban societies are uniquely connected. This presentation discuss the meaning of sustainable municipal water supplies globally while looking at the experiences in Cape Town, South Africa and those in urban areas of Arizona of the United States.

Water supply sources and demands for metropolitan areas are reviewed as well as the tools for seeking a sustainable water future for ever-growing urban areas. Planning efforts and structural and non-structural supply and demand projects for urban water sustainability are discussed. Suggestions are made to avoid crisis water management.

Mapping Indonesian's Transition Movement towards a Circular Economy

Juli Nurdiana, University of Twente
Laura Franco, University of Twente
Michiel Heldeweg, University of Twente

Abstract

While the Indonesian government has proclaimed their support to embrace a circular economy (CE), it appears that implementation is still in the early stage. The transition itself is an on-going process that requires systemic changes in a wide array of different functions, types of organizations and levels of implementation. However, it has not been discussed in advance by how much and to what extent the Indonesian government, businesses, and civil organizations should engage in CE. This paper aims to support the deployment of a CE in Indonesia by analyzing the transition movement from linearity to circularity. We argue that, in recent years, the CE concepts, policies, and initiatives that have emerged do respond to the environmental sustainability efforts. In this context, this study provides a systematic mapping tool for policy makers to understand better how Indonesia is actually addressing environmental sustainability, while transitioning towards a CE and by going through different phases. Our descriptive and exploratory analysis is based on a systematic literature analysis and stakeholder interviews to understand the past and recent approaches to the CE transition. The study findings address the transition using these three perspectives: institutional aspects; stakeholder's perspective; and, the scale of CE adoption. We show that different types of policies and instruments - in particular for waste management - have been enforced in this transition process. However, stakeholder engagement has been limited to certain specific roles and types of business. We also found that CE approaches and initiatives have not been adopted in a wide range of contexts or at scale.

Keywords: circular economy, Indonesia, transition, sustainability, developing country

Measures of Wealth and Subjective Well-being

Maria Cornachione Kula, Roger Williams University

Abstract

Many have suggested discontinuing the use of real GDP per capita as a proxy for social progress in favor of a subjectively determined well-being or "happiness" measure, based on the claim that income is not a satisfactory measure of well-being. Despite extensive research, the relationship between income and well-being is unsettled. This question is an important one; if income and well-being don't move in tandem, a policy of maximizing economic growth is inappropriate. This paper sheds light on the well-being – income controversy and the larger debate about appropriate macroeconomic policy by considering the relationship between wealth and subjective well being. As a positive result is found for the impact of wealth per capita on subjective well-being, using two different measures of wealth and controlling for the impact of the inflation and unemployment rates on subjective well-being, the evidence suggests that a public policy aimed at maximizing economic growth is correct.

New NAFTA, USMCA: Anything Green?

Minoo Tehrani, Roger Williams University
Dari Tavekelian, Roger Williams University

Abstract

The foundations of the North American Free Trade Agreement (NAFTA) were based on the reduction of tariffs, protection of the intellectual property rights, and establishing the rules of origin resulting in free movement of goods and services between the three countries. U.S., Canada, and Mexico.

Twenty-five years later, the issues and problems of NAFTA are clear: Exploitation of labor, definition of the rules of origin, and environmental pollution. This research examines the new NAFTA, USMCA (U.S., Mexica, Canada) and explores the changes in the new trade agreement. Does USMCA address the labor issues and the rules of origin? Does it deal with sustainability and protection of human resources and the physical environment? In addition, the study discusses the ramifications of the new treaty for the U.S., Mexico, and Canada.

Circular Economy at Regional Level: The Province of Friesland as Showcase

Laura Franco-Garcia[1] and Juli Nurdiana

University of Twente

Abstract

The Netherlands is one of the front-runners on the development and implementation of policies to transit from a linear to a circular economy (CE). Conceptually, CE is in the core of a plethora of publications to better understand its origin, systematic approach and its multilevel application. Scholars but also organizations, such as Ellen MacArthur Foundation and Metabolic (among others), identified features and developed frameworks to boost circularity at city level. From a larger regional perspective, in the Netherlands several provinces are working on their circular roadmaps, starting by inventorying those initiatives that already qualify as "circular" and/or present the potential to become "circular". Initiatives which were promoted by specific groups or as a result of a coordinated effort among actors through sectorial value chains and/or across sectors. Without a doubt, "collaboration" has been crucial and recognized as a successful factor to enable this transition. This study focuses on the agri-food and construction materials which came across as some of the most dominant material flows in Friesland. Hence, these two sectors were used to show case the situation of CE in Friesland, leading us to the following research question: *What are technically and economically feasible options for circularity in the agri-food and construction sectors in Friesland?* The Horbach's CE determinants ((i) Government and institutions; (ii) demand side and; (iii) supply side) were used to classify those existing practices and to identify CE possibilities. Desk research, interviews and survey were applied as research methods in this project. It is important to indicate that for the construction sector, the expectation between 2030 and 2050 is to have fully circular constructions. The transition also focuses on CO_2-reduction generated across any activity to the production and transportation of construction materials. Whilst for the agri-food sector, the potential to become more circular is centered on those resources that are in the category of biomass, in particular food waste which represents one of the biggest challenges of the humanity at global scale.

---

1 Corresponding author: m.l.francogarcia@utwente.nl University of Twente, The Netherlands

Integrated Diagnosis for Industrial Development Path Dependence of Mineral Resource-Based Cities: A Study Based on an Improved Cobb-Douglas Production Function

Wei Li, Beijing Normal University

Abstract

In China, there more than 200 resource-based cities suffering from serious problems including instable industrial growth, environmental pollution, and urban health due to excessive depending on resource exploitation and processing. How to break up the so-called industrial path dependence (IPD) is absolutely critical for those cities to move forwards sustainable development. Here, by incorporating the elements of resource use, ecological conservation and environmental quality into the conventional Cobb-Douglas (C-D) production function, an improved method (REEID) is established to diagnose industrial development path dependence of Ordos, a coal resource-based city in Inner Mongolia Autonomous region of China. The results show that the integrated output elasticity was 0.8158 from 2001 to 2015 with decreasing returns to scale. The overall IPD showed by the integrated marginal revenue (MR_{KLME}) had been increasing from 2001 to 2007, and then entered into a decreasing process from 2008 to 2015. In particular, the ecological and environmental costs of industry growth had increased significantly during the period, which resulted in a dramatic decline of MR_{KLME} curve exhibiting 2 to 4 years earlier presence of the inflection point than estimated by the conventional C-D simulation. It is indicated that an overlook of the resource uses and environmental effects may bring about more or less bias to the diagnosis results of IPD of the resource-based cities. In order to spur a green transition and development of Ordos, a dual-capping policy is recommended to control the total volume of raw coal extraction and the productivity of coal-base industries (e.g. power generation, and chemicals) by taking ecological security and environmental quality into account respectively.

A Niche Market for Urban Agriculture?

Thomas Cox, Cox Consulting
Minoo Tehrani, Roger Williams University

Abstract

Despite tremendous progress in the food insecurity, hunger and malnutrition are still widespread. Today, 13% of the global population is undernourished (IFPRI, 2019). In the United States, 41.2 million people live in food-insecure households (Coleman-Jensen et al., 2017). The global population is projected to exceed 9.7 billion by the year 2050 (UN/DESA/PD, 2017). Food production will need to increase by 25–70% above the current levels (Hunter et al., 2017) to keep pace with the growing demands of increases in population. How can society address the unprecedented food security challenge?

Natural resources fundamental to agricultural production are limited. Expanding agriculture into the marginal lands of sensitive ecosystems is an unsustainable path and would have tremendous negative impacts on habitats, biodiversity, carbon emission, and soil conditions (Foley et al., 2011). Meanwhile, current agricultural land faces competition from urbanization and other sectors of the economy. In addition, the problems of land degradation due to salinization, desertification, soil erosion, and acidification amplify the shortage of land for cultivation of food crops (Blum, 2013).

Improving the use of food that is already produced by cutting back food loss and proper waste management offers a great opportunity for "Urban Agriculture" to simultaneously address increase in food security and sustainability. This vital strategy can have worldwide application with multiple benefits and relatively few conflicts or negative consequences. This research concentrates on two constructs, food waste reduction and "Urban Agriculture" and explores potential economies of "Urban Agriculture". Furthermore, the study examines major factors that will drive potential for expansion of "Urban Agriculture" production in addition to issues related to the expansion potential.

Blum, W. E. H. 2013. Soil and land resources for agricultural production: General trends and future scenarios—A worldwide perspective. *Int Soil Water Conserv Res* 1 (3): 1–14, doi:10.1016/ S2095-6339(15)30026-5.

Coleman-Jensen, A., M. P. Rabbitt, C. A. Gregory, and A. Singh. 2017. *Household Food Security in the United States in 2016*. Economic Research Report No. 237. USDA–ERS, Washington, D.C.

Foley, J. A., N. Ramankutty, K. A. Brauman, E. S. Cassidy, J. S. Gerber, M. Johnston, N. D. Mueller, C. O'Connell, D. K. Ray, P. C. West, C. Balzer, E. M. Bennett, S. R. Carpenter, J. Hill, C. Monfreda, S. Polasky, J. Rockström, J. Sheehan, S. Siebert, D. Tilman, and D. P. M. Zaks. 2011. Solutions for a cultivated planet. *Nature* 478:337–342, doi:10.1038/nature10452.

IFPRI, 2019. 2019 global food report. Internationa food Polciy Research Institute. http://www.ifpri.org/publication/2019-global-food-policy-report

United Nations/Department of Economic and Social Affairs/Population Division (UN/DESA/PD). 2017. *World Population Prospects: The 2017 Revision—Key Findings and Advance Tables*. Working paper no. ESA/P/WP/248. United Nations, New York.

Sustainable Tourism

Marco Marinelli, Johnson & Wales University

Abstract

This research concentrates on the concept of sustainable tourism. Considering that tourism is one of the largest global industries and a major source of revenue for numerous countries, this study examines the impacts of tourism along several dimensions, social, economics, and environmental dimensions. Mass tourism has a significant influence on cultural identity and diminishing the quality of life in different communities. In addition, mass tourism can result in unplanned and careless development and increased pollution. Furthermore, the political influence over the local communities can result in inappropriate investments. This study explores such impacts and proposes recommendations with the potentials of turning mass tourism into sustainable and low impact tourism that can enhance the economic standards of the communities.

Workshop

AACSB Continuous Improvement Review and Faculty Driven Processes

May Lo, Western New England University

This workshop addresses the following topics: (a) The steps in the faculty-driven AOL process; (b) Implement a robust and sustainable AOL program; (c) Manage and communicate the AOL data effectively; and (d) Incorporate AOL results in revising curricula and business program learning goals to continuously improve student learning.

Paris Accord: Goals & Objectives

Minoo Tehrani, Roger Williams University
Yasmin Hernandez, Roger Williams University

Abstract

This study concentrates on the goals and objectives of the Paris Accord. The focus of Paris accord in on the climate change and emission control. Currently, in addition to the European Union (EU) countries, 174 other countries have signed the agreement. This research examines the strategies adopted by the top polluting countries (e.g., China, EU Countries) that have signed Paris Accord. In addition, the study addresses the obstacles and difficulties that can hinder the achievement of the goals and objectives of the agreement.

Direct Charitable Donation vs. Cause-Related Marketing: Consumer Happiness and Donations in China

Miao Zhao, Roger Williams University
Yimin Zhu, Sun Yat-Sen University

Two ways that consumers can support a cause are direct charitable donation and cause-related marketing (CRM). CRM has been defined as "an offer from the firm to contribute a specific amount to a designated cause when consumers engage in revenue-providing exchanges (Varadarajan and Menon 1988, p.60). Examining U.S. sample, Krishna (2011) suggests that consumers are less happy and donate less to a cause if they substitute CRM for direct donation since participating in CRM is perceived more selfish by consumers. The object of this study is to explore whether such relationship stays true in China. A one way between-subjects experimental design was conducted and 182 subjects participated in the study. Consistent with the current literature, prosocial spending (using financial resources to help others), both direct donation and participation in CRM, leads to greater happiness in China. However, our research suggests Chinese consumers, different U.S. consumers, prefer CRM to direct charitable donation since they are happier and donate more when participating in CRM due to the unique donation culture and environment in China. Managerial implications are discussed.

ACKNOWLEDGMENT

GAMESMANSHIP BEHAVIOR IN OUTSOURCING VIA COMPETITION

Mohsen Ahmadian, University of Massachusetts Boston, Boston, MA, USA

mohsen.ahmadian001@umb.edu

Ehsan Elahi, University of Massachusetts Boston, Boston, MA, USA ehsan.elahi@umb.edu

Roger Blake, University of Massachusetts Boston, Boston, MA, USA roger.blake@umb.edu

ABSTRACT

The importance of outsourcing is widely acknowledged in both academia and in practice. A big challenge in outsourcing is the question of how suppliers can be induced to provide the highest performance to the buyer. One approach is to establish a competition between suppliers seeking to win the buyer's business. In a competition, a decision maker's payoff depends not only on his efforts and the resulting costs, but also on his opponents' decisions. In this situation, the decision-maker might seek a decision anchor or a benchmark as a comparison point against which he evaluates his decisions.

In this research, we intend to introduce the definition of an equilibrium point for a competition in which each player aims to maximize the difference between his profit and his competitor's profit. We call this equilibrium point the "gamesmanship equilibrium". We then show the existence and uniqueness of such equilibrium for different types of competition, in which suppliers compete for the demand share of a buyer.

The idea of making decisions to perform superior to competitors might be appealing to managers since in the complicated business world it is virtually impossible to identify the maximum feasible expected profit of a large company. On the other hand, it is fairly easy to compare the performance of a company with the performance of similar companies working in the same industry and market. Therefore, the relative performance of a company with respect to its competitors might be a better determinant of its stock price or its managers' bonuses. As a result, decision-makers have strong and direct incentives to show gamesmanship behavior as we mentioned above.

Our research considers the scenario of suppliers competing to win the business from a single buyer who is outsourcing the manufacture of a commodity product and who defines three different competition criteria, or performance benchmarks, by which demand is allocated. These competition criteria result in different levels of competition intensity, and we investigate how these different intensity levels affect the suppliers' behavior. We also examine how heterogeneity in suppliers' costs will impact their gamesmanship behavior.

Using controlled laboratory experiments, we then examine the behavior of subjects who play the role

of competing suppliers in an outsourcing problem. Our results show that in most cases, the subjects' average decisions fall somewhere between the Nash equilibrium and gamesmanship equilibrium. This observation suggests while suppliers aim to maximize their own expected profit, they also tend to beat the competition. We also find that the proposed gamesmanship model significantly outperforms the Nash model and completely explains the deviation between what Nash model predicts and the experimental results.

Keywords: Behavioral Operations Management; Gamesmanship Equilibrium; Bounded Rationality; Outsourcing; Simultaneous Competition

The Potential of GHG Emission Reduction in Terms of Household Behavioral Changes in the Himalayan Region

Silu Bhochhibhoya, University of Twente
Ramesh Kumar Maskey, Kathmandu University
Shital Kumar Gupta, Vanderlanda
Francesco Marinello, Padova University
Raffaele Cavalli, Padova University

Abstract

The rising human population both local and tourist in the Himalayan region increases the significant amount of energy consumption and its GHG emission is affecting local impact in the region. Thus, the energy conservation is important for environmental protection and sustainable energy consumption in these areas.

This paper gives an overview of possible reduction of energy consumption in highly touristic Himalayan region: Sagarmatha National Park, through the behavioral change on the consumption, which ultimately reduce the GHG emission in household level for the sustainable consumption. Questionnaire survey on the energy consumption pattern for tourist season and off-tourist season were performed in different building types in this region. The GHG emission from each energy sources was calculated by its associated emission factor. Based on the literature review, analysis of GHG emission reduction from the households behavioral changes were performed. The study found that 6,094 tons of CO_{2eq} can be reduced from the household behavioral changes without compromising the comfort.

Keywords: Household energy conservation, Sustainable consumption, Energy saving, GHG emission, Emission reduction, Sagarmatha National Park and Buffer Zone (SNPBZ)

GREEN MANAGEMENT IN SUSTAINABLE ECONOMIC DEVELOPMENT

Adam Sulich

Department of Strategy and Management Methods

Faculty of Management, Computer Science and Finance

Wroclaw University of Economics

adam.sulich@ue.wroc.pl

Abstract: Sustainable development goals can be part of modern organisation strategies. Green management can be also recognized as the proper tool of handling with complex properties of business environment and to define its development goals. One of the directions of building economic development is greening the economy by supporting investments aimed at environmental protection and green jobs creation in this area. Green management aim is to support environment protection provided both by companies and government. The aim of this paper is to analyse the impact of green management on sustainable development in the green strategies in sector of renewable energy sector.

Keywords: green economy, growth factors, economic development

1. Introduction

Although the idea of sustainable development is relatively new, it is a subject of scientific discussion since late 70's (Barbier, 2012; Ryszawska, 2016). There are two sides of the discussion about sustainable development (Sulich, 2018). First is theoretical and is focused on formulation general laws and setting a formalised direction and goals of strategic parts of economy (Czakon, 2011; Niemczyk & Stańczyk-Hugiet, 2014). When, the second side of this discussion tries to address the question about translation of all theoretical ideas related to the sustainability into everyday business activity (Olszak & Mach-Król, 2018; Ostasiewicz, 2015; Sulich, 2018). Both elements of ongoing discussion are crucial, because they are focused on different purposes, first aims to create a theoretical background and explain all processes ongoing in second sphere (Misztal, 2018; Piętak, 2016). Moreover, the contemporary economic environment is characterized by high complexity and volatility, which affects the ways of doing business in all sectors of the economy (Finkbeiner, Schau, Lehmann, & Traverso, 2010; Kulhánek & Sulich, 2018a). Therefore, many publications concern the problems of sustainable development and sustainability in certain sectors of economy (Bem et al., 2019; Ryszawska, 2016), focusing more on examples and cases and their qualitative explanation (Grudziński & Sulich, 2018b; Kozar, 2017; Rutkowska, Sulich, & Pakulska, 2017). Some of these sectors are naturally more involved than ever in scientific discussion about development of so called "green economy" (Łuczka, 2018; Ryszawska, 2016). Among green economy sectors are traditionally related to biomass production (Pajewski, 2014) and consumption, renewable energy sources, and related to the knowledge transfer (Kryk, 2014; Łuczka, 2018). Development of such areas of economy leads to the green economy concept and sustainability (Tadaki, Sinner, & Chan, 2017). This new paradigm of development and concept of life quality refers not only to the balance between social and economic aspects but also environmental dimension (Brundlandt, 1987; Sulich, Rutkowska, & Popławski, 2019; Sulich & Zema, 2018a).

Disparities and inequalities became more visible due to socio-cultural dimension to treat the environment as source of goods and waste reservoir (Sulich & Grudziński, 2019; Wiśniewska, 2004). Then ecological problems became social and then economic problems (Barbier, 2012; Finkbeiner et al., 2010; Truc, 2012), and global economy went through financial crisis in 2008

(Kulhánek & Sulich, 2018b; Michalski, 2012). What is worse, economic growth is still considered through prism of natural resources exploitation (Finkbeiner et al., 2010). Additionally, progressive environmental degradation completely disrupts in social-economy-environment system (Dyllick & Hockerts, 2002). However, some actions were taken, since United Nations (UN), created United Nations Conference on Environment and Development in 1992, which has not brought any measurable positive results (Eurostat, 2018; Olszak & Mach-Król, 2018). Business has always depended on and had an impact on the natural environment (Loknath & Abdul Azeem, 2017), and through proper management it is possible to reverse what business done over last two centuries.

The lack of expected results of sustainable development possibly may be caused by non-strategic approach in management (Sulich & Grudziński, 2019). So far many strategies have been developed and described, therefore various researchers in the field of green management have categorised the concept from different stand points which can be considered from the point of view of strategic approaches adopted or the classification of organisations based on strategic approaches (Loknath & Abdul Azeem, 2017). Some of them can be distinguished as strategies at the national level as well as the enterprise level (Grudziński & Sulich, 2018b). Furthermore, strategic goals have to regard all aspects of sustainable development if these strategies want to be called green (Eurostat, 2018; Sulich & Grudziński, 2019). The objectives of such strategies are aimed to involve improvement of the environment or minimize an anthropopressure, and the use green management (Loknath & Abdul Azeem, 2017). There are 17 Sustainable Development Goals (SDG) proposed by the UN and accepted by the all member states of the European Union (EU), which can be implemented in each strategy (Eurostat, 2018). This is the most important part in a strategic management, the implementation of strategy, which is based on different methods of green management (Loknath & Abdul Azeem, 2017; Sulich & Zema, 2017, 2018a), taking into account its multilevel elaboration.

The one reason of this complexity is caused by the number or goals and factors measuring reaching each of them. Some these sustainable development indicators are present in more than one Sustainable Development Goal (Eurostat, 2018).

This complexity of business ecosystem also results from the growing number of elements (participants) of the environment system (Stańczyk, 2018) and the ties between them, which are the result of unexpected events (discontinuities) that determine volatility, e.g. technological breakdowns, changes in consumer habits, economic transformations and crises (Stańczyk-Hugiet, 2009). Increasing complexity (pluralism) paradoxically is a positive phenomenon, because it provides a specific stabilization, offset by small-scale variability (Jouvet & De Perthuis, 2013). This stability in dynamics is similar to the natural ecosystems and is called a business ecosystem (Stańczyk, 2018).

The next reason of complexity is an increase in the probability of unpredictable so-called black swans, or macroeconomic phenomena causing an unexpected slowdown in economic growth in individual countries (Taleb, 2007), forces decision-makers to take appropriate actions aimed at reversing this trend by anticipating and preventing economic downturns systemically (Karmowska, 2017). Investment in environmental protection may be one of such strategic and multistage activities (Fura, 2015; Vávra, Cudlínová, & Lapka, 2015), and thus the direct creation of green jobs (Grudziński & Sulich, 2018c; Kozar, 2017; Rutkowska-Podołowska, Sulich, & Szczygieł, 2016). The aim of such action is to restore the balance between the complexity and changeability of the economic system, supported by the conviction of a strong, albeit "invisible hand" of the market along with greening processes and environmental protection.

Therefore, the aim of this paper is to analyse the impact of three green management on sustainable development which is visible mainly in the green strategies in sector of renewable energy sector. The choice of these sector is based on the assumption, that companies which provide green energy may have so called green strategy. Therefore, they can become a one of the indicators of sustainable development. This paper examine main Polish renewable energy sector companies using taxonometric method (Grudziński & Sulich, 2018a; Kasztelan, 2016a; Misztal, 2018) which widely used in the research of sustainable development (Kasztelan, 2016b; Popławski, 2009;

Ryszawska, 2013).

2. The green strategies

The implementation of the green strategies has begun in previous century and it was a part of technological progress, which has provided a new eco-friendly solution (Kasztelan, 2016b; Misztal, 2018). That forced companies to leave the so called the brown economy (Ryszawska, 2016; Wiśniewska, 2004). This brown economy is based on fossil fuels consumption, which results also in plastic production. Both, carbon dioxide and plastic wastes became main source of ecological, the social and economic problems (Ryszawska, 2013).

The ability of the company to successfully gain the sustainability depends on its social and environmental sensitivity (Khall Khalid, 2019). In other words, the business must become an eco-centric one and then it must become a sustainability focused business and all these needs many efforts and take time.

There are four groups of various green management paradigms (Meima, 1994; Tadaki et al., 2017). First perceive the environment as an anthropocentric moral or ethical issue in context of gaining financial benefits (Kryk, 2014; Sulich & Zema, 2017; Sulich, Zema, & Zema, 2018). Second group explore a concept of competitive management and competitive advantage (Kasztelan, 2016a). The third paradigm perceives environmental management as a function a quality expressed in normalized systems. The fourth approach to green management is determining ways in which industrial action can be made compatible with nature; for instance, by minimizing emissions, by reducing wastes at source etc. (Loknath & Abdul Azeem, 2017).

In the literature exists also different division based on corporate responses to environmental pressures (Grudziński & Sulich, 2018c; Simpson, 1991; Sulich & Rutkowska-Podołowska, 2017). The first group are the companies that have been forced to improve their environmental performance as a result of some well-publicized event or in result of some outstanding environmental accident acts as a catalyst and induces the company to take some action in the field (Loknath & Abdul Azeem, 2017). The second group are the ones that have been able to exploit the opportunity created by the arrival of the green consumer to gain competitive advantage (Simpson, 1991). The third group include companies that have moved beyond compliance, and have incorporated their environmental strategy into their overall business strategy (Loknath & Abdul Azeem, 2017; Simpson, 1991).

Similarly to the three element conceptual model of strategies there are describes also other four elements models of business categories (Roome, 1994). These four categories are: indifference, offensive, defensive and innovative. Indifferent companies are those that have low environmental risk and even less environmentally based opportunities for growth (Loknath & Abdul Azeem, 2017; Roome, 1994). Offensive companies are those that have considerable potential for exploiting environmentally related market opportunities, and include companies that manufacture pollution control equipment etc. (Loknath & Abdul Azeem, 2017; Roome, 1994; Simpson, 1991). Those adopting a defensive strategy are companies like the chemical companies, which gave high environmental risk and cannot afford to ignore environmental issues, or their very survival could be at stake (Krupski, 2007; Loknath & Abdul Azeem, 2017; Niemczyk & Stańczyk-Hugiet, 2014). The innovators are those that have high environmental risk and also a lot of environmentally-based opportunities for growth (Loknath & Abdul Azeem, 2017).

Although there are models of strategic options which include more than four strategy types, these with four groups are most popular in the literature, because they perceive corporate response to the environment as based on environmental risks (Rutkowska et al., 2017) and marked based opportunities (Roome, 1994). It is argued that environmental pressures like legislation, constrains within the firm, and the ability of managers to bring about an organizational change in order to incorporate environmental issues, are equally important (Loknath & Abdul Azeem, 2017). First group is non-compliance, where all environmental issues are simply ignored. Business entities which are characterized by this type strategy do the minimum that is required by law fall in the

second category. In third category, are companies that move beyond legislation and the last group consist of companies that use the environment as a tool for gaining competitive advantage (Loknath & Abdul Azeem, 2017).

Loknath and Abdul Azeem (2017) in their conference article presented a review of types of green management strategies, among them they list other four element categorizations of strategy types which were compared in table 1.

Table 1. The four group models of green strategies performers

Author/authors	Organisations' profiles according to green strategy types			
	I	II	III	IV
(Sulich & Grudziński, 2019)	Isolation	Redundancy	Adaptation	Cooperation
(Bostrum & Poysti, 1992)	Resistant	Passive	Reactive	Innovative
(Welford, 1994)	Cowards	Laggards	Thinkers	Doers
(Meima, 1994)	Problem Fixer	Obstacle Jumper	Opportunist	Activist
(Roome, 1994)	Indifference	Offensive	Defensive	Innovative
(Loknath & Abdul Azeem, 2017)	Stable	Reactive	Anticipatory	Entrepreneurial
(James, 1992)	Non-compliance	Compliance	Compliance-plus	Excellence

Source: Author's own elaboration based on (Loknath & Abdul Azeem, 2017).

The first group are organisations, which not only assume that concern for the environment is a passing phase and their impact on the environment is negligible, but also assume that their competitors feel the same and hence do nothing to conserve the environment. The second group consist of organisations that are aware of the environmental challenges facing them, but are unable to combat those challenges because of cost constraints, lack of trained manpower, lack of knowledge. The third group are organisations which are aware of problems but still waiting for others to show the way forward. Then are organisations, that have proceeded to put their thoughts into action and consist the fourth group (Loknath & Abdul Azeem, 2017).

3. Concepts related to the economic development

A remarkable phenomenon in the economy is undoubtedly economic growth. Reflections on factors determining economic growth have been conducted for many years (Samuleson & Nordhaus, 1992). A significant scientific achievement in this field falls in the 20th century (Jouvet & De Perthuis, 2013; Piętak, 2016). On the other hand, the broader concept than economic growth is economic development, the essence of which is the increase in economic indicators as well as social factors, and the idea of economic development developed by A. Lewis and W. Rostow treats it (Piętak, 2016). Therefore, economic growth is considered through the prism of quantitative changes, while economic development is a quantitative and qualitative transformation (Kasztelan, 2016a).

The problems of economic development are nowadays taking on particular character due to the ongoing globalization and the consequences of this phenomenon. A dynamic and even turbulent environment implies the need to search for and identify new factors that affect the economic development of countries (Knapińska, 2016).

The fundamental aspects of economic growth are economic factors (Michalski, 2012; Wiśniewska, 2004). Therefore, the value of gross domestic product plays a crucial role in assessing economic growth (Ryszawska, 2013; Sulich & Rutkowska-Podołowska, 2017). Other important

factors are the level of unemployment, the inflation rate, the cost of foreign investments and the amount of public debt (Karmowska, 2017; Kryk, 2014).

Economic growth is undoubtedly favoured by technological progress and the ability of the economy (as a whole) to implement innovations, because according to J. Schumpeter "development is driven by innovation in the economy, therefore development depends on the ability to formulate innovation and implement them in industry and business" (Knapińska, 2016). Product innovations can be captured using four dimensions (Billing, 2003):

1. A degree of market innovation,
2. A degree of technological innovation,
3. A degree of organizational change,
4. A degree of environmental innovation.

The degree of environmental innovation is often neglected or misinterpreted. Changes affect not only the direct players on the market (especially suppliers and consumers) but also the full environment. In particular, radical innovations often require the creation of new infrastructure as well as significant adjustments in regulatory and social conditions.

Product innovation can, therefore, be determined using the four dimensions described above. However, different types of changes can be defined based on four aspects of product innovation. Radical innovations show a relatively high degree of discontinuity in all four dimensions. In particular, the presence of a high degree of environmental change distinguishes radical innovation from less-important innovations.

It is possible to measure economic development using individual and aggregate indicators (Ryszawska, 2013). Examples of such synthetic indicators are an index of economic freedom, a measure of financial aspects of well-being, a measure of sustainable prosperity, a measure of national welfare and a measure of economic well-being (Fura, 2015; OECD, 2014).

Changes in the concept of economic development assessment have changed significantly over the years. In the beginning, only economic aspects were taken into account, and then, social elements were added, and environmental determinants are now being considered (Sulich & Rutkowska-Podołowska, 2017; Sulich et al., 2019). The characteristics of green economics and the links between the ecosystem and human well-being have been reflected not only in European Union documents, or the European Environment Agency but also in numerous scientific publications (Piętak, 2016; Popławski, 2009). An example of attempts to assess economic development taking into account the pillars of sustainable development is the Green Economy Index developed by B. Ryszawska, (2013). This tool is taxonomic and aims to organize individual countries within the framework of the green economy (Ryszawska, 2013), it also illustrates their growth and economic development (Salomo, 2003). Despite the evolution of the concept of economic growth and a significant extension of its definition, currently, economic growth is still measured through the prism of macroeconomic factors and is identified by GDP growth. In this perspective, the only way to economic growth is to increase production and consumption. The consequence of this assumption is also the maximum use of natural resources, which results in a more significant amount of waste and pollution. It should also be emphasized that economic growth is now the central value. Unfortunately, environmental aspects are not treated as the highest value, but without the appropriate means of production available (both in the right quantity and quality), no innovations or improvements in the variety of products are possible.

4. Ecologization of management

The feature of the modern economic system is the externalization of costs and "non-payment of bills," and the implementation of the "grow first and clean up later" strategy. The consequence of this phenomenon is the emergence of imbalances in the economic system manifested, for example, by pollution of the natural environment - water, air, and land. Increasing environmental pollution affects the quality of life and production capacity - production costs are rising because of the participation of clean water and clean air is required in technological processes. In the long term,

this may lead to irreversible changes in the natural environment. Therefore, the current factors that determined economic growth are subject to further depreciation (Grudziński & Sulich, 2018b). What's more, economic development must be viewed through the prism of sustainable development. The visible impact of ecology and seeking a balance in economic development is called greening, which consists in taking into account the environmental aspect of each activity. A manifestation of this trend is the increase in the importance of ecological issues in assessing economic development (Grudziński & Sulich, 2018a, 2018c, 2018b). Such an environment-friendly approach is also noticed in the practice of management of local government units, which is aware of the changes taking place in the surrounding economic reality create favourable conditions for the development of the organization of the green sector or the sector of renewable energy sources (Pawliszczy, 2015).

The financial crisis has forced state institutions and enterprises to seek new growth factors. An expression of this was the emergence of the concept of green growth as a new dimension that will determine economic growth. However, the search for factors of new growth should not be selective but requires a systemic approach (Fiedor, Czaja, Graczyk, & Jakubczyk, 2002; Loknath & Abdul Azeem, 2017). It is postulated, therefore, to adopt a new way of perceiving the world and treating it as a system whose elements are interconnected economics, society and the environment. This view will allow you to choose the right directions of action that will take into account all the aspects necessary for sustainable and sustainable growth (Ryszawska, 2013).

Undoubtedly, the transition from an economy based on fossil fuels to a low-carbon, sustainable and green economy has already begun. That is why the essential issues facing modern science are the exact definition of what green growth is.

5. Problem Formulation

The objects of research were Polish renewable energy sector companies which are branches of main energy suppliers in Poland. Following the renewables sector's restructuring and the consolidation of the Polish power market, four key vertically integrated players have emerged in the country: Polska Grupa Energetyczna (PGE), Tauron Polska Energia, Energa and ENEA, all of which hold stakes in Poland's renewable energy market (Gorczyca, 2011). The formulated problem was to research their eco-branches different strategies towards sustainability and support of transition to the green economy. The qualitative method was used and then qualitative research – the Hellwig method was implemented.

First step was to indicate the common points of their strategies based on the renewables' accessibility in Poland (table 1). The source of the data for this analysis were secondary data obtained from Fitch Solutions report (Fitch Solutions, 2018).

There are some strong trends which support a development of renewable energy sector in Poland such is fact that country is largest beneficiary of European Union capital and support which is also a negative aspect causing over reliance on this funding to "drive construction growth" (Fitch Solutions, 2018).

Although the climatic conditions support wind power plants, according to the data of the Energy Regulatory Office, at the end of 2018, 770 hydropower plants were in operation in Poland with a total capacity of 966 MW (Kowalczyk, 2012). Compared to 2017, there was an increase of nearly 15 MW. In Poland, water has been the dominant source of energy produced from renewable sources but the report prepared by Fitch Solution stress on non-hydro renewables industry (Fitch Solutions, 2018).

Presented in table 1 analysis suggests that there is a huge possibility for the future development of the renewable sector in Poland in the upcoming years. "In policy documents, such as the *Poland's Energy Policy until 2030* and *the National Action Plan in the Field of Renewable Energy*, hydropower development is expected to be mainly based on the use of existing damming to produce electricity. The list drawn up by the National Water Management shows that in Poland there are over 14,000 damming structures (with a damming height above 0.7 m) owned by the State

Treasury. The degree of utilization of these damming structures for hydropower is only 4.5%" (Kowalczyk, 2012). It is possible that capital groups which consist on companies which were examined on this study each has individual vertical integration strategy, and due to fact, they mostly belong to the State Treasury they participate in common projects and cooperate. Furthermore, favourable legislative changes (prosumer energetics) make more and more households interested in renewable energy sources (e.g. photovoltaic panels). This creates a new customer segment for which must be develop a new strategy consider the new role of the client in the process (Zaleski, 2015).

6. Method

The work uses the reference method, which amounts to determining the synthetic variable being a function of the normalized features of the input set. The of the method aims to compare the development of the Czech Republic and Poland measured by variables describing green development (Ryszawska, 2016). Standardization was used as a method of normalizing variables. Therefore, the features marked with the symbol x_{ij} are transformed using the general formula (Kukuła, 2000):

$$z_{ij} = \left[\frac{x_{ij}-a}{b}\right]^k \tag{1}$$

where: a, b, k – normalization parameters; i=1,2, …, n; j= 1,2, …, p.

The following transformation methods were used (Popławski, 2009) as part of the standardization method:

$$\text{a) for stimulant: } z_{ij} = \frac{x_{ij} - \bar{X}_j}{S(X_j)}, \ x_j \in S \tag{2}$$

$$\text{b) for destimulant: } z_{ij} = \frac{\bar{X}_j - x_{ij}}{S(X_j)}, \ x_j \in D \tag{3}$$

where: $s(x_j)$ – standard deviation for chosen factor; $s(x_j) > 0$.

In the reference methods a reference object is defined in relation to which the taxonomic distances of the examined objects are determined. Most often in practice, the Hellwig measure is used, which is based on the concept of development pattern, which is an abstract object with standardized coordinates. In practice, this means the use of formula 4, utilizing which destimulants are converted into stimulants (Kasztelan, 2016a):

$$x_{ij} = \frac{1}{x_i} \tag{4}$$

The distances of each test object are also determined from the established abstract development pattern by the formula:

$$d_i = \left[\sum_{j=1}^{p}(x_{ij} - x_{0j})^2\right]^{\frac{1}{2}} \tag{5}$$

where: $i = 1,2, …, n; j = 1,2, …, p$.
The created synthetic variable is not standardized, therefore, to arrange objects more often a relative taxonomic measure of development, defined as:

$$z_i' = 1 - \frac{d_i}{d_0} \tag{6}$$

where:

$i = 1,2, …, n$
$d_0 = \bar{d} + 2s_d$

$$\bar{d} = \frac{1}{n}\sum_{i=1}^{n} d_i\,;$$

$$s_d = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(d_i - \bar{d})^2}$$

Thus, created synthetic taxonomic development measure z_i' assumes values from the interval [0,1], the more closely its values are closer to one, the tested object is less distant from the pattern d_i and is considered better than the compared objects given more than the standard. Synthetic development measures replace the description of the examined objects with the help of many features, a report using aggregated quantities

The Hellwig's method is a taxonometic method to indicate differences between examined objects which divide the into four groups (Grudziński & Sulich, 2018a; Kasztelan, 2016a; Rutkowska et al., 2017). This method allows a comparison between selected companies from renewable energy sector providing grounds for classifying them into uniform groups characterized by a similar level of particular indicators. The features are standardized according to the formula:

$$z_{ij} = \frac{x_{ij} - \overline{x_{ij}}}{s_j} \tag{7}$$

where: i – is object number, j – feature number, s – is standard deviation. Such transformed features are subject of calculations of taxonomic distances between the investigated factors values and reference model. This distance is calculated according to the formula:

$$d_i = \sum_{j=1}^{m}\left|z_{ij} - z_{0j}\right| \tag{8}$$

Obtained d_i values are used to compute Hellwig's synthetic measure of green economy impact as a result of implemented green strategy:

$$z_i = 1 - \frac{d_i}{d_0} \tag{9}$$

The z_i indicator assumes values within the range [0;1], whereas values closer to the model and are associated with high level of the investigated object. Obtained values z_i were arranged in linear manner in four groups:

$$1. \quad z_i \geq \bar{z} + s_z \tag{10}$$

$$2. \quad \bar{z} \leq z_i < \bar{z} + s_z \tag{11}$$

$$3. \quad \bar{z} - s_z \leq z_i < \bar{z} \tag{12}$$

$$4. \quad z_i < \bar{z} - s_z \tag{13}$$

where: $\bar{z}$ is arithmetic mean, s_z – standard deviation.

This method allows then to distinguish examined organisations' profiles according to green strategy types defined in table 1. Then values of z_i indicators were calculated and compared in table 2.

Table 2. Basic indicators for monitoring the implementation of energy policy in 2016.

No.	The name of the indicator (x)	PGE	Tauron	Enea	Energa
1	Production of electric energy from renewable energy sources (TWh)	2,30	1,30	0,54	1,25
2	Number of clients (mln)	5,17	5,47	2,50	3,00
3	Share of total production of electric energy in Poland (%)	33,00	25,00	13,00	15,00
4	Renewable energy source installation power (MW)	2189,0	459,0	443,0	1396,3
5	Annual volume of CO_2 emissions (mln tons)	15,00	13,90	12,37	2,68

Sources: Author's own elaboration based on companies' integrated reports.

Table 3. Statistical analysis of chosen indicators for leading energy sector companies in Poland

	X1	X2	X3	X4	X5
PGE	2,30	5,17	33,00	2188,972	15,00
Tauron	1,30	5,47	25,00	459,00	13,90
Enea	0,54	2,50	13,00	443,00	12,37
Energa	1,25	3,00	15,00	1396,25	2,68
Module of average value	1,34725	4,035	21,5	766,0833	10,98582
Standard deviation	0,724037	1,502764	9,291573	545,799	5,644265
Coefficient of variation	53,74188	37,24322	43,21662	71,24538	51,37775

Sources: Author's own elaboration based on companies' integrated reports presented by companies.

7. Results

Results of calculations for each energy supply companies in Poland were performed according to the Hellwig's method. The data from the capital groups which consist renewable energy branches were used to compare them with the synthetic calculated development value. In table 4 the final results are presented and suggest that there are some common points of strategies of between capital groups development, because two companies belong to one group. Moreover, these results (table 4) indicate organizations strategic profiles according to implemented green strategy, which were introduced in Table 1.

Table 4. Hellwig's method calculation results compared with strategic profiles

Characteristic	Group	Capital group name
Innovative	I	Polska Grupa Energetyczna (PGE)
Reactive	II	Energa
Passive	III	Tauron, Enea
Resistant	IV	-

Source: own calculations results

Multicriteria analysis based on renewable energy generation indicators (as in table 2) presented that their branches' development is very similar. Although the subject of the research were energy supply companies they rely on the coal and belong to the "brown economy" strategies of their prosperity.

Business models and managerial decisions that create value over the short, medium and long term, based on mutually beneficial interactions between the company's value chain and the social and environmental systems on which it depends. Sustainable strategic management is an effect on the natural evaluation of strategic thinking towards meeting expectations placed in the environment. Therefore, an ever greater number of organizations begun to notice that the idea of sustainability is becoming a natural element of their actions (Radomska, 2015).

Conclusion

Presented in the research results suggest that big energy suppliers are closed in the so called "middle development trap" and they represent different strategic types. As capital groups these companies realise own internal vertical integration strategies. None of want to be a leader in the renewable technology, although their branches are dedicated to this issue. The branches creates therefore green jobs (Sulich &

Zema, 2018b). The reason of this situation is mostly politically motivated although there is existing infrastructure which renewable energy generation capacity is decreasing very fast (Fitch Solutions, 2018; Kowalczyk, 2012). Therefore, only partially we can confirm the proposed hypothesis in this article. Due to the large share of state capital in analysed companies only main trend direction in particular strategies it can be clearly distinguished. The activities under the strategies of the analysed companies are similar in the area of gradual transition to renewable energy sources (which reduces anthropopressure and increase financial efficiency). However, the use of these sources is too small, and there is no possibility to reveal an unambiguous strategic approach in this area.

The single-minded pursuit of growth and scale can produce impressive top-line revenues and good impressions. However, executives can discover that, along the way, organizational issues – including siloed functions, redundant capabilities across business units, and gradual mission creep as functions take on added responsibilities – have impeded greater profitability. Lack of one fully planed strategy is visible, due to existence of only few common points coming out rather forced changes than planned actions in Polish renewable energy sector.

In the modern economic environment, one can notice an increase in volatility, uncertainty, complexity, and ambiguity. The consequence of this phenomenon is a violation of principles that in the past led countries to economic growth. Moreover, basing development only on economic factors (without taking into account the protection of the natural environment) led to the imbalance in the society-economy-environment system. Therefore, it is postulated to take into account new factors when measuring countries' development. These factors define a new - green growth.

Moreover, green growth can be a source of economic transformation. This change leads to a green economy, which is not only indifferent to the environment but also acts on it positively. In this context, the debate on the theory of economics, balance, and models of the economic system is intensifying, the aim of which is to seek solutions and financial regulations that enable organically risky occurrences of crisis phenomena and effective counteraction.

Acknowledgements

Literature

Barbier, E. B. (2012). Économie verte et développement durable: enjeux de politique économique. *Reflets et Perspectives de La Vie Économique*, *LI*(4), 97. https://doi.org/10.3917/rpve.514.0097

Bem, A., Siedlecki, R., Prędkiewicz, P., Gazzola, P., Ryszawska, B., & Ucieklak-Jeż, P. (2019). Hospitals' Financial Health in Rural and Urban Areas in Poland: Does It Ensure Sustainability? *Sustainability*, *11*(7), 1932. https://doi.org/10.3390/su11071932

Billing, F. (2003). *Koordination in radikalen Innovationsvorhaben*. Wiesbaden: Deutscher Universitäts-Verlag GmbH.

Bostrum, T., & Poysti, E. (1992). *Enviornmental startegy in the Enterprise*. Helsinki: Helsinki School of Economics.

Brundlandt, G. (1987). *Our common future*. Retrieved from http://www.un-documents.net/our-common-future.pdf

Czakon, W. (2011). Metodyka systematycznego przeglądu literatury. *Przegląd Organizacji*.

Dyllick, T., & Hockerts, K. (2002). Beyond the business case for corporate sustainability. *Business Strategy and the Environment*, *11*(2), 130–141. https://doi.org/10.1002/bse.323

Eurostat. (2018). Sustainable development in the European Union - Monitoring report on progress towards the SDGs in an EU context - 2018 edition. Retrieved from https://ec.europa.eu/eurostat/web/products-statistical-books/-/KS-01-18-656

Fiedor, B., Czaja, S., Graczyk, A., & Jakubczyk, Z. (2002). *Podstawy ekonomii środowiska i zasobów naturalnych*. (B. Fiedor, Ed.). Warszawa: Wydawnictwo C.H. Beck.

Finkbeiner, M., Schau, E. M., Lehmann, A., & Traverso, M. (2010). Towards life cycle sustainability assessment. *Sustainability*, *2*(10), 3309–3322. https://doi.org/10.3390/su2103309

Fitch Solutions. (2018). *Poland Renewables report, Q4 2018*. Fitch Solutions.

Fura, B. (2015). Realizacja koncepcji zielonego wzrostu w krajach OECD. *Zeszyty Naukowe Uniwersytetu Szczecińskiego. Studia i Prace Wydziału Nauk Ekonomicznych i Zarządzania*, *40*, 57–68. https://doi.org/10.18276/sip.2015.40/2-05

Gorczyca, M. (2011). Energia ze źródeł odnawialnych w Polsce na tle innych krajów Unii Europejskiej. *Energetyka i Ekologia*, (8), 515–518. Retrieved from http://elektroenergetyka.pl/upload/file/2011/8/Gorczyca.pdf

Grudziński, A., & Sulich, A. (2018a). Green European Integration. In M. Staníčková, L. Melecký, & E. Kovarova (Eds.), *Proceedings of the 4th International Conference on European Integration 2018* (pp. 364–371). Ostrava. Retrieved from https://www.ekf.vsb.cz/export/sites/ekf/icei/.content/galerie-dokumentu/ICEI-2018_Proceedings.pdf

Grudziński, A., & Sulich, A. (2018b). Strategic goals of renewable energy sector. In A. Sulich & W. Wodo (Eds.), *Proceedings of 16th Students' Science Conference "Science is our universe"* (pp. 36–44). Boguszów-Górce: Oficyna Politechniki Wrocławskiej.

Grudziński, A., & Sulich, A. (2018c). Zielone miejsca pracy – element przewagi konkurencyjnej przedsiębiorstw sektora odnawialnych źródeł energii. *Marketing i Rynek*, *11*, 170–180. Retrieved from https://www.pwe.com.pl/files/1276809751/file/CSR_MiR_11_2018.pdf

James, P. (1992). The Corporate Response. In M. Charter (Ed.), *Greener marketing*. Sheffield.

Jouvet, P. A., & De Perthuis, C. (2013). Green growth: From intention to implementation. *International Economics*, *134*, 29–55. https://doi.org/10.1016/j.inteco.2013.05.003

Karmowska, G. (2017). Rozwój gospodarczy wybranych krajów Unii Europejskiej w ocenie indeksu wolności gospodarczej. *Prace Naukowe Uniwersytetu Ekonomicznego We Wrocławiu*, *475*, 76–89. https://doi.org/10.15611/pn.2017.475.07

Kasztelan, A. (2016a). Green Competitiveness of the EU Countries. In E. Kovářová, L. Melecký, & M. Staníčková (Eds.), *Proceedings of the 3rd International Conference on European Integration 2016* (pp. 415–424). Ostrava: VŠB - Technical University of Ostrava. Retrieved from https://www.ekf.vsb.cz/export/sites/ekf/icei/.content/galerie-dokumentu/ICEI-2016_Sbornik_Komplet_Web_FINAL.pdf

Kasztelan, A. (2016b). Zielony wzrost jako nowy kierunek rozwoju gospodarki w warunkach zagrożeń ekologicznych. *Studia Ekonomiczne Polska Akademia Nauk. Instytut Nauk Ekonomicznych*, *2*.

Khall Khalid, S. (2019). Create Shared Value, as a New Competitive Advantage, and its Impact on Sustainable Strategy Analytical Study Applied on a Sample of Hotels in Erbil City. In *Proceedings Book of International Conference on Accounting, Business, Economics and Politics, ICABEP 2019* (pp. 402–413). Erbil, Kurdistan Region of Iraq: Tishk International University in Erbil.

Knapińska, M. (2016). Rozwój gospodarczy w podstawowych miernikach makroekonomicznych. *Zeszyty Naukowe Polskiego Towarzystwa Ekonomicznego w Zielonej Górze*, *4*, 134–146.

Kowalczyk, M. (2012). Survey of Damming Structures. In *Today and Tomorrow of Hydropower in Poland and the EU Conference, RENEXPO*. Warszawa: KZGW. Retrieved from http://www.pigeor.pl/hydro

Kozar, Ł. (2017). Produkcja energii elektrycznej ze źródeł odnawialnych w krajach Unii Europejskiej i w Polsce w kontekście koncepcji zrównoważonego rozwoju. *Zeszyty Naukowe SGGW w Warszawie - Problemy Rolnictwa Światowego*. https://doi.org/10.22630/prs.2017.17.2.32

Krupski, R. (2007). *Zarządzanie strategiczne. Koncepcje - metody*. Wrocław: Wydawnictwo Akademii Ekonomicznej we Wrocławiu.

Kryk, B. (2014). Czas na zielone kołnierzyki. *Ekonomia i Środowisko*, *3*(50), 10–20.

Kukuła, A. (2000). *Metoda unitaryzacji zerowej*. Warszawa: Wydawnictwo Naukowe PWN.

Kulhánek, L., & Sulich, A. (2018a). Financial risk in the contemporary environment of enterprises. *Zeszyty Naukowe Wyższej Szkoły Humanitas Zarządzanie*, *19*(2), 49–63. https://doi.org/10.5604/01.3001.0012.2038

Kulhánek, L., & Sulich, A. (2018b). Financial risk in the contemporary environment of enterprises. *Zeszyty Naukowe Wyższej Szkoły Humanitas Zarządzanie*. https://doi.org/10.5604/01.3001.0012.2038

Loknath, Y., & Abdul Azeem, B. (2017). Green Management-Concept and Strategies. *National Conference on Marketing and Sustainable Development*, 688–702. Retrieved from http://www.aims-international.org/myconference/cd/PDF/MSD4-6111-Done.pdf

Łuczka, W. (2018). Green economy and bioeconomy concepts in the context of sustainable development. *Ekonomia i Środowisko*, *4*(67), 8–22.

Meima, R. (1994). Making Sense of Environmental Management Concepts and Practices: A critical exploration of Emerging Paradigms. In *Proceedings of the 1994 Business startegy and the Environment Conference*. Nottingham: The University of Nottingham.

Michalski, G. M. (2012). After-Crisis Relation between General Economic Condition and Liquidity Management: Financial Liquidity Investment Efficiency Model (FLIEM) Use to Diagnose Polish Economics Standing. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2137173

Misztal, A. (2018). Zrównoważony rozwój polskich przedsiębiorstw – ewaluacja. *Handel Wewnętrzny*, *2*(373), 27–40.

Niemczyk, J., & Stańczyk-Hugiet, E. (2014). Cooperative and competitive relationships in high education sector in Poland. *Journal of Economics & Management*.

OECD. (2014). Green Growth Indicators 2014. *OECD Publishing*. https://doi.org/http://dx.doi.org/10.1787/9789264202030-en

Olszak, C. M., & Mach-Król, M. (2018). A conceptual framework for assessing an organization's readiness to adopt big data. *Sustainability*, *10*(10). https://doi.org/10.3390/su10103734

Ostasiewicz, W. (2015). O trwałym rozwoju. *Śląski Przegląd Statystyczny*, (13(19)). https://doi.org/10.15611/sps.2015.13.13

Pajewski, T. (2014). Biogospodarka jako strategiczny element zrównoważonego rolnictwa. *Stowarzyszenie Ekonomistów Rolnictwa i Agrobiznesu Roczniki Naukowe*, *16*(5), 179–184.

Pawliszczy, D. (2015). Wpływ specjalnych stref ekonomicznych na rozwój regionów w Polsce. *Prace Naukowe Wałbrzyskiej Wyższej Szkoły Zarządzania i Przedsiębiorczości*, 253–266.

Piętak, Ł. (2016). Zrównoważony wzrost gospodarczy w teoriach i modelach wzrostu i rozwoju gospodarczego. *Gospodarka w Praktyce i Teorii*, *2*, 51–77.

Popławski, Ł. (2009). *Uwarunkowania ekorozwoju gmin wiejskich na obszarach chronionych województwa świętokrzyskiego*. Warszawa: Wydawnictwo Naukowe PWN.

Radomska, K. (2015). A guide to embedding sustainability into corporate DNA using traditional management tools. *Business and Economic Journal*, *3*(23), 48–63.

Roome, N. (1994). Business Startegy, R & D Management and Environmental Imperatives. *R&D Management*, *24*(1), 65–82. https://doi.org/https://doi.org/10.1111/j.1467-9310.1994.tb00848.x

Rutkowska-Podołowska, M., Sulich, A., & Szczygieł, N. (2016). Green jobs. In E. Kovářová, L. Melecký, & M. Staníčková (Eds.), *Proceedings of the 3rd International Conference on European Integration 2016, ICEI 2016* (pp. 822–829). Ostrava: VŠB - Technical University of Ostrava.

Rutkowska, M., Sulich, A., & Pakulska, J. (2017). Environmental insurance in Poland and selected EU countries. *Zeszyty Naukowe Wyższej Szkoły Humanitas Zarządzanie*. https://doi.org/10.5604/01.3001.0010.6488

Ryszawska, B. (2013). *Zielona gospodarka – teoretyczne podstawy koncepcji i pomiar jej wdrażania w Unii Europejskiej*. Wrocław: Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu.

Ryszawska, B. (2016). Sustainability transition needs sustainable finance. *Copernican Journal of Finance & Accounting*, *5*(1), 185. https://doi.org/10.12775/CJFA.2016.011

Salomo, S. (2003). Konzept und Messung des Innovationsgrades – Ergebnisse einer empirischen Studie zu innovativen Entwicklungsvorhaben. In M. Schaiger & D. Harhoff (Eds.), *Empirie und Betriebswirtschaft* (pp. 399–427). Stuttgart: Schäffer-Poeschel.

Samuleson, P., & Nordhaus, W. (1992). *Economics*. McGraw-Hill.

Simpson, A. (1991). *The Greening of Global Investment - How the Environement, Ethics and Politics are Reshaping Strategies*. London: The Economicst Publications.

Stańczyk-Hugiet, E. (2009). Knowledge-based processes - A strategic perspective. *Argumenta Oeconomica*.

Stańczyk, S. (2018). *Tożsamość ekosystemu biznesu*. Wrocław: Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu.

Sulich, A. (2018). Znaczenie koncepcji ekonomii zrównoważonego rozwoju. *Rynek - Społeczeństwo - Kultura*, *4*(30), 24–27.

Sulich, A., & Grudziński, A. (2019). The analysis of strategy types of the renewable energy sector. In S. Kapounek & H. Vránová (Eds.), *Enterprise and Competitive Environment : 22nd Annual International Conference* (p. 59). Brno, Czech Republic: Mendel University in Brno.

Sulich, A., & Rutkowska-Podołowska, M. (2017). Green jobs and changes in modern economy on the labour market. In R. Borowiecki & J. Kaczmarek (Eds.), *The propensity to changes in the competitive and innovative economic environment: processes - structures - concepts* (pp. 87–94). Kraków.

Sulich, A., Rutkowska, M., & Popławski, Ł. (2019). Green jobs, definitional issues, and the employment of

young people: an analysis of three European Union countries. *Journal of Environmental Management*, in press.

Sulich, A., & Zema, T. (2017). Problem zarządzania ryzykiem we współczesnej filozofii techniki. In M. Olkiewicz, M. Woźniak, M. Drewniak, & J. Chmura (Eds.), *Nauka i biznes - wyzwania XXI wieku. Cz. 2* (pp. 8–21). Waleńczów: Wydawnictwo Naukowe Intellect.

Sulich, A., & Zema, T. (2018a). Green jobs, a new measure of public management and sustainable development. *European Journal of Environmental Sciences*. https://doi.org/10.14712/23361964.2018.10

Sulich, A., & Zema, T. (2018b). Green jobs, a new measure of public management and sustainable development. *European Journal of Environmental Sciences*, *8*(1), 69–75. https://doi.org/10.14712/23361964.2018.10

Sulich, A., Zema, T., & Zema, P. (2018). Green entrepreneurship in the European Integration Context. In M. Staníčková (Ed.), *Proceedings of the 4th International Conference on European Integration 2018, ICEI 2018* (pp. 1393–1400).

Tadaki, M., Sinner, J., & Chan, K. M. A. (2017). Making sense of environmental values: A typology of concepts. *Ecology and Society*. https://doi.org/10.5751/ES-08999-220107

Taleb, N. N. (2007). Black Swans and the domains of statistics. *American Statistician*. https://doi.org/10.1198/000313007X219996

Truc, G. (2012). Tracés. *Revue de Sciences Humaines*. https://doi.org/10.4000/traces.5454

Vávra, J., Cudlínová, E., & Lapka, M. (2015). Green Growth from the Viewpoint of the Czech Green Growth from the Viewpoint of the Czech Republic. In *Current Challenges of Central Europe: Society and Environment*. Praga: Faculty of Arts, Charles University in Prague.

Welford, R. (1994). *Cases in Enviornmental Management and Business Startegy*. London: Rtman Publishing.

Wiśniewska, A. (2004). Startegie proekologiczne w zarządzaniu przedsiębiorstwem. In M. Kistowski (Ed.), *Studia ekologiczno-krajobrazowe w programowaniu rozwoju zrównoważonego. Przegląd polskich doswiadczeń u progu integracji z Unią Europejską* (pp. 91–98). Gdańsk.

Zaleski, P. (2015). Perspektywa rozwoj Odnawialnych Źródeł Energii w Polsce. *Nowa Energia*, *5/6*, 24–

A Supply Chain Ecosystem Enhancing a Creative Territorial Development

Thierry Houé, ICN Business School
University of Lorraine – CEREFIGE thierry.houe@icn-artem.com

Renato Guimaraes, ICN Business School
University of Lorraine – LGIPM renato.guimaraes@icn-artem.com

Keywords: inter-organizational collaboration, relationships, resource-based view, creative territorial development, supply chain ecosystem

Context and research question

In thirty years, logistic activities have been turned into a transversal and integrated tool, for productivity, profitability and quality of service. In today's volatile and highly competitive environment, they are now seen as an instrument of competitiveness for firms (Christopher, 2016). The professionalization and the diversity of businesses resulting from these changes, allow the public authorities to consider the creation and the anchoring of flows activities as the opportunity to enhance a creative territorial economic development (Hall, 2000). Following this trend, and in the same way as the sectors of eco-technologies, health, automotive equipment and e-commerce, the Grand Duchy of Luxembourg has supported for fifteen years, a strong determination for the development of logistic activities on its territory. This strategy of expanding logistics has recently been clarified by the desire to strengthen the attractiveness of the country with the growth of high value-added supply chain activities (Théry, 2018).

The paper considers this aspect of Luxembourg's diversification strategy by analyzing a supply chain ecosystem based on the creation of a free port near the international airport and its links with others economic sectors. Aimed at the storage, handling and trading of high-value items, particularly artworks and jewelry, the Luxembourg Freeport started its activities in September 2014 in a 20,000-m² building. The international art market reached €45 billion in total sales of art and antiques in 2016 (The European Fine Art Foundation, 2017). It is complex and often requires the intervention of numerous specialists in transactions. This complexity is materialized by a multitude of players as artists, collectors, auctioneers, galleries, antique shops, museums, sponsors, foundations, third party logistics or financial investors. Thus, creating an advantageous environment to the development of an ecosystem in this sector is therefore a difficult task and requires some assets.

Based on a resource-based approach and exploiting the data of a qualitative study, the paper tries to answer the following question: *Is there an ecosystem of resources related to logistics activities dedicated to high value-added items that can creatively improve Luxembourg's economic territorial development?*

The aim is to understand the motivations for the setting of a free port and define a resources grid analysis could offer a sustainable and creative competitive advantage for the development of these activities (Martin *et al.,* 2015). The research tries to answer to the research question through a literature review and a qualitative analysis. The originality of the paper is twofold. First, it uses the resource-based view in order to provide a structured analytical framework of a sustainable and creative attractiveness strategy of a territory, and moves away from a traditional review of economic development policies (Stiglitz, 2002). Second, the field of study is relevant because it is still relatively unusual in the academic literature (Calderon-Kabigting, 2010, Rifai-Hasan, 2009).

Theoretical framework

Usually dedicated to the strategic analysis (Newbert, 2007), the resource-based view (Wernerfelt, 1984) has been chosen as a diagnostic tool to identify which resources of the country are considered as strategic for attracting high value-added supply chain activities. The aim is to identify resources giving a competitive advantage that can lead to the development of a creative system combining art, finance and logistics in a long-term period. The paper draws on research using the RBV as a framework for analyzing the attractiveness of a geographical area (Hervás-Oliver and Albors-Garrigós, 2007). Coming from theoretical frameworks mobilized in strategic management (Foss and Ishikawa, 2007), the use of a resource-based perspective seems justified in the context of the strategic analysis of a company or a territory. For both, the question of the orchestration of resources is required to answer the question of the attractiveness and economic development in a long-term view.

Research design and methodology

The research is influenced by interpretive methods, which allow the understanding of a phenomenon (Sachan and Datta, 2005). The interpretive approach seeks to deduce information from subjective representations of interviewees, which reflect the phenomenon studied. A semi-structured interview guide was designed as a tool for investigation. It focuses on identifying resources and capabilities of different types (technical, relational, processual) developed by the players of the territory and their relationships. Several interviews were conducted with the CEO of The Freeport Luxembourg, a Director in charge of the economic development agency of the Chamber of Commerce, and an agent of the Customs agency. These interviews were used to underline aspects of the topic that do not naturally occur to the researcher (Ritchie *et al.,* 2013). Data collection from a documentary review

comes in addition to these interviews. Conceptually clustered matrices proposed by Miles *et al.* (2014) have been used as coding outlines to reduce, structure and analyze data in order to link them to the research question. This tool have been valuable to interpret respondents comments and in particular their motivations and attitudes in relation to the theoretical framework.

Findings and discussion

This section provides a presentation of the main findings of the study. It suggests a summary outlining the territory as a collection of suitable resources to develop a competitive advantage and strengthen its attractiveness.

Attractiveness elements of the territory for high value-added logistics activities

The geographic situation of the Grand Duchy at the heart of Europe played in favor of the final choice of location of the free port. The area is directly connected to the highways network. Located near the international airport, the free port has a direct access to the tarmac. This situation allows a reduction in transport and handling costs as well as a limitation of logistical risks. Luxembourg also represents a complementary location to the other free ports managed by the same company in Geneva and Singapore. Luxembourg is also a direct access to the European market for artworks and valuables. Finally, the Grand Duchy has developed the needed technological infrastructures for this type of supply chain activities (an electronic certification authority, a fast and reliable optical fiber network, etc.). The role of infrastructures in logistics performance remains fundamental (Rietveld and Vickerman, 2004). Nevertheless, a territorial development based almost exclusively on a satisfactory supply of infrastructures can have limited effects (Burmeister *et al.,* 2003). The economic growth of the territory must be seen as a dynamic transformation of already existing elements and often of intangible mechanisms.

The reputation of the financial sector in terms of management of investment funds has played an important role in the final location decision. For interviewees, close ties exist between Luxembourg financial centre and the art and valuables market. There are many interactions related to this highly monetized market. These comments are similar to those of Boyer (2011) for whom the art market has always been intimately linked to the economic sphere and has become a real source of investment and asset diversification. The adoption of the 6266 Act in 2011 by the Luxembourg Parliament has been essential in the final location decision of the free port (under deferment of VAT and customs duties). According to interviewees, voluntarism and timeliness of Luxembourg authorities to support the project through a law entirely consistent with the requirements of European legislation on taxation have positively influenced the final decision.

The ability to mobilize a multilingual skilled workforce has also considered as a major asset for the

location. Since January 1 2011, the circular LIR n°95/2 promotes the attraction of highly skilled foreign workers and attracts new international talents to the Grand Duchy, especially in very specific professions such as those related to art (restoration, etc.).

Interviewees emphasize responsiveness and constant support provided by the Luxembourg Government. It is considered as a key element for the setting-up as well as the future growth of the free port. The quality of the relationships between Customs and the business world facilitates financial and logistical operations on an art market necessarily international. The Customs action is not limited only to the collection of duties and taxes. The market players also seek the security dimension in processes. The risks along the supply chain (Kilubi, 2016) transform Customs as a key factor for an efficient logistics system (Ching-Chiao and Hsiao-Hsuan, 2013).

A supply chain ecosystem seen as a competitive advantage for the territory

Following the qualitative study, findings show an articulation of three distinctive resources justifying the location of the free port and enhancing the emergence of a creative territorial development system. In interaction with each other, this set of resources provides a competitive advantage to Luxembourg in the context of a creative territorial development for logistics value-added operations. The first resource is an intangible asset (Hall, 1993). It takes the form of trust in Luxembourg public institutions and authorities, granted by the players of the Freeport but also by the financial, logistical and artistic spheres of the territory. Trust is the result of fifteen years of development activities related to finance, art and logistics. Some actions (e.g. political decision dedicated to the value-added logistics sector) contributes to create a positive environment. This resource must be seen as tacit and difficult to transfer and/or imitate. It provide a creative advantage in a long term view as part of the attractiveness and sustainability of these activities. The second resource is a key competence of the Grand Duchy in the context of relational management with players in the financial and logistics sectors. These relations are embedded within private and institutional spheres. It is the ability of Luxembourg to coordinate and promote the exchange to a set of resources. The control and management of this network of relationships is the building blocks of that capability. Agglomeration externalities can lead to reduced costs and risks, and improve the spatial diffusion of knowledge. This situation creates a new asset for the country. This capability as difficult to transfer and / or imitate in a long-term view. The third is the consideration of the country as a space of access to strategic resources. It gives to firms an access to resources (financial services innovation, new logistics and transport services, etc.) necessary for the development of their high value-added supply chain activities. This resource is an element generally challenging to transfer and / or imitate in a medium-term view. It can offer an advantage for the country. Finally, this supply chain ecosystem of complementary resources provides a real value for investors, and promote the attractiveness and the

development for high value-added logistics activities. This resources ecosystem can be considered as the first step in the emergence of a creative and integrated "art-finance-logistics" cluster (Lin, 2018) for the Luxembourg economy.

Conclusion and further research

The research leads to several conclusions. The study shows the existence of a resources ecosystem supporting a creative attractiveness of the Grand Duchy for high value-added logistics activities. Three major complementary resources emerge from the analysis: the trust felt by the players with respect to the institutions of the territory; the ability in territorial management of the Grand Duchy; the territory as an access area to a stock of strategic resources (infrastructures, etc.).

Our findings pave the way for new research opportunities. The analysis proposed here is static and does not take into consideration quantitative and qualitative changes in the resource portfolio. Much more work is required in particular on the dynamic aspects of the resources management of the territory. A comparative study across multiple territories may also be appropriate to confront this combination of resources and its impact on territorial development.

References

Boyer, C.M. (2011), "The market for fine art and the economy", *The Journal of Wealth Management,* 13(4): 77-83.

Burmeister A., Meunier C., Rallet A. and Rychen F. (2003), "Réseaux de transports et de télécommunications et efficacité des systèmes productifs", In Dupuy C. and Burmeister A. (eds.), *Entreprises et territoires : les nouveaux enjeux de la proximité,* Paris, La Documentation Française, pp. 111-131.

Calderon-Kabigting, L.Y. (2010), "Foreign Direct investments in subic bay free port zone", *Journal of International Business Research,* 9(1): 133-148.

Ching-Chiao, Y. and Hsiao-Hsuan, W. (2013), "The effect of supply chain security management on security performance in container shipping operations", *Supply Chain Management,* 18(1): 74-85.

Christopher, M. (2016). *Logistics and supply chain management,* 5th edition, New York, NY: FT Publishing International.

Foss, N.J., Ishikawa, I. (2007), "Towards a dynamic resource-based view", *Organization Studies,* 28(5): 749-772.

Hall, P. (2000), "Creative cities and economic development", *Urban Studies,* 37(4): 639-649.

Hall, R. (1993), "A framework linking intangible resources and capabilities to sustainable competitive advantage", *Strategic Management Journal,* 14(8): 607-618.

Hervás-Oliver, J.L., Albors-Garrigós, J. (2007), "Do clusters capabilities matter? An empirical application of the resource-based view in clusters", *Entrepreneurship & Regional Development: An International Journal,* 19(2): 113-136.

Kilubi, I. (2016), "The strategies of supply chain risk management: a synthesis and classification", *International Journal of Logistics Research and Applications,* 19(6): 604-629.

Lin, C. (2018), "Emerging challenges of an urban creative economy: reflections on the governance of creative clusters in Taipei city", *European Planning Studies,* 26(2): 421-437.

Martin, R., Florida, R., Pogue, M. and Mellander, C. (2015), "Creativity, clusters and the competitive advantage of cities", *Competitiveness Review,* 25(5): 482-496.

Miles, M.B., Huberman, A.M. and Saldaña, J. (2014), *Qualitative data analysis: a methods sourcebook,* 3rd ed., Sage Publications, Thousand Oaks.

Newbert, S.L. (2007), "Empirical research on the resource-based view of the firm: An assessment and suggestions for future research", *Strategic Management Journal,* 28(2): 121-146.

Rietveld, P. and Vickerman, R. (2004), "Transport in regional science: The "death of distance" is premature, *Regional Science,* 83(1): 229-248.

Rifai-Hasan, P.A. (2009), "Development, power, and the mining industry in Papua: A study of freeport Indonesia", *Journal of Business Ethics,* (89): 129-143.

Ritchie, J., Lewis, J., McNaughton Nicholls, C. and Ormston, R. (2013), *Qualitative research: a guide for social science students and researchers,* 2nd ed., Thousand Oaks, Sage Publications.

Sachan, A. and Datta, S. (2005), "Review of supply chain management and logistics research", *International Journal of Physical Distribution and Logistics Management,* 35(9): 664-705.

Stiglitz, J.E. (2002) "Towards a new paradigm for development: strategies, policies and processes", *Applied Econometrics and International Development,* 2(1): 116-122.

The European Fine Art Foundation (2017), *TEFAF Art market report,* TEFAF, Maastricht.

Théry, P. (2018), "La logistique veut du monde pour se développer", *L'Essentiel,* November 23.

Wernerfelt, B. (1984), "A resource-based view of the firm", *Strategic Management Journal,* 5(2): 171-180.

A Multi-Objective Decision Framework for UrbanMobility Planning

Tristan Stull, University of Massachusetts – Boston

ABSTRACT

This study applies decision analysis to 21st urban mobility planning. A holistic, well-designed urban mobility system solves several kinds of problems at once. Issues such as congestion, flexibility, urban design goals and pollution can be influenced by municipal administrative and political levers, and also exhibit cross-influencing behaviors. A multi-objective decision analysis framework incorporates external uncertainties as well as internal political, financial, technical and organizational decision factors vis-á- vis the extant analytic and fiscal capabilities of a municipal administration. A scenario is used to explore the details of the process. A quantitative visual model binds the various concepts and supports sensitivity analysis. The result is a normative process that supports effective decision-making for a complex public policy issue. The contribution is a structured process application as well as a researched causality model.

I. INTRODUCTION

The Problem

With increasing urbanization and a legacy over-reliance on cars, personal mobility in the city is faced with growing congestion as well as concerns over sustainability and cost. At the same time, urban residents have multiple wishes related to the mobility system such as more mobility options, better pollution control, and better urban design to improve quality of life in the city.

As these wishes become known, the questions arise. What should a city be trying to achieve, exactly, with its transportation efforts? Should it be promoting one form of transportation over another? Should it be neutral as regards citizens' mobility options? Has it been neutral in the past? Cities build and maintain roads at the expense of other things they could be doing. They also undergo large, ambitious public works projects in pursuit of visions. But how would a new vision for mobility be supplied? How comprehensive should it be? How invasive? If an ambitious shared vision could somehow be articulated, how would it be implemented? Could a city propose to create and operate a new mobility system on its own, or would it depend on outside consent and cooperation?

With any significant change process in public life there is inevitably an uphill movement required against the inertia of entrenched interests. For example, the cooperation of the local transit authority may be required - such as use of property, and in operational coordination. Equally, the cooperation of any number of other private firms or organizations may be essential. One perspective would ultimately postulate the future of urban design as a system of political choices that we make today (Montezuma, 2005). At first blush, this may be intuitively unsatisfying if we find ourselves (as it seems today in the United States) in an age of deep skepticism in the ability of the political process to appropriately conceive, manage

and execute the kinds of 'megaprojects' required for transformative change in urban mobility (Ville, Gonzalez-Feliu, & Dablanc, 2013), (Flyvbjerg, 2014), (Szyliowicz & Goetz, 1995), (Poole Jr & Samuel, 2011). While there will be critical technical factors to be considered, the question of how to approach this becomes in a foundational sense not an engineering problem, and so cannot be met with by engineering solutions (Poli, 2011). It also has an important fiscal dimension, but it is clearly not a finance problem. In fact, it has so many interrelated themes and tendrils that it is not easy to say what kind of a problem it is to begin with. This makes it an appropriate subject for decision analysis.

A Possible Solution

There are two questions motivating this paper. The first is whether it is feasible for a small city to holistically design its own mobility system based on the decision "levers" and resources available to a municipal government. Secondly, if this were to be undertaken we would want to know how it would be done in terms of soliciting and distilling public opinion and operationalizing it. In this, we want to know how the wishes of public stakeholders are to be synthesized with evaluations of external uncertainties and expert technical knowledge to produce a set of realistic scenarios and realizable options. We identify key attributes and measures that might be used in evaluating the decision process. The aim of this is to delineate a workable process for the city that is inherently rigorous in terms of stakeholder responsiveness. This makes it a normative, constructivist study.

The research question concerns how an agreement on the urban mobility strategy for a city can be created systematically from shared values and then articulated in a way that supports the identification of associated attributes, measures and value ranges which are operationalizable into viable decision options. The output is not a decision, but a decision process. The contribution of this study is the specific application of this method to holistic 21st century multimodal urban mobility planning.

Decision analysis models are created to compare and contrast expected values for parameters in a range of scenarios in situations where there is no available experience data (Eckman, Rosand, Knudsen, Singer, & Steven, 2003), (Berger, Gerstenfeld, & Zeng, 2004). They are using to achieve consensus in situations where the experts differ in their evaluations dues to complex factor interactions (Cipollini, Cipollini, Maruyama, & Zimmerman, 2015). Decision analysis is also employed to tackle social obstacles: to impose a structured, strategy-oriented decision framework on a committee experience in the face of emotional as well as thematic complexity (Gregory & Long, 2009), (Ewing, Tarantino, & Parnell, 2006). Decision analysis can also be used as an instrument for extending an organization's frame of reference, connecting it to the outside world in terms of the critical externalities, articulating and quantifying these in relation to local objectives and agency (Min, 1994). All of these apply to the creation of a new urban mobility strategy.

A scenario is detailed below which addresses the development of an urban mobility planning process in a small city. The goal is to determine the process based on the decision levers and available knowledge about externalities. The process begins with public stakeholder participation, and then proceeds to objective refinement, externalities research and finally to model building. Further, the model itself is subjected to sensitivity analysis that shows how

different decisions and variable values can impact the outcomes. Before exploring this scenario, we first ground the rationale for using this method and explore what has been done to date.

Background and Literature Review

Stakeholder Engagement in Mobility Planning

Sustainable development in transportation planning recognizes the need for changes in how planning is done (Curtis, 2008). Existing work explores public consensus building (Loukopoulos & Scholz, 2004), and institution of a visioning exercise to develop a sustainable urban mobility plan (Wefering, Rupprecht, Bührmann, & Böhler-Baedeker, 2013). There is also a multi-level model for engagement with local and regional governments (Bulkeley & Betsill, 2005). While our approach sees consensus and vision building as essential, decision analysis goes further by applying a computable model with measurable variables. The variables are endogenous and exogenous. The former are the specific decision levers that can be applied; the latter are externalities that may impact the outcome.

Decision Analysis

Decision Analysis (DA) was defined as a discipline in the mid-1960s, but traces its heritage back to operations research efforts in the World War II Anglosphere (Howard, 2007), (Raiffa, 2002). A concise definition: "*Decision analysis is a logical procedure for the balancing of the factors that influence a decision.*" (Howard & Matheson, 2005). Another, more involved, definition is: "*We use the term decision analysis to refer to a set of quantitative methods for analyzing decisions based on the axioms of consistent choice… Decision analysis is normative, rather than descriptive. That is, it provides a systematic quantitative approach to making better decisions, rather than a description of how unaided decisions are made.*" (Keefer, Kirkwood, & Corner, 2004). The challenges in DA have centered around identification and articulation of these factors in a way that is both acceptable to relevant stakeholders, and operational in terms of a quantitative model.

The practice of decision analysis has been introduced into multiple industries, as well as into various issues of concern to the public. (Ewing et al., 2006) apply it to military base closures. It is also applied to environmental concerns such as decommissioning off-shore oil drilling platforms (Henrion, Bernstein, & Swamy, 2015). Other applications include energy and smart city planning (Papastamatiou, Marinakis, Doukas, & Psarras, 2017), (Zhou, Ang, & Poh, 2006), and (Pohekar & Ramachandran, 2004). More generally (Huang, Keisler, & Linkov, 2011) situate the method as well-established in its application to environmental issues with their comprehensive survey. Recently, DA has also become part of the urban planning conversation, particularly in the emerging literature on smart cities (Rondini, Lagorio, Pezzotta, & Pinto, 2017), (Battarra, Gargiulo, Pappalardo, Boiano, & Oliva, 2016), (Branchi, Fernández- Valdivielso, & Matias, 2014).

Decision Analysis in Urban Mobility Planning

Research applying decision analysis to urban mobility planning (UMP) is sparse and incomplete in the sense of a lack of available work analyzing the mobility problem within the city as a unit, but then as holistically as necessary to ensure the suitability and viability of the work product. One method: multi- criteria decision analysis (MCDA), has been applied to specific facets of the urban mobility problem in the manner of a local thematically-oriented optimization technique. For example, Won (1990) examines three MCDA methods specifically in the context of automobile restraint solutions. Yeh, Deng and Chang (2000) look at the application of MCDA to measure on-the-ground performance of bus companies, and Rybarczyk and Wu, (2010) use it to look at placement of bicycle facilities. Da Silva et al (2008) propose a more holistic framework for solicitation and incorporation of different regional goals and solutions across a large nation. This paper adapts parts of their broader perspective, but re-points this to a single city as a decision-making nexus.

The urban mobility discussion is conscious of the need for decision analysis methods, if not always able to articulate it. Starting with the argument that civil engineering alone has not and cannot solve this, Poli (2011) argues for multiple disciplines to be involved, a re-set of the traditional approaches:

> *… consensus-building and decision-making are more important than any supposed rational, technologically advanced, good-for-all solution... We can assume that a rational approach exists only if there is enough rationality in the communication and decision-making process* (Poli, 2011).

Janasz (2017) states:

> *Such a multidimensional approach, as described above, requires a strong capacity for interdisciplinary work, which in turn may have a significant impact on the capacity for proper knowledge acquisition.*

His thorough discussion moves to specific technical archetypes as examples of how to implement better mobility. His Basel case study focuses less on the particulars of the deliberative process that led to parking restrictions and bicycle infrastructure, but rather on a decades-long, general political consciousness that worked to enable the mandate.

Wendle & Eriksson (2014) state:

> *A key to success is a unified version of the current state of affairs, challenges and opportunities, goals and what needs to be done to reach the goals.*

The integrationists argue that institutional integration itself is part of the answer. Beyond the technical and operational integration of multimodal transport systems, there must be integration between the various organizations and authorities responsible for transport. Seeing aside any Weberian questions of why an institution would consent to integrating itself with another, there is no recipe for how this is to be achieved (Givoni & Banister, 2010), [see specifically Anderton's chapter].

For purposes of defining and stewarding an urban mobility planning effort, there are three relevant DA themes. Firstly, the work done in value-focused thinking will help in the perception and stewardship of public aspirations (Keeney, 1994). This concept is of primary importance, as it creates a bridge between the unarticulated desires, assumptions and inherent conflicts of the political realm, and an actionable wisdom based on principled negotiation and shared vision. Secondly, there are the methods used to elicit information from experts as well as the quantitative tools for processing subjective-probability assessments (Kirkwood, 1997). These are used to create a computable model that highlights the effect of different options as well as the impact of uncertain externalities. Significant parts of this approach have been implemented into a commercial software tool called *Analytica* ("Lumina," 2018)[1], which is used to develop a computable model for this study.

Lastly, we also need to connect traditional decision analysis to decision support systems for public policy. This is because policy analysis has shied from identifying decision options (Walker, 2000). To bridge this gap, we can place DA in the larger context of operations research (OR), which allows us to reference conceptual frameworks that define and contextualize public policy OR. Massam (1988) provides a comparative survey of different multi-criteria decision making techniques in public planning[2]. This work also provided a useful reference model in the form of a generic planning problem that can be addressed using multi-objective techniques. Generation of the options themselves entails productive engagement with the community (Keeney, 1994), (Johnson, 2014). This contribution carries this conceptual work forward, and applies it to the specific set of attributes and measures in an urban mobility planning context.

Scenario

Introduction to the Scenario

The scenario focuses on a small city as a unit of analysis. Cities are acquainted with the particulars of their local mobility patterns, and already budget for and manage aspects of their transportation systems such as road works, snow removal, emergency services, parking regulations and various local permitting processes. The city represents the first line of defense (or complaint, as the case may be) for urban planning. In that sense, it enjoys the 'right of first refusal' in addressing its mobility system. [The scenario description presented here has been abridged from the research in progress for brevity; some technical details of the model have been removed].

Burqueville is a fictional North American city of 50,000 located in a larger metropolitan area. It is connected to the area via the metropolitan transit network, and a portion of its working residents commute there and back again each day. It has a number of small industries whose workers who commute in, a significant volume of transit traffic, and a sizable and growing senior and subsidized living community who rely on public transportation and specialized assistance. The newly elected mayor has incorporated concerns about transportation into his first-term agenda. In town hall meetings he has heard numerous complaints of congestion in the town center, parking limitations, problems with the transit system, as well as concerns about sustainability, pollution and flexibility in

transportation. There are already several works projects underway to develop bicycle paths and expand access to green spaces, but the mayor wonders how much of the problem these efforts will address, and if more can be done. He engages a decision analysis consultant who outlines the following process for constructing a transport strategy for the city.

An Outline of the Process Steps

1. First, armed with a city-wide survey, the mayor convenes a <u>transport study committee</u> constructed of a representative cross-section of the city's populace. Its purpose is to discuss and generate ideas outside of the sphere of the municipal bureaucracy.

2. The objectives suggested by the study committee are refined and articulated in an iterative process with the consultant. The deliverable of this step is a set of <u>fundamental objectives</u> that can be associated with measurable attributes.

3. The <u>attributes</u> associated with each objective are developed through a process of research and review.

4. Next, the mayor and one or two assistants attend an <u>urban mobility conference</u> as well as meetings of regional mayors. These are to gather information on the administrative and political mechanisms for influencing mobility strategy, as well as information on emerging technical solutions.

5. Following this, the consultant runs a series of workshops with specialists in the administration. The purpose of these workshops is to systematically <u>elicit expert opinions</u> informing the variable definitions and ranges for their attributes.

6. Using the information gathered above, the consultant guides the team in defining a set of decision sets (<u>strategies</u>) to be used in the decision model. These provide a reference for showing how certain combinations of municipal actions combined with specific exogenous outcomes will produce progress against the goals. They essentially present the <u>decisions</u> to be made.

7. With the above information, a <u>decision model</u> is developed based on a set of quantification theses of the variables in question. This model can be used to show a distribution of outcomes against a set of administrative strategies and uncertainties' values.

8. A process of <u>sensitivity analysis</u> is conducted to test different assumptions about the model, to help drive depth and perspective into the understanding of the various paths and the impact of uncertainties.

_____

2

For our purposes, we retain the label "multi-objective decision making" to highlight the emphasis on maximizing the set of different stakeholder values. MCDA remains an important distinguishing label within the DA community, for ontological purposes.

9. Lastly, some remarks are offered as to how the model and contents of the analysis process can be enfranchised into the city's decision-making structure in such a way as to retain resilience, adaptability and relevance over time, as dynamic factors change.

The Process

P-1. Transport Study Committee

As consulted, the mayor uses the results of a comprehensive city-wide survey to guide the composition of a "study committee" comprising a cross-section of the city's residents. The task of this committee is to articulate community values and goals towards generation of ideas for transport strategy options. They meet several times with the consultant attending. The constitution of the committee is adapted from (Nuvolati, 2003) to match the residential and relatively utilitarian nature of this city vis-à-vis its situation in the larger metropolitan context. "Seasonal tourists" are replaced by "Senior citizens" to emphasize for need for accessibility and flexibility in the system (Salomon & Mokhtarian, 1998), (Tyrinopoulos & Antoniou, 2013). "Daily or weekend city users" are removed, and "Inhabitants" are split into "workmen", "pupils" and "health enthusiasts." This last change is motivated by research identifying distinct mobility patterns based on sociological factors such as occupation and age (Camarero & Oliva, 2008). [Some details abridged.]

P-2. Articulation of the Objectives

From study committee workshops as well as the survey, the consultant has distilled the following eight values:

1. *reduced congestion*
2. *cost*
3. *safety*
4. *flexibility*
5. *improved urban design*
6. *convenience*
7. *less pollution (air and noise)*
8. *sustainability*

From this, the fundamental objectives can be defined. A fundamental objective is expressed in terms of what is to be achieved, and why (Keeney, 2007). Its heritage is in business planning culture with a dual emphasis on clarity of purpose and achievability. The 'correct' articulation of the objective in this context suggests it to be measurable. Measurability is achieved by identifying measurable attributes and expected value ranges. For the Burqueville UMP, these objectives became as follows:

Fundamental objectives:

**Minimize
congestion
Minimize
costs
Maximize
safety
Maximize
flexibility
Improve
urban design
Maximize
convenience
Minimize
pollution
Maximize
sustainability**

Overall strategic objective:

Maximize quality of life in the city.

P-3. Measurable Attributes for the Objectives

The consultant then does research to determine how each of the values will be usefully measured, to be able to gauge progress against any possible courses of action. The [abridged] results of this research are below.

Congestion. Typically, peak hour traffic flow volume is measured in relation to road capacity (V/C), with a V/C ratio .77 or higher defined as a state of congestion (Boarnet, Kim, & Parkany, 1998). Average travel speeds are considered at a V/C ratio of 1.00 (e.g. < 20 mph in 25 or 30 mph urban zones). The stated congestion reduction target is reduction of the V/C (e.g. to below the designated threshold for peak hours).

Cost. The Average Daily Usage cost over GDP per capita (Haghshenas & Vaziri, 2012), (Mitchell, Hainley, & Burns, 2010) cite the cost of automobile usage in the United States at around $0.55 per mile. Burqueville's targets are to contain cost *increases* across the multi-modal mobility spectrum at less than or equal to the inflation rate, plus ten percent.

Safety. Wikipedia reports 12 U.S. road deaths per populations of 100,000 in 2013. The stated goal of the
city is to achieve zero road deaths and zero serious injuries in a given year. A related concern under the rubric of 'safety' involves pedestrians and cyclists avoiding certain poorly-lit streets at night.

Flexibility. Flexibility is defined as the ability of a system to adapt to external changes while retaining service level (Morlok & Chang, 2004). Flexibility is measured as the amount of reserve capacity given a fixed base traffic volume.

Convenience. A multi-criteria aggregate of four dimensions: time, access, coverage and reliability (Yeh, Deng, & Chang, 2000). (See also Susilo chapter in (Givoni & Banister, 2010): travel time ratio).

Improved Urban Design. Metrics used include the amount of green space available per resident, and the percentage of residents within a ten-minute walk of a public green space (Pafi et al, 2016).

Reduced Pollution. Air pollution is measured via an Air Quality Index (AQI), one component of which is the national standard for particulate matter ($PM_{2.5} <= 15$ μg/m^3 annual standard, three-year average) (EPA, 2018), (EPA New England, 2018). While Burqueville is normally at acceptable levels, there is a belief that downtown air quality could be significantly improved. It is clear that air quality deteriorates significantly during congested times in certain weather, and that measurement could be expanded.

Sustainability. Defined as the "ability to meet today's transportation needs without compromising the ability of future generations to meet their[s]..." (Richardson, 2005). Measurement of mobility-related sustainability (insofar as it relates to city decision levers) can be focused on reduction of personal car travel (Munda, 2005).

Armed with this context, the consultant builds a model of the objectives that reflects the articulated needs of the citizen stakeholders. In other words, the set of objectives is not inferred merely from aged census data.

P-4. Mobility Conference, Meeting of Mayors

To gather more information and perspective, the mayor attends two external events: 1. A conference on urban mobility and 2. a meeting of local mayors in the region. There are three important outputs from this conference: (1) a short list of urban transport scenarios for local cities that could be envisioned within a ten-year period, (2) a list of specific measures that might be taken at the federal, state and local municipality levels - each cross-referenced to the appropriate scenario it is meant to support, and (3) risk assessments from the experts regarding an array of issues such as the likelihood of certain policy measures taking hold, risks associated with specific technologies relied on for the scenarios, and other risk information about scenarios (e.g. such as the risk of doing nothing).

P-5. Definition of Decisions and Variables

The next stage involves a series of consultant-led workshops with city administrative and political staff, the city engineers and the city comptroller. There are two outcomes of these meetings: 1. define the set of decision levers, the values of which together comprise the administrative strategies the city can take. 2. define a set of variables that will influence the outcomes, along with the best estimates of their value ranges. The variables are understood

to be in two categories. The first is decision levers: specific administrative actions that can be taken by the city. The other category is exogenous variables, expressed here as 'uncertainties'. These ranges are processed into expected 'given values' for the current state, five- year and ten-year planning scenarios.

Decision Variables
PLAN
COORDINATE
DESIGN
COMMUNICATE
RESTRICT

External Variables	
Gas Prices	Subsidies (State, Federal)
Transit Authority Development	MaaS Tech
Intercity Coordination	Laws & Regulations
Political Acceptance	Smart City Tech
Stakeholder Acceptance	Population Growth

Figure 1: Decision Levers Available to the City Figure 2: External Uncertainties

P-6. Strategies

Once the variables have been defined, a selection of high-level strategies is compiled comprising the best information available on the advantages and risks for each. The strategies are 'Status Quo', 'Incremental', Transit-Oriented Development, and 'Integrated.' Below is a detail box for each with the decision values, rationale, and discussions of advantages and disadvantages.

Strategy 1: Status Quo		
Parameters	**Decision**	**Value**
	PLAN	**1**
	COORDINATE	**1**
	DESIGN	**0**
	COMMUNICATE	**1**
Description & Rationale	Burqueville is funded by local property and excise taxes, with a few targeted state and federal subsidies for named programs. There is no identifiable fiscal source for a major effort, nor was there a clear political mandate in the last election cycle.	
Advantages	• No additional fiscal pressure. • Less pressure on city administration to build out skill sets and add staff. • Entails less political risk.	
Disadvantages / Risks	• Nothing is done to address the various aspirations. • Population growth combined with car usage may increase to the point where the city cannot keep up with the load on the streets. • Literature suggests that this is actually the costliest urban mobility model. • As surrounding cities improve their mobility systems, Burqueville risks falling behind in stature, which might lead to businesses and residents exiting. • This scenario contributes nothing to sustainability, accessibility, or flexibility.	

Strategy 2: Incremental	
Parameters	<table><tr><th>Decision</th><th>Value</th></tr><tr><td>PLAN</td><td>2</td></tr><tr><td>COORDINATE</td><td>2</td></tr><tr><td>DESIGN</td><td>1</td></tr><tr><td>COMMUNICATE</td><td>2</td></tr><tr><td>RESTRICT</td><td>0</td></tr></table>
Description & Rationale	A gradated plan towards preparing for a more comprehensive UMP later. Initiate communications and citizen education programs to reduce unnecessary driving, but make no formal restrictions. Provide a 'warm reception' to MaaS service providers. Start a systematic dialogue with the transit authority, state and federal governments on mobility. However, make no new fiscal commitments, and divert only a minimum of current resources. May add a transport specialist to city hall, subject to current budget limits. No additional parking restrictions or road limitations downtown.
Advantages	- Minimal political fallout (as not much is changing immediately). - No additional fiscal stress created. - Incrementalism is currently a highly fashionable approach.
Disadvantages / Risks	- There is no evidence that incrementalism yield improvements before inherent instabilities lead to catastrophic system failures. - It is unclear how city staff will be motivated to make progress, with no real vision - or resources being provided. The effort may become subjugated to other priorities.

Strategy 4: Integrated	
Details	<table><tr><th>Decision</th><th>Value</th></tr><tr><td>PLAN</td><td>4</td></tr><tr><td>COORDINATE</td><td>4</td></tr><tr><td>DESIGN</td><td>4</td></tr><tr><td>COMMUNICATE</td><td>4</td></tr><tr><td>RESTRICT</td><td>4</td></tr></table>
Rationale	This is the most comprehensive strategy as well most involved in terms of city participation. Applying the maximum amount on all decision levers, this effects fast, dramatic changes and sees the interplay of feedback effects increasing the impact. Details include creating a network of bicycle sharing racks, bike paths and other bicycle oriented infrastructure, and re-architecting the downtown, removing entire swathes of street parking, expanding sidewalks and greenscapes, and setting aside space for MoD/MaaS solutions. It further involves a mobility web and smart traffic management system, as well as interfaces to a smart power grid. This approach presumes an integrated regional transport plan, coordinating with surrounding towns, the state and the federal governments. It infers working with the transit authority and local developers to foster TOD (incorporating Scenario 2) as well as ensuring that an integrated last mile solution is included. It debits car usage significantly, raising parking fees and excise taxes, and introducing zoned driving regulations. Restrictions extend to car-oriented infrastructure such as building permits for gas stations and parking lots.
Advantages	- Addresses traffic congestion on multiple fronts. - Integrates with the regional transport plan. - Significantly improves road safety. - Significantly improves flexibility. - Significantly improves convenience and. - Achieves lowest operating costs (per-mile transport costs) throughout. - Significantly ameliorates the city profile.

Disadvantages / Risks	There are a number of risks involved:
	• Fiscal: there is no known fiscal model in place to support this. See below.
	• Technical: unknown for what kinds of future technology the infrastructure should be planned.
	• Coordination: if surrounding towns and cities do not adopt similar strategies, Burqueville will be under pressure as a stand-out.
	• Political risks: The changes involved will seem "drastic" to some residents and might well lead to backlash.
	• Fiscal risks:
	◦ Costs for infrastructure build are unknown.
	◦ Any funding model depends on federal and state transportation grants, making it subject to their respective political processes.
	◦ Any municipal bonds, zoning charges and excise tax increases, would be subject to city referendums as well as to potentially strong political pushback.

The planning horizon is set at ten years nominally, with an interim strategy check for five years out. Setting an appropriate planning horizon serves several purposes. It allows time for planning, design and construction of certain infrastructure (if so indicated). It captures the changes in certain measures such as population growth, and dollar measures such as cost-per-mile, cost of gasoline, and the levels of external subsidies. Lastly, it also creates space in which certain technological advances and trends might mature to the point where they can be more easily implemented.

P-7. The Decision Model

The decision model is a quantitative meta-model that translates the decision sets and the experts' opinions of the uncertainties into measurable outcomes against the defined objectives. Its primary purpose is to illustrate causal relationships. Its secondary purpose is to support sensitivity analysis. Visually, it takes the form of an influence diagram that has been developed using the *Analytica* tool. An influence diagram is defined as "a formal description of the problem that can be treated by computers and a representation easily understood by people in all walks of life." (Howard & Matheson, 2005). In fact, the influence diagram for a complex decision is a layered model. The top level (Figure 1) shows the interaction amongst several modules (dark blue) each of which is a sub-division containing individual related elements specific to its purpose. The arrows signify information flow and relationships.
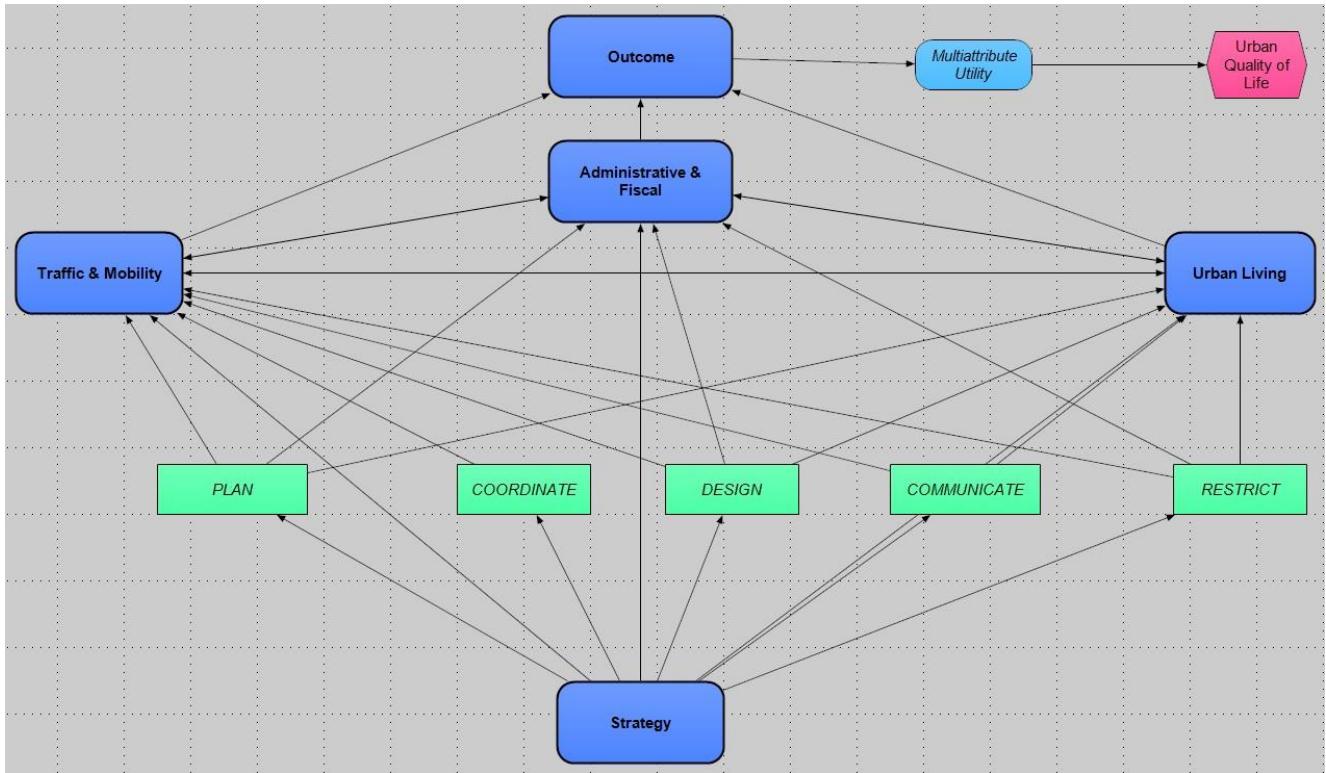
Figure 1: Top-Level Burqueville Mobility Influence Diagram

For instance, if we looked inside the Strategy module, we would see the elements required to map each decision in the set to the specific values it should take for the direction. [Note: model drilldown discussion and visuals removed for brevity].

For each objective, an additive linear function relates each set of variables with their coefficients to the corresponding objective[3]. Effectively, the modules represent less cohesive, exclusionary cliques, than organizational conveniences. The full diagram without any intermediate sub-divisions is a heady tangle. For complex models, it is only by establishing some reasonable cognitive boundaries that we can expect either the modelers or the consumers of the model to make any headway in interpretation and useful reasoning.

P-8. Model Analysis

Given ten uncertainties, and four decision levers, each with five possible values, there are $14^5 = 537,824$ possible scenarios. Not all are considered viable. For the set of uncertainties column, the aggregate values are "Low", "Medium" and "Strong." This aggregation approach assumes *(semiplena probatio)* high covariance in the uncertainties. For example, city planners believe that low gas prices will obtain in the same scenarios as low political acceptance of change, along with low levels of intercity coordination and transit coordination. The tool produces an arbitrary numerical value (e.g. "18.53K") that is used comparatively, as an interval value such as a common temperature grade (it has no standalone interpretation). The model's value is in its efficacy in showing relationships and

response surfaces through experimentation (i.e. sensitivity analysis). In particular, it shows how the impact of municipal decision-making combines with different expectations of the uncertainties. The most progressive strategy will have a downstream impact of over 14% more than the status quo, against the median uncertainties. Given an alternate scenario (with stronger uncertainties) the utility disparity between the progressive and status quo is about the same, but the overall utility value is 8% higher.

P-9. Enfranchisement

When presenting the work product, the consultant takes pains to explain that a decision model is not a decision. It is a mechanism for supporting effective decision making. In decision analysis, identifying the role of the decision maker is normally considered a critical pre-requisite to the process. However, in public policy decisions the identity of the decision maker is more complicated. The mayor may well have a personal preference among the strategies but will keep this to himself, at least for the time being. Championing any one strategy would inevitably invite targeted reactions, given the nature of the political environment. He sees his leadership as creating a 'change culture' through mechanisms of "multiple access" and "multiple advocacy" in the mobility conversation (Burns, 1978). The default strategy is not "do nothing." The city is already building a new bicycle path, expanding certain green spaces, and enabling some MoD at the expense of downtown parking. The actual strategy will bubble out of the various political processes, in due course. As it emerges, and citizens and city staff become more engaged, the decision model and the work that went into it will serve as a useful tool.

Conclusions

Contributions

This study applies decision analysis to a complex public decision problem in the form of a multi-objective (multi-stakeholder) utility function. For the academy, it outlines a decision process in this context as well as supplying research on a candidate set of attributes. For the practitioner, it interprets the techniques in terms of the capabilities of a city administration to support pragmatic contemplation of its role in a fundamental and fluid discussion. It provides a path for how such an entity can consider a "fully-engaged" mobility strategy and compare it with alternatives. The general theme of this study is the application of management science techniques to complex public policy issues. As such, this study helps to progress the conversation by showing how a well-established method could be employed to tackle urban problems and translate them into measurable plans of action that can be reasoned about and compared.

---

[1] Separate work by the same author looks at a multi-objective linear optimization model.

For Further Work

This is an important discussion which is intrinsically complex and multi-disciplinary in nature. The purpose of this paper was to introduce and define the overall process rather than to reveal it in full detail. The numerical model can be expanded to account for probabilistic reasoning as well as to explore different scenarios in detail via sensitivity analyses. An optimization model can be added to compute individual objective optima and show their impact on the meta-objective. Other work being done on data analytics in urban mobility can be adapted and applied to show how citizen feedback as well as technical mobility data can be harnessed to support the process of capturing and refining objectives. This study consciously stops short of providing a technical blueprint for action on the assumption that planning and execution of works projects are capabilities the city already has. Lastly, it would also be helpful to add a suitable fiscal model that complements the rest of the analysis and uncovers both the constraints and the possibilities of the finance dimension.

Conclusion

A problem like this will not be easily solved in a single pass. It must be solved if we are not to choke on our gases in a few years while caught in intractable gridlocks, paying exorbitant sums to get nowhere fast. The paper set out to address two questions. Firstly, we asked whether it makes sense for a small city to underwrite an UMP process based on its decision powers and capabilities, and secondly, how this would be done. We do not answer the first *per se* but show instead how a city might go about finding its own answer. In this we are also reminded of an essential truth in dynamic contexts: not to decide is also to decide. For the second question, the process and model provide a detail-rich illustration of an effective decision mechanism, albeit not a simple one. Problem complexity is not an excuse for inaction, but rather a challenge to be met by expansion of analytic skill sets as well as deepening of perspective. The mechanisms leading to the articulated objectives, variables and to the numerical model provide a kind of support harness for policy contemplation. Overall, to paraphrase Emerson, this was a fiction: a fiction to reveal the truth that reality had obscured.

References

Battarra, R., Gargiulo, C., Pappalardo, G., Boiano, D. A., & Oliva, J. S. (2016). Planning in the era of Information and Communication Technologies. Discussing the "label: Smart" in South-European cities with environmental and socio-economic challenges. *Cities*, *59*, 1–7. https://doi.org/10.1016/j.cities.2016.05.007

Berger, P. D., Gerstenfeld, A., & Zeng, A. Z. (2004). How many suppliers are best? A decision-analysis approach. *Omega*, *32*(1), 9–15. https://doi.org/10.1016/j.omega.2003.09.001

Boarnet, M., Jae kim, E., & Parkany, E. (1998). Measuring Traffic Congestion. https://doi.org/10.3141/1634-12

Branchi, P., Fernández-Valdivielso, C., & Matias, I. (2014). Analysis Matrix for Smart Cities. *Future Internet*, *6*(1), 61–75. https://doi.org/10.3390/fi6010061

Bulkeley, H., & Betsill, M. (2005). Rethinking sustainable cities: Multilevel governance and the 'urban' politics of climate change. *Environmental Politics*, *14*(1), 42–63.

Burns, J. M. (1978). *Leadership*. New York: Harper & Row.

Camarero, L. A., & Oliva, J. (2008). Exploring the social face of urban mobility: daily mobility as part of the social structure in Spain. *International Journal of Urban and Regional Research*, *32*(2), 344–362.

Cervero, R., & Arrington, G. B. (2008). Vehicle trip reduction impacts of transit-oriented housing. *Journal of Public Transportation*, *11*(3), 1.

Cipollini, K., Cipollini, K. A., Maruyama, A. L., & Zimmerman, C. L. (2015). Planning for Restoration : A Decision Analysis Approach to Prioritization Planning for Restoration : A Decision Analysis Approach to Prioritization, *13*(October), 460–470. https://doi.org/10.1111/j.1526-100X.2005.00057.x

Curtis, C. (2008). Planning for sustainable accessibility: The implementation challenge. *Transport Policy*, *15*(2), 104–112. Eckman, M. H., Rosand, J., Knudsen, K. A., Singer, D. E., & Steven, M. (2003). Can Patients Be Anticoagulated After, 1710–1716. https://doi.org/10.1161/01.STR.0000078311.18928.16

EPA. (2018). EPA Air Quality Reference. Retrieved from https://www.epa.gov/air-research/air-monitoring-measuring-and- emissions-research#aqmm

Ewing, P. L., Tarantino, W., & Parnell, G. S. (2006). Use of Decision Analysis in the Army Base Realignment and Closure (BRAC) 2005 Military Value Analysis. *Decision Analysis*, *3*(1), 33–49. https://doi.org/10.1287/deca.1060.0062

Flyvbjerg, B. (2014). What you should know about megaprojects and why: An overview. *Project Management Journal*, *45*(2), 6– 19.

Givoni, M., & Banister, D. (2010). *Integrated Transport: from policy to practice*. Routledge.

Gregory, R., & Long, G. (2009). Using structured decision making to help implement a precautionary approach to endangered species management. *Risk Analysis*, *29*(4), 518–532. https://doi.org/10.1111/j.1539-6924.2008.01182.x

Haghshenas, H., & Vaziri, M. (2012). Urban sustainable transportation indicators for global comparison. *Ecological Indicators*, *15*(1), 115–121. https://doi.org/10.1016/j.ecolind.2011.09.010

Henrion, M., Bernstein, B., & Swamy, S. (2015). A multi-attribute decision analysis for decommissioning offshore oil and gas platforms. *Integrated Environmental Assessment and Management*, *11*(4), 594–609.

Howard, R. A. (2007). Advances in Decision Analysis, chapter 3: The Foundations of Decision Analysis Revisited. Cambridge, MA: Cambridge University Press.

Howard, R. A., & Matheson, J. E. (2005). Influence Diagrams. *Decision Analysis*, *2*(3), 127–143. https://doi.org/10.1287/deca.1050.0020

Huang, I. B., Keisler, J., & Linkov, I. (2011). Multi-criteria decision analysis in environmental sciences: ten years of applications and trends. *Science of the Total Environment*, *409*(19), 3578–3594.

Johnson, M. P. (2014). Decision Models for Location of Community Corrections Centers Decision models for the location of community corrections centers, (May 2006). https://doi.org/10.1068/b3125

Keefer, D. L., Kirkwood, C. W., & Corner, J. L. (2004). Perspective on Decision Analysis Applications, 1990–2001. *Decision Analysis*, *1*(1), 4–22. https://doi.org/10.1287/deca.1030.0004

Keeney, R. (1994). Creativity in decision making with value-focused thinking. *MIT Sloan Management Review*, *35*(4), 33. Keeney, R. (2007). Developing Objectives and Attributes. In *Advances in Decision Analysis* (pp. 104–128).

Kirkwood, C. W. (1997). *Strategic decision making: multiobjective decision analysis with spreadsheets* (Vol. 59). Duxbury Press Belmont, CA.

Loukopoulos, P., & Scholz, R. W. (2004). Sustainable future urban mobility: using 'area development negotiations' for scenario assessment and participatory strategic planning. *Environment and Planning A*, *36*(12), 2203–2226.

Lumina. (2018). Retrieved from https://lumina.com/

Min, H. (1994). International Supplier Selection: *International Journal of Physical Distribution & Logistics Management*, *24*(5), 24–33. https://doi.org/10.1108/09600039410064008

Mitchell, W. J., Hainley, B. E., & Burns, L. D. (2010). *Reinventing the automobile: Personal urban mobility for the 21st century*. MIT press.

Montezuma, R. (2005). The Transformation of Bogotá, Colombia, 1995-2000: Investigating In Citizenship and Urban Mobility. *Global Urban Development*, *1*(1), 1–10.

Morlok, E. K., & Chang, D. J. (2004). Measuring capacity flexibility of a transportation system. *Transportation Research Part A: Policy and Practice*, *38*(6), 405–420. https://doi.org/10.1016/j.tra.2004.03.001

Munda, G. (2005). "Measuring sustainability": a multi-criterion framework. *Environment, Development and Sustainability*, *7*(1), 117–134.

New England, E. (2018). EPA New England Air Quality Information. Retrieved from https://www.epa.gov/aboutepa/epa-region- 1-new-england

Nuvolati, G. (2003). Resident and Non-resident Populations : Quality of Life , Mobility and Time Policies. Pafi. (2016). *Measuring the Accessibility of Urban Green Areas*. https://doi.org/10.2788/279663

Papastamatiou, I., Marinakis, V., Doukas, H., & Psarras, J. (2017). A Decision Support Framework for Smart Cities Energy Assessment and Optimization. *Energy Procedia*, *111*(September 2016), 800–809. https://doi.org/10.1016/j.egypro.2017.03.242

Pohekar, S. D., & Ramachandran, M. (2004). Application of multi-criteria decision making to sustainable energy planning - A review. *Renewable and Sustainable Energy Reviews*, *8*(4), 365–381. https://doi.org/10.1016/j.rser.2003.12.007

Poli, C. (2011). *Mobility and Environment: Humanists Versus Engineers in Urban Policy and Professional Education*. Springer Science & Business Media.

Poole Jr, R. W., & Samuel, P. (2011). Transportation mega-projects and risk. *Reason Foundation Policy Brief*, *97*.

Raiffa, H. (2002). Decision analysis: a personal account of how it got started and evolved. *Operations Research*, *50*(1), 179–185. Richardson, B. C. (2005). Sustainable transport: Analysis frameworks. *Journal of Transport Geography*, *13*(1 SPEC. ISS.), 29–39. https://doi.org/10.1016/j.jtrangeo.2004.11.005

Rondini, A., Lagorio, A., Pezzotta, G., & Pinto, R. (2017). Adopting a multi criteria decision method for the introduction of PSSs in the smart city context. *Proceedings of the Summer School Francesco Turco*, *2017–Septe*, 355–361. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-85040455115&partnerID=40&md5=c0c4657e2f7800328171b130e0e1495c

Salomon, I., & Mokhtarian, P. L. (1998). What happens when mobility-inclined market segments face accessibility-enhancing policies? *Transportation Research Part D: Transport and Environment*, *3*(3), 129–140.

Szyliowicz, J. S., & Goetz, A. R. (1995). Getting realistic about megaproject planning: The case of the new Denver International Airport. *Policy Sciences*, *28*(4), 347–367.

Tyrinopoulos, Y., & Antoniou, C. (2013). Factors affecting modal choice in urban mobility. *European Transport Research Review*, *5*(1), 27–39. https://doi.org/10.1007/s12544-012-0088-3

Ville, S., Gonzalez-Feliu, J., & Dablanc, L. (2013). The limits of public policy intervention in urban logistics: Lessons from Vicenza (Italy). *European Planning Studies*, *21*(10), 1528–1541.

Walker, W. E. (2000). Policy analysis: a systematic approach to supporting policymaking in the public sector. *Journal of Multi- Criteria Decision Analysis*, *9*(1–3), 11–27.

Wefering, F., Rupprecht, S., Bührmann, S., & Böhler-Baedeker, S. (2013). Guidelines. developing and implementing a sustainable urban mobility plan. In *Workshop* (p. 117).

Yeh, C.-H., Deng, H., & Chang, Y.-H. (2000). Fuzzy multicriteria analysis for performance evaluation of bus companies. *European Journal of Operational Research*, *126*(3), 459–473. https://doi.org/10.1016/S0377-2217(99)00315-X

Zhou, P., Ang, B. W., & Poh, K. L. (2006). Decision analysis in energy and environmental modeling: An update. *Energy*, *31*(14), 2604–2622.

Why Oregon Wineries and Vineyards Become B Corps and How a Greater Emphasis on Sustainability Has Changed Their Value Chain Activities and Competitive Advantage

Virlena Crosley, Linfield College
Ross Paine, Linfield College

While making a profit or maximizing shareholding value continues to be important aspect of business entities, there is increasing business interest in demonstrating efforts that consider all stakeholder values (Kim, Karlelsky, Myers & Schifeling, 2016). Through this wider acceptance of the importance of leading on or adopting strategies that are based on the evolving triple bottom line business sustainability (economic, social, and environment) concept (Elkington, 1998), many companies are changing their value chain activities in order to become more sustainable.

Additionally, their desire to be part of a community that is recognized for their sustainability efforts, many companies seek B-Corporation (B-Corp) certification. Certified B-Corps go through a comprehensive assessment process that is verified by a B-Lab, a nonprofit organization. The "B Lab certifies companies based on how they create value for non-shareholding stakeholders, such as their employees, the local community, and the environment." (Kim et al, 2016, para. 2) According to Murdoch (2018), the number of B Corps in Oregon's wine industry is growing. Oregon now has seven certified B Corp wineries and vineyards, which outpaces all other states or countries; in fact, Oregon's wineries and vineyards comprise 30% of the 20 global B-Corp community of wineries.

This paper explores through interviews with B Corp representatives why they sought B Corp certification, why they continue to stay certified, and what impact they believe being certified has had on their value chain activities in their effort to strengthen their sustainability efforts and their competitive advantage.

References:

Elkington, J. (1998). *Cannibals with forks. The triple bottom line of sustainability*. Gabriola Island, BC: New Society Publishers.

Kim, S., Karlesky, M. J., Myers, C. G., & Schifeling, T. (2016, June 17). Why companies are becoming B Corporations. Harvard Business Review. Retrieved February 28, 2019, from https://hbr.org/2016/06/why-companies-are-becoming-b-corporations

Murdoch, S. (2018, November 27). Did you know Oregon has the most B Corp wineries…in the world? [blog post] Oregon Wine. Retrieved February 28, 2019, from https://www.oregonwine.org/blog/did-you-know-oregon-has-the-most-b-corp-wineries-in-the-world/

Improving Green Supply Chain with Building Decentralized Cloud Platform
Yu Cui, Otemon Gakuin University

Abstract

In this paper, we first describe and analyze the evolution of green supply chain briefly. Then, we conduct a systematic research on the characteristics of supply chain system in a centralized context and analyze the barriers of green supply chain development in detail. Moreover, we investigate the feasibility and effectivity of blockchain technology which to rebuild supply chain system based on the studies of a decentralized cloud platform. Furthermore, a case study is adopted to illustrates how blockchain-orientated decentralized cloud platform in agricultural supply chain assist green supply chain supply and demand sides to enhance its productivity and reduce transaction costs. At last, we make summarization and prospects for the realization of blockchain technology-orientated and IoT-based green supply chain architecture.

Introduction

Green supply chain is to integrate the idea of sustainable development into supply chain management (SCM) activities and combine the ecological environment and economic development into an integration of mutual causality. Its purpose is to minimize the impact on environment throughout the whole process of product from material acquisition, processing, packaging, warehousing, transportation, utilization to end- of-life treatment, to maximize resource efficiency, and to coordinate and optimize the economic and environmental benefits of the whole supply chain. The ideal state of green supply chain management (GSCM) is internal and external coordination, efficient consensus and unified standards (Bhattacharya, et al., 2015). However, in practice, there are issues such as information asymmetry, opacity, fraud, and etc.

One of the most important premises of coordination is trust (Singh, et al., 2016). Therefore, without trust, the upstream and downstream of the supply chain cannot fully share and interact information, and the information flow will be distorted (Khan, et al., 2016). Likewise, the accounting period in supply chain will become longer and the capital flow will become extremely scarce when there is no trust, and a large number of documents and vouchers have to be checked for the transfer of real right in supply chain, lowering the efficiency of physical logistics (Kerkkamp, 2018).

In order to solve the issue of trust, traditional SCM emphasizes the centralized management model, that is, the so-called core enterprise model. All the business, no matter large or small in supply chain, such as procurement, planning, production, logistics, return and so on, are usually performed "centralized" design, coordination and management by core enterprises. Nevertheless, there are

147

natural limitations in this traditional "centralized" and "intensive" SCM model, and synergistic effect cannot be fully played (Behzadi, 2017).

Barriers of Green Supply Chain Development

Core Enterprise Management is Limited

At present, the upstream and downstream of supply chain span numerous enterprises involved. When the core enterprises extend their management range to the upstream or downstream, sharp rise in costs and declines in efficiency will be inevitably led to. Good core enterprises, such as Toyota, can manage suppliers above level 3 or 4 up. But even so, Toyota will not be able to achieve full peer-to-peer coverage. And for most enterprises which do not have the same strength as Toyota, it is even harder to perform the upstream and downstream GSCM.

Due to the scarcity of talents, tools or funds, many core enterprises are unable to adopt the most advanced management tools or effective resources to appropriately manage the physical logistics, information flow and capital flow in the supply chain, resulting in inefficiency and disorder of supply chain (Silva, et al., 2019). Although with the development of information technology, supply chain has developed to a new stage of intelligent supply chain which is deeply integrated with the Internet and the Internet of things, a series of tools have also been developed in traditional supply chain to assist the upstream and downstream of the supply chain to improve the level of coordination (Chen, et al., 2017). On the other hand, behind these tools and methods, core enterprises are always needed to carry out unified planning and coordination, which also restricts the development of GSCM.

After all, a core enterprise is no more than an enterprise, hence when it is confronted with the suppliers or customers whose scale are far larger, competition emerges, bringing about a great deal of uncertainty and loss of efficiency (Kim, et al., 2017). Meanwhile, as a core enterprise can merely cover part of the supply chain in its own industry, it is difficult to promote the global layout of supply chain and to integrate into the global supply system more deeply and inclusively.

Standards are Hard to Unify

Throughout the supply chain, although some core enterprises in key links develop and implement strict internal standards for environmental management, their upstream suppliers and downstream distributors do not necessarily comply with the same standards, undermining the integrity and systematicness of supply chain environmental management (Gill, et al., 2016). Accordingly, environment protection that core enterprises are aiming at cannot be realized, and a certain degree of resources waste is also caused.

In further analysis, throughout GSCM, it is particularly important for core enterprises to select suppliers that conform to their green development concepts. Wal-Mart, for example, promotes a

balanced scorecard among suppliers to measure, mentor and improve suppliers' environmental qualifications through quantifiable indicators. Nonetheless, as the data between suppliers and core enterprises cannot be shared in real time; there is space for opacity, counterfeiting and tampering; the ability of tracing back to the source of traditional supply chain information is weak; and it is difficult to obtain the whole chain data of supply chain; accordingly, it is unmanageable for the formation of an authentic and credible green evaluation system, resulting in the difficulty of unifying the GSCM standards and iteration.

Financing Difficulties of Small and Medium-sized Enterprises

There are often multiple supply and sales relationships in the supply chain, but in supply chain finance, the credit of the core enterprises can only be extended to the first-level suppliers and dealers that directly trade with them, and cannot be delivered to small and medium-sized enterprises at both upstream and downstream ends where financial services are more needed.

This leads to the condition that demands of secondary and tertiary suppliers / dealers with huge financing needs cannot be met, the business volume of supply chain finance is limited. The lack of timely financing for small and medium-sized enterprises tends to lead to product quality problems, endangering the whole supply chain system, green manufacturing and circulation, and even the smooth development of the real economy. At the same time, the poor flow of funds also leads to a weaker green sustainable development momentum for a great deal of small and medium-sized enterprises in supply chain.

Blockchain Enabling Green Supply Chain

The emergence of blockchain technology based on decentralization, point-to-point network, and intelligent contract brings new ideas and opportunities for the solution of the above problems. The development of blockchain technology can be mainly attributed to the rapid advancement and progress of Internet technology. In recent years, specifically, "big data", "artificial intelligence", "remote communication" and other technologies have played a prominent role in supporting blockchain technology.

The concept of blockchain first appeared in Bitcoin: A Peer-to-Peer Electronic Cash System, a paper written by Satoshi Nakamoto in late 2008. In this paper, blockchain technology is considered to be the basic technology to construct Bitcoin data structure and encryption transmission of transaction information, which can realize the mining and trading process of Bitcoin.

Nakamoto (2008) believes that the rapid development of blockchain technology lies in the fact that the information group processing mode supported by third-party organizations has three inherent defects that are difficult to make up for itself: Firstly, the mode of processing information with the

help of the third- party institutions has the inherent weakness of lack of trust between points. Secondly, the digital signature system itself will lose its value as a result of third-party support, hence the system itself can solve the problem of electronic currency identity. Thirdly, the existence of intermediaries not only increases the cost of transactions, but also limits the minimum transaction size in practical (Tapscott, et al., 2016).

According to Swan, M (2015), blockchain technology is a decentralized database which is both open and transparent. Blockchain can be understood as a spreadsheet with no central management, possessing limited functional permissions such as "add" and "query", and there are no "modify" or "delete". In the meantime, this spreadsheet stores different content for various jobs. Therefore, blockchain is essentially a rule, and generally speaking, it is the process that a group of people who abide by the rule record the contact information.

Viewed from the name itself, blockchain is a system composed of blocks and connected by chains; from the form of expression, blockchain is a distributed ledger; from the technical point of view, blockchain is a distributed chain database; from the perspective of use, blockchain is a credit carrier with high reliability; from users' point of view, blockchain is an information sharing platform without a third party; from the perspective of social development, blockchain the infrastructure of next generation in the process of social development and it solves the problem of credit. All social activities based on such infrastructure will be credible (Kshetri, 2018). People can rely on this to cross the credit barrier and return to the essence of things.

Blockchain is a technical system which stores data with block structure and maintained by multiple parties. With the adoption of cryptography technology, transmission and access are guaranteed, and data storage is realized. Multi-point coordination plus non-tampering truthfulness plus traceability construct the core applicable abilities of blockchain and provide a platform for all participants to cooperate equally (Maria- Lluisa, 2017).

First of all, multi-point cooperation means that there are many nodes distributed in the blockchain network, and these nodes can be freely connected for the exchange of data, assets, information and the like. Secondly, the blockchain adopts cryptography technology to ensure that the information on the blockchain is not tampered with, mainly using the hash function in cryptography and asymmetric encryption. Finally, the form of blockchain holds all the historical data from the first block. In detail, the form of connection is that the latter block has the HASH value of the previous block, and any record on the blockchain can be traced back to the source through the chain structure (Noguchi, 2017).

Transparent traceability, collaboration driven

When green supply chain integrates with blockchain, supply chain will become more transparent,

large- scale collaboration will turn easier, and the cost and risk of the entire supply chain will be lowered. With the role of core enterprises being weakened gradually, supply chain will be assuredly transformed from core enterprise driven to collaboration driven.

In the green supply chain based on blockchain, the asymmetry of information is greatly reduced, along with it, the communication cost between enterprises also declines, and trust is established forthwith. As there is no need for green supply chain enterprises to waste time to struggle, so more energy and resources can be spent on the competition with other supply chains regarding cost and efficiency, providing the best products and services to end customers.

Enterprises in green supply chain will be able to chain for efficient multi-point coordination, and nodes can be freely connected for the encryption and sharing of data, assets, information and etc. without going through the core enterprises. Meanwhile, in an open blockchain system, the private information of all the parties involved in transaction is encrypted, all the participants in green supply chain can join the system on equally, and the information of the whole system is highly transparent. Once the information is verified and added to blockchain, it will be stored permanently, ensuring that all the actions in green supply chain are traceable and non-tamperable.

Unified Standards, Efficient Operations

Block chain system follows established rules to make self-management and operates through consensus mechanisms and smart contracts. By doing so, the efficiency of green supply chain system is significantly improved. When there are sufficient information transparency and mutual trust, the coordination between enterprises depends on the consensus of the whole, rather than the management provisions of a certain core enterprise.

For example, in the environmental management of green supply chain, by exploring and establishing a unified green product standard, certification and identification system, the coordination between enterprises be performed on the basis of multi-consensus environmental standard system. Through the smart contract technology of blockchain, the related processes of supply chain can be controlled and executed automatically, reducing manual intervention and operation errors and raising industrial efficiency. Even in the event of a dispute, the resolution mechanism is simple and effortless owing to the various historical information recorded among enterprises by blockchain. Tracing the source of data is simplified and the identification of responsibilities is facilitated, accordingly, the iteration is optimized.

A so-called "dynamic alliances" can even be formed among enterprises. In detail, enterprises within the alliance can join or withdraw voluntarily, as long as they meet the criteria for access and withdrawal of the alliance, and due to the existence of "consensus mechanism" and trust, the cost of joining and quit for an enterprise is extremely low.

Building a Decentralized Procurement Cloud Platform

Through the blockchain technology and its decentralized and non-tamperable technical characteristics to build a decentralized procurement cloud platform based on blockchain technology, an independent, open and transparent enterprise procurement management process is realized. On the basis of the platform, it can provide credit records such as transaction execution status for mutual parties enter or use the platform, and assist enterprises in understanding or selecting partners through providing references.

With the cloud platform, the procurement information of enterprises is gathered in the cloud. Meanwhile, through big data's analysis and application of the procurement information, the seamless connection of the procurement, inventory, production and other management processes is realized, reducing the stoppage of materials and inventory backlog. Furthermore, the efficiency of enterprise production and management is accelerated, and data support for the government in the formulation of macro policies is furnished.

Technical principles

The decentralized procurement cloud platform based on blockchain technology is constructed with the integration of technical characteristics including highly integrated block chain decentralized distributed storage, non-tamperable information and intelligent contract. And it is formed by the semi-alliance chain and semi-common chain structure. Platform users will be automatically assigned a unique digital identity ID (including public and private keys) after registration, and each user acts as a node of the blockchain platform.

From the beginning of its generation, the node saves all the smart contracts or contract abstracts generated by both parties to the transaction since the platform was built, forming a smart contract data structure by contract information hash summary, bilateral value, ID of transaction parties, transaction time stamp. Three parts, which are alliance node, central service node and peripheral platform enterprise node are concluded in the platform.

Alliance Nodes

The main participants include large or global enterprises and related functional departments in industries or government. And the main function is to package smart contracts generated in a certain period of time into blocks, endorse the good credit records of large and medium-sized enterprises and government agencies, and minimize the probability of occurrence of malicious nodes.

Central Nodes

The main participants are local operators, as the nodes reserve a great deal of smart contracts, the central node provides multi-center storage services, and the child nodes of other platform enterprises

only reserve the summary information of blockchain.

Sub Nodes of Platform Users

The main participants are small and medium-sized enterprises. Only the contract summary information is saved, thereby reducing the storage space occupied by contracts. On the other hand, the child nodes on platform only have the function of viewing, while data cannot be written. All the contract information is broadcast and written to blockchain by the federated nodes. The decentralized procurement cloud platform is built on a consensus mechanism based on workload proof. In order to construct a set of decentralized timestamp servers on a point-to-point basis, we introduce a hash algorithm. The digital identity ID, transaction timestamp and information of transaction amount of both parties in the transaction are written into the smart contract. Once the digital signatures of the two parties are confirmed, they will be broadcast and stored in the whole network.

The signing of smart contracts depends on digital identity, which is actually a pair of public and private keys. In detailed example, if buyer A wants to make a procurement offer to supplier B, A encrypts the digital contract with B's public key, and signs the contract with its own private key and broadcasts it to the whole network. Meanwhile, only B can decrypt the contract with its own private key. And once B decrypts the contract and confirm its correction, it confirms the signature with A's public key and signs the contract with its private key. When the above process is finalized, an electronic contract is confirmed to be successful and broadcast to nodes throughout the network. The federated nodes of platform will package the transactions of a certain period into the blockchain.
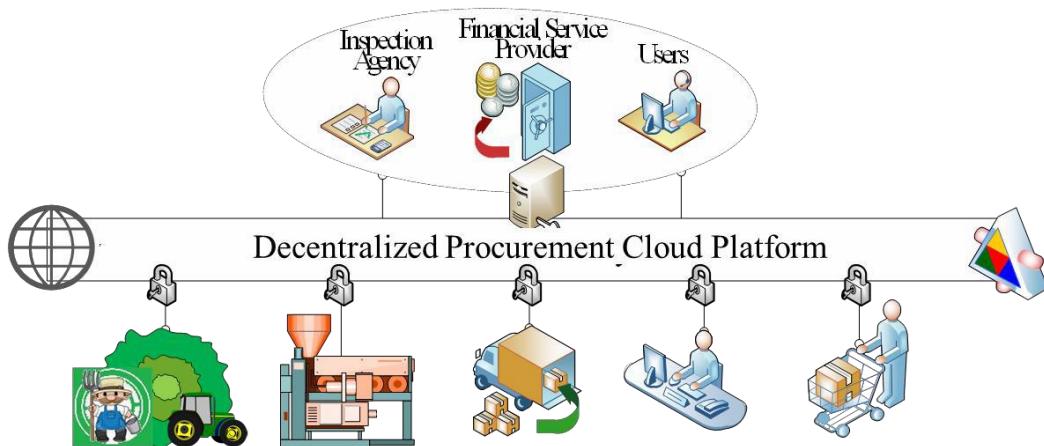

Figure 1. Blockchain-based Decentralized Procurement Cloud Platform

Platform Architecture

The platform is consisted by semi-alliance and semi-public blockchain system and decentralized procurement cloud platform (see Figure.1). Enterprises query the credit index of relevant enterprises through the search engine of platform credit, and the credit index of enterprises is obtained through the smart contract information of blockchain. With the search engine, enterprises can query the credit of users on blockchain collaborative procurement platform, and the contents of inquiry include: the total number of contracts, the total amount of contract, the credit evaluation record of enterprise and so on. Meanwhile, the system calculates the credit index of enterprise through the credit record model.

Enterprise users can apply the information to confirm the historical credit record of the trading parties, so as to support the procurement decision and solve the problem of high procurement cost caused by asymmetric information in enterprise procurement. In the meantime, through the credit index of transaction, the influence of anthropic factors is utterly evaded.

Platform Functional Modules

Collaborative procurement cloud platform consists of two parts, one is the blockchain part, the other is the decentralized procurement cloud platform part. Firstly, the blockchain technology part includes the alliance node smart contract system, central node smart contract system, and ordinary user platform smart contract system.

All these are deployed in the application layer, the same function, the public key of the digital identity is the address, and the corresponding private key, which can issue, receive and confirm the digital signature of smart contract is stored locally. All the historical transaction information is stored at the federation node and the central node, and only the summary information of the platform transaction is stored on the common user platform. At the same time, the alliance node and the central node also bear the responsibility of packaging the transactions in a certain period of time to form a new block through the consensus mechanism of POW.

Secondly, in the decentralized procurement cloud platform, enterprise credit query engine, decision support system of blockchain collaborative procurement platform and data visualization BI system of blockchain decentralized procurement platform are concluded. By accessing the smart contract information on blockchain, the enterprise credit platform can query the total contract number, amount, and the credit evaluation record of enterprise, and consequently calculate the enterprise credit index.

The decision support system of blockchain decentralized procurement platform provides support for enterprise procurement management and supplier management through the big data analysis of massive enterprise transaction information and the establishment of relevant decision-making

models. Blockchain decentralized procurement platform visualization BI, on the basis of historical transaction data of enterprise, provides enterprises with means and models based on big data analysis and display, supporting the entire production and management of enterprises.

Dentsu's Blockchain-Based Cloud Platform

The company of Information Service International-Dentsu, which deals with system construction, to utilize benefits of difficult tampering for food traceability (tracking production history). Since the beginning of October 2016, Dentsu has been conducting demonstration experiments to ensure the quality of organic agricultural products in cooperation with Aya-cho, Miyazaki Prefecture's district.

Organic vegetables take 2 to 3 times more time and effort than ordinary farming methods. However, with the current agricultural mechanism, its cost cannot be reflected in the price as it is. In addition, Japanese consumers stick to whether vegetables are domestic, but they are not very interested in further value (ISID, 2018). Therefore, organic vegetables do not sell very well in normal supermarkets. However, there are certain consumers who are seeking safe vegetables. If reliable vegetables can be delivered to such consumers, the labor of organic farming can be valued (ISID,
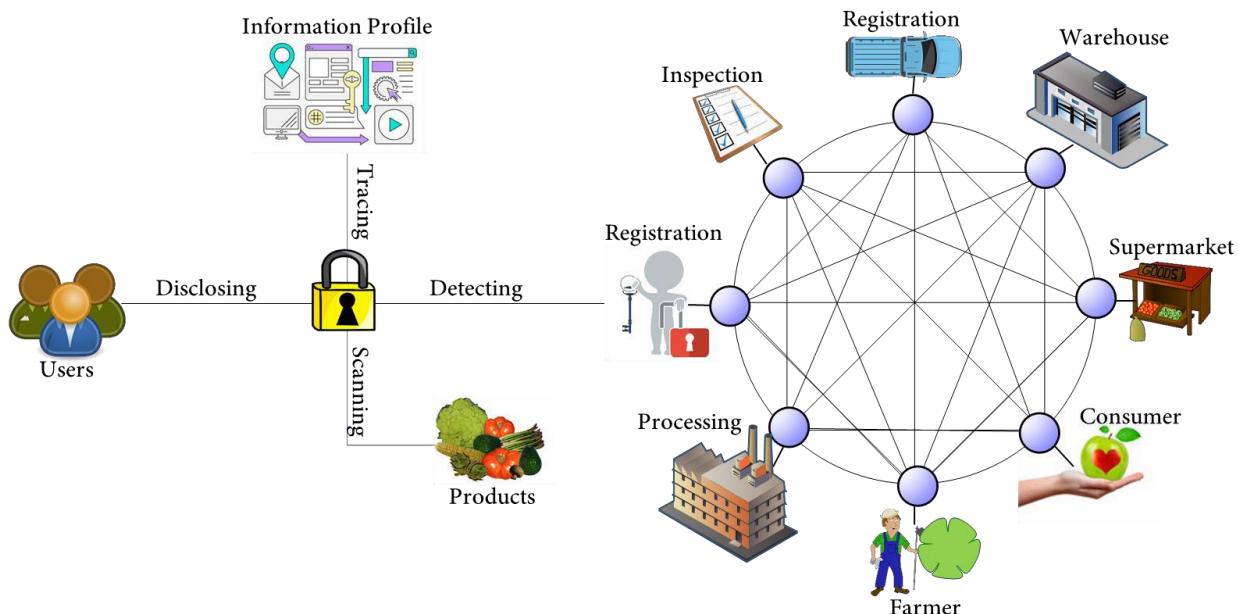
2018).

Figure 2. Dentsu's Blockchain-based Cloud Platform

Each farmer in Aya-cho carries out planting and harvesting, use of fertilizers and agricultural chemicals, quality check of soil and agricultural products, etc. based on the cloud platform established by Aya-cho (see

Figure 2). In the field trial, all of these histories are recorded on the cloud platform. Aya-cho grants a unique ID along with an approval mark by its own standard to agricultural products shipped after this process. By searching with this unique ID, consumers can confirm on the Internet that the agricultural products are definitely produced by Aya-cho, that they were produced based on Aya-cho's strict certification criteria, that their history has not been tampered. If these vegetables are sold to consumers directly by Marche etc., the value of organic farming method can be reflected in price.

The cloud platform that registers production management information by this demonstration is a so-called "private type" blockchain which Aya-cho operates and manages. Such unique private blockchain are characterized by faster processing than public blockchain used in bit coins and the like. However, this system alone can not maintain objectivity like a public blockchain. Therefore, in Aya-cho, data was first written to a rapidly processing blockchain, and the information was managed by a public blockchain provided by Estonia's Guardtime. In this way, by realizing information management with high reliability and security guaranteed by using blockchain technology, it is possible to create new value in the field that has been overlooked so far.

Conclusions

To sum up, through the underlying infrastructure support of blockchain technology, the production relations of green supply chain will be further optimized. There will be more efficient collaboration among enterprises, and the integration of blockchain and green supply chain will surely play a greater role. For example, it can be applied into the green management throughout product life cycle in the category of green manufacturing, green regulation for supply chain, the tracking of green logistics system, and the transaction of recycled resources.

Moreover, in the near future, an end-consumer only has to scan a bar code to get the clear information of overall supply chain and green evaluation information of the commodity, and the environmentally relevant pollution coefficient at each production and service node will be attached, thereby affecting the purchase decision of end-consumers. This traceability feedback mechanism also promotes the nodes in supply chain to pay more emphasis on environmental protection, thus gradually eliminate high-polluting enterprises.

In the new era, new missions have to be solved by new technologies and modes. With the immense development of global enterprises and the continuous strengthening of ecological civilization construction, the green supply chain management model will be accepted by more and more enterprises, and will assist enterprises in their achievement of economic, environmental and social benefits. Last but not least, block chain will make greater contribution to the realization of digital enterprise through enabling green supply chain.

Reference

Behzadi, Golnar, O'Sullivan, Michael Justin., Olsen, Tava Lennon., Scrimgeour, Frank., Zhang, Abraham. (2017) 'Robust and resilient strategies for managing supply disruptions in an agribusiness supply chain', *Int. J. of Production Economics*, Volume 191, September 2017, pp.207-220

Bhattacharya, Arijit; Dey, Prasanta Kumar; Ho, William. (2015) Green manufacturing supply chain design and operations decision support. *International Journal of Production Research*. Nov2015, Vol. 53 Issue 21, pp.6339-6343.

Chen, Lujie., Zhao, Xiande., Tang, O., Price, Lydia., Zhu, Wenwen. (2017) 'Supply chain collaboration for sustainability: A literature review and future research agenda', *Int. J. of Production Economics*, Volume 194, December 2017, pp.73-87

Gill, Asif Qumer., Phennel, Nathan., Lane, Dean., Phung, Vinh Loc. (2016) 'IoT-enabled emergency information supply chain architecture for elderly people: The Australian context', *Information Systems*, Volume 58, June 2016, pp.75-86

ISID. (2018). Guaranteeing Production, Distribution and Consumption History of Agricultural Products through Blockchain, *Press Release of IT Solution Innovator*, 17 May 2018, pp.1-3

Kerkkamp, R.B.O., Heuvel, W. van den., Wagelmans, A.P.M. (2018) 'Two-echelon supply chain coordination under information asymmetry with multiple types', *Omega*, Volume 76, April 2018, pp.137-159

Khan, Mehmood., Hussain, Matloub., Saber, Hussein M. (2016) 'Information sharing in a sustainable supply chain', *Int. J. of Production Economics*, Volume 181, Part A, November 2016, pp.208-214

Kim, Minkyun, Chai, Sangmi. (2017) 'The impact of supplier innovativeness, information sharing and strategic sourcing on improving supply chain agility: Global supply chain perspective', *Int. J. of Production Economics*, Volume 187, May 2017, pp.42-52

Kshetri, Nir. (2018) '1 Blockchain's roles in meeting key supply chain management objectives', *Int. J. of Information Management*, Volume 39, April 2018, pp. 80-89

Maria-Lluisa Marsal-Llacuna. (2017) 'Future living framework: Is blockchain the next enabling network?' *Technological Forecasting and Social Change*, In press, corrected proof, Available online 12 December 2017

Ribeiro, Joao Pires., Barbosa-Povoa, Ana. (2018) 'Supply Chain Resilience: Definitions and quantitative modelling approaches ? A literature review', Computers & Industrial Engineering, Volume 115, January 2018, pp.109-122

Singh, Anil., Teng, James T.C. (2016) 'Enhancing supply chain outcomes through Information Technology and Trust', *Computers in Human Behavior*, Volume 54, January 2016, pp.290-300

Silva, Graça Miranda; Gomes, Paulo J.; Sarkis, Joseph. (2019) The role of innovation in the implementation of green supply chain management practices. *Business Strategy and the Environment*, Feb 10, 2019

Swan, Melanie. (2015) 'Blockchain: blueprint for a new economy', O'Reilly Media.

Tapscott, Don, Tapscott, Alex. (2016) 'Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money', Business, and the World. Portfolio.

Wang, Xinhui., Guo, Hongmei., Wang, Xianyu. (2017) 'Supply chain contract mechanism under bilateral information asymmetry', *Computers & Industrial Engineering*, Volume 113, November 2017, pp.356-368

Noguchi, Yukio. (2017) 'Blockchain Revolution: The Advent of Distributed Autonomous Society' (in Japanese). Nikkei Publishing Inc.

Nakamoto, Satoshi. (2008). 'Bitcoin: A Peer-to-Peer Electronic Cash System', Retrieved 30th January 2018, from https://bitcoin.org/bitcoin.pdf

Ready, Set, Go! How Graduates See Their Job Readiness

Amiee Shelton, Roger Williams University
Carley Egan, Roger Williams University

Abstract

Work readiness in college students not only adds to the marketability of a student, but they gain different skills over time from programs within their universities, extra circular activities, internships and other experiential learning experiences, ultimately making them more valuable and experienced when they enter the professional work setting. However, while it is known these activities provide hard skills for the respective disciplines, it is not clear from the literature what soft skills are being cultivated, and if students see the value in these skills. Therefore, this present quantitative study explores respondents attitudes (N=200) towards what "soft" skills students learned to be active and ready for the workplace, where they learned these skills, and the level of importance students place on these skills. This information is important due to the nature of the job market and the impact that soft skills bring to a prospective workplace environment. Findings from this paper will assist career services in determining if additional programs, polices or requirements are needed to get students more workplace ready.

Keywords: work readiness, experiential learning, soft skills, interdisciplinary, career service

THE NEED FOR DEVELOPING AN INTERACTIVE MAP OF COLLEGE-LEVEL CYBERSECURITY ACADEMIC PROGRAMS IN THE UNITED STATES

[1]RUSSELL BEAUCHEMIN, [2]DR. DOUG WHITE

[1,2]School of Justice Studies Roger Williams University -
Rhode Island, USA Email: [1]rbeauchemin@rwu.edu
[2]dwhite@rwu.edu,

Abstract: The U.S. Department of Labor reports a 28% increase in jobs in the field of Information Security Analysts between 2016 – 2026. They continue on to report a median pay of $95,510/year and a minimum of a bachelor's degree required to enter the field making this an attractive option to students considering potential majors and investigating possible career avenues. This statistic for growth only takes into account jobs in the U.S., the world-wide market will be much bigger based on extrapolation. As of now, there is no specific unbiased and comprehensive resource for people looking to explore academic programs in the field of Cybersecurity or any of its many more-specialized subsets such as digital forensics, penetration testing, and cryptography. While there are resources like cybersecurityventures.com, studyusa.com, and cyberdegrees.org, they are either commercial sites representing the interests of paid-participants, incomplete lists highlighting only the top x programs, or too specific and focused on other aspects such as region or cost to be comprehensive. This lack of resource prevents upcoming students from seeing the whole picture of program offerings and allowing them to make more informed decisions from a comprehensive and unbiased data set. This paper will discuss (more in-depth) the need for a project such as this, present a walk-through of the project, and demonstrate a sample of a working map.

Keywords: Cybersecurity, Academic Programs, College Degree, Degree Programs, Security

The Effects of Network Governance on the Manufacturer's Rent in the Triadic Supply Chains – Empirical Evidence

Artur Swierczek

University of Economics in Katowice
Department of Business Logistics
ul. 1 Maja 50
40-287 Katowice, Poland
email: artur.swierczek@uekat.pl
ORCID: 0000-0001-6198-6377

Abstract

The triadic research perspective becomes imperative to further comprehend network dynamics in supply chains and is instrumental when investigating network as the mechanism of governance and its influence on the network rent. The goal of this study is to investigate whether the rent generated by the manufacturer sitting on the structural hole is dependent upon the network governance mechanism covering three distinct, but overlapping and interdependent modes, namely market, hierarchy and clan.

Keywords: triad, supply chain, manufacturer's rent, network governance

1. Introduction

The concept of triads has risen to prominence in the literature over the last few years offering a powerful tool for investigating increasing complexity of contemporary supply chains. In this study we consider triadic supply chains composed of three subsequent actors establishing two dyadic relationships: supplier-manufacturer and manufacturer-customer. In such a triad, the manufacturer is positioned centrally, on top of the structural hole. This position can be used by the manufacturer as a means of adding value through brokerage. Consequently, the manufacturer who sits on the structural hole may reap substantial information, control and reputational benefits derived from its privileged position in the triadic supply chain. These benefits may take the form of additional rent that is determined by structural variables, covering a wide range of enduring bilateral relationships among interacting social actors - the manufacturer, its supplier and customer.

The goal of the study is to investigate whether the rent generated by the manufacturer from the structural hole is dependent upon the network governance mechanism covering three distinct, but overlapping and interdependent forms, namely market, hierarchy and clan. The study reveals a different constellation of network governance in the triadic supply chains contributes to yielding the highest rents for the manufacturer.

Following the introduction, the paper covers the literature review, research design and methodology. Then, the analysis and obtained findings are depicted. Finally, the future directions for further research are defined.

2. Literature review

The concept of supply chain has undergone through tremendous changes over the last decade. One of the pivotal challenges is the shift in the research focus from dyadic into the network perspective (Dubois and Fredriksson, 2008; Kim, 2014; Wilhelm, 2011). The smallest unit of network is a triad (Choi and Wu, 2009; Dubois, 2009), that can be depicted as the triadic supply chain, consisting of two dyads, established by the focal company (also known as ego) and its immediate actors, positioned on both sides (also known as alters) (Mentzer *et al*., 2007). These three actors are directly linked by one or more of the upstream and downstream flows of products, information and finances in the triadic supply chain (Wuyst *et al*., 2004). Accordingly, this sort of triadic supply chain is typical for the manufacturing setting (Li and Choi, 2009), where the manufacturer is positioned in between the supplier and the customer, and all three actors establish linear flows (Mentzer *et al*., 2007). Through its privileged position between two disconnected actors, the manufacturer is the actor in a triad, that holds a key to be in charge of governance (Yang *et al*., 2011). From the classical perspective of the Relational Contracting Theory and Transaction Cost Analysis (TCA), governance is viewed as the choice between market and hierarchy. The constructs of market revolves around contractual relationships over property rights. It involves relationships mediated by a price mechanism and provides a high degree of flexibility to the companies in determining their willingness to form supply chains. Essentially, the construct of market argues that the companies prefer to be independent and will choose to collaborate only when they see particular advantages to themselves (Powell, 1990). In other words, this form of governance resembles early market-based relationships, characterized by arm's-length ties, deprived of both personal bonds and any form of central coordination of activities (Baker, 1990).

The hierarchical construct of governance is positioned on the other side of the continuum. It is supposed to overcome the problems of non-engaged and loose relationships typical for market

governance. Therefore, the construct of hierarchy emphasizes a necessity to impose a supervisory structure to implement integration and to apply bureaucratic routines. In this way, it assumes that the companies are more engaged to the established and committed long-lasting relationships (Lowndes and Skelcher, 1998). However, hierarchy may reduce flexibility and innovation due to the higher level of formalization and centralization of power (Powell, 1991). Beyond the recognition of market and hierarchy, as mutually exhaustive bipolar framework of governance, there have been numerous attempts to develop alternative forms or supplement the existing model with other characteristics (Uzzi, 1996). Subsequent debates enabled to develop one of the most widely accepted approach, which added to bilateral framework a third construct of network governance (Coleman, 1988). In the course of time, a discussion unfolded as to whether network governance is simply a combination of the constructs of market and hierarchy, or whether it would be better understood as a unique form of governance. In early works, network governance had been framed as a form combining the tenets of both market and hierarchy, and positioned somewhere in the middle of continuum between these two extreme forms of governance (Thorelli, 1986). In other words, the gap between market and hierarchy was filled in with this third form of governance. Nonetheless, the current view usually acknowledges that network is a distinct, non-market and non-hierarchical, and thus not an intermediate form of governance, possessing complementary, multi-relational and reciprocal characteristics (Powell, 1990). Network governance highlights that purely economic exchanges may be shaped by social capital which is a tacit resource attainable by individual actors through the networks of relationships (Whipple *et al*., 2015). In other words, social capital creates opportunities for economic exchanges of goods which are difficult to price and enforce contractually (Uzzi, 1996). Therefore, the particular form of network governance will be, at least partially anchored in the discretion of supply chain decision makers, based on managers' previous experience, perception capability, mimicry, personal attitude (Provan and Kenis, 2008), professional background, opportunism, ambiguity, information accessibility, etc. In other words, economic exchanges anchored in the theory of market and hierarchy are shaped by social relationships. This phenomenon, referred to as 'embeddedness' offers a potential link between sociological and economical accounts of business behavior (Uzzi, 1996).

In the opinion of Dyer and Singh (1998) governance plays a critical role in generating rents as it influences the willingness of network partners to engage in value-creation initiatives. In this vein, we presume that the components of network governance affect, though to different extent, the value of network rent generated in supply chains. The network rents seeks to explain variation in relational performance among supply chain dyads. Drawing upon the study of

Cheung *et al.* (2011), we define the relational performance as joint benefits produced by two actors that cannot yielded by any of these two organizations alone. Consistent with this logic, the relational performance can be referred to as the relational rent developed by Dyer and Singh (1998), and then extensively explored by Lavie (2006). The notion of network rent brings the relational performance on the next level by analyzing how the relational performance generated by one dyad affects the relational performance of another dyad (Swierczek, 2018). The network rent considers the outcome of reciprocal interactions between the relational performance of two dyads in a triad, which in turn yields stronger effects than these dyads would ever produce individually (Swierczek, 2019). Consequently, the network rent is based on synergy, defined as an interaction among parties, that creates an enhanced combined effect (The American Heritage Dictionary of the English Language, 2018). It enables to capture the interplay between the relational performance within the supplier–manufacturer–customer triad (Mena *et al.*, 2013). In this study, we particularly refer to the rent that accrues to the manufacturer sitting on top of the structural hole (Kogut, 2000). This approach reflects the Italian phrase: between two fighters, the third benefits (Burt, 1992). Consequently, this type of rent is aimed at by the manufacturer that opportunistically exploits its bridging position, usually at the expense of others (Batjargal, 2010; Burt, 2017). Figure 1 depicts the idea of network rent from the manufacturer's perspective.
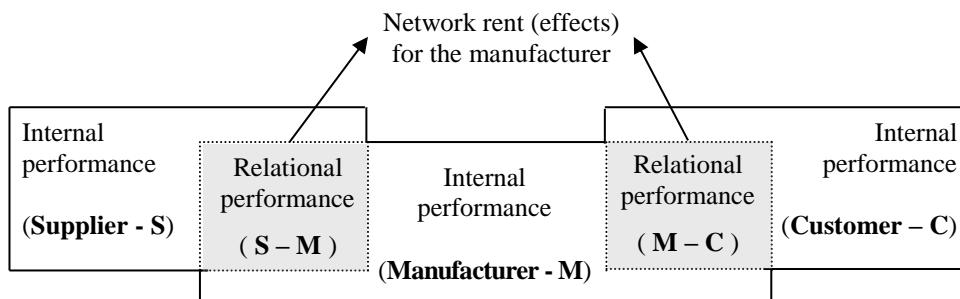
Fig 1. The network rent in the triadic supply chain
Adapted from Carter *et al.* (2017)

3. METHODOLOGY

3.1. Data Collection and Sample

The process of data collecting spanned over 5 months from December 2018 thru May 2019, and consisted of several stages. We used a multiple-respondent approach to collect data for our study. In order to collect data from all three actors forming the triadic supply chain, we combined probability and non-probability sampling.

In the first stage of the data collecting process, conducted by stratified sampling, a group of 98 Polish manufacturers was targeted. Then, to collect data from the suppliers and the customers the snowball sample method was used. In other words, both groups of actors were indicated by the manufacturers. Out of 98 manufacturing companies, a number of 10 firms refused to fill in the questionnaire maintaining that their suppliers or customers will not be willing to participate in this sort of research. Likewise, a large group of 50 manufacturers encountered problems with a bad attitude of suppliers or customers towards the questionnaire. Finally, a group of 4 manufacturers managed to encourage their suppliers and customers to participate in the survey, however after receiving the questionnaire, they refused to take part in the research. Consequently, the remaining portion of 34 triads that establish a simultaneous relationship with both a supplier and a customer were investigated in the study.

3.2. Measures and Research Instrument

We applied several constructs to measure the role of the effects of network governance on the manufacturer's rent. First, to capture the construct of network rent, we used two groups of measures. The first one covered the relational performance of upstream and downstream dyads, and showed the extent to which both parties in a dyad generated combined effects. We used five opinion-based measures that were inquired from respondents separately for two dyads. As a result, based on the average responses of companies in the triad, two constructs were formed – one for the upstream dyad (supplier-manufacturer), and the other one for the downstream dyad (manufacturer-customer). The interaction between these two constructs indicated the manufacturer's rent. The second group of measures included the metrics of operational performance to demonstrate the manufacturer's performance in the triadic supply chain. On the other hand, to grasp the issue of network governance, we used three constructs of market, hierarchy and clan. The responses concerning different modes of governance, obtained from three actors separately, were then averaged to deliver the holistic mechanism of governance for each triadic supply chain.

The structure of the survey questionnaire was adapted to certain groups of respondents – actors playing different roles in the examined triadic supply chains. Accordingly, depending on the function served in a triad, each responding company answered a specific set of questions. Due to its central location, the manufacturer answered the questions concerning different modes of governance (categories 3-5 in Appendix A) and the relational performance of upstream and downstream dyad (category 1 in Appendix A). Likewise, the manufacturer also responded to the questions on the operational performance (category 2 in Appendix A). The other two groups

of actors in a triad, the suppliers and the customers, answered the questions concerning governance (categories 3-5 in Appendix A) and the relational performance yielded in a certain dyad formed with the manufacturer – (category 1 in Appendix A).

4. Analysis

4.1 Research procedure

In order to address the problem raised in the paper, we employed a three-step research procedure. First, to identify the manufacturer's rent as a combination of the relational performance of two dyads in the examined triadic supply chains, we conducted the Multiple Regression Analysis with Interaction Effects. Then, we performed Principal Component Analysis (PCA) to group the variables, reflecting distinct modes of governance, into three constructs of market, hierarchy and clan. Finally, we employed the Multiple Regression Analysis to test the strength and direction of the effects of governance on the manufacturer's rent.

4.2 Multiple Regression Analysis with Interaction Effects

Having employed the Principal Component Analysis with Varimax Rotation, two constructs of the relational performance of upstream dyad and downstream dyad were used as main terms manifesting independent variables in the regression model. The cross-product of these two constructs, referred to as interaction term, manifested the network rent. Likewise, the factor scores for the operational performance were used as a dependent variable.

Following the approach recommended by Aiken and West (1991), the multiple regression model with interaction effects was developed to test for the interaction between two variables manifesting the relational performance of upstream dyad and downstream dyad. If such interaction exists, we posit that the manufacturer's rent is present in the triad. The results of the regression analysis with interaction effects are depicted in Table 1.

The regression analysis for the supply chain performance showed that the adjusted coefficient of determination ($R^2_{adjusted}$) was .24. It suggests that the predictors explain 24 percent of the variance in the operational performance. As depicted in Table 1, all three predictors were significant in the model.

Table 1. Multiple Regression Model with Interaction Effects

Adjusted R^2=.241	β [a]	t	p-value
Relational performance of upstream dyad	.215	3.47	.000
Relational performance of downstream dyad	.221	3.78	.000
Network rent	.175	2.64	.007

Note: [a] dependent variable: Operational Performance

The standardized regression coefficients indicated the relative strength of each of the significant independent variables, as demonstrated by (beta, p) at the end of each variable. There was a positive influence of relational performance generated by the upstream dyad (.215, .000), downstream dyad (.221, .000), and the network rent (.175, .007) on the operational performance. It is also worth noting that both factors of relational performance quite similarly contributed to supply chain performance. In other words, the higher relational performance generated upstream and downstream dyads, the greater overall operational performance. Interestingly, the manufacturer's rent, interpreted as the effect of reciprocal influence of relational performance generated by two dyads, was significant in the model (at $p < .01$). This finding suggests that the network rent actually existed in the examined triads. Moreover, it had a positive influence on supply chain performance. This clearly evidences that the increase of network rent significantly contributes to the higher level of operational performance. The obtained findings show that the combination of relational performance of two dyads contributes to generating the manufacturer's rent in the investigated supply chains.

4.3. Principal Component Analysis

Before assessing the final regression model for the manufacturer's rent, we first employed the Principal Component Analysis (PCA) with Varimax Rotation in the space of variables manifesting three distinct modes of network governance, including market, hierarchy and clan. The aim of PCA is twofold: first, to assess if the observable variables affect enough into their postulated constructs, and second, to evaluate whether the appropriate variables load substantially on their hypothesized factors and no larger than .30 on any other factor (Hair *et al.*, 2017). In consequence, a total group of three items were removed from the further analysis – Table 2. The retained variables manifesting market, hierarchy and clan with sufficient value of loadings above 0.65 were fed into the final regression model.

Table 2. Structure of constructs derived from the Principal Component Analysis (PCA)

Construct	Description	Loadings	CR	AVE
Market	The price is a predominant factor that determines my collaboration with B	.651	.772	.465
	My company is very active in searching for new partners who can potentially substitute B	.621		
	My company can easily switch to another partner, dropping out the collaboration with B	.751		
	The goods delivered by my company to B can be easily delivered by my competitors	.680		
	My company keeps reminding our partner that it can be easily replaced, if it does not offer good deals	*		
Hierarchy	My company very actively interfere in the operations performed by B	.741	.744	.493
	My company controls B using certain formal methods	.705		
	My company would be exposed to high costs when switching B	.658		
	My company provides B with formal guidelines concerning how to solve problems and/or deal with disruptions.	*		
	My company resolves ongoing disputes with B by referring to clauses in signed contracts	*		
Clan	My company strives to build trust and sense of community by organizing meetings and trainings to encourage B to share empathy and mutual understanding	.812	.805	.510
	My company maintains a discussion with B which concerns all relevant issues of its operations and strategy	.675		
	My company keeps trying to develop trust with B	.704		
	Disruptions in collaboration with B are productively resolved in the spirit of mutual understanding	.657		

* item removed

As depicted in Table 2, the composite reliability values (CR) of constructs varied between .744 and .805, and exceeded the suggested value of 0.70 (Chin, 1998). Although, the AVE indices are not greater than .5 cut-off point for all constructs (due to a relatively small number of manifesting variables building some constructs), we decided to keep the structure of constructs, as their AVE values appear to be close to the threshold, and thus indicate sufficient convergent validity (Hair *et al.*, 2017).

4.3. Multiple Regression Analysis

The Multiple Regression Analysis was carried out to compare the contribution of network governance to variance in the manufacturer's rent. Three constructs of market, hierarchy and clan are independent variables based on their relevance as indicators of network governance.

The regression analysis allowed to capture relationships between the dependent variable reflecting the manufacturer's rent and the independent constructs of network governance. As demonstrated in Table 3, all three modes of network governance have a significant impact on the manufacturer's rent.

Table 3. Multiple Regression Model for the Manufacturer's Rent

Adjusted R^2=.582	β [a]	t	p-value	Collinearity Statistics	
				Tolerance	VIF
Market	.285	3.64	.000	.312	3.20
Hierarchy	.431	5.28	.000	.205	4.87
Clan	-.412	4.95	.009	.220	4.54

Note: [a] dependent variable: Manufacturer's Rent

To detect whether three independent constructs are not too strongly correlated in the regression model, multicollinearity was assessed using variance inflation factors (VIFs). The values of *VIFs* in the obtained model ranged from 3.20 to 4.87, which is a commonly accepted level for detecting multicollinearity (Akinwande *et al.*, 2015). Though, however, in line with some recent works, correlation between constructs may cause minor problems as some values exceed the cut-off point of 4.0 (Hair *et al.*, 2017).

5. Findings and Future Research

The conducted analysis demonstrated that three constructs manifesting different modes of governance significantly affect the manufacturer's rent. Specifically, two modes of market and hierarchy have a positive impact, while the third construct of clan negatively affects the manufacturer's rent. The obtained findings show that the mechanisms of governance coexist with each other when the manufacturer's rent is considered. Interestingly, the traditional mechanisms of market and hierarchy seem to still play a crucial role in managing the investigated supply chains. This probably stems from the fact that the rent is yielded by the manufacturer, who sits on the structural hole, and thus have a higher bargaining power over its supplier and customer. To leverage the strength, the manufacturer fosters contractual and control-based relationships to yield its own benefits, most often at the expense of two other actors in the triadic supply chains. This finding corroborates the conceptual study of Choi and

Wu (2009), who underline that a broker sitting on the structural hole can play two actors against each other. Having said that, the manufacturer may tend to easily switch between its suppliers, imposing high requirements on them, while the customers, having no other or better option to obtain the product from, might accept, sometimes unsatisfying service level, delivered by the manufacturer. Market and hierarchy are therefore two modes of governance, that appear to significantly contribute to the manufacturer's rent. Consequently, our study extends the work of Wynstra *et al*. (2015) who argue that the middleman in a triad can tend to foment a conflict between two other actors to maximize its own benefits.

On the other hand, the third construct of clan has a significant but negative impact on the rent produced by the manufacturer. The obtained finding indicates that to yield the rent, the manufacturer does not establish social-based relationships, characterized by trust, commitment, openness and reciprocity. Quite the contrary, not only should the relationships be deprived of any social aspects, but the manufacturer may misbehave and act to facilitate opportunism, selfishness and self-interest, curbing any tendency towards commitment and goal-sharing.

To sum up, we conclude that network governance, composed of market, hierarchy and clan, has a significant role in yielding the manufacturer's rent. Having said it, it is worth noting that not only do market and hierarchy contribute to achieve a higher manufacturer's rent, though they demonstrate a positive impact. Concomitantly, clan as the third dimension of governance also demonstrates a key role for the manufacturer's rent, though its impact is negative. The obtained findings suggest that for instance, fomenting conflict or encouraging competition among the actors in the triadic supply chain may turn out be significant for the rent to be yielded by the manufacturer. Therefore, our study indicates that network governance, including coexistence of three modes of market, hierarchy and clan, is an important contributor to the manufacturer's rent.

The obtained findings may also indicate the avenues of future research. First, as we investigated manufacturer's rent, it would be worthwhile to investigate the impact of network governance on the rent, not only from the perspective of manufacturer, but also from the standpoint of two other actors in the triadic supply chains. Second, future research might also cover the issue of rent yielded in the triadic supply chains composed of three dyads without the structural hole and leading role of the middleman. Third, other research may also deal with the rent that is produced not only in the manufacturing setting but also in the service triads.

References

1. Aiken, L.S. and West, S.G. (1991), *Multiple regression: Testing and interpreting interactions*. Newbury Park, London, Sage.

2. Akinwande, M., Dikko, H. and Samson, A. (2015), "Variance Inflation Factor: As a Condition for the Inclusion of Suppressor Variable(s) in Regression Analysis", Open Journal of Statistics, Vol. 5, pp. 754-767.

3. Baker, W. (1990), "Market Networks and Corporate Behaviour", American Journal of Sociology, Vol. 96 No. 3, pp.589- 625.

4. Batjargal, B. (2010), "The effects of network's structural holes: polycentric institutions, product portfolio, and new venture growth in China and Russia", Strategic Entrepreneurship Journal, Vol. 4 No. 2, pp.146-163.

5. Burt, R.S. (1992), *Structural Holes: The Social Structure of Competition*. Boston, MA: Harvard University Press.

6. Burt, R.S. (2017), *Structural holes versus network closure as social Capital*, Routledge, New York, NY, pp. 31-56.

7. Cheung, M.S., Myers, M.B. and Mentzer,J.T. (2011), "The value of relational learning in global buyer-supplier exchanges: A dyadic perspective and test of the pie-sharing premise", *Strategic Management Journal*, Vol. 32 No. 10, pp. 1061-1082.

8. Chin, W.W. (1998), "The partial least squares approach for structural equation modeling", in Marcoulides, G.A. (Ed.), Modern Methods for Business Research, Lawrence-Erlbaum, Mahwah, NJ, pp. 295-336.

9. Choi, T.Y., Wu, Z. (2009), "Triads in supply networks: theorizing buyer-supplier-supplier relationships", Journal of Supply Chain Management, Vol. 45 No. 1, pp. 8-25.

10. Coleman, J.S. (1988), "Social capital in the creation of human capital", American Journal of Sociology, Vol. 94, pp. 95–120.

11. Dubois, A. (2009), Comment on "Taking the leap from dyads to triads: Buyer-supplier relationships in supply networks" by Choi and Wu – To leap or not to leap: Triads as arbitrary subsets of networks of connected dyads. Journal of Purchasing & Supply Management, Vol. 15, pp. 267-268.

12. Dubois, A., and Fredriksson, P. (2008), "Cooperating and competing in supply networks: Making sense of a triadic sourcing strategy", Journal of Purchasing & Supply Management, Vol. 14, pp. 170– 179.

13. Dyer, J.H. and Singh, H. (1998), "The Relational View: Cooperative Strategy and Sources of Interorganizational Competitive Advantage", Academy of Management Review, Vol. 23 No. 4, pp. 660-679.

14. Hair, J.F., Hult, G.T.M., Ringle, C.M. and Sarstedt, M. (2017), *A Primer on Partial Least Squares Structural Equation Modeling*, Sage, Thousand Oaks, CA.

15. Kim, D.Y. (2014), "Understanding supplier structural embeddedness: A social network perspective", Journal of Operations Management, Vol. 32 No. 5, pp. 219–231.

16. Kogut, B. (2000), "The network as knowledge: generative rules and the emergence of structure", Strategic Management Journal, Vol. 21, pp.405-425.

17. Lavie, D. (2006), "The competitive advantage of interconnected firms: An extension of the resource-based view", Academy of Management Review, Vol. 31 No. 3, pp. 638-658.

18. Li, M., Choi, T.Y. (2009), "Triads in Service Outsourcing: Bridge, Bridge Decay and Bridge Transfer", *Journal of Supply Chain Management*, Vol. 45 No. 3, pp.27-39.

19. Lowndes, V. and Skelcher, C. (1998), "The Dynamics of Multi-organizational Partnerships: An Analysis of Changing Modes of Governance", Public Administration, Vol. 76 No. 2, pp. 313-333.

20. Mena, C., Humphries, A. and Wilding, R. (2009), "A comparison of Inter- and Intra-organizational Relationships: Two case studies from the UK food and drinks industry", International Journal of Physical Distribution and Logistics Management, Vol. 39 No. 9, pp. 762-784.

21. Mentzer, J, Stank, T.P. and Myers, M.B. (2007), *Why Global Supply Chain Management?* Global Supply Chain Management, SAGE Publications, Inc.

22. Powell, G. B. (1991), " 'Divided Government' as a Pattern of Governance", Governance, Vol. 4 No. 3, pp.231-235.

23. Provan, K.G. and Kenis, P. (2008), "Modes of Network Governance: Structure, Management, and Effectiveness", Journal of Public Administration Research and Theory, Vol. 18 No. 2, pp. 229-252.

24. Swierczek, A. (2018), "The inverted U-shaped relationship between the network profile and the competitive advantage of supply chains: Chasing the perfect network setting", International Journal of Logistics Management, Vol. 29 No. 4, pp.1379-1400.

25. Swierczek, A. (2019), "Manufacturer structural embeddedness and the network rent: the intervening role of relational embeddedness in the triadic supply chains", Supply Chain Management: An International Journal, Vol. 24 No. 3, pp. 334-354.

26. *The American Heritage Dictionary of the English Language*. (2016), 5th Edition, Houghton Mifflin Harcourt Publishing Company.

27. Thorelli, H. B. (1986), "Networks: Between markets and hierarchies", Strategic Management Journal, Vol. 7 No. 1, pp. 37-51.

28. Uzzi, B. (1996), "The Sources and Consequences of Embeddedness for the Economic Performance of Organizations: The Network Effect", American Sociological Review, Vol. 61 No. 4, pp. 674-698.

29. Whipple, J.M., Wiedmer, R. and Boyer, K.K. (2015), "A Dyadic Investigation of Collaborative Competence, Social Capital, and Performance in Buyer–Supplier Relationships", Journal of Supply Chain Management, Vol. 51, pp. 3-21.

30. Wilhelm, M.M. (2011), "Managing coopetition through horizontal supply chain relations: Linking dyadic and network levels of analysis", Journal of Operations Management, Vol. 29, pp. 663–676.

31. Wuyts, S., Stremersch, S., Van Den Bulte, C. and Franses, P.H. (2004), "Vertical marketing systems for complex products: A triadic perspective", Journal of Marketing Research, Vol. 41 No. 4, pp. 479-487.

32. Yang, C. and Liu, H.-M. (2012), "Boosting firm performance via enterprise agility and network structure", Management Decision, Vol. 50 No. 6, pp. 1022-1044.

APPENDIX A.   An Excerpt of the Questionnaire

Categories	No.	Question
Please rate the relational performance of dyad with reference to company B in each of the following areas: *(1-'strongly disagree', 3-'neutral', 5-'strongly agree')*		
1. Relational performance	1.1.	Two companies are more profitable or more competitive together than they would have been alone
	1.2	The benefits derived from the combination must be greater than the capabilities of each individuals
	1.3.	Sharing opinion and discussion between firms often lead to increased benefits for both actors in a dyad
	1.4.	The ongoing costs of coordination of a dyadic relationship is balanced by its benefits
	1.5.	Working with a partner has allowed to overcome some problems, and thus derive substantial benefits for a dyad
Please rate the operational performance in the following areas: *(1-'strongly disagree', 3-'neutral', 5-'strongly agree')*		
2. Operational performance	2.1.	Product quality
	2.2.	Product conformance to customer specification
	2.3.	Production volume/variety flexibility
	2.4.	Delivery speed
	2.5.	Delivery reliability
	2.6.	Response to changes in delivery due dates
Please rate mechanisms of network governance with reference to company B in the following areas: *(1-'strongly disagree', 3-'neutral', 5-'strongly agree')*		
3. Market	3.1.	The price is a predominant factor that determines my collaboration with B
	3.2.	My company is very active in searching for new partners who can potentially substitute B
	3.3.	My company can easily switch to another partner, dropping out the collaboration with B
	3.4.	The goods delivered by my company to B can be easily delivered by my competitors
	3.5.	My company keeps reminding our partner that it can be easily replaced, if it does not offer good deals
4. Hierarchy	4.1.	My company very actively interfere in the operations performed by B
	4.2.	My company controls B using certain formal methods
	4.3.	My company would be exposed to high costs when switching B
	4.4.	My company provides B with formal guidelines concerning how to solve problems and/or deal with disruptions.
	4.5.	My company resolves ongoing disputes with B by referring to clauses in signed contracts
5. Clan	5.1.	My company strives to build trust and sense of community by organizing meetings and trainings to encourage B to share empathy and mutual understanding
	5.2.	My company maintains a discussion with B which concerns all relevant issues of its operations and strategy
	5.3.	My company keeps trying to develop trust with B
	5.4.	Disruptions in collaboration with B are productively resolved in the spirit of mutual understanding

Roger Williams University