Proceedings

The Global Interdisciplinary Green Cities Conference 2021

Business, Engineering, Art, Architecture, Design, Political Science, International Relations, Applied Science & Technology

June 22 – June 26 2021

Painting by Gabriele Münter (1877 - 1962)

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University of Augsburg

Welcome Message from Dr. Peter Welzel

Vice President, University of Augsburg

It is my pleasure to welcome all the eminent speakers and guests to the 2021 Virtual Green Cities Conference. Unfortunately, you cannot be here in Augsburg physically to enjoy our university's campus and Germany´s third oldest city with its impressive "Altstadt" (historic city centre). However, while we regret that the COVID pandemic prevented us from holding the traditional type of conference we all enjoy, we are excited about organizing and offering an innovative virtual Green Cities conference. Hopefully, you will feel the attraction of Augsburg and will visit this city at a later point in time!

This virtual conference reflects the phenomenon of a global coexistence, altered by transnational commerce, migration, and culture as well as economic, social and political interdependence. In other words, it reflects the concept of a "Global Village" in which the entire world is becoming more interconnected as the result of the propagation of media technologies. Moreover, the notion of a global village emphasises the idea of one community linked together by electronic communications. As far as the Green Cities Conference is concerned, the concept of a global village is indispensable in approaching environmental issues. Prevailing environmental problems call for collaboration between states, and consequently need to be addressed on an international platform. Apropos, this virtual conference is coincidently in line with the forthcoming online environmental conference organised by President Joe Biden. The message here is clear: When it comes to solving the climate crisis, the entire world needs to pull together.

The focus of this Green Cities Conference is on two core components: virtual and green. At this point, allow me to recognize the host city of Augsburg as a thriving and aspiring green city. Recently, its potential in this area further increased with the new Centre for Climate Resilience Research at the University of Augsburg. Nine additional full professors and their research staff will be combined with existing professorships to build an outstanding and visible research unit. The Centre aims at developing scientific foundations as well as holistic and implementable strategies and applications at regional, national, and international levels, thus showing options for adaptations to the inevitable consequences of climate change. Among other things, this initiative gives Augsburg reason to take pride in its favourable position to host this year's Green Cities Conference.

With that, ladies and gentlemen, I warmly welcome you to the 2021 Virtual Green Cities Conference hosted by the University of Augsburg. I wish you a rewarding, productive, and successful conference.

Peter Welzel, Vice President
University of Augsburg

Welcome Message from Dr. Ioannis Miaoulis

President, Roger Williams University

Bristol, Rhode Island

At Roger Williams University, we encourage our faculty and students to channel their energy and knowledge toward solving the problems that matter most to society, and there is no doubt that some of the most pressing issues today center around how humans can live more sustainably within the natural and built worlds. I commend the talented faculty members from RWU and all researchers and thought leaders who are sharing new ideas and scholarship at "The Global Interdisciplinary Green Cities Conference 2021."

Complex problems can only be solved by an interdisciplinary approach to experiential education. At RWU, we recognize that drawing upon multiple disciplines and diverse perspectives and ideas is the key to driving the innovation and the solutions required to improve our future. We need to work together to realize a collective impact for change; and this effort cannot be just across academic disciplines, but also must span across industry and community borders and across countries and continents in this urgent work.

With our shared goal to "Build the University the World Needs Now," we are proud to have our faculty share in intellectual discourse with scholars from 50 universities and organizations from around the globe. And just as importantly, we will learn from others, bringing back a wealth of knowledge to help RWU pursue its purpose of strengthening society through engaged teaching and learning.

Ioannis N. Miaoulis, President
Roger Williams University
Bristol, Rhode Island, USA

Our Sincere Appreciation

Dr. Carol Leary, the President of Bay Path University, and Dr. Anthony Caprio, the President of Western New England University, both retired in summer 2020.

Our sincere appreciation for their continuous support of our conferences throughout the years.

Hopefully, we will get the chance to celebrate their years of service to the higher education next year in Switzerland.

Dr. Carol Leary
President, 1995-2020
Bay Path University
Longmeadow, MA, USA

Dr. Anthony Caprio
President, 1996-2020
Western New England University
Springfield, MA, USA

Longmeadow, MA

Program Chairs

Minoo Tehrani
Roger Williams University

Andreas Rathgeber
University of Augsburg

Nuno Guimarães Da Costa
ICN Business School

Greetings to all:

We would like to take this opportunity and express our sincere appreciation for your participating in the Global Interdisciplinary Green Cities Conference 2021, Augsburg, Germany.

As you are aware, we postponed the conference to 2021, hoping to be able to travel to Germany. However, we will be having our conference virtually in June 2021.

We very much appreciate receiving submissions across four continents, Africa, Americas, Asia, and Europe, from 128 authors representing 15 countries and 50 universities and organizations. Our 41 tracks have 82 track chairs from 13 countries.

With the theme of the conference, Green Cities and Sustainability, and the research articles from numerous universities and organizations, we will have an amazing opportunity to share our knowledge and information with each other and our students.

We look forward to meeting you virtually.

Best,

Minoo, Andreas, Nuno

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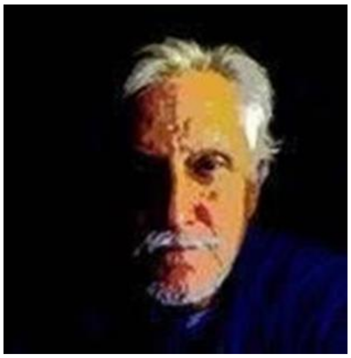

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Best Paper Award in Contribution to Theory

Green Cities and Waste Management: The Restaurant Industry

Minoo Tehrani, Roger Williams University, USA
Lawrence Fulton, Texas State University, USA
Bryan Schmutz, Western New England University, USA

Best Paper Award in Application of Theory

Green for the Environment and Green for the Pocketbook: A Decade of Living Sustainably

Lawrence Fulton, Texas State University, USA
Bradley Beauvais, Texas State University, USA
Matthew Brooks, Texas State University, USA
Clemens Scott Kruse, Texas State University, USA
Kimberly Lee, Texas State University, USA

Geospatial-Temporal, Explanatory, Demand, and Financial Models for Heart Failure

Clemens Scott Kruse, Texas State University, USA
Bradley Beauvais, Texas State University, USA
Matthew Brooks, Texas State University, USA
Michael Mileski, Texas State University, USA
Lawrence Fulton, Texas State University, USA

Richard Briotta Best Paper Award in Knowledge Management & Strategy

Health Disparities and Cardiovascular Disease

Ava Niakouei, University of North Carolina – Charlotte, USA
Minoo Tehrani, Roger Williams University, USA
Lawrence Fulton, Texas State University, USA

Calculating External Climate Costs for Different Food Categories: A German Case Study

Maximilian Pieper, Technische Universität München, Germany
Amelie Michalke, University of Augsburg, Germany
Tobias Gaugler, University of Augsburg, Germany

A Publicly Available Cost Simulation of Sustainable Construction Options for Residential Houses

Lawrence Fulton, Texas State University, USA
Bradley Beauvais, Texas State University, USA
Matthew Brooks, Texas State University, USA
Clemens Scott Kruse, Texas State University, USA
Kimberly Lee, Texas State University, USA

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University of Augsburg

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Sustainable Foodstuff Valorization – A Framework for Internalizing External

Costs of Agricultural Production

Sustainable Lifestyle via Establishing a Community of Responsible Bakery Shoppers and Operators

The Collapse of US Oil Prices, Futures and the Impact on Oil ETFs: Theory and Practice

The Geopolendpoint Indicator: Measuring the Economic Impact of the Use of Critical Raw Materials. Application to Li-Ion Batteries

Roger Williams University

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Analysis of International initiatives and Trends: Opportunities and Niches in the Sector of Sustainable Urban Development

Alba Arias, Olatz Grijalba, Xabat Oregi, Rufino Hernandez
Basque Country University (UPV/EHU), Architecture Department

Abstract

Over the last few decades, the environmental situation of the planet has worsened. Much of the pollution and energy consumption is attributed to cities, which are expected to host 68% of the world's population by 2050. It is therefore necessary to develop systems to make cities more sustainable and resilient. In this regard, different agendas, strategies, plans and regulations have been published to promote climate actions and a sustainable development, such as Agenda 2030, establishing the 17 Sustainable Development Goals, and the New Urban Agenda that promotes the development of more inclusive, compact and connected cities.

The current research has carried out a surveillance process of all these agendas, strategies, plans, projects, initiatives,… that are promoted (past, present and future context) in the field of sustainable cities development at international level . The objective is to identify the potential niches and opportunities of the sector at global level for its subsequent application to specific local contexts.

It has been concluded that the areas in which the different organisations, both on a national and international level, are currently paying special attention are: health, low-tech (NBS, nature and environment...), sustainable mobility, energy, governance, digitalisation, the human factor, resilience, the green economy and decarbonisation. Besides, due to the COVID 19 health crisis, the European Commission has reviewed the budgets and themes for the 2020-2027 period, reiterating the importance and need for economic recovery and resilience through digitalisation, energy rehabilitation and green transition. These are fields on which most of the European budget is going to be invested. Therefore, these issues are going to be considered as the main ones to be promoted in the Basque Country.

A Mathematical Approach for Modeling a Parkinson's Disease Based Dopaminergic Cell Signaling Pathway

Edward Dougherty, Elizabeth Gilchrist, Abigail Small
Roger Williams University, Department of Mathematics

Abstract

Parkinson's disease (PD) continues to impact the lives of millions of individuals globally, yet no cure exists. Further, a comprehensive understanding of precise PD neuronal pathogenesis is lacking. To address this, we have developed a mathematical model of a dopaminergic neuron that incorporates key proteins, transcription factors, ions, and phenotypes of a dopaminergic neuron. Following a literature search to construct an intracellular signaling pathway wiring diagram, the law of mass action and Michaelis–Menten kinetics were utilized to generate an ordinary differential equation-based mathematical model that offers applicability to PD. A unique aspect in the development of this model was a numerically-driven reverse engineering approach to computationally identify those kinetics not yet known by the biomedical research community. This approach employed the well-known Metropolis Algorithm integrated with *in silico* phenotype-based testing, clustering, and sensitivity analyses. The resulting mathematical model accurately simulates the inner signaling of a dopaminergic neuron as well as a cell with PD pathogenesis.

A Publicly Available Cost Simulation of Sustainable Construction Options for Residential Houses

Lawrence Fulton, Bradley Beauvais, Matthew Brooks, Clemens Scott Kruse, Kimberly Lee
Texas State University

Abstract: This publicly available simulation analysis compares baseline construction options versus sustainable options and evaluates both break-even costs as well as environmental effects. The simulation (https://rminator.shinyapps.io/sustain4/) provides users with comparative estimates based upon existing research on costs. This is the first simulation of its type that quantifies multiple sustainable construction options, associated break-even points, and environmental considerations for public use. Results estimate that a 100% solar solution for the baseline 3,000 square foot / 279 square meter house with 2 occupants results in a break-even of 9 years. The simulation includes options for rainwater harvesting or wells, Icynene foam, engineered lumber, Energy Star windows and doors, low flow water fixtures, aerobic / non-aerobic waste treatment or municipal services, and many other options. This is the first simulation of its type to provide publicly available sustainable construction analysis based on research, and it illustrates that sustainable construction might be both green for the environment and green for the pocketbook.

Keywords: construction, rainwater harvesting, simulation, solar

1. Introduction

Reducing the impact of the built environment is a necessary step to address concerns of climate change as well as population growth. Green building codes and certification (GBCC) have arisen to help provide best practice for green construction. Understanding what codes actually result in effective environmental changes that are positive for the consumer is necessary [1]. Incorporating requirements into GBCC systems improves environmental performance between 15-25% across 12 environmental impact categories when compared with the construction of a standard office building, as defined by National Institute of Standards and Technology [1].

In a recent study, electricity, tap water consumption, and employee commuting dominated 10 out of 12 environmental impact categories, categories that included global warming, human health consequences, eutrophication /acidification and use of water, as well as smog formation. For land use impacts, wood products contributed the most (perhaps, unsurprisingly) [2]. Overall, GBCC has been found to consume up to 25% less environmental impacts than standard building techniques. Specific improvements include acidification (25%), human health-respiratory (24%), and global warming (22%) [2].

Net Zero (or even Net Positive) construction involves the design of facilities that either consume no net energy (demand less supply) or that produce more energy than consumption [3], reducing global warming. Net Zero construction may even power user transportation [4]. Rainwater harvesting removes the stress on below-ground and ground water sources for both residential and business construction (including hospitals) [5, 6].

While sustainable construction is important for the environment, there are economic considerations that will be evaluated by consumers prior to inclusion with new building. Therefore, green construction should be green for the pocketbook as well. This study evaluates break-even potential for user selected sustainable interventions. The study focuses only on options that involve power through electricity rather than natural gas or propane, as the residence informing the simulation was located in an area where neither natural gas nor propane were options. Natural gas, propane, and wind power will be investigated in future work.

The simulation analyzes best practice construction design for both the environment and the consumer selections of house design features. The motivation behind the simulation was to evaluate which green construction techniques might prove cost-effective. The components included in the simulation were informed partially by a residential research property and an author's decade-long experience with it. The research home, once the highest certified home for sustainable construction based on the National Association of Homebuilders standards [4], exists on 100% solar and 100% rainwater harvesting. The user interactive simulation is based on cost, demand, supply, and environmental considerations. The primary hypothesis is that many elements of green construction might also be green for the pocketbook as well. Break-even analysis is therefore produced.

This simulation and the associated analysis are unique. This is the first simulation of its type that quantifies multiple sustainable construction options, associated break-even points, and environmental considerations. Making this simulation publicly available provides a unique starting point for those considering sustainable construction.

2. Materials and Methods

In this simulation study, we evaluate break-even considerations, environmental impacts, and efficacy of multiple sustainable building innovations for residences. Included in the simulation are user options for lumber selection, insulation selection, window and door selection, the water system, the electrical system, the water heating system, geothermal heating and cooling, and vehicle selection. Vehicle selection is an important consideration, as an EV powered 100% by the home requires additional solar power but may reduce emissions and eliminates the owner's need for gasoline, all of which have impacts on costs and the environment.

A simulation of costs over time, based on construction materials selection provides information about the cost and environmental effects of residential construction decisions. Measured outputs include cost, demand for water / electricity, CO2e emissions, trees required for the construction process, and water required to support the demand of occupants. The simulation is implemented in R Shiny [7] and freely available here: https://rminator.shinyapps.io/sustain4/ .

2.1. Residence Motivating the Simulation

Figure 1 is the Google Maps satellite image of the research house [8] that informed the simulation. This house includes all sustainable features available in the simulation. Median monthly electrical consumption is zero, and water costs involve only maintenance of the rainwater harvesting (RWH) system.

Figure 1. The residence as constructed

2.2. Acquisition Costs and Selection of Lumber, Engineered vs. Traditional

Finger-jointed studs use reclaimed wood that might otherwise be discarded (Figure 2). They are straighter and result in less wood wasted. Further, they have a strong vertical load capability, with evidence that many species (including pine) have better structural properties when finger-jointed [9]. The residence and the simulation evaluate both financial and environmental effects of using this lumber.

Figure 2. Finger-jointed stud used in the residence construction

A 20" diameter tree with 42 feet length of usable wood produces about 260 board feet (.614 cubic meters). The Idaho Forest Products commission estimated that a typical 2,000 square feet (185.8 square meteres) house would use 102 trees of that size, 19.6 trees per square foot [10]. For the simulation, there is little quantitative support about the amount of reduction achieved in construction through the use of engineered lumber. This uncertainty translated to a uniform distribution with a conservative range of 10% to 20% reduction (flexible) based on the user input on trees per square foot (defaulted to 20, flexible). Equation 1 provides the operationalization for lumber usage. In this equation, the number of trees used is a binomial mixture, where *LUM* is an indicator for the use of engineered lumber. The resulting equation reduces consumption by 10 to 20% uniformly when engineered lumber is selected and 0% otherwise.

$$\#\, Trees = LUM \times \frac{trees}{ft^2} \times U(0.8, 0.9) \times house\ size\ ft^2 + (1 - LUM) \times \frac{trees}{ft^2} \times house\ size\ ft^2 \qquad (1)$$

The cost of finger-jointed studs may be more expensive than regular studs. At one lumber site, retail cost of a 2 x 4 x 104 5/8″ regular pine stud versus the same size finger-jointed stud is listed at \$3.62 [11] versus \$5.59 [12], respectively. This is a 54.4% cost increase for materials, which might be offset by lower labor costs due to engineered lumber's straightness. Engineered lumber typically results in a lowered installed cost per square unit [13].

The cost differential is not atypical, as many engineered lumber products have upcharges between 1.5 and 2 times the cost of traditional lumber [14]. A reasonable estimate for the total cost of traditional framing between \$4 to \$10 per square foot for labor and \$3 to \$6 per square foot for materials [15]. These values were used in a uniform distribution for non-engineered lumber. Conservatively a uniform 10% to 20% reduction in labor costs and uniform 1.5 to 2.0 increase in material costs were used for engineered lumber calculations. Equation 2 shows the lumber cost calculations in the simulation. In this binomial mixture equation, the indicator variable *LUM* mixes traditional wood construction (*1-LUM*) with engineered wood construction (*LUM*). Traditional wood construction labor and material costs are modeled uniformly between \$4 and \$10 per square foot and between \$3 and \$6, respectively. For engineered wood construction, labor costs are reduced between 10 and 20% uniformly and material costs are 1.5 to 2.0 times higher. No operations and maintenance costs (O&M) were assessed for lumber selection due to its lengthy lifetime.

$$\begin{aligned} \$\, Lumber = (1 - LUM) \times house\ size\ ft^2 \times \big(U(\$4, \$10) + U(\$3, \$6)\big) + LUM \times house\ size\ ft^2 \\ \times (U(\$4, \$10) \times U(0.8, 0.9) + U(\$3, \$6) \times U(1.5, 2.0)) \end{aligned} \qquad (2)$$

2.3. Acquisition Costs of Air, Water, and Vapor Barriers

For the research house motivating this simulation, Icynene spray-foam was selected over other products (e.g., fiberglass, cork, pressed straw, coconut fiberboard, etc.) as it is multipurpose in that it provides an air barrier, vapor barrier, and water barrier, eliminating the need for attic vents, test ductwork, or air-seal attics. Icynene is environmentally friendly, made of 100% pure water-blown air, and it contains no chemicals [16]. Residential spray-foam insulation (Figure 3) provides a thermal barrier with exceedingly low conductivity (.021 W/mK in one study [17]). Spray foam has reasonable hygrothermal properties and is resistant to moisture migration. The practical relevance of the tight seal around the residence is that during the heat of the Texas summer (in excess of 100 degrees F), the observed temperature in the attic spaces does not exceed 80F/26.7C with the house thermometer set to 76F / 24.4C. The estimated wall U-values was .12, while the U-Values for the slab foundation (8″ to 8′ on the slope) are estimated between .07 to .83. The simulation includes an Icynene spray-foam option for these reasons.

Figure 3. Open-cell spray-foam insulation installed in the residence

The 2020 cost for open-cell spray-foam insulation is about $.35 to $.55 per board foot [18]. Assuming 3.5″ depth of spray converts to $1.23 to $1.93 per square foot, values used in the simulation of cost. Fiberglass batt insulation runs $.64 to $1.19 per square foot (2,359.17 cubic centimeters) [19]; however, this value provides an incomplete picture. Spray-foam works as an air barrier, vapor barrier, water-resistant barrier, and insulation. There is no need for attic vents, test ductwork, or air-seal attics. When evaluated in this manner, it is actually 10-15% less expensive than traditional construction [20]. To account for these components when selecting non-spray foam insulation, a uniform distribution between .85 and .90 was divided by the non-spray foam insulation costs to inflate them (see Equation 3). In this equation, the indicator variable INS is coded as 1 if Icynene foam is selected and 0 otherwise and U indicates a uniform variable on the ranges provided. No O&M costs were assigned for insulation, as all forms can last beyond 40 years.

2.4. Acquisition Costs and Selection of Windows and Doors

$$\textbf{3. } \$\,Insulation = INS \times Size \times U(\$1.23, \$1.93) + (1 - INS) \times U(\$1.23, \$1.93) \,/\, U(0.85, 0.90) \quad (3)$$

In the simulation, the user has the opportunity to select Energy Star windows and doors similar to those used in the motivating residence's construction. The choice of windows and doors based on Solar Heat Gain Coefficient (SHGC) is important to the home energy usage. SHGC is defined as the fraction of incident solar radiation admitted through a window. In warm climates, windows should have solar heat gain coefficients (SHGC) less than .25 [21]. Further, the U factor, a factor that expresses the insulative value of windows, should be .4 or lower. Low emissivity Jeldwen windows and doors with SHGC of .23 and U-Factor of .3 were used throughout the research residence, a factor which motivated this simulation component.

Low emissivity windows are typically 10 to 15% more expensive than standard windows [22]. The typical cost range in 2020 dollars is $385 to $785 with an average of $585 [23]. The Department of Energy (DOE) estimates savings of $125 to $465 dollars per year from replacing windows with new windows that have higher Energy Star ratings [24]. In the simulation, Energy Star windows are modeled as a 12% reduction from kWh based on DOE estimates [24]. The simulation requests that the user specify the number of windows and doors in the house and select whether they will be Energy Star certified (checkbox). Acquisition costs are shown in equation 4 based upon a 15% premium for Energy Star doors and windows per the Department of Energy. In this equation, $ENERGY$ is an indicator variable indicating that Energy Star doors were installed. Doors need not be replaced during the maximum 40-year simulation, but windows are modeled as being replaced every 20 years.

$$\begin{aligned}\$\,Windows\ and\ Door\ Acquisition \\ &= ENERGY\ \times \left(\#Doors \times U(\$900, \$1200) + \#\,Windows \times U(\$385, \$785)\right) \\ &+\ (1 - ENERGY)\ \times \left(\frac{\#Doors \times U(\$900, \$1200) + \#\,Windows \times U(\$385, \$785)}{1.15}\right)\end{aligned} \tag{4}$$

3.1. Selection of Water System

The decision to install a rainwater harvesting system (RWH) versus a well or municipal water is one that is dependent on environmental considerations, the availability of municipal water, the homeowner's wishes, and regulations. For the residence that informed the simulation, no city water sources were available, so the choice was either well or RWH. After a cost analysis, it was estimated that the acquisition costs for a well and the cost for an RWH system would be nearly identical based on well depth and rainwater design considerations. The simulation provides the user the opportunity to select rainwater, well, or municipal water options. Because of its uniqueness and rarity, a short discussion of RWH systems is necessary.

3.1.1. About Rainwater Harvesting Systems

Figure 4 depicts the RWH as currently installed in the research residence. The system works as follows. Rainwater falls on the roof and is captured by gutters. The guttered water flows to the cistern where ~100 gallons or so is flushed out through a pipe with a ball float to eject the debris on the roof. This is called the first flush. Once the ball float seals the flushing tube, the water continues into French drain and basket filters and then into a cistern. Parallel on-demand pumps push water towards the house where it is processed through a sediment filter, charcoal regeneration system, and ultraviolet light which is an effective method for inactivating pathogens through irradiation [24]. The water is then used and exits to a septic system.

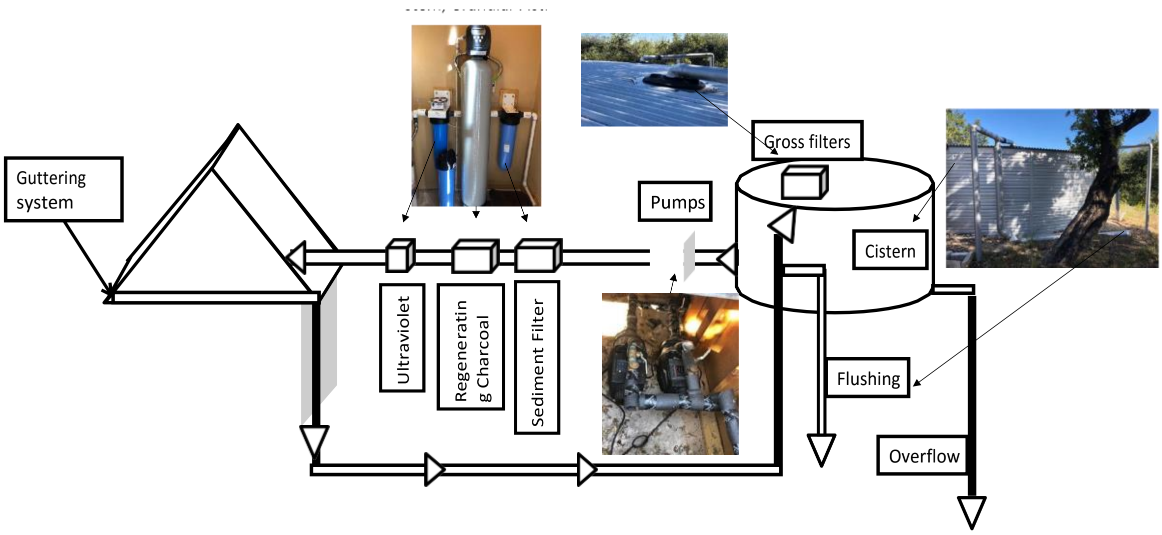

Figure 4. Rainwater harvesting system as designed

Quality considerations for water are significant. Using rainfall for potable house needs requires proper roof selection (ceramic or metal as examples), flushing (first flush), gross filtering (e.g. French drain and basket filters), storage (food-grade butyl rubber), pumping, cleansing (e.g., sediment filter and charcoal regeneration, Figure 12), purifying (ultraviolet purification as one example, Figure 13), and disposal of gray water (aerobic septic system). For the research residence, *The Texas Manual on Rainwater Harvesting* [25] provided the baseline quality construction requirements.

Design of an RWH capable of meeting the needs of an entire household required separate simulation modeling, so that the distribution of the minimum in the cistern (order statistic) would be strictly greater than zero over all supply and demand considerations and all simulation runs. Details of the simulation used for the residence that informed this model are available externally [5,26] .

3.1.2. Acquisition Costs of Well, Rainwater, and City Options

Acquisition costs for an RWH system (guttering, PVC piping, cistern with butyl rubber liner. and accessories) cost approximately $8,000 to $10,000 [27], but a large tank requirement can increase this value (e.g., $25,500 for the tank [28]). The cistern is the largest expense. The retail cost per gallon is 6.25 cents per gallon for a Pioneer tank at one location [27], although it is possible to use fiberglass tanks at a less expensive rate (.50 cents per gallon) [28]. Current well drilling prices in the U.S. are between $15 and $30 per foot and up to $50 for difficult terrain [29]. For the simulation, users select the well depth or the cistern size. If city or municipal water is available, there is no acquisition cost. Equation 5 illustrates how acquisition costs were assessed. In this equation, *WELL* is an indicator variable for the construction of a well with an associated cost distribution (triangular) based on [29] and well depth. *RWH* is an indicator variable for the selection of a rainwater system with the price equal to $.50 to $.70 per gallon of storage. This price includes complete installation of the system (including the pump). The indicator *CITY* is omitted, as municipal connection fees are nominal and not charged as part of the acquisition of a water system.

$$\$\,Water\ Acquisition\ = WELL \times T(\$15, \$30, \$50) \times Depth + RWH \times U(\$0.5, \$0.7) \times CisternSize \tag{5}$$

3.1.3. O&M Costs for Water

Equation 6 accounts for the annual maintenance and operations (M&O) of the water system selected for the simulation scenario. According to the EPA, the average American uses about 88 gallons of water per day [30]. The cost of municipal water in the US is approximately $.006 per gallon per person per day [31]. According to the Centers for Disease Control and Prevention (CDC), wells should also be inspected annually [32] at a cost of $300 to $500 per year [33]. Rainwater harvesting systems also have annual maintenance expenses. If gutter and roof cleaning is done by the owner, then the cost is estimated at $328 per year by the Environmental Protection Agency [34]. These costs are represented in Equation 6. In this equation, city water costs is based on a per gallon demand and a rate between ($.004, $.006) per gallon. Well O&M costs are $300 to $500 per the CDC, and RWH maintenance costs are centered around the EPA cost estimate. The accumulation rate is defined as 1 + inflation.

$$\begin{aligned} Annual\ Cost\ of\ Water\ O\&M \\ &= CITY \times 365\ days \times Occupants \times Annual\ Water\ Demand\ \times U(\$0.004, \$0.006) \\ &\times Accumulation\ Rate^{k-1} + WELL \times U(\$300, \$500) \times Accumulation\ Rate^{k-1} + RWH \\ &\times U(\$230, \$430) \times Accumulation\ Rate^{k-1} \end{aligned} \tag{6}$$

Selection of appliances and fixtures is important for a sustainable house reliant on 100% rainwater. Toilets, shower heads, and other water fixtures in the residence that insprired this simulation were low flow / high pressure (see Figure 15). Mayer et al. [35] estimate that toilets use 29% of indoor water consumption, while water used for showering/bathing, dishwashing and laundry consume about 36%, 14%, and 21%, respectively. The Environmental Protection Agency (EPA) shows that high pressure, low flow shower heads reduce flow from 2.5 gallons per minute to 2.0 gallons per minute, a 20% reduction [36]. The Department of Energy estimates water savings between 25% and 60% [37], values used in the simulation. Costs for low flow fixtures are comparable to standard fixtures, so acquisition costs were omitted. Equation 7 is the water demand. In this equation, LOW is an indicator variable for installation of low-flow devices, and the mixture equation includes a uniform reduction of 25% to 60% if those fixtures are installed.

$$\begin{aligned} &Annual\ Water\ Demand \\ &\quad = LOW \times U(80{,}100)gl \times 365\ days \times\ Occupants \times U(0.4{,}0.75) + (1 - LOW) \\ &\quad \times U(80{,}100)gl \times 365\ days \times Occupants \end{aligned} \tag{7}$$

2.5.4 Acquisition, Replacements Costs and Environmental Considerations based on Selection of Water Heater, Adjusted Water Demand

One of the current additions to the research residence has been the inclusion of an on-demand electric, tankless water heater for a guest room, guest kitchen, and guest bathroom. These water heaters take up less space than those with tanks and do not constantly use energy to keep water warm. One study indicated that the life-cycle savings over traditional electric storage systems is $3,719 Australian dollars (about $2500 US dollars) [38]. However, that study does not consider the possibility that all electrical power needed is generated by solar. Further, the carbon footprint is much lower, as it is in operation only when demanded. Tankless water heaters may be as much as 99% efficient [38], saving 27 to 50% of kWh consumption [39]. The acquisition cost of an electric tankless heater is largely dependent on size, capability, and brand and may be higher than traditional tank versions; however, many high capacity electric versions are comparable in acquisition costs with traditional tank versions. Tankless may also last 1.5 to 2 times as long as tank water heaters (20 years) and save 8 to 34% on water (values used in the simulation), depending on water demand; however, demand flow for multiple simultaneous operations must be evaluated and proper capability systems selected [40]. The water demand reduction factor was included in the simulation by a unifom distribution between .66 and .92 as shown in Equation 8. Acquisition and replacement costs for tankless and tanked water heaters were based on user input for average cost (inflation adjusted), while the replacement life was estimated at 8-10 years (uniform distribution) for tanked heaters and 15-20 years (also uniformly distributed) for tankless [41].

$$\begin{aligned} &Annual\ Water\ Demand\ with\ Tankless\ Water\ Heater \\ &\quad = U(0.66{,}0.92) \times LOW \times U(80{,}100)gl \times 365days \times Occupants \times U(0.4{,}0.75) \\ &\quad + U(0.66{,}0.92) \times (1 - LOW) \times U(80{,}100)gl \times 365days \times Occupants \end{aligned} \tag{8}$$

2.5.5. Environmental Consideration: Water Supply Requirements for Meeting Residents' Water Demand

For the simulation, users select from RWH, well, or city / municipal water sources. From a sustainability perspective, RWH requires far less water for the same aquifer demand (either well or municipal). Specifically, run-off, absorption / adsorption, and evaporation / transpiration reduce aquifer resupply to about 30% [42]. On the other hand, RWH systems capture 75% to 90% of rainwater, depending on design and rainfall [25]. The amount of water pulled from the aquifer to supply one gallon is therefore at 2.5 to 3.0 times as much as rainwater harvesting. Equation 9 illustrates how the simulation accounts for the water supply requirements to satisfy demand. RWH is an indicator variable indicating a rainwater harvesting system. This equation is adjusted later for selection of low flow devices and installation of tankless water heaters.

$$\begin{aligned} &Water\ Supply\ Requirements\ for\ Meeting\ Residents'\ Water\ Demand \\ &\quad = RWH \times Water\ Demand\ /\ U(0.75,0.90) + (1 - RWH) \times U(2.5,3.0) \\ &\quad \times Water\ Demand\ /\ U(0.75,0.90) \end{aligned} \tag{9}$$

2.6. Acquisition, O&M Costs and Environmental Considerations for Waste Management System

Cradle-to-grave water management requires that black water be treated responsibly and sustainably. Traditional municipal waste management and septic systems (aerobic and anaerobic) are two options for treating waste at residences, while traditional wastewater treatment plants are a third option. All three are available in the simulation.

The research residence informing the simulation had installed a Jet Biologically Accelerated Treatment (BAT) plant (also termed Biologically Accelerated Wastewater Treatment, BAWT, plant). BAT plants work by treating wastewater physically and biologically in a pre-treatment compartment. Water then flows through the treatment compartment where it is aerated, mixed, and treated by a host of biological organisms (a biomass). The mixture then flows to a settlement compartment where particulate matter settles, returning to the treatment compartment, leaving only odorless and clear liquid (gray water produced by the biomass) which is discharged through sprinkler heads [43]. Figure 5 is the encased BAT system installed at the residence. Aerobic systems break down waste far quicker than anaerobic due to the nature of the bacteria.

Figure 5. Biological Accelerated Treatment plant during installation

Installing a typical anerobic system averages \$3,500, whereas an aerobic costs about \$10,500 [44]. Maintaining the aerobic septic system is about \$200 annually [45], which is somewhat more than anaerobic systems [46] (modeled as 50% of the cost on average). There are benefits to the environment in that 1) pumps for transporting water to wastewater treatment plants are not necessary (and the associated energy costs), 2) treated water returned to the environment is cleaner, 3) electricity for processing water (in this case) is largely if not entirely generated by the sun. Equations 10 and 11 are the acquisition and operation costs for the simulation. In these equations, *AEROBIC* is an indicator variable for an aerobic septic system, *ANAEROBIC* indicates an anaerobic septic, and city waste management is omitted (zero cost and nominal O&M).

$$\$\,Acquisition = AEROBIC \times U(\$9500, \$10{,}500) + ANAEROBIC \times U(\$2000, \$3000) \tag{10}$$

$$\$\,O\&M = Previous\ O\&M\$ + AEROBIC \times U(\$150{,}250) + ANAEROBIC \times U(\$100{,}200) \tag{11}$$

2.7. Acquisition / O&M Costs, Electrical Systems

The simulation provided the opportunity for 100% electric or 100% solar. No mix of other electrical sources was evaluated in the first version of the simulation. The research residence initially had installed a 7.25 kW system (32 x 225 watt panels) with a Sunny Boy inverter ($33,600 in 2011, Figure 18) and then subsequently added another 9.585 kW system (27 x 355 watt panels, $31,317 in 2018, Figure 19) with a Solar Edge inverter after home expansion and capitalization of the original solar power system. The total cost of both systems was $64,917. After 30% federal tax credits, the total cost to the resident was approximately $44,441.90. From installation date until 31 January 2020, the initial 7.25 kW system has produced 90.579 MWh of power in 35,212 hours of operation for 2.57 kWh per hour, saving 153,984 lbs CO2. The 9.585 kWh system has produced 25.86 MWh in about 18,240 hours since installation, saving 40,038.49 lbs CO2 emissions and resulting in only 1.4 kWh per hour. The efficacy of this system is one of the reasons that motivated this simulation.

For the simulation, users are asked to select the percent of kWh provided by solar. Acquisition of a system includes extra capacity to account for .004% decay per year. In doing so, O&M costs for the duration of the simulation are built in [47]. To illustrate, a 30-year horizon would require 11.33% more panels. Further, users were required to select their state, as geography has an impact on capture. That impact was acquired by evaluating the ratio of the recommended photovaltaic system size recommended by manufacturers to the kWh used monthly (e.g., [48]). Cost per solar panel watt was a user option, set between $2 and $5 with the default value of $3.18 [49]. Equation 12 is the solar acquisition cost when selected, where *SOLAR* is an indicator variable for the inclusion of a solar system, *ENERGY* is an indicator variable for energy star windows/doors.

$$\begin{aligned}\$\,Solar\ Acquistion &= ENERGY \times \%\,Solar \times (1 - Tax\ Credit) \times \$\,per\ Watt \times (Total\ Monthly\ kWh)\\ &\times .88 + (1 - ENERGY) \times (1 - Tax\ Credit) \times \$\,per\ Watt \times (Total\ Monthly\ kWh)\end{aligned} \tag{12}$$

O&M costs for solar are negligible, particularly since the decay factor is included in the system [50]. Residential electricity rates are anticipated to be fairly stable over time as well [51]. For the simulation, the user inputs the initial cents per kWh, which are inflated over time based on the anticipated electrical inflation rate. Equation 13 provides the electrical O&M costs for the simulation. The total kWh is calculated later.

$$\begin{aligned}\$\,Electrical\ Cost &= \%\,Solar \times U(\$100, \$350) \times Accumulation\ Rate^{k-1} + (1 - \%\,Solar) \times \$\,per\ kWh\\ &\times Total\ kWh \times Electrical\ Accumulation\ Rate^{k-1}\end{aligned} \tag{13}$$

The footprint of solar is 6 g CO2e/kWh, while coal CCS is 109 g and bioenergy is 98 g. Wind power produces less emissions (4 g); however, the research residence location is a low-production wind area [52]. Wind will be incorporated in a future version of the simulation.

Equation 14 is the CO2e/kWh formula used in the simulation.

$$CO2e = \%\,Solar \times 6.0\ g\ \times Total\ kWh + (1 - \%\,Solar) \times 109g\ \times Total\ kWh + (1 - EV) \times 12 \times miles\ /\ mpg \times 8887\ g/gallon\ used \tag{14}$$

2.8. Acquisition / O&M for Vehicle (Important for EV Considerations.)

In the research residence, electricity generated from the solar panels was used to charge an electric Nissan Leaf (early adopter, see Figure 6). Nissan Leaf ownership costs over 8 years are estimated to be $36,537.82 with total 8-year energy costs (kWh) at $3,969 [53]. When powered by solar that is 100% capable of producing both home and automobile power, there are negligible O&M energy costs. Thus, the difference in cost between an equal value gasoline car (after accounting for any tax credits and residual) would be the maintenance and energy costs. In the simulation, the user selects the car acquisition cost for comparison (possibly zero to omit this element). Equation 15 reflects the implementation of the comparison in the simulation if a user selects an electric vehicle. The last portion of the equation uses the complement of the indicator for electric vehicles (EV) and multiplies that by the annual cost of driving. The use selects the starting gasoline cost (inflated), miles driven, and miles per gallon.

$$\$\ Vehicle\ Acquisition\ \&\ O\&M = Initial\ Car\ Cost + Inflated\ Replacement\ Car\ Costs\ at\ Life\ Cycle\ End + 12 \times miles\ driven\ monthly\ /\ mpg \times gasoline\ cost \times (1 - EV) \tag{15}$$

Figure 6. Nissan Leaf and final charging station

2.9. Acquisition Costs for Heating, Ventilation, and Air Conditioning

As part of the research construction, the residence was equipped with a closed loop, geothermal system (see Figure 7). This became an option in the simulation. Vertical, closed-loop geothermal units are heat exchangers that leverage the fact the temperature 200′ below the Earth remains relatively constant. The cost of the system including wells, unit and ducting (complete) was $26,500. The tax credit for the research residence was 30% or $7,950, and so the end cost to the resident was $18,550. Climatemaster (the brand installed) estimates a $1000 savings in electrical costs per year over an electric heat pump ($3,135 versus $4,169) [54].

Acquisition costs for geothermal are much more than traditional heat pumps [55]. In the simulation, the user selects the tonnage required, and this tonnage is used to estimate the total install cost. Equation 16 illustrates the simulation implementation, where GEO is an indicator variable for the installation of a geothermal system.

$$\$\ HVAC\ Acquisition = GEO \times U(Tonnage \times 5000, Tonnage \times 6000) + (1 - GEO) \times U(Tonnage \times 1000, Tonnage \times 2000) \quad (16)$$

Geothermal systems may be more expensive but reduce kWh usage. This reduction is factored into the total kWh calculation in Equation 17 along with Energy Star windows and doors, tankless water heaters, and electric vehicle consumption. *ENERGY*, *GEO*, *TANKLESS*, and *EV* are indicator variables for the presence of Energy Star doors / windows, geothermal heating, tankless water heaters, and an electric vehicle, respectively.

$$\begin{gathered} base\ kWh\ Required = 12\ x\ monthly\ kWh - ENERGY\ x\ 12\ x\ monthly\ kWh \\ if\ GEO == 1\ then\ kWh\ required = base\ kWh\ reqired\ \times U(0.5,0.9) \\ if\ TANKLESS == 1, then\ kWh\ required = kWh\ required\ \times U(0.5,0.73) \\ Total\ kWh\ Required = kWh\ required + EV \times\ EVkWh\ \times\ miles\ \times\ 12 \end{gathered} \quad (17)$$

Figure 7. Geothermal unit and vertical drilling of wells

2.9. Simulation Runs and Flowchart.

The number of simulation iterations is user specified from 1,000 to 8,000. A confidence interval of 95% is graphed across the break-even graph for users to evaluate the variability of the estimates. The default value is 2,000 iterations. Figure 8 is the flowchart.

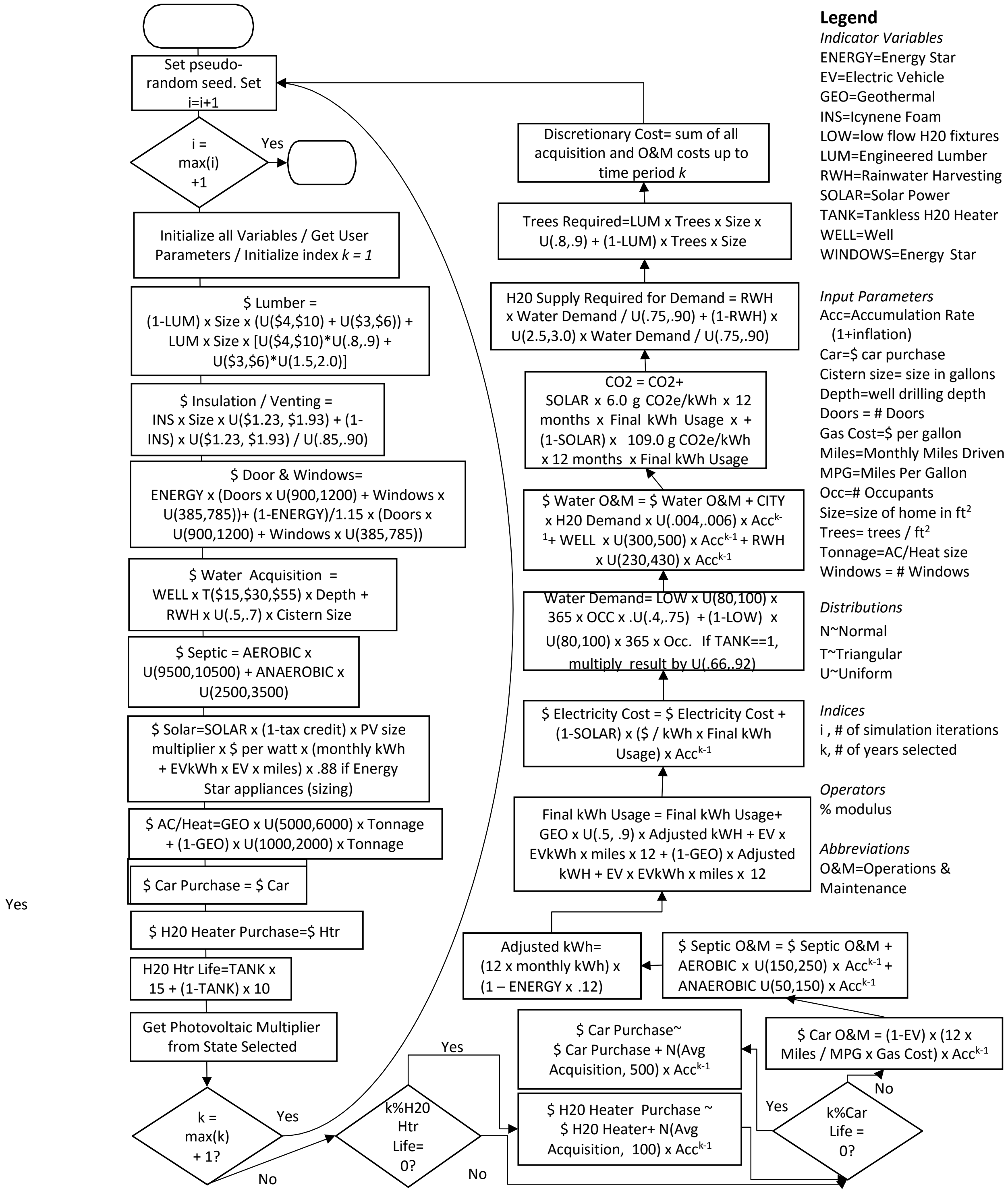

Figure 8. Flowchart for the simulation

2.10. Verification and Validation (V&V)

Since the simulation was written in R Shiny, several methods were available for verification and validation. To investigate validity, prior and posterior distributions were investigated to ensure that output distributions matched the input distributions. For validity across experimental conditions, a common random number stream was used. In doing so, we ensured that comparison differences would not be due to the selection of pseudo-random numbers alone. Third, visualization of the simulation results ensured that the outcomes were as expected.

4. Results

4.1. Baseline vs. Scenario 1

The baseline scenario was set to include the parameters in Figure 9. Runs were based on 30-year ownership, 3000 square feet construction (279 square meters), 25 windows, 3 external doors, 2 occupants, 2 water heaters, $1000 water heater acquisition, 30% tax credit, 5 ton (4.5 metric ton) heat pump / geothermal heat pump in Texas, 1500 base kWh usage per month, $.13 per kWh utility costs, $3.30 per watt solar panels, 3% annual inflation, .3 kWh per mile for EV, $30K base cost for vehicles, 1100 monthly miles, 30 mpg for gas vehicles, $2.20 per gallon for gasoline, 8 year car life, and 2000 simulation runs. Comparative construction analysis in Figure 8 included all possible sustainable options offered in the simulation.

4.1.1. Scenario 1-All Sustainable Items Checked to Mimic Research Residence Components

Figure 10 shows the graphical results of the break-even analysis for Scenario 1. The break-even time based on this analysis is about 21 years due to the up front expenses. At 30 years, the cost savings is estimated to be $80,000. Figure 11 breaks down both costs and environmental considerations for the baseline versus this construction. The sustainable construction option saves 56,921 kilograms of CO2 and requires 5,501 fewer kilogallons of water to meet demand over the 30-year lifespan. The sustainable option requires 217 fewer MWh over the course of 30 years, and the grid cost is zero as solar provides 100% of the power required. While better for the environment, water and wastewater are more expensive for the sustainable construction and can never achieve any break-even.

4.1.2. Scenario 2-100% Solar, Geothermal, Tankless Water Heater, Engineered Lumber, Icynene Foam, Electric Vehicle, Energy Star Windows & Appliances, Low Flow Fixtures, Rainwater Harvesting, Aerobic Septic

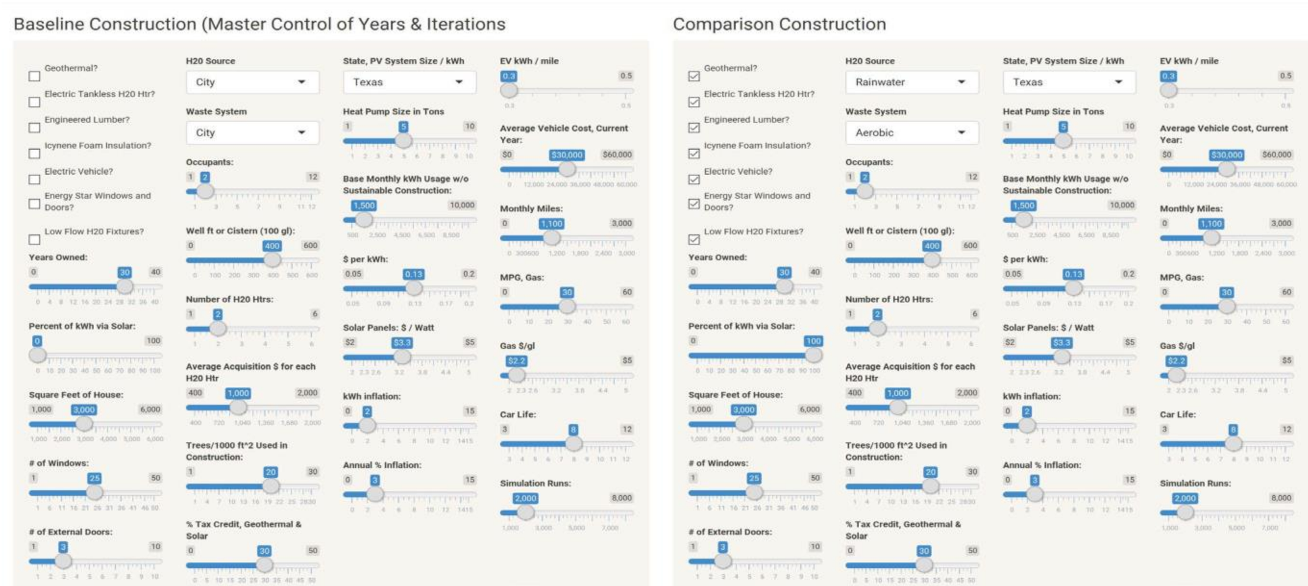

Figure 9. Baseline and comparison construction information, Scenario 1

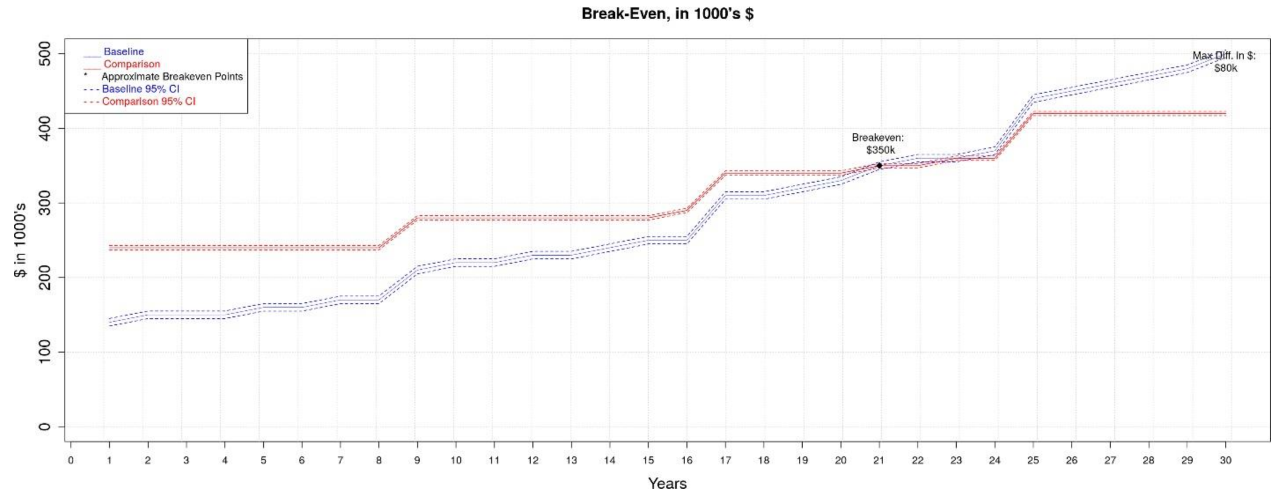

Figure 10. Break-even analysis for Scenario 1

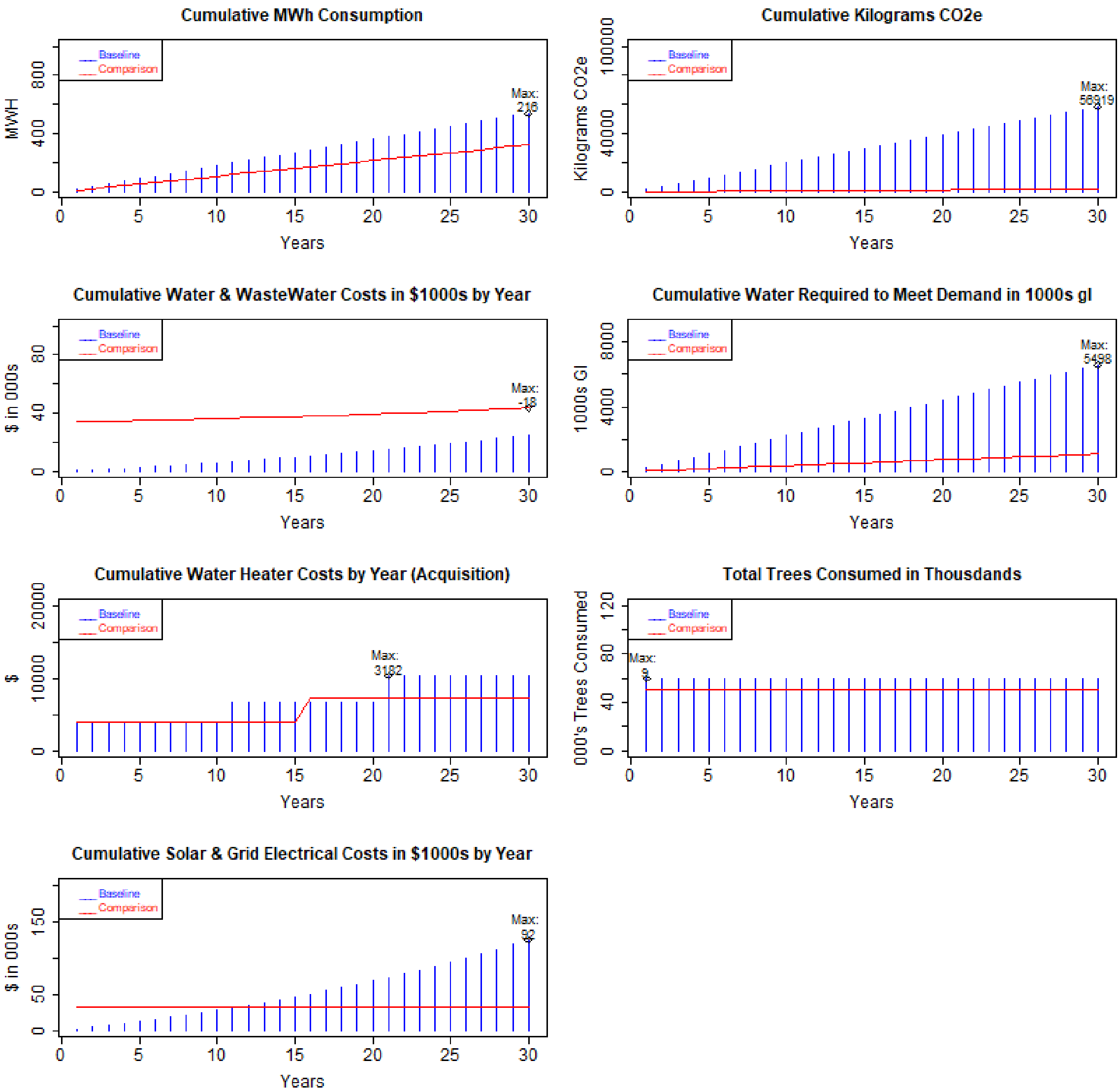

Figure 10. Comparison of costs and environmental costs are depicted for the baseline construction (left) versus the 100% solar construction (right). "*Max*" is the maximum difference between comparison construction and baseline construction.

3.1.2 Scenario 2-100% Solar Only

Scenario 2 includes 100% solar as the comparison option. Break even is at 9 years with the maximum cost savings at 30 years equal to $140,000. See Figure 11. CO2e savings over traditional construction total 55,620 kilograms. If tax credits are reduced to zero, then the break-even moves to 12 years rather than 9, and the 30-year maximum benefit is reduced to $130,000.

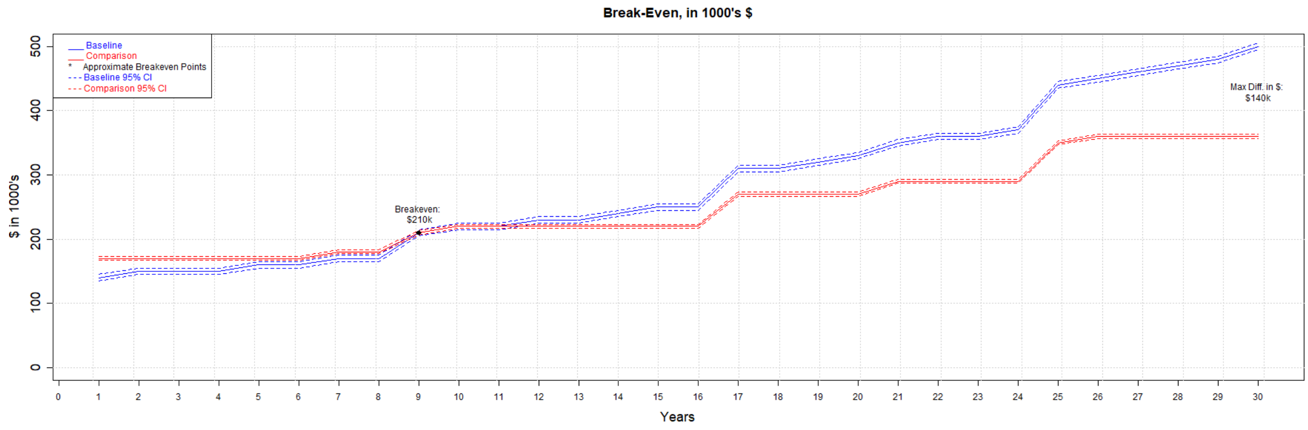

Figure 11. 100% solar versus the baseline

3.1.4 Comparison Tables for Various Scenarios

The number of scenarios available is beyond enumeration, as the simulation is designed to support user input. Thus, design of experiments and response surface methodology are outside the scope. Given the fixed parameters for the baseline discussed previously, comparison changes were made for many of the sustainable construction options. Interestingly, Icynene Foam and engineered lumber are not major contributors to the cost or break-even analysis. The hypothetical advantage of EV's is offset by the requirement for more solar in a 100% solar solution as well as gas prices. Other combinations are left to the user to explore. Table 1 illustrates the results.

Table 1. Comparison of simualtion results

Baseline Plus the Following	Years to Break Even	30-Year Savings in 000's	Notes
100% Solar	9	$140	
50% Solar	7	$70	
25% Solar	2	$25	
Geothermal	15	$50	
Electric Tankless	0	$80	
Energy Star Windows & Doors	2	$20	
Low Flow	0	$20	
Rainwater, 40 kilogallons	NA	NA	
Rainwater, 30 kilogallons	30	$0	
Electric Vehicle	NA	NA	(Requires more solar acquisition)
Aerobic	NA	NA	

5. Discussion

The results show that building a sustainable house can be both green for the environment and green for the pocketbook depending on the trade-off considerations of the consumer. The initial up-front costs may be quickly offset by savings depending on construction options. Of importance, we note that a 100% solar solution alone offsets the acquisition costs for the baseline construction in 9 years. Other options do similarly as well. Aside from the economic considerations, the environmental responsibility issues are clear. Avoiding carbon emissions is responsible construction. The analysis of individual construction options based on this simulation will help consumers with decision making.

The significance of this study is multi-fold. First, the study informs a unique, original decision-support simulation for consumers. Second, the study evaluates both break-even and environmental considerations for complex decisions associated with building. Third, the study shows that building sustainably may be green for the environment and the pocketbook.

4.1.1. Policy.

There are also policy requirements for sustainable construction. That policy push towards sustainable construction is evolving to a universal mandate with penalties for failure to comply. The prime example is in California where a new law passed a solar mandate where all new homes built after 1 January 2020 must be equipped with a solar electric system. That system must be sized that it will offset 100% of the home's electricity usage. This mandate is one aspect of the California Energy Commission's initiative to have 50% of the entire State of California's energy production be from a clean energy source by 2030 [56]. Continuing with the California mandates on sustainability mandates, California passed another law recently signed by Gov. Brown that imposes water usage requirements. The law states that all California residents will be restricted to 55 gallons/day water usage by 2022 and is reduced to 50 gallons/day by 2030 [57]. While both initiatives discuss the mandates, neither has shown the penalty for failure to comply or even specifics on implementation. What is clear is that the mandates on both electric and water usage are the wave of the future and appear to be only the start in California with certainty that other States will adopt similar measures. A proactive approach leveraging the analysis presented here and elsewhere will help both builders and buyers.

Another implication of this analysis shows that the return on investment requires the occupant to live in the home for an extended period to make the up-front costs viable on the back end. An issue that is imperative to ensure economic break-even is the inclusion of accessibility as part of the engineering design process. One reason people must leave their homes is impairment of mobility and access. The solution to this from a policy perspective should be that all homes being built should also be required to meet basic American with Disabilities Act Accessibility Guidelines. The ADA does not apply to private residences, but a significant sustainability policy implication is that it should be extended along with the resource mandates as mentioned on power and water. These guidelines have minimum standards to exterior access, parking, hallway dimensions, bathroom access, as well as reach and appliance access. The International Code Council publishes new International Building Codes every 3 years, and the current code was published in 2018, known as ICC IBC-2018. The time is now to incorporate the ADA accessibility standards into the new code to be published in 2021, which would require all new construction, both private and public, to meet these standards. In so doing, this would allow individuals to remain in their homes longer, and experience longer ROI on all sustainability aspects of their home. While the residence discussed in this case study is not yet fully ADA compliant, it was designed with the minimum hallway, bathroom, and parking requirements to support future disability of its residents.

4.1.2. Limitations

The limitations of the simulation in this study are significant. First, only a limited subset of sustainable and non-sustainable construction components is considered. Many others will be added in future work, but modeling the universe is not realistic. Second, the estimates in this study are based on evidence and professional assessment; however, they may contain more error than modeled. Third, the distributions selected, while ostensibly reasonable, may be improved with additional analysis.

4.1.3. Future Sustainable Improvements and Modeling

All add-on construction to the residence included mini-splits (both in wall and in roof systems). These systems have more upfront costs but are much more energy efficient, as they do not lose energy through ductwork. Further, they are now inconspicuous and highly effective [58]. See Figure 25 for pictures of in-roof and in-wall systems installed in the residence. In new construction, these systems should be considered due to their efficiency and elimination of ductwork and other requirements.

Figure 25. Mini-split units mounted in research residence, wall and roof versions

Another new construction consideration is the use of wireless multi-gang light switches. These fixtures can minimize wiring requirements by using a single drop instead of multiple drops. With the advent of 5G, it might be possible to eliminate CAT6 wiring during residential construction in the future as well.

This is the first simulation of its type that quantifies multiple sustainable construction options, associated break-even points, and environmental considerations. In future simulations, wind power as well as natural gas and propane will be modeled. Distributions and parameters will be refined where possible, and additional input options for users will appear.

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A Comparative Analysis of Health Care Systems in India and Vietnam

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The United Nation's 2030 Agenda for Sustainable Development aims to "end poverty and hunger, in all their forms and dimensions, and to ensure that all human beings can fulfill their potential in dignity and equality and in a healthy environment." According to the Agenda, the elimination of poverty and the improvement of health can be attained through the implementation of universal health care in all countries. Countries that have adopted universal health care have been shown to improve health indicators such as health status, risk factors, service coverage, etc. (World Health Organization) The shift towards universal health care exists because of three primary reasons: health benefits, political benefits, and economic benefits. It is, therefore, crucial to note that the political economy of a country has the ability to influence the health care reform process. These UN Goals are being considered proactively in developing countries. For this paper, we will be analyzing the healthcare systems in two developing countries, viz. India and Vietnam and both the countries' efforts to implement universal healthcare. We will evaluate their systems while taking into consideration the political economy and history of these two countries; as well as introduce certain metrics that will help us define what "successful" health coverage looks like. The success of the indicators is closely tied with the model and success of the health coverage system. An analysis of these two countries will allow us to form conclusions about the efficacy of certain models in developing countries. Our conclusions will allow us to provide key findings and recommendations to other countries in similar conditions seeking to implement universal healthcare.

User Experience Improvement on Digital Platforms through Personalized Helpful Information

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Abstract

Nowadays, user-generated content (UGC) is an important source of information on digital platforms. Online users share millions of contents daily; however, not all UGC's are helpful for other users to use them as a source of information in their decision-making process. Digital platforms can help their users by providing the users with personalized helpful information that makes the decision-making process faster and easier for them. In this study, we develop a model that predicts the helpfulness of UGC's. We extract the predictor variables from the characteristics of the contents, the generators, and the user. We, then, apply machine learning techniques to real data from an online platform to develop and test the model. Findings of this study can help the digital platforms to improve their performance by providing personalized user experience for their users.

Keywords: User Behavior, Personalization, User-Generated Content, Digital Platforms, Review Helpfulness

Putting a Price on Everything? Dealing Responsible with the Internalization of Environmental Damage Costs

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Abstract

The concept of internalizing external environmental costs by putting a tax on them has gained much popularity in recent times and is seen as a potential key economic instrument for tackling climate change and other forms of environmental degradation. In contrast to alternative measures such as the cap-and-trade scheme, the simplicity of a taxation concept allows for fast political implementation and little bureaucratic effort. The payment of environmental costs has also opened a market for voluntary compensation payments. For example: For every flight one takes, one can pay the price of the caused environmental damage to a company, which will finance a sustainable project somewhere in the world with this money; thereby compensating for the environmental damage of the flight. The question arises, however, whether such internalization is effective in combating and stopping the tremendous anthropological impact on the ecosphere. What are the pitfalls of an environmental tax and how can national and international politics deal with them? Such comprehensive assessment of this form of internalization seems to be missing in current literature. I aim to fill this gap by mapping three essential forms of rebound effects on the internalization method of environmental taxes and propose a framework on how to deal with such effects.

In this paper, I make the point that an uncritical application of environmental taxes not only fails to tackle the anthropogenic ecological impact, but further runs danger of enhancing and justifying it. There are three different aspects contributing to this criticism. Those three aspects can be thought of as three types of rebound effects, whereby I refer to the characterization by Paech [1] : Growth effects, psychological rebound effects and technical rebound effects are differentiated. These rebound effects arise because of an isolated observation of positive sustainability effects of environmental taxes on one decision level, while simultaneously neglecting further (negative sustainability) effects on other levels. More specific, all three rebound effects arise out of the illusion that environmental damage is indefinitely reversible through monetary compensation payments.

[1] „Directional Certainty in Sustainability-Oriented Innovation Management“, in *Innovations Towards Sustainability*, hg. von Marco Lehmann-Waffenschmidt (Heidelberg: Physica-Verlag HD, 2006), 121–39, https://doi.org/10.1007/978-3-7908-1650-1_10.

The first aspect of criticism is that this illusion leads to growth effects and thus to the expansion of markets and further economic growth, the main driver of increasing rates of ecological degradation. When the incommensurability of certain goods is neglected, everything can be turned into a commodity with an associated price. Goods that were previously not part of the market system can be traded, extracted or destroyed, if only the associated price is paid. The second aspect of criticism relates to psychological rebound effects. Taxing environmental effects may negatively influence the decision-making process of the individual, in the sense that such payments are thought to completely level out the environmental damage of one's consumption or investment decisions. If environmental damages are monetarily compensated, a person might lose its feeling of guilt for causing them. The individual may thus consume more products and services associated with high environmental damage. Additionally, environmentally conscious individuals formerly avoiding such problematic products and services could become additional consumers of them. The third aspects concerns technical rebound effects. Not all forms of environmental damage can be quantified and monetized with the same precision, as data might not always be available or controversial value judgements about the worth of certain goods might be involved. Out of this follows that not all forms of environmental damage can be taxed. Technical rebound effects might thus occur; in the sense that businesses will avoid producing those environmental damages that are monetized. However, this might be achieved by shifting towards unmonetized environmental damages. Take for example a certain pesticide in agriculture whose environmental damage was calculated and taxed accordingly. Instead of switching to a more eco-friendly pesticide or using no pesticide at all, the farmer might instead choose a pesticide that is just as bad as the old one but whose effects on the environment couldn't yet be estimated and taxed.

Building on these three identified rebound effects and the according shortcomings of environmental taxes I propose a framework for policymakers which allows for a responsible implementation of this form of internalization. Instead of discarding environmental taxes all together, an approach that combines this instrument with other market control mechanisms appears to be more reasonable. That is, because not pricing in the environmental impacts into the monetary value of a good would implicitly set the price of those impacts to zero. In the proposed framework, growth effects can be prevented by deliberately banning the commodification of (ecologically or ethically) critical goods and thereby preventing their entry into the market sphere. This would have to be paired with the intentional decommodification of critical goods that have already entered the market sphere. Regarding psychological rebound effects, these can be tackled by introducing limits to the consumption of non-essential products and services with an especially large ecological footprint. Exemplary, one could allow for only two flights per person per year. Last, the technical rebound effects can be prevented by extending on policies such as the European REACH-legislation, introduced to register, evaluate, authorize and restrict chemicals upon entry to the market. Such process could be extended by a mandatory assessment of ecological damages of all chemicals and resources before being allowed in the market. If a monetary impact assessment of a chemical turns out not to be possible due to insufficient data, approximated values from familiar chemicals could be consulted. If an approximation might also be not possible, the market entry of a chemical could be delayed or prohibited.

This paper should be seen as a first approach towards pricing in and thus internalizing environmental damage costs, in which the danger of rebound effects is considered and addressed. Consequently, the proposed framework for the introduction of environmental taxes does not run danger of stimulating further economic growth effects, which lie at the heart of the current ecological crises.

Air Pollution

Competent Waste Control, Management and Maintenance: A Heuristic Approach to a Sustainable Habitation, Clean Oxygen and Environment: A Study of Owerri Municipal, Nigeria

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Abstract

Solid waste is regarded as any moveable items, materials or objects becoming a hazard and no longer useful, ready to be disposed by the user. This paper was undertaken to analyze and access the management, maintenance and control strategies of solid waste disposal in Owerri Municipal, Imo State, Nigeria. It also delved into the various patterns of which wastes are being generated and indiscriminately disposed, posing a hazard and threat to public health and contamination to the environment. This paper also investigated the inability of various government agencies involved in waste control management to effectively team up to facilitate and deliver a potent waste management services. Also identified in this paper is the poor environmental policies and legislation, poor technology, corruption, traffic congestion, insecurity, ignorance and poor developmental plans were seen as major challenges. Some objectives were identified in this study and the data collected were also analyzed. There are vital suggestions, contributions, guides and recommendations geared towards bringing cohesion, harmony, efficiency, consistency and awareness to a cleaner, unpolluted and sustainable habitation in Owerri urban.

Keywords: Solid waste, Hazard, Contamination, Control Strategies, Indiscriminately, facilities, potent.

An Integrated Approach to Preparing Business Plan Financials for First Year College Students

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Abstract

A rigorous and full Business Plan for a new venture is a core requirement of BUSN100: Enterprise, a freshman level course at our business school. Students follow a Business Plan outline, which includes the preparation of basic but complete financial projections and statements. This task is challenging for students without introductory Financial Accounting or exposure to financial forecasting methods. In addition, faculty who teach Enterprise, mostly Adjuncts, come from various practitioner backgrounds and have varying degrees of familiarity with Accounting and financial forecasting models. Given these challenges, and noting the benefits of consistency in student outcomes and assurance of learning, the authors have developed a multi-tool integrated system to effectively educate and train first-year students in the preparation of a Business Plan including financials. This approach includes:

(1) Linked Excel financial statement templates;
(2) Step-by-step student instructional narratives explaining the logic and rationale behind the financial forecasting methodologies and the templates;
(3) A faculty instructional manual explaining how to use the Excel templates;
(4) A series of audio/visual Panopto videos explaining to students the systematic process to create financial statements.

Two school of business faculty, one adjunct and one tenured developed this system with significant assistance from students in the advanced Accounting course. These advanced Accounting majors assisted in the development of the templates, instructional narratives and Panopto videos. The underlying assumption is that student-to-student learning is often very effective when presented at a peer conceptual level versus professor-to-student. The individual tools from this effort were implemented in the Enterprise classroom by one of the professors involved in the development of the system. The fully integrated learning system will be completed and tested in Enterprise in the spring semester of 2020. Our presentation will focus on explaining this integrated approach to teaching a freshman course in new venture financial planning.

Assessing the Impact of Professional Certifications on Time-to-Hire, Job Satisfaction, and Career Growth of Health Administration Alumni

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Abstract

Professional certifications are valuable resources; they reassure hiring organizations about the knowledge and competence of candidates and they help certified individuals to be more competitive in the job market. As such, some academic programs have included professional certifications in their curricula. The purpose of this study was to assess the effectiveness of professional certifications implemented in both undergraduate (BHA) and graduate (MHA) healthcare administration programs on time to employment, job satisfaction, and career growth. Data were collected using a survey of BHA and MHA alumni administered on Qualtrics (response rate = 24%; n=75). Our dependent variables included job satisfaction, job growth, a linear combination of the two, and time to employment. Validated survey instruments were used to measure the dependent variables. Our independent variable was "professional certification" using the dichotomous values of Lean Six Sigma, Excel Basic, Excel Expert, and QuickBooks certifications. Survey response latitudes and longitudes were also captured to assess the impact of geographic location on the dependent variables. Results from Welch two-sample t-tests suggested that Excel Basic certification was significantly associated with shorter time to employment, while Excel Expert was marginally associated with shorter time to employment. None of the certifications were associated with job satisfaction, job growth or the combination of the two. Results also suggested that students hired in larger cities reported higher levels of satisfaction and growth. While this is a preliminary study, findings support preceptors' requests for students with Excel skills.

Introduction

Professional certifications are often included as a formal aspect of higher-education programs such as health administration and business. For these types of programs, the certification is often a clear fit with the curriculum. Research suggests that even when such certifications are not closely related to program requirements (e.g., liberal arts programs), students and the institution can still benefit from certifications that demonstrate industry-specific skills (Blumenstyk, 2018, 2019). Employees and human resources managers have shown increased interest in hiring candidates with recognized professional certifications that provide third-party verification of skills (Adams, Brauer, Karas, Bresnahan, & Murphy, 2004; Raymond, 2001). Such external certifications may also play a major role in career growth (HRCI, 2010).

Extant literature suggests that professional certifications benefit both employers and employees. On the one hand, employers benefit from hiring applicants with external certifications because they add credibility to the organization, they possess up-to-date knowledge and skills that increase effectiveness and efficiency in job performance, they expose the organization to innovative ideas, and they have a positive impact on organization's profitability (HRCI, 2010; Lee, 2018; Stefl, 2008). Furthermore, research demonstrates that individuals value these external, professional certifications because they increase and update their knowledge of the profession, indicate employee's possession of required competence and commitment to the profession, increase confidence in job performance, provide job security, enhance work quality, determine credibility, increase reputation, ensure ease of finding future jobs, facilitate professional growth, offer potential for higher compensations, and increase employee satisfaction (Adams et al., 2004; HRCI, 2010; Niebuhr & Biel, 2007; Schroeter, Byrne, Klink, Beier, & McAndrew, 2012; Stefl, 2008).

Professional certifications are part of lifelong learning of healthcare administrators as suggested by the American College of Healthcare Executives (ACHE, 2012) and there are some job postings that include professional certifications in their list of credentials. Program faculty conducted an assessment of their healthcare management courses and provided suggestions for external certifications that mirror their course objectives and overall competency model. While several professional stakeholder organizations offer both membership opportunities (to include student memberships), credentialing opportunities also exist in the field of healthcare management (Healthcare Management Degree Guide, 2020). It was quickly recognized that such credentialing programs were not attainable for current students (both BHA and MHA), most often due to a) program membership dues, and b) often a requirement for membership tenure (number of years as a student and/or full-paying dues member) prior to entering the credentialing process. Further, it was then identified that other external certifications attainable by both undergraduate and graduate students better mapped to the program's competency model and curriculum at a more organic, learning objective level.

In addition, these certifications, infused into program curriculum, were intended to apply course objectives to 'real-world' practitioner processes and programs, as well as assist in the marketability of program graduates upon graduation.

Given that professional certifications enhance graduates' competitiveness in job search, because they validate the candidates' knowledge and expertise of the subject matter, graduates with professional certifications will find a job faster than those without certifications, holding other variables constant. Once hired, employees with professional certifications are viewed as more knowledgeable and competent than those without certifications. Therefore, they may be given more challenging responsibilities and higher compensation that may lead to faster career growth and satisfaction, respectively. The researchers also assumed that if assessed value of the certifications was to be conducted in the study, job satisfaction would also be important to evaluate (possibly linking certification to performance, with performance influencing the alumni's overall job satisfaction).

If professional certifications have a positive effect on both employers and students (future employees), academic program administrators should consider their adoption (assimilation into program curriculum). To determine the value of the certifications also requires proper and ongoing assessment by the academic program. Programs should consider including assessment mechanisms to measure the effectiveness of any adopted certifications, and which certification(s) to adopt is a question that requires exploration.

Often lacking (but not entirely a new concept) in higher education (White & Vester, 2017), the knowledge of Six Sigma quality improvement initiatives, Microsoft Excel spreadsheet intricacies, and especially financial accounting software particulars, these job-ready skills are typically learned after employee has been hired and training is issued on-the-job. Furthering the initiative for job-ready graduates, such certifications assist (and formally document) the candidate's qualifications for the position, both the graduating student and future employer with these on-the-job tasks, instilling additional confidence by possessing a certification from an external entity/organization. (Mangan, 2015; Blumenstyk, 2019).

The authors of this manuscript are faculty and administrators in both undergraduate and graduate professional programs for healthcare administration. Two years ago, our programs chose to adopt multiple professional certifications commensurate with our role as healthcare administrators. The Board of Governor's Exam for the American College of Healthcare Executives requires five years tenure as an ACHE member (does not include student membership type) before Fellowship status is considered. However, there are other certifications appropriate for healthcare administration students to assist in this initiative during career readiness preparations.

The Advisory Board for undergraduate and graduate programs at the authors' university asked the programs to increase proficiency of Microsoft Excel skills. The program leadership for both the Bachelor of Health Administration (BHA) and Master of Health Administration (MHA) programs responded by teaching the body of knowledge for the MS Excel MOS Basic and MS Excel MOS Expert certifications. Implemented in the appropriate courses, these certifications must be attempted by all students and are part of the course grades. For the undergraduate student, the Excel MOS Basic certification is required as part of the finance course, and the Excel MOS Expert certification is part of the operations management course. For graduate students, Excel MOS Basic is part of statistics course, and the Excel MOS Advanced is part of healthcare finance. Students are provided LinkedIn learning tutorials and a faculty-led training session to prepare. Pass rates for the MOS Excel Basic are between 95% and 100% (undergraduate and graduate). MOS Excel Expert is more difficult, and the pass rate is between 70% and 80%.

Our programs selected Lean Six Sigma Green Belt, Microsoft Excel, and QuickBooks certifications to address the following competencies: Quality Improvement, Risk Management, Patient's Perspective, Quantitative Analysis, and Professional Development and Lifelong Learning. They were also chosen to meet the needs/suggestions of stakeholders. For instance, Microsoft Excel proficiency was suggested by our programs Advisory Board and an important skill that students should acquire. Based on the recommendation of our CAHME accreditation team and our preceptors we included Lean Six Sigma Breen Belt certification in health care in our curricula. Also, LSSGB certification is valuable due to the growing pressure health care organizations are facing with respect to improving health care quality while reducing cost. However, the US health care system has a shortage of workforce that specialize in quality improvement. Therefore, equipping our students with this certification will make them more competitive in the job market. In the same vein, we chose QuickBooks certification to fill the shortage in accountants in the US healthcare system, who are important helping organizations to become more cost-effective.

The Institute of Industrial and Systems Engineers (IISE) provides LSSGB in Healthcare certification for both BHA and MHA programs. This certification is provided during the quality improvement courses for both the BHA and MHA programs. Students are provided at most three opportunities to pass this examination; the pass rate for the undergraduate students ranges between 80% and 93%. For the graduate students, the pass rate is typically between 90% and 100%.

QuickBooks certification was also included in the curriculum to Students in the BHA must now attempt Intuit's QuickBooks certification (QuickBooks Certified User) as part of the financial accounting course, while MHA students are provided the option to do so. The financial accounting course in the BHA curriculum remains the benchmark study-skills and math applications course for the degree program, preceding a rigorous financial management course to be taken the following semester. Students in this accounting course are to ultimately develop valid and reliable financial statements using specific GAAP-compliant procedures, as well as recent ACA (2010) income statement requirements. The first two-thirds of the course's semester follow traditional classroom protocols, to include textbook readings, lecture, homework, and high-stakes examinations. One competency to be demonstrated by the student is manually creating detailed healthcare organization financial statements (handwritten). However, reality is then infused into the course curriculum by focusing the final third of the semester on automated bookkeeping and financial statement development. This task is completed by using Intuit's QuickBooks educational software and related instructor resources in the School's on-campus computer lab. Utilized by many business schools across the country, QuickBooks offers a Certified QuickBooks User (QBCU) credential for students who pass the Intuit online QuickBooks desktop examination. In the end, students learn the intricacies of financial accounting by manual collection, accumulation, and presentation of financial information, and then apply the accounting cycle process and related classwork within an automated accounting software to best-replicate their professional expectations beyond graduation.

Two years have passed since these decisions were made, so the leadership of these programs chose to conduct an initial alumni query (assessment) to determine the marketability and job satisfaction relative to these certifications. The program leadership designed a survey separate from its annual alumni survey to measure the effectiveness of the certification. The research questions were: 1) What has been the alumni marketability effect of the professional certifications (additional offers, rapid employment), 2) what has been the job-satisfaction of alumni who obtained professional certifications (high paying jobs, desirable locations), and 3) what has been the career growth of alumni who obtained professional certification? We hypothesized the following: *Compared with alumni who have not obtained professional certifications, alumni who obtained professional certification(s) will have a shorter time to employment, a higher job satisfaction, and a faster career growth.* Further, we gathered information regarding placement location to map satisfaction by region and looked for patterns (exploratory). Limited research on the incorporation of external certifications in healthcare administration programs currently exists, while program faculty conducted this exploration to assist in due-diligence and competency-based curriculum initiatives.

Methods

Research Question Review and Sampling Frame

This preliminary study evaluated the value of professional certification and the number of its associations with the dependent variables: job satisfaction, job growth, a linear combination of satisfaction and growth, as well as time to employment. The baseline hypothesis was one-directional, assuming that certifications should positively affect all dependent variables. Gender differences were also investigated. The study leveraged previously validated surveys on job training and job satisfaction (Schmidt, 2004) and career growth and organizational commitment (Weng, McElroy, Morrow, & Liu, 2010). In addition, location of each survey respondent was also evaluated to see its effect on the dependent variables through geospatial mapping.

This study was approved by the university's Institutional Review Board (protocol # 6790). The sampling frame for the study were all 2014 -2019 Bachelor and Master of Health Administration alumni from the university's BHA and MHA programs. The sampling frame is expected to be a reasonable representation of the population of interest. The total number in the sampling frame was 415 alumni.

Data, Missing Data, and Software

Survey data were collected using Qualtrics. Over the course of 6 weeks, 415 alumni were invited three times to participate. During this time, 101 attempts to take the survey were recorded (24% response rate). However, 24 responses were almost totally incomplete resulting in 77 useful observations. Additionally, 1 individual selected "I choose not to participate," and another provided two different submissions, ostensibly to update job status. The latter of the two submissions was retained. The result was n=75 complete responses.

In addition, four of the remaining respondents (all out of state placements) were missing latitudes and longitudes. These were imputed using their current positions and alumni LinkedIn information. Two respondents did not answer the certification question. These non-responses were assumed to be modal (no certification) responses. Four respondents did not respond to time to employment. Three of these were known, and one was not seeking employment. Imputation using actual values was performed. Two respondents did not select citizenship status, and we populated those missing values by using academic programs data. After these manipulations, only 3% of the observations were missing. The 3% missing were imputed with means column-by-column. This is a conservative method that will result in more Type 2 errors during mean testing. R Statistical Software (2018) and Microsoft Excel were used for the analysis (Team, 2018). Excel provided the GIS mapping using 3D Maps connected to Bing, while R generated the remainder of the descriptive and inferential analyses.

Variables and Definitions

The dependent variables of interest were job satisfaction, job growth, a linear combination of the two, and time to employment. Job satisfaction is defined as the average of the Schmidt (2004) survey instrument responses shown in Table 1 after reverse coding. The scale for each question was a 6-point Likert scale. Job growth is the average of the Weng et al. (2010) survey instrument measure on a 5-point Likert scale (see Table 1 for the instrument). A linear combination of the two variables was generated by re-scaling and addition. The 6-point Likert scale average was re-scaled to 5-points and added to the 5-point Likert average. See Equation 1.

$$\frac{5}{6} \times Average\ Satisfaction\ Score + Average\ Growth\ Score \tag{1}$$

Survey questions are shown in Table 1. Question 13 and subcomponents evaluate job satisfaction, while question 14 and parts evaluate job growth. Other variables measured and defined are shown in Table 1.

Survey Item Re-coding. Gender responses were assigned based on academic program data (all were recent graduates of approximately the same age group). Job data were recoded as administrator/manager, analyst/coordinator/specialist, or other. Occupation data were recoded as either direct care or other. Work / visa status was either "American citizen" or "other." Time to employment ("Time_to_Job") was coded as {-3, 0, 3, 6, 9, 12, 15} to estimate (as a quantitative variable) the categories {>3 months before graduation, 0 to 3 months before graduation, >0 to 3 months after graduation, >3 months to 6 months after graduation, >6 months to 9 months after graduation, >9 months to 12 months after graduation, >12 months after graduation}, respectively. Further, the variable was collapsed to {employment before 3 months after graduation, employment later than 3 months after graduation} to evaluate as a categorical variable. Finally, respondents with Microsoft Excel Expert certification were also coded as having Excel Basic certification (a dichotomous variable), as it is a subset of skills.

Geographical Information System (GIS) Analysis. Survey response latitudes and longitudes were captured as part of the analysis. While these may not perfectly reflect the locations of the respondents' positions, a sample of 20 proved a 1:1 match for the city where their occupation was. Using these location variables, maps of satisfaction, growth, and the linear combination of the two were generated using 3D mapping in Microsoft Excel (which links to Bing mapping). This analysis is descriptive in nature only but provides interesting and logical insights.

Statistical Tests. Due to the relatively small sample size, it was not possible to build large multivariate models. Instead, we evaluated the effects of certification and associations on the dependent variables separately. While this increases Type 1 error, the study itself was preliminary, intended to generate ideas and insights for a larger-scale implementation and further faculty member collaboration on the initiative.

Welch two-sample t-tests (robust to violations of normality) were used for evaluating certifications, associations, and gender against mean job satisfaction, mean job growth, the linear combination of the two, and mean time to employment. The dependent variables were also evaluated against the number of associations via correlation.

Results

Reliability

We first evaluated the reliability of the survey items using Cronbach's alpha after reverse coding the appropriate items. For question 13 subcomponents, Cronbach's alpha was .879 with a bootstrapped 95% confidence interval of (.831, .909) after 10,000 samples. For question 14 subcomponents, Cronbach's alpha was .938 with a bootstrapped 95% confidence interval (.901, .960). Both results indicate that the survey questions are measuring their associated constructs reasonably.

Descriptive Statistics

Means, standard deviations, minimums, and maximums are shown in Table 1. The average alumnus was employed in 4 months (sd=4.5) and had mean job satisfaction of 4.4 out of 6 sd=0.67). Mean job growth potential was rated as 3.7 out of 5 (sd=0.7) for the average alumnus, and the mean linear combination of satisfaction and growth was 7.4 out of 10 (sd=1.13). Most respondents were female (64%), citizens (87%), and part of direct care organizations (68%). A large number of respondents were administrators / managers (36%). The average number of professional associations identified by respondents was .200, although many may have forgotten to include IISE, which provides the certification for LSSGB once membership is established. Nearly 35% of alumni reported LSSGB certification, with 33% reporting Excel Basic certification, 18.7% reporting Excel Expert certification, and 17.3% reporting QuickBooks certification. Statistics for individual questions from the survey are shown in Table 1.

Descriptive Graph

The boxplots for the dependent variables showed only a few outliers for job satisfaction and job growth and a large right-skew for time to employment (Appendix A-Figure 4). A hierarchical clustered correlation plot of the independent and dependent variables of primary interest showed that job growth and job satisfaction were highly correlated (r=0.92) at the a=.05 level. Surprisingly, time to employment was negatively correlated with satisfaction (r=- 0.3) and the linear combination of satisfaction and growth (r= - 0.27), both at the a=.05 level (correlation matrix not shown).

Geographic Information Systems Maps

Plots of satisfaction, growth, and the linear combination of the two revealed some interesting descriptive maps (Figures 1 through 3). Students placed in larger cities such as Austin, San Antonio, Houston, and Dallas reported higher levels of satisfaction and growth. This finding is not surprising, as larger cities typically offer more career options and possibilities, as compared to more isolated, rural locations. There are implications for placement here, as El Paso, Midland, and other outlying suburbs were associated with lower perceived satisfaction and growth by survey respondents.

Inferential Statistics

Welch two-sample t-tests confirmed no statistical significance between female and male time to employment, job satisfaction, and job growth; however, there was limited evidence (a=.10) that the linear combination of satisfaction and growth favored males ($t_{72.03}$=-1.679, p=.097, Xbar1=7.228, Xbar2=7.609). Citizenship status, organization, and job types had no bearing on any of the dependent variables. Figure 5- Appendix A depicts the distribution of satisfaction/growth via gender.

Welch t- tests of time to employment versus each of the four certifications provided strong evidence that Excel Basic certification reduced time to employment ($t_{70.5}$=2.007, p=.025, Xbar1=4.62, Xbar2=2.76) and limited evidence that Excel Expert had the same effect ($t_{36.1}$=1.314, p=.099, Xbar1=4.23, Xbar2=3.00). Lean Six Sigma and QuickBooks certifications were not statistically related to time to employment. The mean time to employment for those with Lean Six Sigma certifications was 3.35 months versus 4.44 months for those without it. Surprisingly, QuickBooks certification resulted in little difference in time to employment (4.15 vs. 4.03). Correlation analysis between time to employment and the number of associations was also insignificant. Welch t-tests revealed no statistically significant relationships between satisfaction, growth, or the combination of the two in relation to certifications or the number of associations. Figure 6- Appendix A depicts boxplots of time to employment versus certifications.

Discussion

In this exploratory study, we found three major results. First, time to employment is statistically lower for those with Excel MOS Basic (2.76 months versus 4.62 months) and Excel MOS Expert (3.0 months versus 4.23 months). This finding supports our preceptors' requests for students with Excel skills. While not statistically significant, the time to employment for those with Lean Six Sigma Green Belt certification is also lower (3.35 months versus 4.44 months). The time to hire value of certification holds up from a Human Resources Management (HRM) point of view. Competency-based interviews that link competencies to job tasks have been suggested to be highly predictive of a successful hire (Peregrin, 2014). Coincidentally, they also satisfy Joint Commission requirements for job descriptions, performance evaluations, and employee development documentation.

While QuickBooks certification does not have a meaningful statistical effect in this study, program faculty acknowledge the necessity of student exposure to an automated financial accounting software (which incorporates MS Excel spreadsheet use) as a vital addition to the program curriculum. Additionally, a low number of survey respondents with this specific certification may be due to the QuickBooks certification initially being offered as extra-credit (initially) in the financial accounting course, prior to being changed to a required course task for all enrolled students.

A secondary finding indicates that males have a higher linear combination of satisfaction and growth versus females (7.228 versus 7.609). The reason for this is unknown and may require further investigation. Since this study is exploratory, we will replicate with a larger sample in the future to see if this result remains. In addition, the potential linkage between professional certification and job satisfaction may require the application of certification-based skills on an initial hire or soon thereafter. Otherwise, there would be little contribution of certification to job satisfaction (Herzberg, 1968).

A third finding (descriptive) suggests that students placed in larger cities report higher mean levels of satisfaction and growth, while students placed in suburban areas are associated with less satisfaction and growth. This finding may just reflect that larger cities have more possibilities. Placement policies should focus more on the large metro areas subject to student-specific requirements.

Study Limitations

The study has some limitations. First, our sample size precluded the use of more robust inferential statistics such as regression that allows us to control for some confounding variables that may be associated with time to hire, job growth, and job satisfaction. Second, we used survey data that may be subject to recall and social desirability biases. Third, given our sampling frame, the results of this study are not generalizable to all BHA and MHA programs.

Additional areas for future research identified include additional mapping of certifications to job postings and position descriptions across a variety of healthcare management markets, further assessing the study variables between the graduate and undergraduate degree programs, and continuing to build upon the overall perceived value of the infusion of external certifications in program curriculum. Opportunities to continue the exploratory analysis will assist program leaders in demonstrating competency-based knowledge and skills by both program completion and external, third-party certification at the individual student level. It is also suggested that program reputation and overall marketability of program graduates be assessed long-term. Furthermore, another area for future research may consist of assessing the relationship between professional certification type and the kind of jobs that graduates obtain.

Conclusions

Recent years have demonstrated an ongoing concern surrounding higher education costs and benefits, as assessed by multiple stakeholders: students, graduates, parents, and especially employers of these graduates. Everyone involved is searching for the best value (quality over cost), yet such variables continue to be inherently latent, with many expectations and perceptions for each varying by individual (Borden & Holthaus, 2018). Higher education institutions, while changing in its delivery methods rapidly, continues to work on delivering a product that will satisfy as many stakeholders as possible (Newman, 2019; Weissman, 2019), and the infusion of external certifications into the course content and classroom experience demonstrate such initiative. However, often higher education competencies and workforce development skills (such as additional industry certifications and continuing education credits) are often viewed as separate initiatives (Kim & Tamborini, 2019).

Higher education continues to also serve as a gateway toward career development and progression for many professions. Individual motivations to attend college may vary, and the conferred degree upon completion of one's studies is still considered quite an achievement. That said, the overall value of the undergraduate education has continued to be investigated by younger generations as they are expected to pay more now, more than ever, for the same educational opportunities as their predecessors (Lobo & Burke-Smalley, 2018). Often using government (subsidized and unsubsidized) loan programs, the demonstrated burden of school debt has all higher education stakeholders continuing to question overall value.

Healthcare administration programs are professional management programs, teaching competencies required in the many sections of the healthcare industry. Ongoing societal perspective regarding the difference between 'book smarts' and 'street smarts' is often discussed by those hiring recent graduates of programs, and educational programs are constantly trying to demonstrate the relevance of course objectives, as related to the 'real world' (Witt, Sandoe, Dunlap & Leon, 2019; Caplan, 2018; Darling-Hammond, Wilhoit & Pittenger, 2014). In an attempt to further demonstrate applicability of course material to the external field, our BHA and MHA programs choose to incorporate external certifications into selected courses to help achieve this initiative in their curriculums. Healthcare Administration programs should consider incorporating appropriate certifications and assessing the value of those certifications. These considerations should include stakeholder input and value, as well as follow-on assessment of perceived effectiveness. From a HRM perspective, perceived merit (professional certifications) versus earned merit (actual job performance) are important concepts and issues to consider as hiring managers try to make these distinctions.

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Table

Table 1. Descriptive statistics

Variable (n=75)	Mean	SD	Min	Max
Aggregated Survey Scores				
Time to Employment	4.000	4.502	-3	15
Job Satisfaction	4.401	0.667	2	5
Job Growth	3.698	0.701	1	5
Satisfaction & Growth	7.365	1.131	3	9
Demographics and General Information				
Male?	0.360	0.483	0	1
Direct Care Organization?	0.680	0.470	0	1
Administrator / Manager?	0.360	0.483	0	1
Citizen?	0.867	0.342	0	1
Number of professional Associations?	0.200	0.520	0	2
Lean Six Sigma Certified?	0.347	0.479	0	1
Excel Basic Certified?	0.333	0.475	0	1
Excel Expert Certified?	0.187	0.392	0	1
QuickBooks Certified?	0.173	0.381	0	1
Time-to-Employment				
Length of time (in months) taken to obtain a job before or after graduation	4.00	4.502	-3	15
Job Satisfaction				
1. Paid fairly	4.520	1.389	1	6
2. Little promotion chance	4.284	1.419	1	6
3. Unsatisfied with benefits	4.747	1.462	1	6
4. Receive recognition	5.027	1.219	1	6
5. Job meaningless	4.973	1.262	1	6
6. Infrequent raises	3.667	1.417	1	6
7. Fair chance promotion	4.440	1.211	1	6
8. Fair benefits	4.613	1.365	1	6
9. Feel unappreciated at work	4.800	1.305	1	6
10. Efforts seldom blocked	3.067	1.464	1	6
11. Like Work	4.720	1.279	1	6
12. Unappreciated due to pay	4.487	1.435	1	6
13. Equitable benefits	4.581	1.346	1	6

Variable (n=75)	Mean	SD	Min	Max
14. Few employee reward	4.351	1.278	1	6
15.Too much work	3.548	1.507	1	6
16. Feel a sense of pride	4.917	1.148	1	6
17. Some benefits not provided	4.082	1.592	1	6
18. Too much paperwork	4.137	1.527	1	6
19. Efforts not rewarded	4.370	1.380	1	6
20. Satisfied with promotion chance	4.176	1.329	1	6
21. Proactive in self-improvement	5.356	0.812	3	6
22. Satisfied with chances for salary increase	4.095	1.347	1	6
23. Promotion as fast as elsewhere	3.438	1.335	1	6
24. Deliberate in seeking out opportunities	4.838	0.930	3	6
25. Job is enjoyable	4.784	1.189	1	6
Career Growth				
1. Job helps career goals	4.014	0.966	1	5
2. Job Relevant to career goals and growth	4.073	0.920	1	5
3. Present job sets foundation for career goals realization	4.000	0.930	1	5
4. Preset job provides good opportunities to realize career goals	4.103	0.856	1	5
5. Present job encourages development work skills	4.177	0.869	1	5
6. Present job encourages work knowledge development	4.279	0.836	1	5
7. Present job encourages accumulation of richer work experience	4.191	0.793	1	5
8. Present job continuously improves professional capabilities	4.191	0.889	1	5
9. Present job offers fast promotion	3.088	1.049	1	5
10. Present job promotion probability is high	3.456	1.032	1	5
11. Present position is ideal	3.764	0.902	1	5
12. Being promoted faster compared with colleagues	3.132	1.102	1	5
13. Salary growing quickly	2.895	1.080	1	5
14. Present job has high probability of salary increase	3.264	1.122	1	5
15. Salary grows faster that colleagues’	2.835	1.085	1	5

Statistics based on reversed coding where appropriate.

Figures

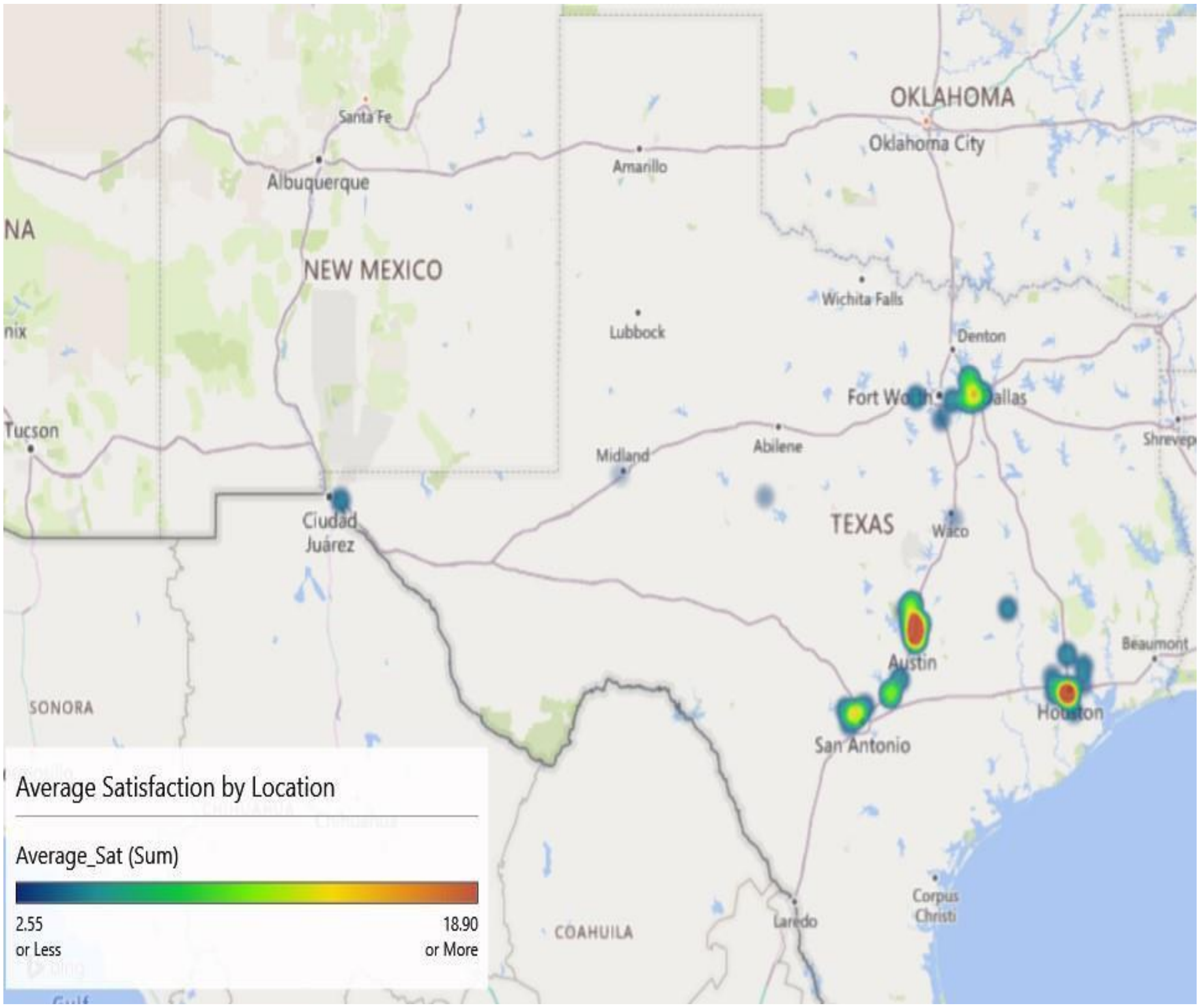

Figure 1. Mean satisfaction by location

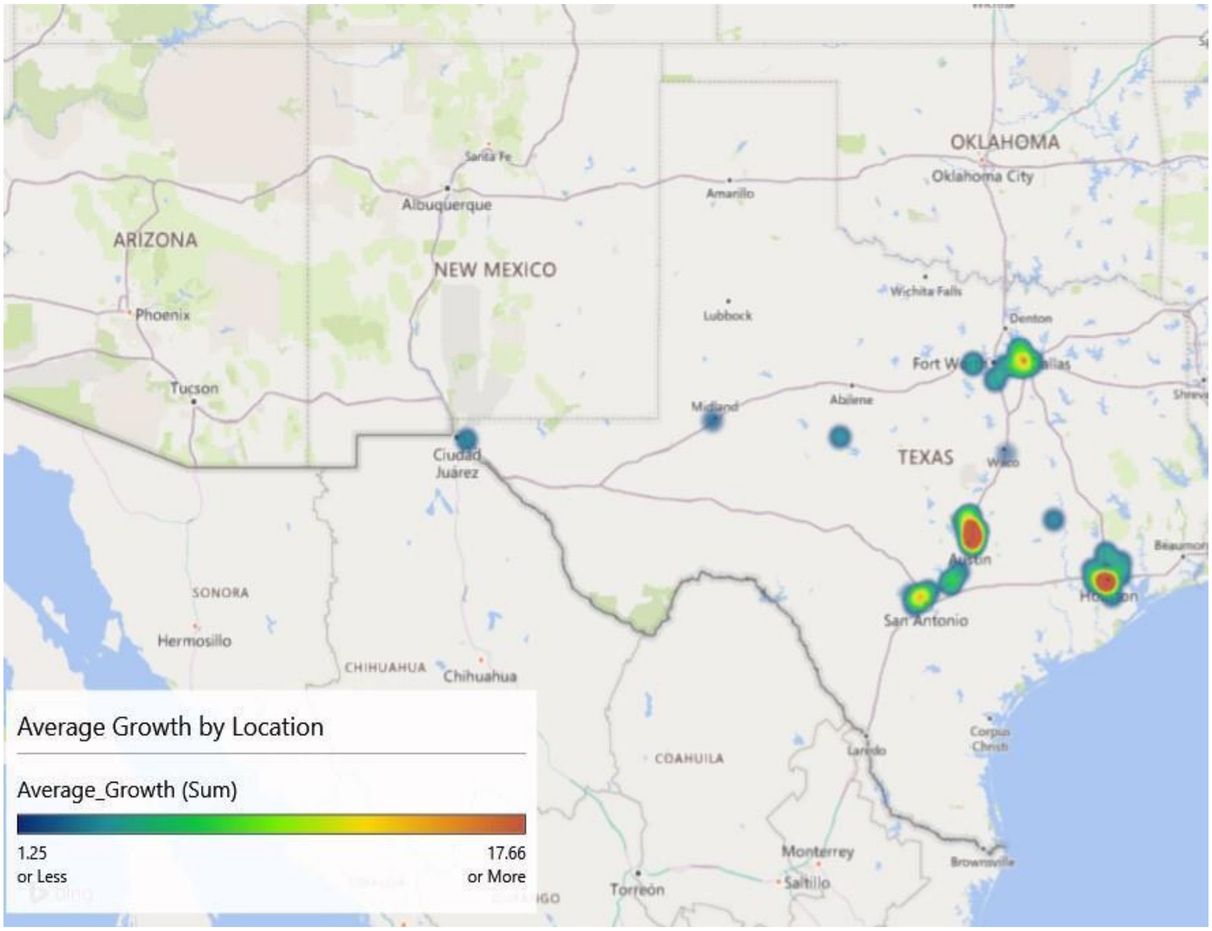

Figure 2. Mean growth by location

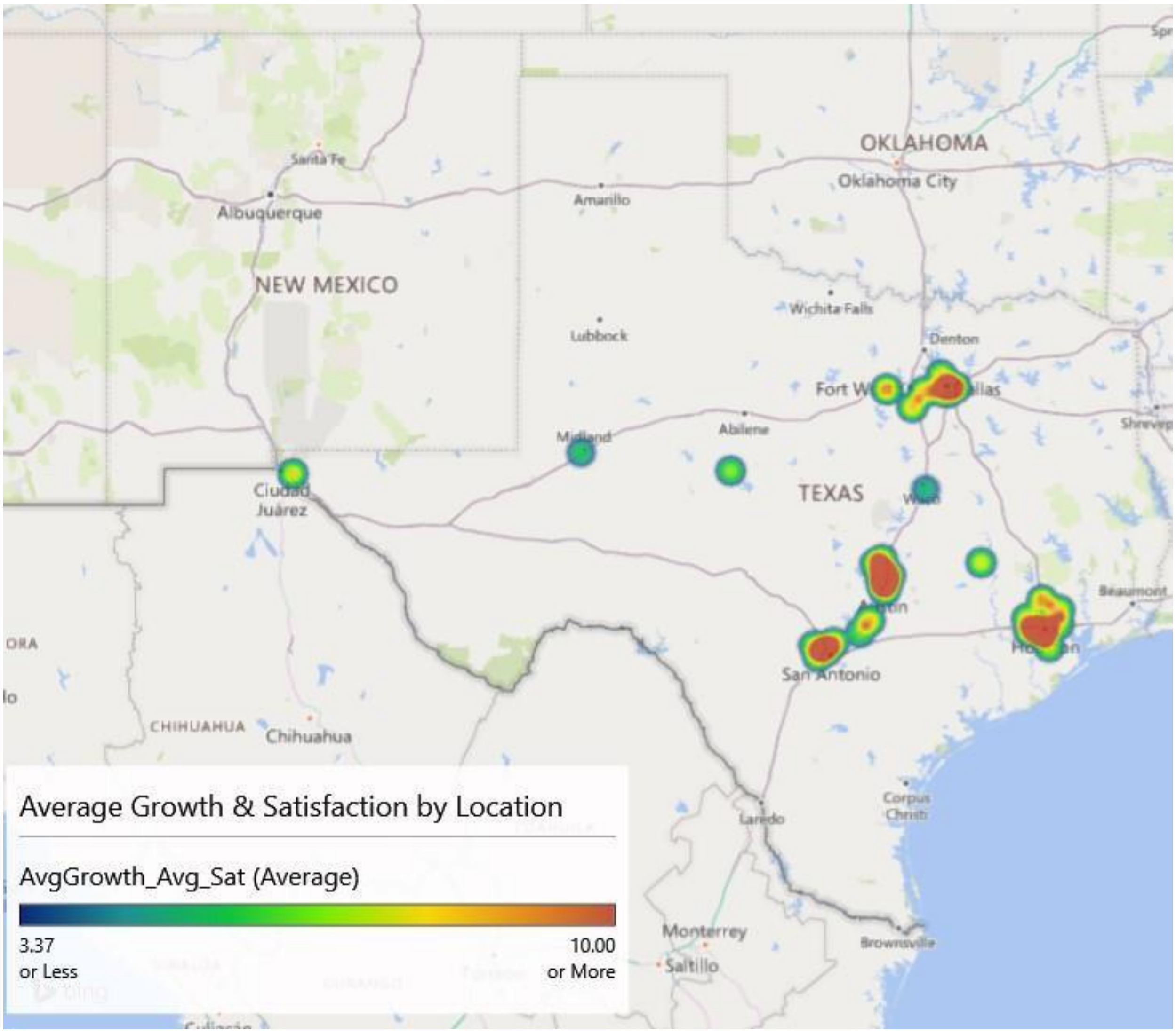

Figure 3. Mean of the linear combination of growth and satisfaction by location

Appendix A

Table 2. Survey questions data type

Variable	Definition	Type
Mean Job Satisfaction	Mean of Table 1 Questions, {0, 1, …6}	Quantitative
Mean Job Growth	Mean of Table 1 Questions, {0, 1, …5}	Quantitative
Mean Job Sat. & Growth	5/6 x Mean Job Satisfaction + Mean Job Growth	Quantitative
Time to Employment	Re-coded Categorical Variable	Qualitative
Latitude	Latitude where survey was taken	Quantitative
Longitude	Longitude where survey was taken	Quantitative
Organization Type	{Corp., Gov't, Hospital, University, Group Practice, Other}	Qualitative
Work Visa Status	{American Citizen, Other}	Qualitative
Any Association	{1=belongs to professional associations, 0=otherwise}	Qualitative
Lean Six Sigma	{1=Certified, 0 = Not Certified}	Qualitative
Excel Basic	{1=Certified, 0 = Not Certified}	Qualitative
Excel Expert	{1=Certified, 0 = Not Certified}	Qualitative
QuickBooks	{1=Certified, 0 = Not Certified}	Qualitative

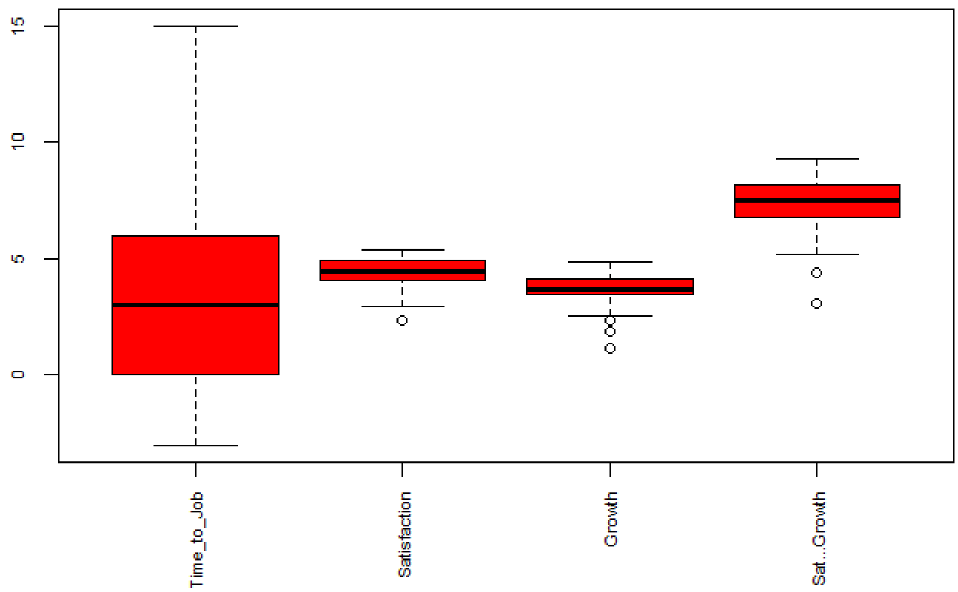

Figure 4. Boxplots of dependent variables

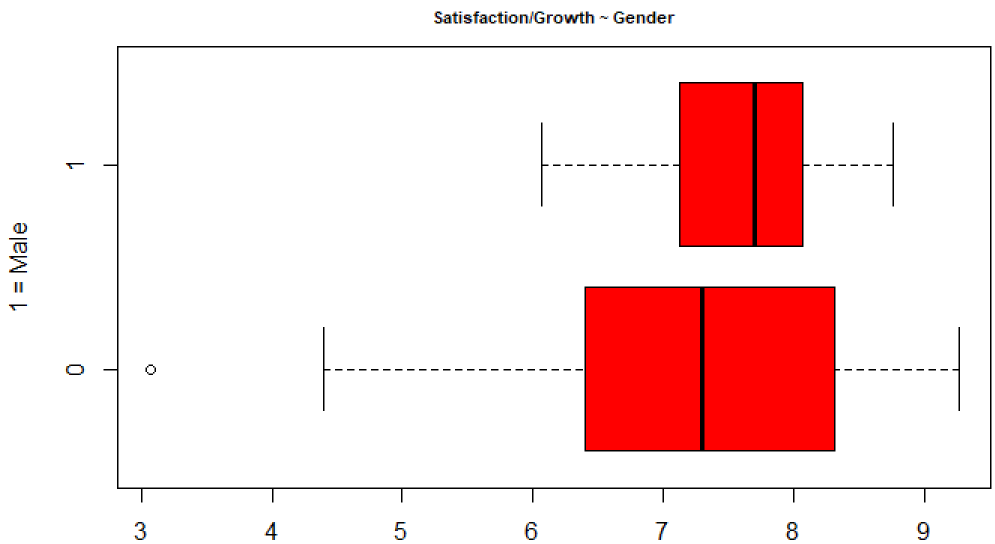

Figure 5. The linear combination of job satisfaction and job growth scores (x-axis) by gender (y-axis)

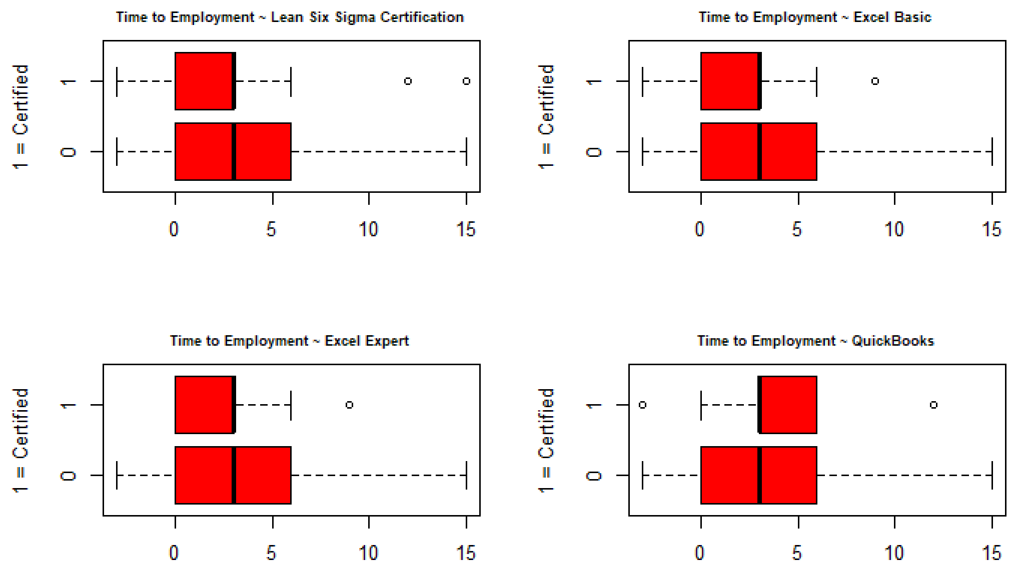

Figure 6. Time to Employment (x- axis) by certification status (y-axis) for Lean Six Sigma Green Belt Certification (upper left), Excel Basic (upper right), Excel Expert (lower left), and QuickBooks (lower right)

Bio-modification of Rubberized Asphalt for Road Construction

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Abstract

Application of recycled rubber in pavement construction can significantly enhance its sustainability and long-term performance. However, it has been documented that rubber particles have tendency to segregate from asphalt binder matrix. There have been many attempts to reduce the segregation issue. It has been shown that microwave-irradiation of crumb rubber can enhance interaction of rubber with asphalt binder leading to an improved storage stability. This study examines the merits of surface activation of rubber using various bio-oils to improve rubber-asphalt interaction. To do so a hybrid method combining microwave irradiation and bio-chemical treatment was used to graft biomolecules onto the exterior surface of the rubber. Five surface activated rubbers were prepared using waste vegetable oil, wood pellet, miscanthus, corn stover, and castor oil. The effectiveness of each oil was examined by measuring the chemisorption of the bio-oil and elastic recovery of bitumen containing rubber particles treated with each bio-oil. Our quantum-based density functional theory calculations showed presence of both physical and chemical interactions between polar aromatic components of bio-oils and rubber. Among studied bio-oils, wood-based bio-oil found to have the highest content of polar aromatics such as phenolic resins leading to its enhanced interaction with rubber. This was evidenced in percent recovery, which was nearly doubled (from 13% to 24%) when wood-based bio-oil molecules were grafted onto the surface of rubber. Overall, wood-based bio-oil was shown to adsorb well to the rubber surface and reduce its tendency to separate from bitumen by 82%. The study results showed how composition of bio-oil affects its efficacy to activate rubber surface. It also proved the technical merits of using surface activated rubber to reduce segregation between rubber and bitumen which commonly occurs in rubberized asphalt. Therefore, the outcome of this study promotes recycling of waste tire to promote sustainability in pavement construction.

Connectedness and Consumers' Vices vs. Virtues Choices

Ruby Saine, Miao Zhao
Roger Williams University, Mario J. Gabelli School of Business

Abstract

Consumers' perceived (dis)connectedness has been associate with unhealthy consumption of vices and obesity in our society. In the present research, we are interested in exploring whether or not different forms of perceived (dis)connectedness have varying effects on individuals' choice of virtues vs. vices in general. The different forms of perceived (dis)connectedness can derive from an absence of a wide social network that an individual desires or an absence of an intimate partner. Our approach departs from previous literature that may fail to consider the unique needs and motivations engendered by different forms of the phenomenon. In our presentation, we will share the testing results of the series of experimental design studies that we have conducted. Our research has significant implications to consumer decision making on virtues vs. vices, public health, and marketing campaigns.

Consumers Confused by Certification Labels - a Chasm on the Road to Informed Consumerism

Gayatree Siddhanta, Michelle Nelson
Linfield College
Craig Ostbo
Koopman Ostbo Marketing Communications

Abstract

In the area of sustainable consumption and production (SCP), product certification plays an important role. Corporations consider these certifications as a part of one of the three pillars of sustainability, viz. environmental sustainability. Sustainable consumption -oriented consumers looks for certification on labels in order to make an informed and responsible consumption decision. But in the absence of a discernible and recognizable labeling system, particularly with consumer products, there prevails a sense perplexity and confusion. Consumers perceive certification as an indicator of product quality but often fail to distinguish between their sustainable qualities. Research indicates that green labels (eco-labels) are significant enablers for consumers willing to pay more for a sustainable product; (Xu, et al. 2012) and that consciousness of the consumers about green appearance is driven by their consciousness of presence of ecological labels and certifications. (Paraschos, 2016) If the idea of a business is to create differentiation through sustainable sourcing, production and distribution, it must be conveyed to the potential consumers clearly and effectively. Based on multiple consumer interviews and literature review, the authors contend that both corporations and certifying agencies have a greater responsibility to disseminate public information and use certification as a communication tool to create informed consumerism in a $15.5 billion dollar industry.

Xu, Pei, et al. “Chinese Consumers’ Willingness to Pay for Green- and Eco-Labeled Seafood.” *Food Control*, vol. 28, no. 1, 2012, pp. 74–82., doi:10.1016/j.foodcont.2012.04.008.

Maniatis, Paraschos. “Investigating Factors Influencing Consumer Decision-Making While Choosing Green Products.” *Journal of Cleaner Production*, vol. 132, 2016, pp. 215–228., doi:10.1016/j.jclepro.2015.02.067.

Country Conditions: Examples of Asylum Cases in the U.S.

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Abstract

This paper addresses the issues that are discussed in the courts when there is a hearing for the people that are seeking asylum in the U.S. The paper discusses the responsibilities of the individuals that are considered "country conditions experts". A country conditions expert puts together a report for the court that includes the condition of the countries of the asylum seekers, verifying and validating their stories versus the conditions of the country in question, and provides a report to the court. This paper depicts several real-life cases that the author has been assigned to produce the country conditions report for the asylum seekers that have been deliberated in the U.S. courts.

Cross-Cultural Education: Storytelling

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Introduction

The Organization for Economic Co-operation and Development (OECD) is currently working on a measurement tool designed to assess Global Competency as part of the PISA 2018 (Program for International Student Assessment). This survey is administrated every three years to 15-year old pupils in around 80 countries (OECD, 2016). This new initiative should serve as a reminder that at the tertiary education level, globally minded business schools should ever more strive to fulfil their mission of preparing students with the appropriate knowledge, skills, attitudes, and values to operate effectively in a complex global environment.

Both AACSB (2016) and EQUIS (2016) accreditation frameworks require business schools to develop “intercultural sensitivity”. In addition, businesses are increasingly seeking workready graduates trained to answer the needs of a global work environment and economy.

EM Strasbourg Business School (University of Strasbourg, France) has long placed a strong emphasis on its students’ global competency and intercultural sensitivity through long-term mobility by offering one-year study abroad exchange programs to all students as early as 1994. This commitment to extending cross-cultural education to all has given rise to network partnerships for dual-degree programs. The latest is a multi-university dual-degree program, which was launched in December 2013 and is called SCRIBE 21 (Sustainable Regional Advantages in International Business for EU-- in the 21st Century).

This partnership has brought together EM Strasbourg Business School in France, the University of Adelaide and the University of Western Australia in Australia, the Corvinus University in Hungary, and Ca’ Foscari University in Italy. It is jointly funded by the European Commission’s Industrialized Countries Instrument -Education Cooperation Program (ICI-ECP), and the Australian government. Its overarching purpose is to enhance students’ cross-cultural professional competencies and to create business synergies between Europe and Australia in the 21st century.

SCRIBE 21 features a one-year study-abroad exchange period complete with three International Intensive Weeks and a three-month professional internship. The three International Week sessions focus on enhancing students’ cultural understanding and self-discovery.

As part of the final International Intensive Week for the second SCRIBE 21 cohort (17 students), which took place in Perth, Australia, in January 2017, I ran a two-hour workshop entitled “Distinctive Expat Stories – Storytelling your Way through Job Interviews”. The specific approach to the workshop was a response to requests by the organizers to focus on culture and employability.

Workshop Design and Dynamics

The workshop aimed to test a new approach to assist students to utilize their cross-cultural and self-discovery acquired knowledge to better communicate in a global work environment. To achieve this goal, the workshop was based on two main foundations:

1. Guiding students (Deardoff, 2011) to clearly describe their overseas learning experiences and how such experiences can enhance their employability across diverse cultures.
2. How connotative narrative structures can be efficiently used to allow both decoding and encoding of cultural and personal messages.

From metaphors to full-blown literary works, connotative narrative structures can assist students to develop their own understanding of foreign cultures and to utilize their acquired narrative competency for job-searching purposes. Specifically, metaphors are imagery-based narrative structures that rely on connotation to provide concrete representations of abstract ideas. Similarly, fables, literary and tribal myths as well as literature in general -if taken as a representation of worldviews- rely on connotative narrative structures.

Lakoff and Johnson (2003) argued, “human *thought processes* are largely metaphorical”. (Carpenter, et al., 2012) contended that metaphors are “an effective creative strategy for learning about the unknown and gaining a perspective on it”. As a result, this central mental mechanism is often relied upon as a creative learning tool in university courses across all disciplines.

In this workshop, the concepts lending themselves to explanations based on metaphorical constructs were foreign cultures. Gannon (2004) resorted to the heuristic power of cultural metaphors for “understanding easily and quickly” foreign cultures and cultural paradoxes to better understand intrinsic differences.

Since metaphors only highlight certain sets of cultural features while ignoring some others, metaphorical associations are open-ended and malleable. Reporting on application exercises for management students and practitioners, Gannon (2011) stated, “a metaphor is only as good as the value it creates in providing new insights and increased understanding”. For instance, he himself put forth two metaphors for China (the Family Altar and the Great Wall) and developed one common metaphor, with variations to the theme, for two different cultures (the Spanish and the Portuguese Bullfight).

The wide explanatory and interpretative potentials of cultural metaphors is further highlighted in the questions that Gannon provided at the end of his paper (2011). The questions are designed to prompt students to:

1. Discuss the relevance of the proposed metaphors;
2. Produce their own alternative metaphors for their home countries; 3. Imagine what metaphors foreigners may associate to their countries.

In allowing for different cross-cultural viewpoints, cultural metaphors undoubtedly provide a powerful learning tool. Exercises on cultural metaphors in addition to complementary practice on cultural dimensions (Hall, 1990; Hofstede, 2010) have been extensively utilized in management courses to increase students’ awareness of cross-cultural issues in the field of management (Altman et al., 2012).

Moving beyond metaphors, the workshop added a literary dimension to the cross-cultural investigation developed through Gannon’s cultural metaphors. Literature is sometimes used as a compelling means to teach the fundamentals of leadership (Badaracco, 2006). My workshop relied on the idea that well-selected, full-blown literary works can also help to identify enduring cultural traits and to provide inspiring models for students to shape and enrich their job-searching communication.

Given my own familiarity with French and English language literatures, I selected literary works originally written in French and English. I considered that two fables by 17th century writer Jean de La Fontaine, “The Funeral of the Lioness” and “The Cicada and the Ant” (1668), would provide a fit framework enabling students to understand the high levels of “Power Distance” and “Uncertainty Avoidance” in Hofstede’s surveys. I also referred to a part-fiction, part-documentary novel by British travel writer and novelist Bruce Chatwin, *The Songlines* (1987). The book offers an insightful approach to Australian Aboriginal thinking as well as a compelling philosophical enquiry into the nomadic streak in human kind.

In order to allow for full participation, readings and handouts were sent to the students prior to the workshop. In the first part of the workshop, the seventeen participants were divided into three bi-national groups based on their home/host country exchange situation. The groups were required to negotiate their understanding of the home/host country’s cultural specificities with a view to producing an alternative cultural metaphor based on Gannon’s book.

Having established this metaphorical ground, the students were then asked to individually track some red lines, which they were not ready to cross, in terms of “Power Distance” and “Uncertainty Avoidance”, the two main dimensions exemplified in La Fontaine’s fables.

In the second part of the workshop, the students practiced communicating on their newly enhanced cross-cultural skills and attitudes. To this end, they were reminded of the basic components and core structure of professional stories. In addition, some overarching cross-cultural skills were highlighted (e.g. code switching and resilience) in order to avoid disorderly lists of soft skills and lack of focus and consistency.

One last area for further investigation involved taking a cue from the Australian Aboriginal ‘tjuringa’, as described in the second literary artefact selected for the workshop: “an oval ended plaque, carved from stone or mulga wood and covered with patterns which represented the wanderings of its owner's Dreamtime Ancestor”. The students were asked to think of their own ‘tjuringa’, the knowledge associated with their journeys across countries and spaces and with the new mental paths criss-crossing their global minds.

Conclusions

SCRIBE 21 is a selective program through which students face challenging mobility experiences (Jones et al., 2016). In my workshop, the students all performed the required pre workshop assignments and demonstrated strong engagement and creativity. At the end of the session, they all felt better equipped to produce creative and consistent narratives about their individual cross-cultural experiences. They better understood how structure and insight was key to effective communication about their experiences overseas. The focus of the workshop on communication therefore addressed a two-fold need among students:

1. To bridge the gap between their theoretical knowledge of cultures and cross cultural interactions and their actual experience of cross-cultural challenges;
2. To communicate in an individually distinctive manner in order to enjoy higher credibility as global thinkers and doers.

Interestingly, through one of the workshop discussions, participants came to the realization that they did not simply have to adapt to their host country's culture, but to increasingly international campus environments. This is an undisputable fact of today's academia that needs to be further taken into account in study-abroad programs. Lastly, using connotative narrative structures as a catalyst for communication is particularly appropriate for students for whom storytelling techniques are not integral to mainstream professional communication in their home countries.

Evidently, cross-cultural awareness and competence is an on-going process. The connotative narrative approach provides a fit medium for progressive training over the whole duration of extended global programs. Students could thus be better empowered to see their stories evolve as their cross-cultural knowledge and competencies are further enhanced. Such personal progress should undoubtedly be evaluated at regular intervals and not only on a one off basis. This could bolster collaboration for course design and research between participating universities.

In sum, connotative narrative structures are useful in generating insightful interpretations that prompt students' reflective thinking and enhance their communication skills. Such learning and teaching tools should be appropriately utilized to assess two related aspects of study abroad learning outcomes, creative reflective thinking and reflective verbal communication.

Acknowledgements

This work was supported by the EU-Australia-funded SCRIBE 21 program (Sustainable Regional Advantages in International Business for EU-Australasia in the 21st Century).

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Personality and Organizational Identification on Employee CSR Participation

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Project Description

Corporate Social Responsibility is considered an effective way to balance what a company needs and what its consumers expect from that company. Lerro, Caracciolo, Vecchio, and Cembalo (2018) find that consumers' perspectives must be considered when making choices on socially responsible actions, partially because many consider CSR activities in their everyday purchasing decisions. When companies use CSR techniques, it positively affects them as well because research has shown that they gain brand loyalty and long-term relationships from their customers. Hong, et al. (2010), found that when companies engage in CSR initiatives, consumers are likely to assume that the companies have desirable characteristics. Therefore, CSR is positively affects companies because it makes their public see them in a positive way. Elhergeni, et al (2018), concluded that voluntary CSR leads to mandatory CSR. Mandatory CSR comes out of what was learned from voluntary CSR and then becomes required by companies for the future benefits they will receive.

CSR activities attempt to benefit the community, however, the community is often skeptical of the CSR activities. CSR messages need to increase credibility. This is because there are two types of perceived motives for a company's CSR activities, as described by Change and Lee (2019). The two types are public-serving and self-serving. When the community sees the company as having publicserving motives, they will support the company and their CSR efforts. Their findings show that it sometimes isn't enough to simply partake in CSR activities, but the companies need to post and engage with CSR messages and images for the community.

According to Njite, Hancer, and Slevitch (2011), CSR is linked to the belief that acting as a responsible organization leads to profitability and good business. Some examples of CSR are financing employee education, adopting environmentally friendly programs, and the sponsorship of community events. Social responsibility is a major factor and motivation for large businesses participating in the welfare of society. They found that other motivating factors are business commercial benefits, employee benefits, and perceived obligation or "moral duty." However, they also say that the main motivation for small businesses engaging in community action is the "concern for cause". In order for CSR to be successful, it needs an enabling environment.

Previous research on CSR has emphasized the importance of similarity between organizationaland personal values in CSR engagement by embedding its principles and practice in an employee'sheart and mind Seunghee, Chung & Yang (2017). In particular, it has been found that congruencebetween employees' CSR values and their organization's CSR values is associated with employees'quality of work life (ibid). Organizational identification is defined as the extent to which a person senses oneness or sameness with an organization. Furtermore, there is a significant relationship between CSR activities and organizational identification (Brammer, He, & Mellahi, 2015). Specifically CSR participation is shown to be a powerful tool in enhancing employees awarness of their organization's desired behavior. Generally, people who are actively involved in an organization tend to identify more with their organization. In the current study we will examine whether and to what extent participants' likelihood of participation in corporate Employee CSR activites will change based on the type of activity, personality type and organizational identification.

Participants

Recruited of 200 participants will be through Mechanical Turk. Each participant will be randomly assigned to one of three conditions via the Online system. Participants will be compensated with .20 cents after the completion of the entire survey.

Procedures

Participants will be informed that they will be involved in a study exploring various demographic characteristics, personality traits, and attitudes towards participating in company CSR. After obtaining informed consent, participants will begin the survey. Participation in an Online survey will take approximately 15 minutes. Participants will begin by answering questions regarding their current knowledge about what CSR is and their feelings towards it. Next, they will answer questions regarding personality type. They then will read a fictional description of a company and their CSR efforts and read one of three emails that ask for a form of personal donation (time/money/ both), from the view of an employee and will answer a series of questions related to the previous reading. Then respondants will be presented with questions to gauge their organizational identification and finish with demographic questions. Following the completion of the survey, all participants will be thanked for their participation and debriefed.

Proposed Analysis

We will be assessing personality through the TIPI, a 10-item measure of the Big Five (or Five-Factor
Model) personality dimensions: (1) Extroversion, (2) Agreeableness, (3) Conscientiousness, (4) Emotional Stability, and (5) Openness to Experience. Items are rated on a scale from 1, disagree strongly, to 7, agree strongly. Scales to determine the participants attitudes towards CSR before reading the manipulation come from Turker (2009) with items are rated on a scale from 1, disagree strongly, to 5, agree strongly. Lastly, scales from Toliver (2013) comprise the measures for organizational identification. We expect to find that the participants with a high organizational identification will be rated higher for giving time and money to CSR actives, and those scoring high on the personality test for conscientiousness will be rated higher for volunteering time.

Consent Procedures, Data Confidentiality, and Anonymity

This study will follow the guidelines set by the American Psychological Association. The participants will be fully informed of the procedures, and told that they may discontinue their participation at any time without prejudice or penalty. Potential participants will be informed that their data will remain confidential, should they decide to participate. Data will be collected in such a way that no one, other than the researchers, will have access to the responses of the participants of the study. This will insure full confidentiality. In addition, any identifying information will be separated from responses; thus, insuring anonymity. Consistent with the guidelines of the American Psychological Association, data will be stored on the computer in the office of the faculty member serving as principal investigator at least five years after the date of a potential publication.

Risks/Discomfort and Benefits to the Participants

It is believed that participants should experience no risks or discomforts. A potential benefit is that, based on the completion of the questionnaires, participants may come to have a better understanding of communication research.

Rebuilding Food Supply Chain with Introducing Decentralized Credit Mechanism

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Abstract

Although the trust mechanism for agricultural product transactions has systems and laws to endorse the contract, this kind of "credit relationship" and security mechanism lack sufficient trust. Currently, the design of the RFID traceability system is used to solve the problem of data reading, but situation such as data can be tampered with and problem of data security exist. Blockchain is a distributed, shared and encrypted database. Through distributed accounting, a decentralized credit system is established to enhance data security, which is a new mode to save time and costs.In this paper, On the basis of systematically sorting out the focal points and problems of food supply chain system, reanalyzes the framework of traditional food supply chain systems. Moreover, after analyzing the characteristics the blockchain technology, a decentralized credit mechanism of food supply chain is proposed. Furthermore, the traceability of agricultural products based on the blockchain can realize fast and secure authentication permissions and achieve data security in which data cannot be tampered with or forged from anti-counterfeiting, and information privacy is protected.

Introduction

One of the causes of frequent food safety incidents is the lack of integrity of food producers and operators, and there is information asymmetry among producers, government agencies and consumers, which leads to trust problems of both parties in the transaction. For this reason, the construction of a social credit system regarding food safety must be accelerated. Food safety application refers to the process of food production, processing, transportation and marketing, and explicit or implicit contracts are established between various relevant stakeholders. The contract reflects the claims and commitments of food safety among different relevant stakeholders (Chen et al., 2015). View from the concept, we can find out that the main segments of food supply chain include production, processing, distribution, consumption, and etc. During the process, food manufacturers, processors, distributors, operators and consumers form mutually unknown stakeholders and all of them are in pursuit of the maximization of self-interest (Johnson-Hall, Tracy., 2017).

Based on various policies and systems, laws and regulations, religions, values, customs, business practices, and so on, the economic relations under the market economy is formed so as to complete food transactions. To ensure the fair and just operation of the market economy, the information has to be complete, while information in the actual food supply chain is usually not completely, leading to various food safety problems accordingly (Koufteros, 2017). Therefore, a complete and effective food safety credit system is an important measure to solve economic activities of food safety. It mainly includes the establishment of food safety traceability in its full life cycle, establishment of corporate credit files, evaluation of credit grades, disclosure of food safety incidents or credit ratings, awards and punishments to related companies, which as indicated in Figure 1.

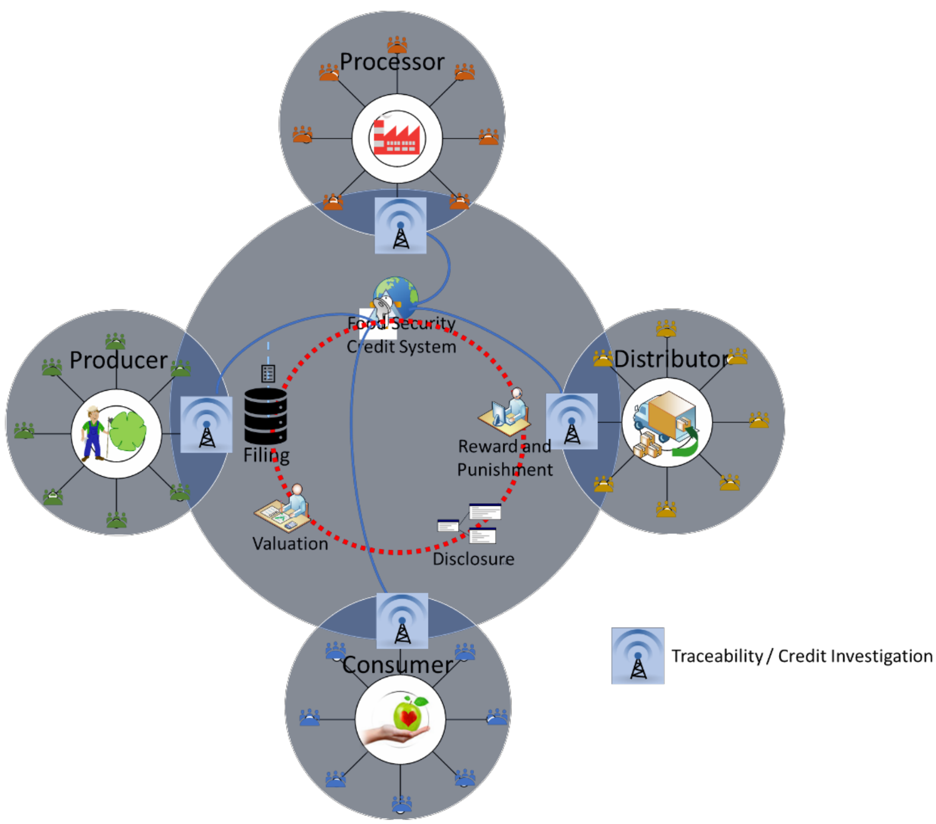

Figure 1. The Security Credit System in Food Supply Chain

Preceding Studies of Security System within Food Supply Chain

Lu et al. (2017) proposed that the establishment of an information system of food safety is the foundation and core of the construction of a credit system, which mainly includes credit subjects, credit activities, and credit system. Furthermore, the maturity of the credit environment and the soundness of the legal system are also crucial. Abiyev et al. (2018) proposed that to promote the healthy and sustainable development of the ecological economy and society and to ensure food safety, an effective way is to accelerate the construction of a food safety credit system. By doing so the credit crisis in the food industry is eliminated.

Allen et al. (2019) investigated the construction of evaluation model of food safety credit, established a three-level evaluation index regarding the causes of changes in food safety credit problems, and tested the effectiveness and reliability of the evaluation index. Navarrete et al. (2016) proposed a framework of food safety credit system, which mainly includes eight aspects: working mechanism, text system, management system, information collection and disclosure, evaluation system, self-discipline mechanism, publicity and cultural construction, reward and punishment mechanism.

On the other hand, in the research of food supply chain information system, Kasten, Joseph. (2019) proposed a food safety traceability system based on blockchain technology to solve the problem of information asymmetry among government, producers and consumers.

From the perspective of information ecology, George, et al. (2019) made functional design and information chain process reengineering and combined with the principles of blockchain to build a theoretical framework model. By exploring key standards and technologies of food traceability, Kamble, et al. (2020), using the alliance chain model and the platform of hyperledger, established a food safety traceability system based on the Internet of Things and blockchain.

From the perspective of information asymmetry, Krzyzanowski, et al. (2019) analysed the causes of food risks and explored the application of blockchain technology in the social co-governance system of food safety. In terms of engineering practice, Wal-Mart, Tsinghua University, and IBM jointly launched a scientific research project on the application of blockchain for food blockchain traceability in September 2016, using mango as an experimental target in the United States and pork as an experimental target in China (Kim, et al., 2018).

In December 2017, the first safe food blockchain traceability alliance of China was established to further strengthen food tracking, the cooperation of traceability and security through blockchain technology (Zhao, et al., 2019). The practical results show that it is technically feasible, but large-scale application is still constrained by the quality of traceability information, the willingness of the subject to participate and the cost of technological development.

We can find out from the above-mentioned review of literature that scholars and engineering practitioners have conducted theoretical and practical research on the safety system of food supply chain in a certain aspect. However, the credit problem in the aspect of food safety caused by the information asymmetry regarding combining food supply chain and credit system of food safety has not been completely solved.

For this reason, based on the study of the theory of food supply chain and food safety credit system, the information platform of food safety credit is designed by using the principle of blockchain and information technology, which integrates food supply chain traceability and food safety credit system and is helpful to solve various food safety problems caused by asymmetric information in food safety.

Basic characteristics and functions of blockchain

Blockchain is a decentralized and distributed database, which has the characteristics of being decentralized, untamperable, no need of trust , and programmable for collective maintenance. With blockchain, people who do not know each other and have no basis of trust will build trust and solve the trust issues caused by information asymmetry in the field of food safety with low cost and high efficiency (Kittipanya-ngam, 2020).

Blockchain, which originated from Bitcoin, was proposed in Satoshi Nakamoto's white paper in 2008 as a combination of innovative application model of computer technologies such as distributed systems, peerto-peer networks, consensus algorithms, encryption algorithms and so on, and it has the following characteristics:

I. It is decentralized. On the basis of P2P model, the process of verification, accounting, storage, maintenance, and transmission of blockchain data use mathematical methods instead of central institutions to establish the trust relationships between nodes, thereby forming a decentralized and trusted distributed system.

II. It cannot be tampered with. Asymmetric cryptography is adopted to encrypt the data, and consensus algorithms is used to ensure that the data cannot be tampered with or forged.

III. No trust is required. Data exchange between nodes uses an open and transparent algorithm, and all the client nodes can exchange data in a trusted environment. In the entire transaction, credit ratings of human are not required, and it is completely dependent on the trusts of machines. Intervention of human does not work.

IV. It is maintained collectively. With the consensus algorithm mechanism, specific nodes are selected to join the blockchain, and incentive algorithms is adopted to ensure that all the nodes in the distribution can participate in the transaction verification process of data blocks.

V. It is programmable, providing a flexible script code system to achieve flexible transaction control, which is the basis of flexible programming and data operation in the blockchain system and supports users to create advanced smart contracts or other decentralized applications.

According to different application scenarios, user needs and node participation methods, the blockchain mainly can be categorized as three types: public chain, private chain, and alliance chain.

The public chain is a completely open blockchain. Anyone can participate in the maintenance operations as a node in the network. The interconnection between nodes is flat, and no centralized server node is located in the network. Each node can participate in the reading / writing transactions and consensus achievement of data on the chain.

In the private chain, the write permission of each node is controlled within an organization, and the read permission can be selectively opened to the outside according to specific conditions. There is a high degree of trust between nodes, and each node is not required to verify transactions.

The alliance chain is not completely decentralized, but it is a kind of multi-centralization or partial centralization. It can join and withdraw only after authorization. The consensus process is controlled by certain designated nodes, and each institution or organization forms a stakeholder alliance, jointly maintains operations of the blockchain.

Application of Blockchain Technology in the Construction of Food Supply Chain Security Credit System

From the perspective of the concept and characteristics of the blockchain, there are better solutions for the problems to be solved in the construction of a food safety credit system. According to the current situations of building food safety credit system and the development of blockchain technology, it is concluded that there are three main application modes.

I. Decentralized mode. With using existing food safety traceability information systems, credit information systems, credit archive systems, credit evaluation, disclosure, and joint reward and punishment systems etc. by different stakeholders from business scenarios. There is no need to repeatedly build the system, the upgrade is easy, the cost is relatively small, and the original system is easy to transform, based on extracting data from these systems and transmitting them to a public or private blockchain.

II. Connected mode. With using blockchain technology to upgrade and reform the food safety traceability information system, credit information system, credit archive system, credit evaluation, disclosure, reward and punishment systems that have been established by different stakeholders. Between different blockchains, side-chain technology is used to link and confirm data. Upgrading is more difficult, and data exchange between chains is further complicate.

III. Associated mode. without the need for the project owner to develop or upgrade the food safety traceability information system, credit information system, credit archive system, credit evaluation, disclosure, and joint reward and punishment system in accordance with the technical specifications of the alliance blockchain, and to establish a unified food safety credit chain system. System technical standards and specifications are unified, and future system upgrades have strong expansion capabilities, which is conducive to comprehensively promoting the information construction of the food safety system.

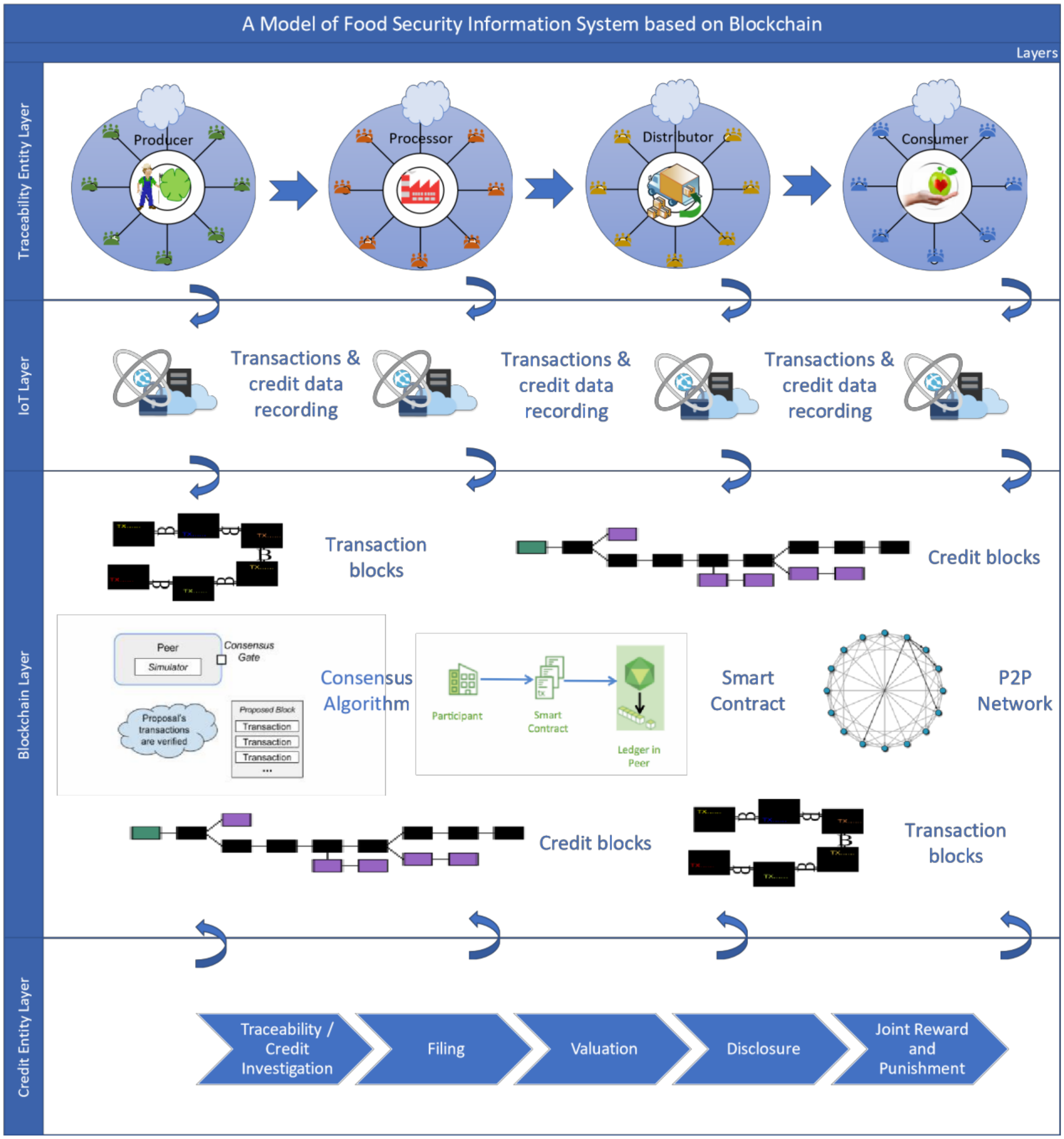

Figure 2. The Model of Credit Security System of Food Supply Chain based on Blockchain

From the analysis of the above three modes, combined with the current development of the food safety information system, the application scenarios and needs of stakeholders in the food supply chain, as well as the development trend of blockchain technology, problems of informatization of food safety credit system should be solved with alliance blockchain technology.

A Model of Blockchain in the Formation of Food Safety Credit System

In the food supply chain and food credit information supervision process, food manufacturers, processors, distributors, operators, consumers, governments, media, banks and credit agencies are all designated nodes that should be authorized to jointly maintain the credit information such as daily traceability data, transaction data, and credit information data. That would improve system scalability and execution efficiency, and the technical scheme of the alliance blockchain will be more applicable. A food safety credit system model based on the alliance blockchain is shown in Figure 2.

The system model is mainly divided into four layers: Traceability entity layer, Internet of Things (IoT) layer, blockchain and the credit entity layers. The traceability entity layer is the main segment of the food supply chain. The layer can install multiple IoT sensors to form food safety traceability data. The IoT layer collects and transmits project data on the food supply chain and transfers it to the blockchain layer. The blockchain layer records transactions and credit data on the block, and uses a consensus algorithm to ensure that data is written into the block. Smart contracts define the interaction rules between users and the system, the P2P network completes the communication of different nodes. The credit entity layer is the main segment of the food safety credit system, and the credit data is transmitted to the block synchronously. The members of the blockchain include producers, processors, distributors, consumers, governments, media, banks, and credit agencies.

Conclusions

Food safety issues have led to a serious global crisis of trust and caused huge socioeconomic losses. As a machine for recreating trust, the application of blockchain technology will provide a new effective way to alleviate information asymmetry, rebuild social trust, and ensure food safety.

From a theoretical and practical perspective, blockchain technology with open, transparent, sharing, and security characteristics has great potential for food safety management. It is possible to change the relationship among food supply chain's stakeholders and reshape the food ecosystem, in addition to bring hope to fundamentally solve food safety problems.

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Enhancing Forecasting Performance of Metal Commodities Using Microeconomic Factors

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Abstract

To understand, model and forecast commodity prices, microeconomic factors are - not only in microeconomic theory – still an essential component, whilst previous studies are mainly focusing on macroeconomic and capital market factors. In this study, we enhance predictive ability of forecasting models on commodity returns by including commodity specific microeconomic variables. Our models significantly outperform the benchmark model based on the mean of historical returns for four of the seventeen investigated commodities. We achieve these results by using a predictive regression setup and are to our knowledge the first to include commodity specific microeconomic variables, amongst macroeconomic and capital market variables, in a prediction setup for a broad set of commodities. Our findings are in line with previous results on forecasting commodity returns (see Issler et al. 2014 amongst others), which show that forecasting is difficult but possible. With an out-of-sample test, we find evidence that for antimony, silicon, titanium and tungsten forecasting performance is significantly enhanced. Further, we find differences in forecast ability between LME traded and non-LME traded commodities. Our results indicate that even with an ongoing financialization of commodities, microeconomic factors enhance forecasting performance of prices and therefore their inclusion is beneficial.

Keywords: predictive regressions, commodity prices, microeconomic factors

Exploring the Potential Effect of Message Sidedness on Ethical Consumption

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Abstract

Consumerism has imposed severe consequences on the environment and society. In order to postpone the escalation of negative impacts created by human being, not only companies started to take their corporate social responsibilities more seriously, but consumers also become aware of what they can do to help build a better environment through their decisions in daily purchase. Consumers' behaviors such as reducing consumption, buying products ethically produced or with ethical content, boycotting unethical business conducts, directly or indirectly encourage firms to make decisions that inclined to an ethical fashion. While consumers show increased concern for the environment and society and are willing to act, there is still a gap between their willingness and actual behaviors. One of the reasons that impedes people's eagerness to practice ethical consumption is the way current ethical information is delivered is often difficult to process and consumers tend to purposefully ignore it. Moreover, unlike unethical practices, ethical consumption cannot be enforced by certain law or regulation. Therefore, there should be a better way to convey messages about ethical consumption to consumers so that they can engage more in ethical consumption practices. One of the communication measures often adopted by researchers to study attitude and behavior change is message sidedness effect, which contains one-sided and two-sided messages. Especially, two-sided messages, which address both sides of the arguments, have long been applied in the field of commercial advertising as an approach to increasing persuasiveness. In the meantime, the majority of studies concerning non-commercial communication aim at reducing unhealthy or harmful behaviors to the selves and the environment while relatively limited research addresses these communication messages' influences on the promotion of ethical behaviors. Instinctively, consumers attach certain benefits to unethical consumption behaviors to justify their decisions. To influence these decisions, it might be more effective to employ a two-sided message strategy that acknowledges the perceived benefits while emphasizing the negativity imposed by ethically questionable behaviors, rather than simply delivering one-sided message stressing negative consequences of unethical consumption. Therefore, this research attempts to investigate whether two-sided messages are more effective than one-sided messages in promoting ethical consumption. Specifically, this present study intends to explore whether two-sided messages can stimulate higher consumers' awareness towards ethical content involved in consumption, and thence influences following ethical decision making process which is likely to lead to ethical consumption behaviors. To test proposed hypotheses, experimental design will be employed to investigate the effectiveness of different types of message sidedness on perceived moral intensity as well as subsequent ethical decision making. Through extensive review of literature, scenarios involving common issues related to ethical consumption will be first identified and developed. Within each scenario, the message sidedness will be manipulated by presenting different types of arguments. Findings are expected to increase understanding about the impact of message sidedness on customer's engagement in ethical consumption. Results of this study are expected to provide insights for policy makers or marketing practitioners to promote ethical consumption.

Keywords: Message sidedness, one-sided message, two-sided message, ethical consumption, moral intensity, ethical decision making.

Reality Check: Consumer Determination of Fake News

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Abstract

The spread of fake news online has been called "echo chamber effect" (Törnberg, 2018). The chamber effect is when people gather into groups that reinforce their own ideologies. This type of bunching allows for confirmation bias, or the act of interpreting data to further one's own agenda (Törnberg, 2018). Combined with the personal nature of social media, nowadays the social media landscape is being used as a way to share the opinions of peers as facts and not personal sentiments, this blurring the line between fake and real news. The purpose of this study is to examine the individual's ability to determine if news content is real or fake. Two hundred respondents from Mechanical Turk participated in a 2x2 between subjects factorial with four levels of treatment (fake/real news coverage and mainstream/fringe masthead). Participants were given questions about their media usage, and overall opinion of the news, and then randomly assigned one news article with a masthead. After reading the news story, participants were asked if they thought the article was real or fake, and explore why they believed this. The purpose of this study was to investigate if and how participants identify if a story is fake or real. This information can assist in media literacy efforts for both researchers, academics and individuals.

Background

Fake news, or the spread of misinformation, is not a new obstacle for the United States of America, yet today it is on the forefront of public communication. Fake news is defined as the dissemination of false information for the manipulation of the masses (Bondielli, 2017). Due to the high rate of social media usage, more of the general public were posting stories that reflected their opinion or false information in order to gain more views, likes, and shares (Napoli, 2015). In order for online news websites to keep up with social media, they began publishing stories with attention-grabbing headlines. This decision resulted in readers skipping the story and trusting the information that the headline and a supplemental image provided them (Meel & Vishwakarma, 2019). This action leads to the spread of information that could be misleading or hard to understand. When people share fake news online, the attitudes and beliefs of their friends and families change because the news came from a trusted source (Masip & SuauMartinez & Ruiz-Caballero, 2018). Exposure to fake news through a trusted source is dangerous because it can be perceived as actual news and can change the perception of readers (Napoli, 2015).

The viewing of fake news changes thoughts, ideologies, and attitudes (Balms, 2014). It was found that there is a relation between how much fake news an individual is exposed to compared to how much hard news they consume. Fake news is observed to be real news more often by people who are more exposed to fake news than hard news. Individuals who read equally hard and fake news are less likely to observe fake news as real (Balms, 2014). This is because individuals who are exposed to fake news and hard news can recognize the satire that is being used in most fake news articles.

Credibility and objectivity are two terms that help the general public decipher between fake and real news. Credibility refers to the reliability, trustworthiness, and accuracy of information found in the news (Meel & Vishwakarma, 2019). If given the option individuals would, while consuming news, divide themselves into partisan audiences for biased media (Kelly, 2018). The lack of real and truthful information progresses the effect of biased ideologies. The credibility of news sources is in part how credibility is assessed by the viewer. This idea is driven by how the information in the news story matches with the opinions of the consumer (Kelly, 2018). This action makes the public think that they are getting the most accurate and truthful information that there is, when in reality they are just finding news that they agree with. When media consumers only view media that they agree with, they are blind to other sources of information and points of view. The credibility of a news sources is not only judged by if a consumer agrees with its ideologies but also if the topic of the story is interesting, what the photos in the story depict, source information, and writing style (Meel & Vishwakarma, 2019). Meel and Vishwakarma (2019) found that identifying the original source of fake news or misinformation is a crucial measure in stopping the spread of fake news.

Overall, it is important to understand how society views fake news as a whole and why fake news exists. Understanding how individuals could fall for or believe in fake news could help answer why it is so compelling and how to stop it. One thing not found in these studies is the thought process of an individual when they are deciding if something is fake news or factual news.

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Sustainable Development: How Should SDGs Be Measured?

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Abstract

All the rage today in the financial analysis arena is a headlong rush towards delivering data on environmental, social, and governance (ESG) aspects of the business enterprise. At the same time, appraisers of corporate social responsibility and "citizenship" have been caught up with distributing measures of the movement towards achievement of the United Nations' 17 Sustainability Development Goals (SDGs). Given these alternative information portals, it is reasonable to ask: Are these two initiatives (1) separate, (2) complementary, or (3) duplicative attempts to determine progress on global sustainability?

The current research explores this question by comparing financial and nonfinancial reporting that is currently available on several of the SDGs. A significant matter of concern in this domain of inquiry has been connecting quantitative data with qualitative outcomes. Another area of difficulty has been with agreement/disagreement on the standard metrics to report. A final concern relates to underlying verification of the measurements that are delivered.

This research contributes to the on-going debate regarding the intersection of profit generation and sustainable development. Its focus is on reporting and disclosure. Managing the production process requires measurement of achieved outputs—both explicit and collateral ones. Enhancing movement towards the goal of a wholly sustainable production-consumption function—one that will allow satisfaction of current needs without compromising the ability of future generations to enjoy a comparable level/standard of living—similarly necessitates an agreed-upon set of metrics against which progress can be judged. Comparing extant ESG and SDG reporting, as is done here, will assist in understanding how far down the path to achieving worldwide sustainable development the global economy actually is.

Green or Greenwashing: Starbucks versus Fiji Water

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Abstract

This research focuses on two companies, Starbucks and Fiji Water, and examines their sustainability and corporate social responsibility (CSR) strategies. These strategies are analyzed along different stakeholders, suppliers, employees, customers, community, other impacted groups, and environment in addition to their waste management practices. The findings of the study indicate that Starbucks sustainability and CSR strategies are “green” practices considering their suppliers, employers, and customers. In addition, conserving energy, water, restoring natural habitat in the communities of suppliers, and green building construction are other practices employed by Starbucks to ensure the health and the welfare of the environment and communities that they are located. This research indicates that the area that Starbucks needs to improve its sustainability practices is along the waste management, specifically recycling. On the other hand, investigating marketing practices, dealing with the community, the government of Fiji, suppliers, and conservation of environmental resources of the Fiji Water indicates that these are the areas that the company has breached the promises and its claims to be a “green” company. The results of this research discuss the differences in sustainability/CSR and waste management practices of these two companies.

The Geopolendpoint Indicator: Measuring the Economic Impact of the Use of Critical Raw Materials. Application to Liion Batteries

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Energy storage has become a key concern to support efforts for reducing greenhouse gas emissions in the mobility sector, and a significant presence of Li-ion batteries (LIB) in the market resulted in a growing interest in quantifying the impacts associated to their use. Concerns about access to critical raw materials are currently not integrated in the assessment of abiotic resources use in life cycle assessment (LCA). In this contribution, selected materials in LIB are assessed with the aim to understand which of these have a higher contribution to impacts analyzed from the criticality perspective at midpoint and endpoint level as a

complement to LCA.

The use of the Geopolitical Supply Risk Method (GeoPolRisk) has been recognized as one of the suggested practices by the UNEP Life Cycle Initiative to quantify supply risk in LCA. We build upon this methodology designed as a midpoint level indicator in life cycle sustainability assessment (LCSA) to present the GeoPolEndpoint indicator, a measure of the economic implications of the use of critical raw materials based on price elasticity of raw materials and geopolitical supply risk considerations.

The methodology is applied to four relevant materials in the supply chain of LIB: Aluminum (Al), Cobalt (Co), Copper (Cu) and Nickel (Ni). As first part of the analysis we assess the mass contribution of the selected materials to the cells of LIBs with nickel-cobalt-aluminum (NCA-C) or nickel-manganese-cobalt (NMC-C) cathode active material. GeoPolRisk values from the perspective of the member countries of the OECD are calculated for the years 2015 to 2017 as a proxy for assessing supply risk at a global scale; these midpoint level results along with estimations on price elasticity are the base for the obtention of the endpoint level indicator. The GeoPolEndpoint method was used to assess the relative socio-economic damage attributable to the use of Al, Co, Cu and Ni in LIB in monetary units.

Results show that despite Cu and Ni dominating the mass share for both types of LIB, Co stands out at the midpoint level mainly due to the fact that it's being extracted from high risk countries outside of the OECD. At endpoint level, Al and Cu lose relevance due to their relatively low price and low supply risk; while a predominant role of Co and Ni confirms the importance given to these materials deemed critical. Future work on this method should address how these results compare to environmental impact categories in order to complement decision making processes based on LCA, and explore the use of the methodology for other regions or economic blocks that have a relevant role in the global economy.

Keywords: Life cycle Sustainability Assessment, Geopolitical supply risk, Endpoint indicator, Critical Raw Materials, Li-ion batteries

Impact of Corporate Culture on Participation of CSR Activities

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Review of Literature

Employee engagement focuses on strong communication and commitment between an organization and its members. Azim et.al. (2014) found that there is a positive relationship between CSR and employee satisfaction and engagement. Employees like to see their companies do good things for their communities, which makes them feel proud to be a part of that organization (Azim et.al. 2014). Furthermore, stronger levels of engagement and commitment from employees to the organization have been found if there are articulated CSR activities (Ahamad & Islan, 2018), and Dhuthler and Dhanesh (2018) found that when companies communicate their CSR activities internally with their employees, the employees have a more positive perception of their company. When the company is legitimate about their CSR with their employees, employees are more attached to the firm, which leads to more credibility of the company (Soojung, et.al. 2018). Krasnoploskaya, Roza, and Meijs (2016) found that by bringing CSR outside of the office and engaging employees in corporate volunteering in their local community, it boosts productivity. Overall, corporate volunteerism creates a positive experience for employees, pushing them to want to volunteer on their own time (Krasnoploskaya et.al. 2016).

The culture of a company has strong influence on the levels of employee engagement. In a study that surveyed managers across the United States, Posner (1985), found that clearly stated and well- implemented organizational values have a significant difference in employee’s lives and their performance in the organization. Organizations that value teamwork, cohesion, and employee involvement tend to perform better than organizations that do not (Gregory, et. al., 2009). Companies perform better when they have a high culture with strong values. According to INC, Corporate culture refers to the shared values, attitudes, standards, and beliefs that characterize members of an organization and define its nature. Corporate culture is rooted in an organization’s goals, strategies, structure, and approaches to labor, customers, investors, and the greater community. Culture has been studied from the viewpoint of organizational effectiveness. Emerging from this research is The Competing Values Framework (CVF) which identified organizational effectiveness criteria (Quinn & Rohrbaugh, 1981). Four organizational culture types were determined: the dynamic, entrepreneurial Create Culture, the people-oriented, friendly Collaborate Culture, the process-oriented, structured Control Culture, and the results-oriented, competitive Compete Culture. These organizational culture types are also known as Adhocracy culture, Clan culture, Hierarchy culture, and Market culture (Cameron & Quinn).

Regardless of the corporate culture, America's Charities Snapshot Employee Research found that 71% of employees surveyed say it's imperative or very important to work where culture is supportive of giving and volunteering. Corporate volunteering programs help to increase involvement in a community as well as the company's own reputation gives employees a sense of purpose, and makes them feel more connected to the community and your company-wide social responsibility efforts. Hamilton (2019) found that employees are more motivated to participate in employer-organized activities if it will enhance their own ego or prevent them from feeling guilty for not volunteering (Hamilton, et. al, 2019). Similarly, people decide to donate for reasons that will benefit them, not necessarily the charity. A study done by Hyung Mann (2006) found that a person's willingness to donate to charity is based on a combination of the desire to demonstrate their own virtue and to make themselves look better to their peers. Corporate volunteering, strong organization culture and values, and employee engagement are all factors that contribute to the success of the organization.

The following study examines company advocacy of CSR activities and investigates employee motivation in those activities regarding their level of company culture. After obtaining informed consent, participants were assigned one of two fictional scenarios concerning corporate culture . Respondents were then given the same three examples of CSR activities, and asked to assess their likelihood of participation based the individual's general opinion of volunteering and donating, and various factors that influence whether they would volunteer/donate. Respondents also answered the ISA Engagement Scale, which are nine questions on a seven-point scale from 'strongly disagree' to 'strongly agree to measure employee engagement. Academic research generally suggests that 'engagement' is a positive work-related state of mind with a number of different facets or components. The ISA engagement scale is based on the view that engagement has an 'intellectual', a 'social' and an 'affective' dimension. Taken together, these three given an overall level of engagement for each person.

Green Countries: The Case of Canada and Germany

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Abstract

This study concentrates on two countries, Canada and Germany, and investigates their sustainability initiatives along several constructs, development of renewable energy, waste management, transportation, agriculture, and healthy communities. The research examines Germany's strategies to accomplish the European Union (EU) goal of achieving a net-zero carbon emission economy by the year 2050. These strategies include replacement of nuclear, coal, and natural gas by non-fossil fuel energy sources. In addition, the eco-tax, efficient building codes, green transportation system, and waste management directives of Germany are explored in regards to the accomplishment of a net-zero carbon emission economy. The study also investigates the goals of Canada established to reduce greenhouse gas emission by 30% by the year 2030. These goals are implemented through reduction of Canada's reliance on fossil fuel and by developing wind, offshore wind farms, and wave energy sources. Furthermore, Canada's goals of sustainable agriculture to protect the farmlands and the water sources and creation of green communities are discussed. The study concludes by highlighting the sustainability initiatives of Germany and Canada, two of the most progressive countries across the globe in implementing effective strategies to address the climate change.

India Refuses to Run on Dunkin and Home Depot Fails to Find a Home in China: When Too Much Reliance on Data Alone Becomes a Weakness in International Marketing

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Abstract

The lure of a promising global market has never been greater than in the last three decades. As a result, developed economies' businesses and corporations have been targeting emerging economies, particularly India and China in order to capture their combined trillion dollar markets. In the beginning of the current globalization process Theodore Levitt suggested that "the same countries that ask the world to recognize and respect the individuality of their cultures insist on the wholesale transfer to them of modern goods, services, and technologies" (Levitt, 1983), essentially lauding standardized marketing. Though many challenged his notions, some corporations seemed to follow this philosophy. Instead of making a concerted effort at understanding cultures and their preferences and resultant consumer behavior, they simply focused on data provided through market research. The result was a chase for "phantom markets" (Bolton, 2014), elusive and unpredictable, where new products failed to take off or fizzled out too soon. This qualitative paper will comprehensively review a few such instances of failure and address how in international marketing an interpretivist approach to consumer behavior is more valuable than reliance on sheer market potential indices.

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Net-Zero Carbon Emission Economy: Germany & Norway

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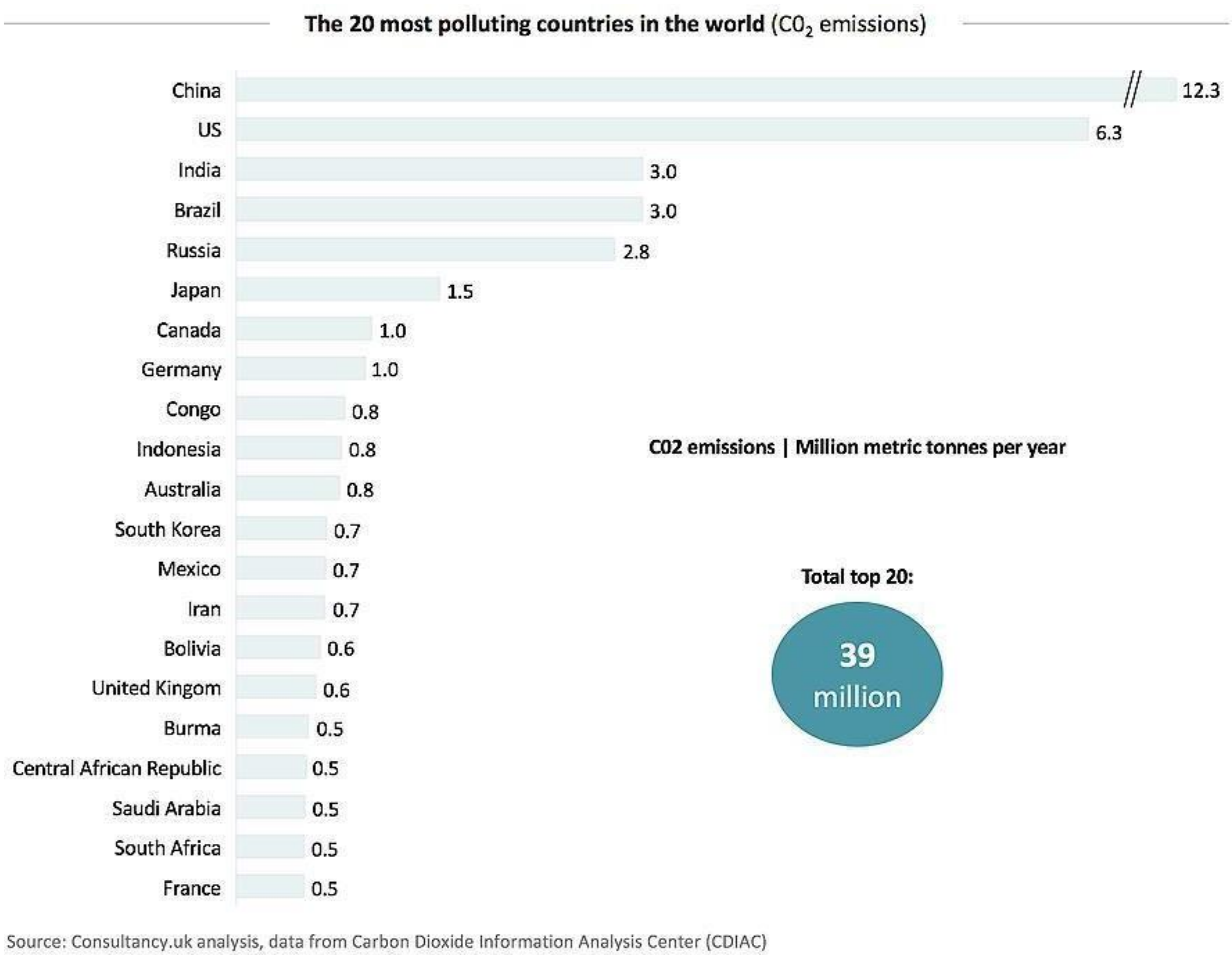
Abstract

This research discusses how two of the best economies in Europe, Germany and Norway, that depend upon fossil fuel energy are to achieve a net-zero carbon emission economy. Norway is the world's 13th largest oil producer. Oil and gas account for 20% of Norway's GDP. Germany is also heavily dependent upon fossil fuel energy. Germany's coals reserves amount to 31 billion tons with 172 million tons mined in 2017. In addition, Germany is heavily dependent upon natural gas import from Russia, 5.9 billion cubic meters per year. This study concentrates on how these two very advanced economies in Europe will be able to achieve the Paris Accord major goal, net-zero carbon emission economy by the year 2050.

Germany's GDP is about $3.9 trillion, which is the highest in Europe (World Bank, 2020). As indicated in Figure 1, Germany is one of the top polluting countries in the world (Global Carbon Atlas, 2017). Norway's GDP is around $434.2 billion (World Bank, 2020). Considering the size of the country's population, Norway has a very high GDP. Meanwhile, both these countries are heavily dependent upon fossil fuel energy for usage and export. In addition, as mentioned above, Germany imports a huge amount of natural gas from Russia.

Figure 1. The Top Polluting Countries



Paris Accord that was initiated in 2015, and is currently signed by 197 countries (Climate Change News, 2020), including Norway and Germany has the ultimate goal of achieving the net-zero carbon emission economy by the year 2050. This research follows the actions taken by Germany and Norway to accomplish the set goals and objective of the Paris Accord through the year 2020.

Current policies for Norway is to reduce CO2 emission by 14% - 21% from 10 years ago (Climate Action Tracker, 2020). As for Germany, the goal is to reduce the CO2 emission level of the year 1990 to 55% by the year 2030 (Clean Energy Wire, 2020).

This research investigates the ways that these two countries have been able to achieve the set goals and objective for reduction of CO2 by the year 2020.

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Social Media for Urban Participation: Challenges and Issues

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Abstract

The world tends to become more and more virtual, several practices have been digitized over time including signing, voting and decision making. The increase in this digitization is more visible in the use of social media, which are communication channels that are more or less efficient depending on the field in which they are used.

In the urban domain, the co-creation of space becomes a determinant of the sustainability of the city but also of the well-being of the inhabitants, this co-creation takes place through the bay of citizen participation in decision-making in urban planning. However, citizen participation in other areas has developed in many ways, including e-participation or digital participation.

In this research, it is a question of verifying the extent of the challenge of integrating citizen participation into social networks in the field of town planning. It is therefore important to know the stakes of this potential in order to measure its effectiveness.

Sustainable Foodstuff Valorisation – A Framework for Internalizing External Costs of Agricultural Production

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With the UN's Sustainable Development Goals in mind the severe environmental impacts of today's industrial agriculture must be reduced drastically. Transforming the consumers' behaviour towards sustainable dietary choices is one auspicious approach. Unfortunately, consumers are currently misled towards demand of inadequately priced, environmentally damaging foodstuff by an insufficient internalization of external environmental costs and thereby distorted market prices.

Therefore, we build a framework that translates ecological damage into economic impact: following the polluter-pays-principle we calculate market-price surcharges for different food categories which account for their external effects. Life cycle assessment from cradle to farmgate is used to adjust producer prices regarding foods' greenhouse gas emissions, energy use and nitrogen surpluses. Emission data for 11 food groups of plant and animal origin is therefore retrieved from the Global Emissions Model for Integrated Systems (GEMIS). We then conduct a meta-analysis based on 39 primary sources referring to the environmental difference between organic and conventional farming practices to differentiate external costs even further. The results show significant differences between the categories: while organic produce should be an average of 31.27% more expensive, effects of conventional production resulted in an average surcharge of 150.73%. Plant based organic food appears to be the currently most reasonably priced group with a calculated surcharge of only 1.13 (vegetables) to 14.72% (cereal) whereas animal based conventional foods should be 33.17 (eggs) to 353.95% (pork) more expensive. A price shift in the category of beef and poultry can be observed, as both conventional products are more expensive than their organic counterpart after internalization. Overall, these results display the vastly varying gaps between current market prices and the true costs of different food categories. When their environmental damage is internalized by using this framework the consequential undistorted market design will eventually lead consumers towards demand of reasonably priced, environmentally beneficial foodstuff. This could pose a real chance to reduce agricultural emissions and therefore contribute to achieving the SDGs after all.

Keywords: true cost accounting, LCA, sustainable agriculture, externalities

The Hidden Cost of German Food

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Keywords: Sustainability, Externalities, Food, Agriculture

Purpose: This study aims to quantify the external costs of foodstuff in Germany arising along the entire life cycle. In order to compensate the effects on the environment and human health, external effects should be considered in all food prices according to UN's polluter pays principle.

Method: Based on a comprehensive literature review and following the method of a study by Fitzpatrick and Young (2017) the external costs of the German agricultural production in 2016 are calculated. This study in turn methodologically uses previous research efforts of Pretty et al. (2000), Tegtmeier and Duffy (2004) and O'Neill (2007) for a calculation of externalities from the food sector in the UK.

Based on a comprehensive literature review and following the method of a study by Fitzpatrick and Young (2017) the external costs of the German agricultural production in 2016 are calculated. This study in turn methodologically uses previous research efforts of Pretty et al. (2000), Tegtmeier and Duffy (2004) and O'Neill (2007) for a calculation of externalities from the food sector in the UK. We use weighted averages of the costs of the categories of different studies, which were monetized with different approaches such as the avoidance cost approach, the restoration cost approach or the willingness to accept / pay approach.

Results: If the various external effects of German food production and consumption like greenhouse gases, avoidable food waste, health effects and subsidies were included in the prices, an average price increase of 84% at the retail level would be necessary based on our calculations. It is noticeable that the costs calculated for Germany reach almost the same level as those calculated for the United Kingdom, according to updated figures from the Fitzpatrick and Young study (2017): In the UK one would have to pay an average of £0.87 more per £1 of food purchased to internalize the external effects. However, a major difference between the two countries is the distribution of costs between the different categories: Nutrition-related

health costs account for the largest percentage of the UK's external costs (37%), whereas in Germany this category accounts for only 26%. This is in contrast to the degradation of natural capital, due to greenhouse gas emissions, flood damage and soil degradation, which accounts for 43% of the total external costs.

Conclusion: The large amount of the calculated markups shows and motivates the need for action about the true pricing of food. The results provide a basis for future political decisions to reduce existing market imperfections in the food market.

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Urban Action Structures (UAS) as a Tool for the Effective Implementation of Urban Agendas: The Case of the Basque Country

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The beginning of the 21st century has been marked by a renewed interest in policies specifically aimed at cities, as they are the main responsible for pollution, resource consumption and social inequalities. According to UN-HABITAT (2014) an urban policy consists of a set of coherent decisions, derived from a collaborative deliberative process that brings together different actors towards a common vision and objectives, which should promote long-term, more transformative, inclusive and resilient urban development. Consistent with this definition, there is an international commitment by public authorities to a substantial change in the urban model, which is detailed through the ODS and, subsequently, through the elaboration of international, national and local Urban Agendas that make it possible to implement the ODS on a more local scale. However, there are still difficulties in their implementation and the ODS Report (2019), after evaluating the impacts obtained, underlines the urgency of strengthening operations in order to meet the challenges in 2030.

This work, which deals with the case of the Basque Country, aims to define the Urban Action Structure (UAS) that will act as a catalyst for innovative urban policies and facilitate the implementation of the Urban Agenda of Euskadi Bultzatu 2050. Thus, an UAS is understood as a legally constituted civic entity that acts as a community to improve the quality of life of all people, through the implementation of a process of equitable and inclusive local development in balance with the environment.

Through the study of the literature and the trajectory of existing projects at a European level, the conceptual framework and context have been analyzed, identifying the strategic lines of greatest potential, and the urban structures that could support or promote them have been identified.

The main outcome of the study has been the identification of the Local Energy Communities (LEC) as strategic entities that can assume the role of a catalyst for an UAS. In other words, the EC could be the seed for the establishment of structures that go beyond the strictly energy field and can function as a provider of local community needs in line with global guidelines.

Calculating External Climate Costs for Different Food Categories: A German Case Study

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Abstract

Although about one fifth of greenhouse gas (GHG) emissions worldwide is attributed to the agricultural sector, thorough analysis of the quantity as well as the monetization of these climate relevant emissions has not yet been conducted in the context of differentiating between production systems as well as a variety of food categories. This paper therefore fills this gap in scientific literature by presenting a general method exemplary applied in the context of Germany. By doing so, we methodically show how the economic instrument of internalization of external effects through product-specific mark-up costs can be applied according to the polluter pays principle. Applying our results would ensure a sustainable and climate-friendly price-design of agricultural output. Using life cycle analysis as well as meta-analytical methods we can show that mark-up and external costs are the highest for conventional animal products (1.60€/kg product; 97% mark-up on producer price level), followed by conventional milk products (0.21€/kg product; 78%) and the lowest for organic plant-based products (0.02€/kg product; 5%). In all examined categories, organic products cause less additional costs than their conventional counterparts. The pronounced difference of relative external costs between food categories as well as the general amount of external climate effects in the agricultural sector can be seen as a strong argument for closing the gap between the currently observable market price and true costs in this sector. The true value of different food-groups and agricultural systems provides policy-makers with the relevant information to efficiently reduce associated ecological follow-up costs.

1. Introduction

The global importance of agriculture for climate change is undeniable. In their 2019 special-report on 'Climate Change and Land' the IPCC calculated that the emissions arising from agricultural land use constitute a share of 23% of global anthropogenic emissions (IPCC, 2019). These findings implicate that the relevance of the agricultural sector for climate change is actually significantly larger than that of the whole transport sector (which currently holds a share of 14% of global GHG emissions (Edenhofer et al., 2014, p. 9)). An outlook into the future of the further growing global population and their increasing demand for energy intensive food products due to ongoing industrialization makes the need for political action in this sector pressingly clear. One policy instrument here could be the internalization of external effects, through mark-up costs for foodstuff.

In this paper we contribute to the applicability of this economic instrument, by calculating the mark-up costs for food-stuff needed for a proper internalization of external effects. Hence, we present here a methodology of quantifying and pricing the externalities of greenhouse gas emissions (GHG) (Pretty et al., 2000; Tegtmeier & Duffy, 2004) arising during the production process of foodstuff. Hereby it is differentiated between the categories of conventional and organic production as well as animal, milk and plant-based products but also more narrow categories. By doing so, a generalized method is presented, applicable for different country contexts. However, the method is illustrated in the German context and mark-up up costs for external effects are calculated.

2. Research aim and literature review

In the context of quantifying and monetizing GHG emissions from agriculture, a social cost rate for greenhouse gas emissions is applied. Thereby those costs are identified which are currently not considered in the cost structure of a farmer or the subsequent food chain and are thus a burden on other market participants, future generations and the natural environment. In this context, we speak of external costs or externalities. These are not yet included in the market prices for food and, in the absence of current compensation payments, lead to significant (market) price distortions (Sturm & Vogt, 2011, p. 17) and welfare losses for society as a whole (International Monetary Fund, 2010).

The "Polluter Pays Principle" (UN, 1992) in line with predominant economic theory implies that in order to compensate for the external effects, mark-up costs should be levied on the producer prices of food or other economic policy measures should be taken to reduce or compensate for harmful costs caused by the production process of a foodstuff. For the United Kingdom, Pretty et al. (2000) were already able to record significant environmental impacts of agriculture at the overall societal level in monetary terms for 1996. However, the results of this study appear to be partly outdated and do not differentiate between food categories or production systems. Besides this specific paper, there exist a range of studies analyzing and quantifying the food-specific GHG emissions (Pretty et al., 2005; Hoolohan et al., 2013; Clune et al., 2017; Poore & Nemecek, 2018). Few studies however monetize these emissions, and when they do, only for specific food categories (Nguyen et al., 2012) or for the total food production in a country (Tegtmeier & Duffy, 2004). What seems to be lacking however is a study that not only quantifies but also monetizes GHG emissions, differentiated by food categories or production systems.

The aim of this paper is to fill this lack and in a wider sense provide a method for such a quantification and monetization. We thereby aim to illustrate the present price difference between current producer prices and true costs for the German context. In doing so, we also provide a method applicable for other country's contexts and different externalities. Life-cycle-assessment tools such as the one used in this study (cf. chapter 3.2.1) also offer data for other externalities and production quantities as well as producer prices are easily available for other geographical and country contexts. Thereby applicability and transferability of the presented method of quantification and monetization is ensured.

The terms *quantification* and *monetization* refer to the life-cycle-assessment (LCA) method's terms of category midpoints and endpoints. Hereby midpoints are points in the cause and effect chain of an environmental mechanism for a specific impact category (e.g.: concentration of emissions), whereas endpoints reflect the valuation of societal and environmental concern of an impact category (e.g.: the harm of emissions on human health or the climate) (SETAC Europe, 1999). In general, the LCA method examines the environmental impacts that occur during the entire lifetime of a product. This includes both impacts from production and impacts occurring during the utilization time of a product up to its disposal (or consumption), as well as all intermediate emissions (Klöpffer, 1997). The analysis of this paper focuses on one impact category inside the system limitations from cradle to farmgate, opposed to a multi-category perspective on the whole lifetime of a product. Thereby framing it as a typical LCA approach would be incorrect. Although it is not finitely defined, the method of carbon footprinting seems to be a more appropriate realm to allocate the method of this paper. In carbon footprinting, GHG emissions that occur during different life stages of a product are considered. There are however different perspectives in literature on whether only CO_2-emissions are considered or additionally all CO_2 equivalent emissions, as these also contain many gases that are not based on carbon but still contribute to climate change (Wiedmann & Minx, 2008).

This paper focuses on the carbon footprint of the production process of a product. It is important to mention that emissions are analyzed in relation to the product weight in this study and not in relation to a unit of agricultural land area. For the differentiation between conventional and organic production this makes insofar a difference as the productivity for one unit of land area differs between these two production systems (cf. chapter 3.2.1). All climate relevant gases linked to production up to a product's selling by the farmer (from cradle to farmgate) are considered. In this sense carbon footprints will be understood in line with Pandey et al. (2011)

as to consider all climate relevant gases, which includes CO_2 as well as methane (CH_4) and nitrous oxide (N_2O). The latter two are converted into CO_2 equivalents by applying their respective global warming potential (GWP). This value reflects how much stronger than CO_2 the effect of these gases is on global warming. Setting the default time horizon of 100 years, CH_4 has a GWP of 28 and N_2O a GWP of 265 (IPCC, 2014a). CO_2 is produced in agriculture through microbial degradation ("rotting") and the burning of plant waste. In addition, considerable amounts of carbon dioxide are released into the atmosphere which were previously bound in soils (Smith et al., 2007, p. 501). Indirect CO_2 emissions from agricultural transport, heat generation and emissions from the production of nitrogen fertilizers (Woods et al., 2010) are of quantitative relevance as well. CH_4 is produced during the composting or conversion of organic substances in oxygen-poor environments, i.e. mainly during the digestion of ruminant farm animals (Smith et al., 2007, pp. 505–513). N_2O is produced in agriculture mainly due to direct emissions from agricultural soils, arising from an excess of nitrogen in the soil, mainly caused by the over application of nitrogen fertilizer, and indirect emissions from the production such fertilizer (Mosier et al., 1998, p. 228).

In conclusion, the method outlined here can be understood as the calculation of carbon footprints for foodstuff and their monetary valuation, resulting in food(category)-specific mark-up costs. The resulting mark-up costs, which are to be forced by economic policy in line with common economic theory, would enable external costs to be internalized according to the polluter-pays principle and at the same time strengthen economically sustainable action on the part of consumers. Such a pricing of food, which includes environmental costs, would thus also make a significant contribution to fair market conditions as well as climate change mitigation.

3. Method and Data

The framework for calculating food-category specific external costs from GHGs and their respective mark-up costs will be laid out in three parts.

First the method as a whole will be outlined to give the reader an orientation and context for the following two parts. In the second part, the input data will be discussed. Finally the merging of all this input data and thus the calculation of the output data will be explained.

3.1 Outline of the method

In this method of calculating food-category specific external effects and the resulting mark-up costs, it is helpful to differentiate between two steps. These two steps are first the quantification and second the monetization of external effects from GHGs, visualized in figure 1.

The quantification includes the extraction of food specific GHG emissions during the production process by usage of a material flow analysis tool. In this case the material flow analysis tool GEMIS (Global Emission-model for Integrated Systems) (IINAS, 2017) is used which offers data for a variety of different foods from conventional production. Applying meta-analytical methods the difference of GHG production between production systems this emission data of conventional production systems can be translated to emission data for organic production systems. By weighting these food specific datasets with their production quantities, those datasets can be aggregated to broader food categories. Thereby, emission data for every food category exists.

Through monetization this emission data is translated into a monetary value. This monetary value constitutes the category specific mark-up cost. The ratio of mark-up cost to food price represents the percentage which would have to be added on top of the food price to internalize external effects from GHGs.

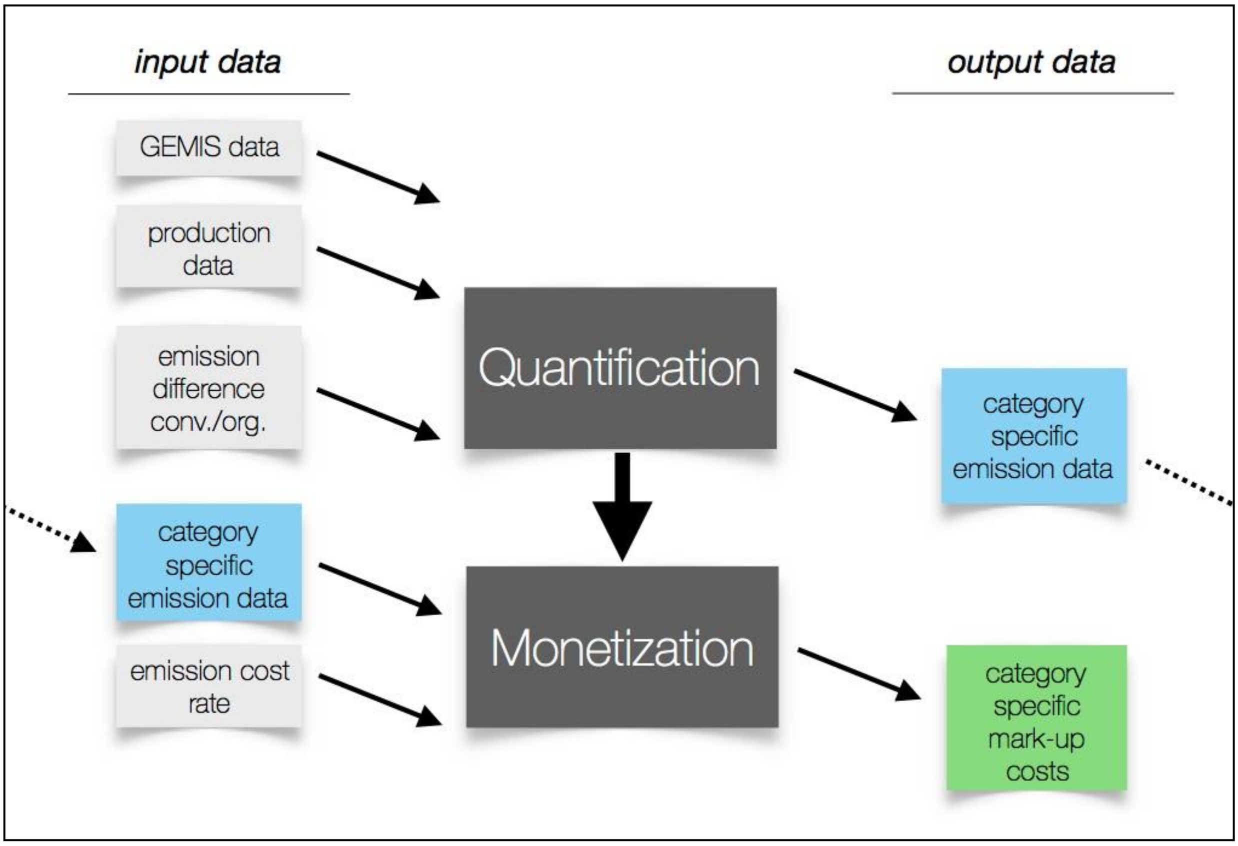

Figure 1: visualization of the method of quantifying and monetizing product specific external effects

3.2 Input data

In the following, it will be differentiated between input data for the quantification and for the monetization of external effects. The reference year for this analysis is 2016 and the reference country – except for a few instances – is Germany. In these instances when no data for individual countries was accessible, EU-data is used.

3.2.1 Input data for quantification

Input data for quantification includes data on the food-specific amount of CO_2 emissions during the production process from the material flow analysis tool GEMIS (IINAS, 2017). However, because GEMIS only lists emission data of conventionally produced foodstuff, the difference of emissions between conventional and organic production systems is calculated through meta-analytical methods. Thereby GHG emissions from conventional production systems can be translated to emissions from organic systems. To aggregate all this food-specific emission data to broader categories, data of production quantities are used. Consequently, three kinds of input data are needed: data on food-specific emissions, data on production quantities of food and data on the difference in emissions between conventional and organic production systems.

Starting with the data on food-specific emissions, the material flow analysis tool GEMIS is used because of its large database of life-cycle data on agricultural products with a geographic focus on Germany. This program is provided by the International Institute for Sustainability Analysis and Strategy (IINAS). GEMIS offers a complete view on the life-cycle of a product, from primary energy and resource extraction to the construction and usage of facilities and transport systems. As GEMIS only offers data for the year 2010, a linear regression on the basis of quantity- and emission-trend was conducted in order to align the data with the reference year 2016. For this, emission data from 2000 to 2010 from the Federal Environmental Agency of Germany was used (Jankowski, 2019). On every level of the process chain data on energy- and material-input as well as data on output of waste material and emissions is provided. This data consists partly of self-compiled data from IINAS and partly of data from third party academic research or other life-cycle assessment tools. Specific information on the data sources can be found for every dataset of a product. In this study the system limitations for selecting food-specific GHG emissions span from cradle to farmgate. This means that all resource inputs and outputs during production up to the point of selling by the primary producer are considered. It follows that for animal products, emissions from feed production, as a necessary resource input, are assigned to these animal products. Generally, emissions arising from land use change (LUC), primarily applicable for agricultural products imported to Germany, are not factored into this analysis. Although such emissions are potentially of significant quantity, corresponding data is not consistently available for Germany. Also, methods on implementing product specific LUC emissions into carbon footprints is still viewed as highly uncertain in the case of the indirect LUC approach (Edwards et al., 2010; Laborde, 2011; Finkbeiner, 2014) and comes with “serious weaknesses” for the direct LUC method (Ponsioen & Blonk, 2012).

Thereby, in this study LUC emissions are conceptualized as emissions outside of production. While it is possible to consider other external effects with GEMIS (e.g. nitrogen output), in this study the focus will be solely on GHG emissions arising in the defined system limitations. These food-specific GHG emissions are observed in relation to the foods weight.

To aggregate emission data from specific food-products to broad and narrow food categories, data on the production quantities of these products is needed. For aggregation to narrow categories, every dataset from GEMIS is categorized into one of eleven food categories. These include vegetables, fruits, root crops, legumes and oilseeds on the plant-based side as well as milk(products), eggs, poultry, ruminant and pig on the animal-based side. The choice of separation into these specific categories is based on the categorization of the German Federal Office of Statistics (Destatis, 2019) from which production data was used. Accordingly to one category's yearly production quantity, every food product is incorporated into the weighted mean of its corresponding food category. Thus, the higher a foods production quantity, the greater the weight of this product's emission data in the food category's emission-mean. All data on the production quantities refers to food produced in Germany in the year 2016. Only production quantities used for human nutrition where considered, thus feed and industry usage of food are ruled out for aggregation. Besides the German Federal Office of Statistics (Destatis, 2019), source for this data was the German Society for Information on the Agricultural Market (AMI (Agrarmarkt Informations-Gesellschaft), 2017b, 2017a). Analogous to this procedure, the above mentioned eleven food-categories are aggregated to three broad categories: 'animal', 'plant-based' and 'milk(products)'. Besides the obvious differentiation between animal and plant-based products, milk(products) are considered separately from animal-products because of their relatively high production volume and their, in contrast to that, relatively lower external effects. Because the weighted mean of to three main categories is affected by the production quantities of its corresponding subcategories, mapping milk inside the 'animal' category would distort the emission data of this very category.

As mentioned before, only data regarding external effects of conventional agricultural production is included in GEMIS and could therefore be aggregated. However by applying meta-analytical methods regarding the percentage difference of GHG emissions between conventional and organic production, emission data for organic production for each of the broad categories (plant-based, animal, and milk products) can be derived. Research was conducted by snowball sampling from already existing and thematically fitting meta-analysis, by keyword searching in research databases as well as forward and backward search on the basis of already known sources. Criteria for selected studies were a climatic and regulative comparable region to Germany. In the selected studies relative external effects between conventional and organic farming are compared in relation to the cropland. Fifteen studies were therefore selected, spanning from 1995 to 2015. Four of these studies have Germany as their reference country while the other eleven focus on other European countries (Denmark, France, Ireland, Netherlands Spain, UK) or the European area in general for their comparison. The difference of GHG emissions between the two production systems amounts to the weighted mean of the individual study results. As the selected studies are based on geophysical measurements and not on inferential statistics, a weighting based on the standard error of the primary study results like in standard meta-analysis (Stanley et al., 2008) was not possible. Following van Ewijk et al. (2012) and Haase et al. (2016) the usage of three relevant context sensitive variables was applied to approximate the standard error of the dependent variable and thereby evaluate the quality of each publication. The primary study results are thus weighted by equally considering the variables of the Scientific Journal Rating (SJR), to account for the journals credibility, the amount of yearly citations (CY), to account for the independent credibility of the paper, and the year of publication (PY), to account for the currency of the paper's results. Thus recently published papers with a high reputation get a higher weighting in the weighted mean. Each of the three variables is rated on a scale between one and ten whereby one is worst and ten is best. For each variable the upper limit of the scale is defined by the study with the best result.

Depending on the relation to this upper limit every other study is assigned a value between one and ten for each of the three variables. The sum of all three variables (SJR, CY, PY) for each study determines its weighting in the weighted mean. The results of this meta-analytical approach are listed in table 2 (chapter 4.1). As considered studies compare GHG emissions of production systems in relation to the crop area but this studies aim is to compare GHG emissions in relation to the weight of foodstuff, the difference in yield between the two production systems has to also be included. This difference in yield was derived from three comprehensive meta studies (de Ponti et al., 2012; Ponisio Lauren C. et al., 2015; Seufert et al., 2012) weighted in the same as already described. The evaluation of the studies shows that the yield in conventional is 17% higher than in organic production. The emission-difference in regards to cropland was then multiplied with the yield difference of the two production systems to derive the emission difference in regards to food-weight:

$$\boldsymbol{D_{conv,org}} = \frac{\boldsymbol{GHG_{org\,food\,weight}}}{\boldsymbol{GHG_{conv\,food weight}}} = \frac{\boldsymbol{GHG_{org\,cropland}}}{\boldsymbol{GHG_{conv\,cropland}}} \times \frac{\boldsymbol{yield_{conv}}}{\boldsymbol{yield_{org}}} \qquad \textbf{(1)}$$

3.2.2 Input data for monetization

Monetization of these external effects requires data on CO_2-eq costs as well as data on the pricing of the food categories.

The cost rate for CO_2 equivalent emissions used in this study stems from the guidelines of the German Federal Environment Agency (UBA) on estimating external ecological costs (Örtl, 2018a). There they recommend a cost rate of 180 euros per ton of CO_2 equivalent emissions, in 2016 euros. This value is very close to the value of the 5th IPCC Assessment Report (173.5€/tCO_2eq), where the mean of all (up to this point) available studies with a time preference rate of 1% was determined (IPCC, 2014b, p. 691). The cost rate from the German

Federal Environment Agency's guideline is based on the cost damage model FUND (Anthoff, 2007) and includes an equity weighting as well as a time preference rate of 1% for future damages. In this model different impact-categories are considered in order to estimate external costs from CO_2 equivalent emissions. Damage costs can be differentiated as 'benefit losses' such as lowered life expectancy or agricultural yield losses and 'costs of damage reduction' such as medical treatment costs or water purification costs (Örtl, 2018b, p. 35). These damage costs are analyzed in the following categories: agriculture, forestry, sea level rise, cardiovascular and respiratory disorders related to cold and heat stress, malaria, dengue fever, schistosomiasis, diarrhea, energy consumption, water resources, and unmanaged ecosystems (Anthoff, 2007, p. 4). Using a cost-benefit-analysis (CBA), an adequate level of emissions is reached when marginal abatement costs are equal with damage costs. In a CBA external damage costs can therefore be conceptualized as a mark-up cost necessary to effect their optimal reduction (Clarkson & Deyes, n.d., pp. 7–9).

For the pricing of the food categories, the total amount of producer proceeds in € (BÖLW, 2017) for each category was divided by its total production quantity. Thereby the relative price of € per ton for each foodstuff was calculated. As the system boundaries only reach until the point of selling by the farmer, solely producer prices are considered.

3.3 Output data

Output data includes the aggregation and separation of food specific categories to the broader categories of animal and plant-based products as well as conventional and organic products. As mentioned above, such aggregation and separation is needed because the material-flow analysis tool we use only lists food-specific emission data for conventionally produced foodstuff. By combing the input data, a quantification and monetization of the external effects of GHGs for different food categories is possible.

3.3.1 Output data of quantification: category-specific CO_2-eq emissions

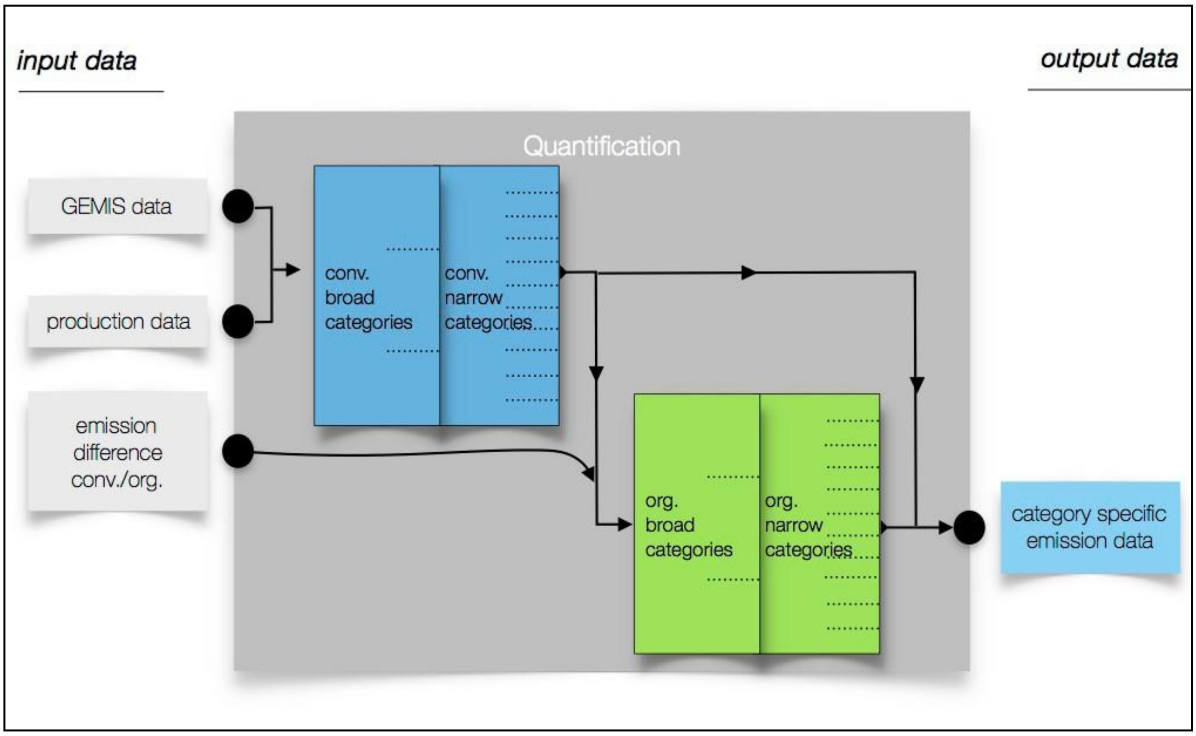

Figure 2: visualization of the quantification

The quantification is defined by two steps. First, the aggregation of emissions data to broader categories and second the differentiation between conventional and organic production systems. These steps will be iterated two times, once for broad categories of animal products, plant-based products and milk(products) and once for more narrow categories of vegetables, fruits, root crops, legumes, cereal and oilseeds on the plant-based side as well as milk(products), eggs, poultry, ruminant and pig on the animal-based side. In the following, the reasoning behind this method as well as the details of the two steps and iterations will be described in greater detail. Concerning the reasoning behind the method, the question that comes to mind is why the differentiation between production systems happens after the aggregation and not before. This is due to the fact that the proportional production quantities of specific food as well as food categories to each other differ from conventional to organic production. Let us imagine aggregation takes place after the differentiation of production systems: For example beef actually makes up over 50% of all produced food in the organic animal product category, while it only accounts for 13% of the conventional animal product category. As beef production produces the highest emissions of all foodstuffs, these high emissions would be weighted far stronger in the organic category than in the conventional category and thereby producing a higher mean for the organic animal product category than for the conventional one. As can be seen from this example, it would be possible for the organic animal product category to have a higher mean of emissions than the conventional animal product category while still having lower emissions for each individual organic animal product than conventional production. Deriving CO_2-eq emissions of foodstuff before aggregating to broader categories would thus be problematic and create means not representative for the elements that make up the broader category. The chosen method in this paper is thus to first aggregate to the chosen level of granularity (broad or narrow food categories) and then to derive emissions of organic production from conventional production data.

The first step of aggregation consists a) of aggregating food specific emission data from GEMIS to narrow categories and b) aggregating emission data from the narrow categories to the broad categories. As mentioned before, all this data only refers to conventional production up to this point. For both iterations the method is identical. To aggregate emission data to broader categories, a weighted mean is calculated whereby the weight of each element of a category is defined by their respective production quantity in relation to the categories total production quantity. This step of aggregation is represented in (2) where '$E_{k,conv}$' stands for the emissions of category 'k' in conventional production. '$e_{k,i}$' is the amount of emissions for the 'i'th element of category k and '$p_{k,i}$' the production quantity of this element whereas 'P_k' represents the production quantity of the whole category.

$$\boldsymbol{E_{k,conv}} = \sum_{i=1}^{n} \boldsymbol{e_{k,i}} \times \frac{\boldsymbol{p_{k,i}}}{\boldsymbol{P_k}} \qquad \textbf{(2)}$$

The second step of differentiation consists of deriving emission data of organic production by applying the calculated emission-difference of both production systems from meta-analysis '$D_{b, org/conv}$' to the aggregated data of each narrow and broad category. The emission difference 'D' is hereby the percentage value, which indicates how much less emissions arise in organic production systems compared to conventional ones (see formula 1). The index 'b' hereby stands for the broad category to which this emission difference relates. As a result, emission data of broad and narrow food-categories for each production system is calculated in formula 3:

$$\boldsymbol{E_{k,org} = E_{k,conv} \times D_{b,org/conv}} \tag{3}$$

3.3.2 Output data of monetization: category-specific mark-up costs

The category-specific emission data derived from quantification is now combined with a cost rate 'P' for CO_2-eq emissions. By multiplying the category specific emission data 'E_k' with the chosen cost rate, the monetary cost of damages 'C_k' resulting from these emissions is calculated (formula 4). By setting this monetary cost in relation to the producer price 'pp_k' of the respective food-category, a percentage mark-up cost 'Δ_k' can be determined (formula 5). This mark-up cost represents the price increase necessary to internalize all external effects from GHG emissions for a specific food-category:

$$\boldsymbol{C_k = E_k \times P} \tag{4}$$

$$\Delta_k = \frac{\boldsymbol{C_k}}{\boldsymbol{pp_k}} \tag{5}$$

4. Results

Now that the method of calculating category specific emission data and mark-up costs is laid out, in this chapter the method will be applied to the German agricultural sector. Quantification and monetization will each respectively be described in the following way: It will be first shown which data is used, second it will be applied to the previously mentioned formulas whereby third output data is derived.

4.1 Quantification

Using the previously defined three kinds of input data for quantification (cf. figure 2) – GEMIS data, production data and data on the difference between conventional and organic production – as starting points, it will be followingly shown how emission data for food-specific, narrow and broad categories is calculated.

Emission data (in kg CO_2eq/kgProduct)

Broad categories	prod. method		**Narrow categories**	prod. method		**Food-specific**	prod. method	
	conv.	*org.*		*conv.*	*org.*		*conv.*	*org.*
Plant-based	0.20	0.11	Vegetables	0.04	0.02	field-vegetables	0.03	0.02
						tomatoes	0.39	0.23
			Fruit	0.25	0.15	fruit	0.25	0.15
			Cereal	0.36	0.21	rye	0.22	0.13
						wheat	0.38	0.22
						oat	0.36	0.21
						barley	0.33	0.19
			Root Crops	0.06	0.04	potatoes	0.06	0.04
			Legumes	0.03	0.02	beans	0.03	0.02
			Oilseed	1.02	0.59	rapeseed	1.02	0.59
Animal	8.91	8.74	Eggs	1.24	1.22	eggs	1.24	1.22
			Poultry	13.16	12.91	broilers	13.16	12.91
			Ruminants	24.84	24.37	beef	24.84	24.37
			Pork	5.54	5.44	pork	5.54	5.44
Milk	1.14	0.84	Milk	1.14	0.84	milk	1.14	0.84

Table 1: emission data for food-specific, narrow and broad categories

Most fundamental for the following calculations is the food specific emission data derived from GEMIS. This data is represented by the column for conventional production highlighted in table 1. As outlined in chapter 3, the narrow categories are based on the categorization of the German Federal Office of Statistics (Destatis, 2019). At this point, food-specific data which can be assigned to one of the eleven narrow categories is extracted from GEMIS. In order to now derive emission data for organic production, the outlined method (cf. chapter 3.2.1) for differentiating between conventional and organic production is applied.

The results of this analysis are laid out in table 2, whereby the emission difference of both systems is calculated on the level of each of the three broad categories. As already explained, for every paper the three factors of relevance (publishing year, citations, journal rank) rank a paper's importance on a scale of 1-10. The sum of these three factors then determines the weight of a paper's result in the mean value. As can be seen in table 2, the choice of production system has the largest effects in the production of plant-based foodstuff. In this category organic production only causes 58% of emissions from conventional production. For animal based products the difference in emissions is the lowest whereby organic production causes 98% of emissions from conventional production. In the middle of those two categories lies milk where organic production causes 74% of conventional emissions. Thus it can be concluded that in all categories, organic production causes lower emissions. Explanations for these differences are elaborated in chapter 5.

Name	Country	Produce	Diff. Org/conv	relevance				
				PY	CY	SJR	SUM	WEIGHT
Plant-based								
Aguilera et al. (2015a)	Spain	citrus, fruits	49%	10	3	10	23	23%
Aguilera et al. (2015b)	Spain	cereals, legumes, veg.	45%	10	3	10	23	23%
Cooper et al. (2011)	UK	crops	42%	9	2	2	13	13%
Küstermann et al. (2008)	Germany	arable	72%	8	3	4	15	15%
Reitmayr (1995)	Germany	wheat, potatoe	63%	6	1	1	8	8%
Tuomisto (2012)	EU	arable	36%	9	2	5	16	16%
			58%				*98*	*100%*
Animal								
Basset-Mens; Werft (2005)	France	pig	95%	8	7	6	21	35%
Casey; Holden (2006)	Ireland	beef	82%	8	3	10	21	35%
Flessa et al. (2002)	Germany	beef/cattle	73%	7	5	6	18	30%
			98%				*60*	*100%*
Milk								
Bos et al. (2014)	Netherlands	dairy	61%	9	3	4	10	21%
Dalgaard et al. (2006)	Denmark	dairy	57%	8	2	6	16	21%
Haas et al. (2001)	Germany	dairy	67%	7	8	5	20	32%
Thomassen et al. (2008)	Netherlands	dairy	65%	8	10	6	24	26%
			74%				*70*	*100%*

Table 2: meta-analytical approach for determination of the emission-difference between organic and conventional production in different countries' contexts; PY = publishing year, CY = yearly citations, SJR = Scimago Journalrank, SUM = sum of all three factors, WEIGHT = weighted sums of category

To aggregate the food-specific emission data from table 1, production data is needed. As discussed in chapter 3.3.1 only production data for conventional production will be used. Thereby we imply equal ratios of production quantities across the food categories. This does not fully reflect the current situation of organic production properties but allows for a fair comparison between emission data of organic and conventional food categories. In table 3 all production data is listed, whereby total production quantities in 1,000t can be found in the right column. Translating these into percentage shares, the column right to the narrow category's column represents the shares of the specific foods inside the narrow categories, whereas the column right to the broad category's column represents the shares of the narrow categories inside the broad categories. These shares are expressed in formula 2 by the term $\frac{B_{C,D}}{E_C}$.

Broad categories	Share in broad categories	**Narrow categories**	Share in narrow categories	**Food-specific**	Total production quantity (in 1,000t)
Plant-based	7%	Vegetables	98%	field vegetables	3,166
			2%	tomatoes	78
	2%	Fruit	100%	fruit	1,183
	33%	Cereal	5%	rye	733
			82%	wheat	13,026
			1%	oat	101
			13%	barley	2,080
	54%	Root Crops	100%	potatoes	8,527
	1%	Legumes	100%	beans	148
	3%	Oilseed	100%	rapeseed	1,595
Animal	8%	Eggs	100%	eggs	716
	17%	Poultry	100%	broilers	1,509
	13%	Ruminants	100%	beef	1,099
	62%	Pork	100%	pork	5,559
Milk	100%	Milk	100%	milk	31,736

Table 3: production data and share in broad and narrow categories for 2016 in Germany

To illustrate the process of aggregation we will look at the aggregation of 'field vegetables' and 'tomatoes' to the narrow category 'vegetables'. Applying formula 2 to these datasets the following term emerges, whereby 'field vegetables' are the 1st and 'tomatoes' are 2nd of the ith elements of the 'vegetables' category k:

$$\boldsymbol{E}_{\boldsymbol{vegetables,conv}} = \boldsymbol{e}_{\boldsymbol{vegetables,1}} \times \frac{\boldsymbol{p}_{\boldsymbol{vegetables,1}}}{\boldsymbol{P}_{\boldsymbol{vegetables}}} + \boldsymbol{e}_{\boldsymbol{vegetables,2}} \times \frac{\boldsymbol{p}_{\boldsymbol{vegetables,2}}}{\boldsymbol{P}_{\boldsymbol{vegetables}}} \quad (6)$$

Applying the data from table 1 and 3, the following term can be derived:

$$\begin{aligned} \boldsymbol{E}_{\boldsymbol{vegetables,conv}} &= \mathbf{0.03}\left[\frac{\boldsymbol{kgCO_2eq}}{\boldsymbol{kgProduct}}\right] \times \mathbf{98\%} + \mathbf{0.39}\left[\frac{\boldsymbol{kgCO_2eq}}{\boldsymbol{kgProduct}}\right] \times \mathbf{2\%} \\ &= \mathbf{0.04}\left[\frac{\boldsymbol{kgCO_2eq}}{\boldsymbol{kgProduct}}\right] \end{aligned} \tag{7}$$

Thus the emission value for the narrow category 'vegetables' is derived, at first however solely for conventional production. By applying formula 3 to this example and using data on emission-differences from table 2, emission data for organic production is derived:

$$\boldsymbol{E}_{\boldsymbol{vegetables,org}} = \boldsymbol{E}_{\boldsymbol{vegetables,conv}} \times \boldsymbol{D}_{\boldsymbol{plant-based,org/conv}} \tag{8}$$

$$\boldsymbol{E}_{\boldsymbol{vegetables,org}} = \mathbf{0.04}\left[\frac{\boldsymbol{kgCO_2eq}}{\boldsymbol{kgProduct}}\right] \times \mathbf{58\%} = \mathbf{0.02}\left[\frac{\boldsymbol{kgCO_2eq}}{\boldsymbol{kgProduct}}\right] \tag{9}$$

Following this same procedure, all food-specific emission data is aggregated to narrow and broad categories, results of which are illustrated in the left and middle columns of table 1.

Examining the broad categories in the left columns of table 1, it can be seen that animal products cause the highest emissions per kilogram of product with 8.74 – 8.91 $kgCO_2eq/kgProduct$, followed by milk with 0.84 – 1.14 and plant-based products with 0.11 – 0.20 $kgCO_2eq/kgProduct$. In the narrow categories, ruminants cause by far the highest emissions with 24.37 - 24.84 $kgCO_2eq/kgProduct$ while legumes cause the lowest emissions with only 0.02 - 0.03 $kgCO_2eq/kgProduct$. As follows from table 2, organic produced food causes fewer emissions than conventional food in all broad and narrow categories.

Explanations for the emission differences between the different food categories and the production methods will be discussed in chapter 5.

4.2 Monetization

As illustrated in figure 1, for monetization the category-specific emission data – derived from quantification – is now combined with an emission cost rate. At the end of monetization external monetary cost of the category-specific emissions as well as the percentage price increase necessary to internalize these costs are derived. This procedure is discussed in the following. The emission cost rate from the German Federal Environment Agency (UBA) was described in chapter 3.2.2. It sets a price 'P' of 180€ per ton of CO_2 equivalent emissions (IPCC, 2014b, p. 691; Örtl, 2018a). By multiplying this price with the emissions 'E' from table 1 (in line with formula 4) the following mark-up costs 'C' in table 4 are derived. Exemplary this step will be illustrated on conventional vegetables.

$$\boldsymbol{C_{vegetables,conv} = E_{vegetables,conv} \times P} \tag{10}$$

$$\boldsymbol{C_{vegetables,conv} = 0.04 \left[\frac{kgCO_2eq}{kgProduct}\right] \times 0.18 \left[\frac{€}{kgCO_2eq}\right] = 0.01 \left[\frac{€}{kgProduct}\right]} \tag{11}$$

Broad categories [b]	prod. method						**Narrow categories [n]**	prod. method					
	Conv.			Org.				Conv.			Org.		
	pp (€/kg Prod)	C (€/kg Prod)	Δ	pp (€/kg Prod)	C (€/kg Prod)	Δ		pp (€/kg Prod)	C	Δ	pp (€/kg Prod)	C (€/kg Prod)	Δ
Plant-based	0.14	0.04	*25%*	0.39	**0.02**	***5%***	Vegetables	0.69	0.01	*1%*	1.10	**0.00**	**0%**
							Fruit	0.50	0.05	*9%*	0.57	0.03	5%
							Cereal	0.09	0.07	*72%*	0.31	0.04	12%
							Root Crops	0.08	0.01	*14%*	0.35	0.01	2%
							Legumes	0.02	0.01	*33%*	0.13	0.00	3%
							Oilseed	0.37	0.18	*50%*	0.42	0.11	25%
Animal	1.66	**1.60**	***97%***	3.41	1.57	*46%*	Eggs	1.21	0.22	*18%*	3.42	0.22	6%
							Poultry	1.72	2.37	*137%*	2.31	2.32	100%
							Ruminants	3.38	4.47	*132%*	3.90	4.39	113%
							Pork	1.35	1.00	*74%*	3.61	0.98	27%
Milk	0.26	0.21	*78%*	0.48	0.15	*32%*	Milk	0.26	0.21	*78%*	0.48	0.15	32%

Table 4: producer prices (pp), mark up costs (C) and percentage price increases (Δ) for narrow and broad food categories when external effects from GHG emissions are monetized

Following formula 5, these mark-up costs are set into relation to the respective producer price of a category's results. The resulting percentage value reflects the increase of the producer price 'pp' necessary to internalize all external effects related to GHGs arising from food-production (table 4). Using the example from above, the following calculation for the percentage price increase 'Δ_k' emerges:

$$\Delta_{vegetables,conv} = \frac{C_{vegetables,conv}}{pp_{vegetables,conv}} \tag{12}$$

$$\Delta_{vegetables,conv} = \frac{\mathbf{0.01} \left(\frac{€}{kgProduct}\right)}{\mathbf{0.69} \left(\frac{€}{kgProduct}\right)} = \mathbf{1}\% \tag{13}$$

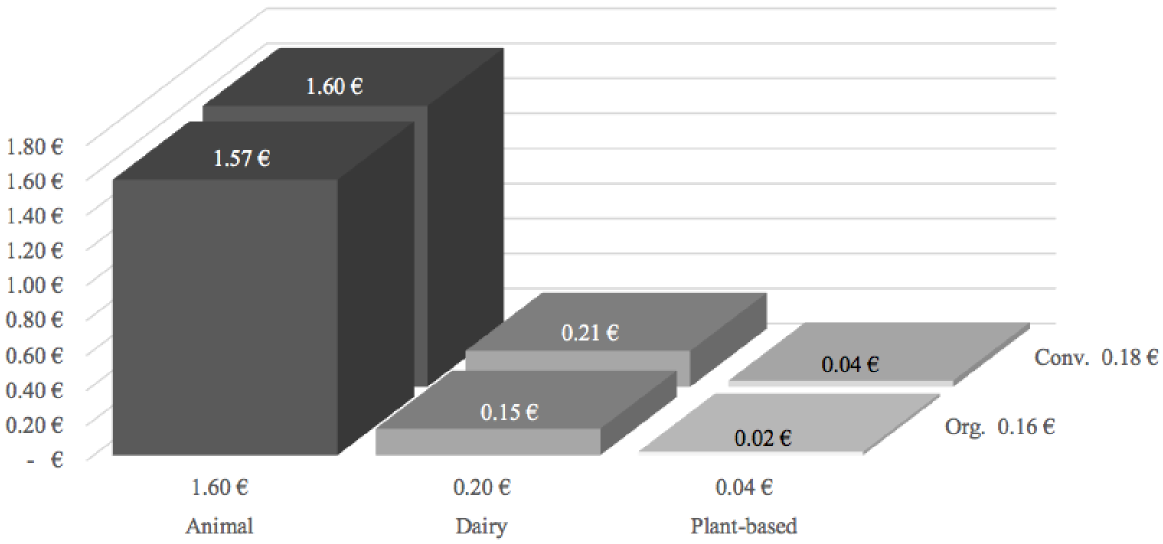

Table 5: visualization of mark-up costs for broad categories (animal, milk, plant-based in comparison to conventional, organic production) arising from monetized external effects of GHG emissions

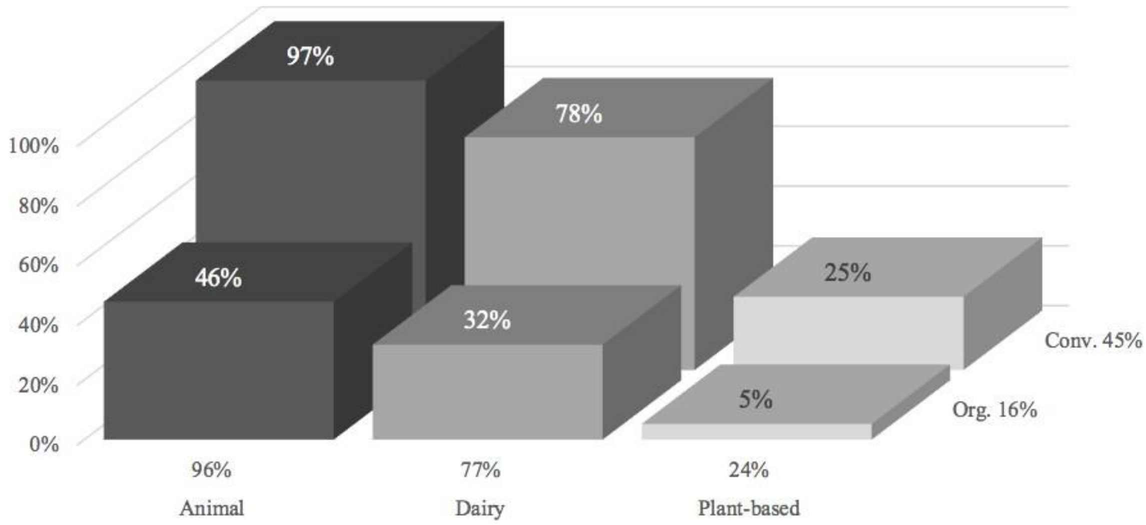

Table 6: visualization of the relative percentage price increases for broad categories (animal, milk, plant-based in comparison to conventional, organic production) when external effects of GHG emissions are included into the producers price

In table 4 for each broad and narrow category the highest mark-up costs and percentage price increases are highlighted in red and the lowest in green. For the broad category percentage price increases and mark-up costs are also visualized in table 5 and table 6. In the following, only the broad categories' data will be further deduced as the narrow categories overall follows the same narrative. Looking at table 4 and table 5, in the broad category the mark-up costs of the organic plant-based products are clearly the lowest (0.02 €/kg product). The mark-up costs for conventional plant-based products are about twice as high (0.04 €/kg product) although still relatively low in regards to the other two broad categories. Animal products cause the highest mark-up costs (1.60 €/kg product), 40 times higher than plant-based and 8 times higher than milk products. Here – as well as in all other categories – conventional production (1.60€/kg product) does not perform as well as organic production (1.57€/kg product).

However, the method of production shows a much stronger effect when it comes to percentage price increases (table 4 and table 6). This is due to the fact that the producer price of organic food is consistently higher compared to conventional food. Therefore, the mark-up costs lead to a less significant percentage price increase for organic products which widens the difference between these two production types. In line with mark-up costs, conventional animal products would have the highest relative percentage price increase (97%) whereas organic plant-based products would have the lowest (5%).

5. Discussion and Conclusion

In the following, the emission differences between food categories and production methods as well as the internalization of external effects through mark-up costs itself will be discussed. This will be followed by a general conclusion.

As the results of quantification have shown, the production of animal products and especially of meat causes the highest emissions. These high emissions stem from the resource intensive production. Meat production is hereby especially resource intensive because of the inefficient conversion of feed to animal product produced. For beef cattle this conversion ratio is as high as 43:1, meaning that 43kg of feed are needed to produce 1kg of beef product. These ratios can also be significantly lower, with broilers having to lowest ratio of all meat with only 2.3:1 (Pimentel & Pimentel, 2003). Still the point remains that the production of meat and other animal products requires a far greater resource input than production of plant-based food. Furthermore emissions from the animal itself through manure and digestion, latter of which is only relevant for cattle and pigs, as well as heating of stables are other relevant factors that contribute to the high emissions of animal products compared to plant-based products. Secondary animal products like milk and eggs cause lower emissions than meat. This can be explained by the fact that the mass of milk or eggs a farm animal produces during its live is significantly higher than its own body weight (respectively its consumable parts) at the day of slaughter. Thus the same amount of resource input leads to a significantly higher amount of secondary than primary animal products. Thereby emissions from these resource inputs have a far smaller weight in secondary animal products.

Looking at the emission differences between conventional and organic production, the lower emissions of organic products in all three broad categories can be explained by the stricter rules under which organic farming is practiced. The EU-Eco regulation (2013) prohibits the use of mineral nitrogen fertilizers on organic farms. Therefore – especially due to the avoided direct (from the soil) and indirect emissions (from production) – CO_2eq emissions are significantly lower compared to conventional farms. Although the question of the extent to which animal fertilizers cause less N_2O emissions than nitrogen fertilizers in form of direct soil emissions is controversial (Cole et al., 1997, p. 226), considerable indirect N_2O emissions from production are avoided in organic farms. With regard to the feeding of animals (emissions of which are always allocated to the respective animal products in this study; cf. chapter 3.2) on an organic farm, Article 14d of the EU-Eco regulation stipulates that only organic feed – mainly produced on the local farm – may be used. CO_2 emissions are thus saved by the more climate-friendly cultivation of the fodder and by avoiding long transport routes. The fact that dairy cows on organic farms have a significantly higher proportion of grazing in their total food intake (29.5% compared to 0.5%) also avoids CO_2 emissions associated with the production of industrial feed (Hülsbergen, 2013, pp. 195–196). Moreover, the use of grassland instead of farmland leads to the preservation of CO_2 sinks (Soussana et al., 2010).

Due to price elasticities of demand for food products (which are consistently regarded as 'normal goods'), appropriate pricing of food would make products of the more climate-friendly organic production more competitive compared to products of conventional agriculture (Andreyeva et al., 2010). As mentioned before (cf. chapter 2), emissions arising from land use changes were neglected for this analysis as the focus was solely on production related emissions. It is however reasonable to assume, that an inclusion of these emissions would increase the relative emissions of animal products to a larger extend than those of plant-based products, due to the excessive farmland needed for the production of feed. A decline in the consumption of resource- and GHG intensive animal products, would thus result in the availability of enormous farmland, which would easily allow for a further expansion of the area-intensive organic agriculture (Westhoek et al., 2014). The introduction of mark-up costs would also likely result in a lowered amount of thrown away food (Reschovsky & Stone, 1994) and would thereby have further positive effects on the efficiency of food production. Furthermore, a change in demand towards organic plant-based food products is thought to positively affect the well-being and health of the individual (Creutzig et al., 2018) and thereby national spending in health care (Springmann et al., 2017).

Price mark-ups for external effects are often perceived as an additional financial burden for consumers. This however is not the full truth and two points shall be made here in response. First, the percentage price increases presented in this paper seem quite high at first glance, but it has to be noted that these relate to the producer and not to the consumer price. As the producer price is only about one fourth of the consumer price (Deutscher Bauernverband, 2014), the presented mark-up costs would result in much lower percentage price increases for the consumer. Internalization would thus require a far greater adjustment in business to business than in the business to customer relations. Second, the costs of external effects from agriculture already arising today are paid for by society and thus also by the individual. This is done indirectly though, for example through emergency aid payments for floods or droughts as an effect of global warming. When external costs are internalized however, it would be possible for these external costs to be paid according to the polluter-pays principle (UN, 1992) and thereby arguably in a fairer way. In addition, there is an opportunity to avoid or mitigate future damage by using additional government revenues for a subsidy policy that provides greater incentives for sustainable agriculture at the farm level. This could be done by ensuring that all the received money from internalization is equally redistributed, whereby farmers are incentivized to lower their environmental impact but also financially worse-dispositioned citizens are not disproportionately affected by such policy. There surely are many political controversies implied in internalization policies, thorough discussion of which shall not be elaborated here in closer detail, as this paper's main focus is to deliver the quantitative basis for such political discussions.

Our results suggest that animal products cause by far the highest emissions with 8.91 $kgCO_2eq/kgP$ for conventional and 8.74 $kgCO_2eq/kgP$ for organic production compared to milk (conv.: 1.14 $kgCO_2eq/kgP$; org.: 0.84 $kgCO_2eq/kgP$) and plant-based products (conv.: 0.20 $kgCO_2eq/kgP$; org.: 0.11 $kgCO_2eq/kgP$). Organic products consistently cause fewer emissions than their conventional counterparts.

Expanding recent studies by Springmann et al. (2018) as well as Clune et al. (2017) and Poore and Nemecek (2018) we monetized these emissions to calculate mark-up costs and percentage price increases. The highest mark-up costs would result for conventional animal products with 1.60 €/kgP and a percentage price increase on the producer price of 97% while organic plant-based products have the lowest mark-up costs with 0.02 €/kgP and percentage price increase with 5%.

What was further pursued in this paper, was to lay out a method of calculating product-specific external effects, illustrated in the context of GHG emissions for foodstuff from German agricultural production. As databases such as GEMIS offer data for other externalities (such as nitrogen discharge or energy consumption), not only for Germany but also in other country's contexts, there is a wide ranging applicability of the method presented here, and with that lots of entry points from which to draw upon and add to the evolving literature on the true cost of our food. A major concern for current carbon footprint methods, and thus a highly relevant research area, is the question how to implement LUC emissions on a product specific level. Since the focus of this study is on German production, LUC emissions are of negligible proportion for locally grown products, as agricultural land area is decreasing in Germany

(Niedertscheider et al., 2014). For animal products however, higher emissions due to additional LUC emissions from feed imports (like soybeans from Brazil) could be expected. Furthermore, the here analyzed agricultural production causes the greatest external effects in the food sector (Vermeulen et al., 2012), but still, further research should also be conducted to the steps succeeding agricultural production in the value chain (e.g. processing and logistics) and the external effects connected to those further steps.

The approach presented here represents a contribution to the true costs of food, which – even with partial implementation – would lead to an increase in the welfare of society as a whole by reducing current market imperfections.

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Rebalancing Effects of Commodity Indices on Open Interest, Volume and Prices

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Abstract

The investment volume from 200 billion $ in 2008 for commodity indices has more than tenfold in the past ten years. Many studies analyse financialization of commodities. Our idea is that we can observe an index effect concerning the reweighting and therefore the influence of financialization. Because the traders have to adjust their positions and these directly affects the prices. The investment growth takes places in the largest index, therefore the Bloomberg Commodity Index and the S&P Goldman Sachs Commodity Index are analyzed from 2006 to 2016. With 200 changes for the S&P Goldman Sachs Commodity Index and 185 changes for the Bloomberg Commodity Index. The results of the event study show significant effects for the rebalancing days by open interest and volume data, but not for price data. Therefore, we can prove a commodity index effect around the rebalancing days and so financialization.

Keywords: financialization, commodity index, index investors, event study
JEL Classification Codes: G11, G14, Q02, Q31

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1. Introduction

Investment in commodities has become a large, popular and profitable activity (Gilbert 2010a). The popularity is steady growing in recent years. According to a Commodity Futures Trading Commission report (2008) and Masters (2008), the total value of various commodity index-related instruments purchased by institutional investors has increased from an estimated $15 billion in 2003 to at least $200 billion in mid-2008. This popularization of commodities as an investment is commonly referred as the "financialization" of commodity markets (e.g., Tang and Xiong 2012). Commodities are attractive for investors for two main reasons according to Arnott et al. (2014). On the one hand inflation protection and the other hand portfolio diversification. The inflation protection is based on a broad portfolio distribution. The diversification rests on a low correlation with other asset classes, which is widely accepted in literature, because a large number of studies like Kaplan and Lummer (1998), Greer (2000), Jensen et al. (2002) and Gorton and Rouwenhorst (2006) prove this fact. Like commodity index funds commodity index-based products show an appropriate opportunity to use the advantages of the commodity market. Commodity indices aggregate the market activities concerning the commodity market and report it in one value. The reweighting of the indices is suitable as an indirect measurement because the index investors have to follow the strategy of the indices. The rebalancing of indices to reproduce the actual market situation results in an adjustment of the positions of commodity index-based products because financial products based on commodity indices want to reproduce or benchmark the respective index. That means, for example, a bank issues an ETF based on the S&P GSCI the investors (private or institutional) want to invest in commodities and buy this product. In order to reduce the financial risk, the bank goes long in future contracts of the underlying commodities. Therefore, the bank hedges its risks via the future market with buying or selling the counter position. Every rebalancing has to be reproduced and results in additional trading activities. With the growing volume and the financialization of commodity markets, we assume a direct influence first on the trading activity or volume of the commodities or commodity indices, second on the open interest of the underlying commodities and third on the commodity prices (future and spot).

Many studies like Edmister et al.; Harris and Gurel; Lamoureux and Wansley and Woolridge and Ghosh measure directly. Therefore, the volume increase combined with the influence on prices is measured.

Also the timeline has to be strongly aggregated and other parameters are controlled. Nearly all other studies related to this topic and introduced in section two also use an indirect measurement. Our approach is to isolate the transaction in the indices better known as the reweighting. The possible effect can be attributed only to the financial investors. Thereby our measurement is derived from Henderson et al. who proves financialisation by concerning emitting processes for financial products.

We select both benchmark commodity indices, the Standard & Poor´s Goldman Sachs Commodity Index (S&P GSCI) and the Bloomberg Commodity Index (BCOM) to answer the questions in the period of financialization. Therefore, the study covers the period from 2006 to 2016. Both indices are described explicitly in section three. Within these periods of ten years the BCOM has 86 positive and 99 negative reweightings as well as four constant ones. The S&P GSCI has 96 positive and 104 negative reweightings. In a combined view there are 189 reweightings with 95 negatives and 94 positives. This can be seen in detail in table 4 in the appendix. Broad literature research concerning index effects for stock indices reveals that the common used methodology is an event study. This methodology is described in more detail in section four.

By using an event study, we find significant results for an index effect for commodity indices concerning open interest and volume data. The results show no significances for spot and future prices. We can prove these results for the cumulative weighting of both indices (BCOM and S&P GSCI) as well as for the weighting in the same direction by both indices. The results stay robust in these cases for the fit to the trading volume concerning the rebalancing dates. For other event days and other setting concerning parameters of the event study the results show less or even no significances. Therefore, we can isolate this effect quite well as described later in section 5.

The final two sections deal with the discussion of the results and the foresight concerning further research related to this topic.

Within this study, for the first time, we analyse a possible index effect for commodity indices related to the rebalancing process with influence on the open interest, volume or price data of the underlying commodities.

2. Literature

The literature review splits in two parts on the one hand literature concerning the financialization of commodity markets and on the other hand studies relating an index effect by stock indices. Starting with the studies concerning financialization, which want to prove the impact of financialization on commodity prices. Concerning Cheng and Xiong (2014) there are three channels related to the spot market for this process. The channels concern the theory of storage, the theory of normal backwardation and the theory of information asymmetry. The connection to our paper is described in figure 1. The basic idea of the tests is to measure the impact of financialization or additional market activity with variables like open interest of financial investors or trading volume as well as spot and future prices. Method of choice is like Brunetti and Buyuksahin (2009) prove financialization for the volume of crude oil, natural gas and agricultural commodities. Sanders and Irwin (2011) can also verify financialization for the volume of agricultural commodities and natural gas. Also, Gilbert (2010b), (2010c) can prove financialization for prices of crude oil, metals and agricultural commodities as well as Mayer (2012) and Robles et al. (2009) only for agricultural commodities. Mayer et al. (2017) can find effects for metal commodities. Contrary to this studies Bohl et al. (2012), Brunetti et al. (2016), Harris and Buyuksahin (2009) and Mutafoglu et al. (2012) cannot find any evidence for financialization for prices and volume in the same commodity classes. A problem is the measurement of the financialization in the context with commodity indices. That means aggregated data and no exact trades for each commodity as well as different frequencies of the data and not the exact date of the change. Also, the analysed variables are problematical because of the measurement. Henderson et al. (2014) who finds evidence for price impact around pricing dates of newly issued certificates and therefore new inflows for the commodity future market. Directly rely on aggregated volume. Using the assumption, that banks hedge their positions. But try to avoid problems by indirect measurement because banks are forced to hedge. Our approach is to isolate and to focus the effects around the reweighting of the two benchmark commodity indices. Therefore, we analyse the effects on open interest (OI), volume (Vol) and price (future and spot) data around the exact rebalancing dates in January of each year. This effects can be assigned directly to financial investors and the effects of financialisation.

This idea is closely related to Henderson´s approach. Otherwise the method is adopted from stock index literature while the theory is different the majority of these studies analyse the S&P500 in an overall period from 1966 until now with the first important studies published in the 1980s and 90s. Most of the studies like Shleifer (1986), Harris and Gurel (1986), Woolridge and Ghosh (1986), Lamoureux and Wansley (1987), Edmister et al. (1994), Lynch and Mendenhall (1997) and Beneish and Whaley (1997) find all an index effect concerning the addition or removal from or to the S&P 500 related with price, volume and open interest of the underlying companies. Thereby they can prove that companies which are in or getting in the S&P 500 are of more interest for investors and therefore the prices are significantly higher than for companies which are not. Therefore, they confirm an index effect around the issue dates for addition or removal to or from the S&P 500. With the addition or removal to or from an important stock index, the information about the related companies is different. The position change reduces or increases the information asymmetry and therefore the cost of capital.

In contrast commodity indices have less addition and removals to or from the index. Therefore, our focus is on the reweightings of the commodity share concerning the index. Because commodity indices are most used by commercial investors and therefore the reweighting leads to an adjustment of their positions. Figure 1 below shows the process for the positive rebalancing as well as for the negative rebalancing, we describe it only for the positive direction because the negative one has the same influence only in the opposite direction. Commercial investors include traders who use derivatives markets as a hedging tool, they are often called hedgers. Non-commercial investors include all investors who have no interest in the physical commodity and therefore, they are speculators. If the rebalancing for the commodity is positive the non-commercial long (NCL) traders rise the long positions. The first of the three possible channels show in the top part of the figure the commercial-long (CL) traders drop and close their positions, this effect should only be seen in the volume data. In the middle part, the commercial short (CS) traders rise their positions. Also, this effect should be seen in the open interest and volume data.Finally, the third part shows a rise in the future price (F_t), which can lead to two effects. The first one is identical to the middle part in figure 1. But the second effect shows no change for the commercial short positions and the risk premium and therefore a rise in the spot price. This effect should be seen in all three analysed data types price, volume and open interest. The effect therefore can be seen easiest in open interest data then volume data followed by future prices and finally spot prices. The last link to the three channels mentioned by Cheng and Xiong (2014).

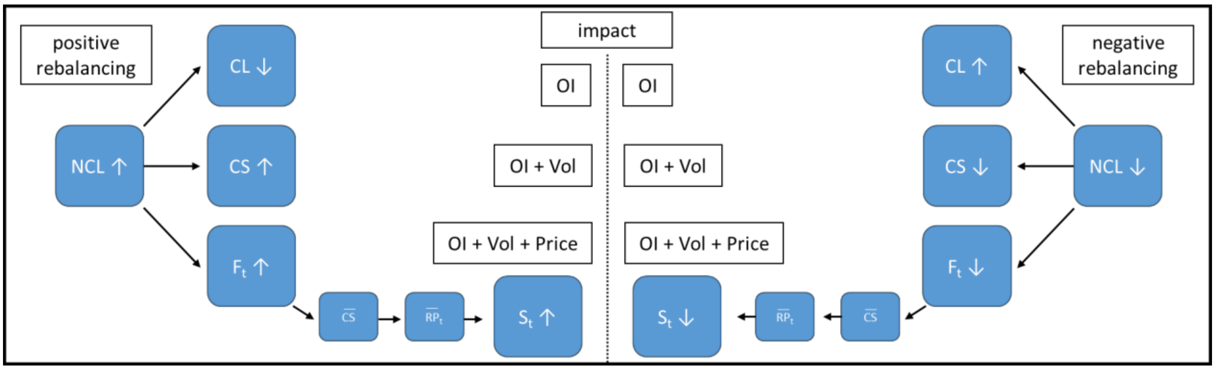


Figure 1 shows the influence of positive or negative rebalancing. If the rebalancing is positive the non commercial investors long (NCL) rise. Commercial investors include traders who use derivatives markets as a hedging tool, and they are often called hedgers. Non-commercial investors include all investors who have no interest in the physical commodity and therefore, they are speculators. That means in the first case the commercial long (CL) drop, this behaviour can be seen only in Vol data, however, no price effect. In the second case, the commercial short (CS) rise. Also, this can be seen with OI and Vol data. And in the third case, the future price (F_t) might cause or not a rise this can follow in two cases. The first case can be seen in the middle part of the figure concerning OI and Vol data. The second case means the commercial short and the risk premium stay constant, and therefore the spot price (S_t) rises, this can be investigated with open interest, volume and price data. The effect should be the same with negative rebalancing; only the direction is opposite.

Moreover, we would like to add that all commercial position can be non-commercials as well and combinations are also possible. Furthermore because of the methodology of the indices an economic influence which causes a reweighting is also possible. The consequence of a reduction is less interest in that commodity and therefore less trading activity for example. Alternative indices present an investment strategy overall, which can influence the reweighting.

3. Commodity indices and descriptive statistics

To describe an index effect details or further information of both indices are needed. Therefore this section gives a short overview of the characteristics of the BCOM and the S&P GSCI.

For our study, we chose the benchmark and therefore largest commodity indices, in this case, the BCOM and the S&P GSCI (Thürer 2014). The effects, which are presented in figure 1, are easier to observe with large indices because the economic influence (concerning trading volume) is bigger and therefore more money will be invested and shifted by index changes. Over the period from 2006 to 2016 we analyse both indices, but figure 2 shows that both indices have performed differently during that time.

This performance difference can be explained with differences in the methodology to calculate the weightings of commodities. These differences are explained below.

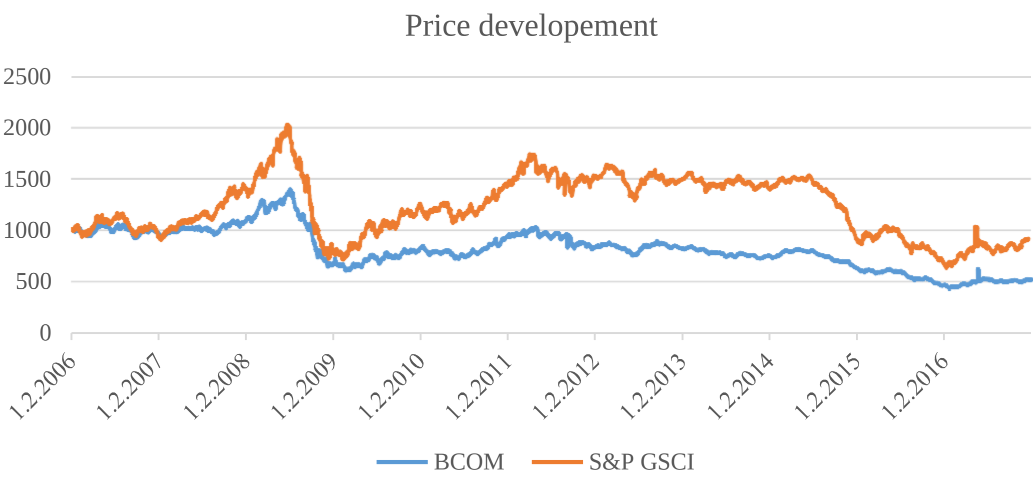


Figure 2 shows the price development from the BCOM (blue curve) and the S&P GSCI (orange curve). The shown period extends from 2006 to 2016. The starting value is standardised to 1000 basis points. The remaining data is also adjusted so that the progress is depicted correctly.

With a standardized starting point of 1000 basis points, it is clear that the S&P GSCI (orange curve) performs better than the BCOM (blue curve) because the relevant curve is on almost all points higher.

The differences result in detail because the S&P GSCI is a production-weighted index. The main design aspect is to reflect the relative significance of each of the constituent commodities to the world economy. The index rebalancing takes place in the beginning of January each year. The rebalancing process starts on the fifth business day and lasts for five days. The announcement takes place roughly half a year before. The current index (2016) includes 24 commodities, which can be divided into four commodity classes. Consequently, the focus concerning the weightings lies on the energy commodities with about 63%. The next biggest class is soft commodities with 15.75%, followed by metal commodities with 12.5% and livestock commodities with 8.6%. This unequal distribution is nearly the same overall years.

The BCOM is designed according to Bloomberg after four principles (economic significance, diversification, continuity and liquidity) to be highly liquid and diversified for commodity investments. This leads to the following weightings for the commodity classes (2016). Energy commodities have 31%, metal commodities 32%, soft commodities 30.6% and livestock commodities 5.6%. The rebalancing rhythm is similar to the S&P GSCI rhythm. The rebalancing takes place also on the fifth business day of January, which is also announced roughly half a year before.

To close the comparison of both indices the following tables sums up the important key facts. The data for both indices covers the period from 2006 to 2016 and all commodities which were analysed.

	S&P GSCI		**BCOM**	
	Positive	Negative	Positive	Negative
Number of commodities	20			
Removed from the index	0		0	
Added to the index	0		2	
Number of reweightings	96[2]	104[2]	86[2]	99[2]
Largest reweighting	12.01%[1]	14.76%[1]	5.31%	5.02%
Smallest reweighting	0.01%	0.01%	0.00%	0.00%
Mean reweighting	1.18%	1.36%	0.31%	0.30%
No reweighting	0		4	

Table 1 shows the descriptive statistics and key facts of both indices. [1]The substantial higher reweightings for the S&P GSCI are based on a calculation change for WTI and Brent Crude Oil. [2]The different size concerning positive and negative rebalancing is based on the choice of commodities which are included in both indices. The different sum of BCOM and S&P GSCI weightings is based on the four constant periods in the BCOM and the two additions.

To close the descriptive statistic following fact, it is also conspicuous that no commodity is over the complete period (2006 – 2016) equal in both indices, although most of the parameters concerning the rebalancing are similar. This is shown in table 4 in the appendix.

The data concerning the indices are obtained from S&P and Bloomberg. For our event study, we use spot and future prices as well as volume and open interest data. The spot prices are acquired from the Thomson Reuters Datastream. The volume, open interest, and future price data are gained from Quandl. Related to the index methodology we designed a custom-fit future price for each commodity. All descriptive statistics can be found in the appendix beginning with table 7.

4. Methodology

We use an event study method according to Henderson et al. (2014) to analyse a possible index effect. However, for the volume and open interest data, we follow Milonas (1991) to analyse a potential half month-effects concerning the analysed period.

To use the event study method, first, we calculate log-returns (R_{it}) from the raw data (future and spot prices, volume or open interest). Next, we calculate abnormal returns ($AR_{i,}$) from the returns (R_{it}) and test these ARs for statistical significance. The abnormal returns based on historical 15-day window or on basis of the market model or for open interest and volume data the final trading peak in November as a period. To test for abnormality in our sample we use either the non-parametric test of Corrado (1989) or the parametric t-test as comparison.

To calculate the abnormal return, we need an expected or normal (benchmark) return ($NR_{i,}$) as

$$AR_{it} = R_{it} - NR_{it},$$

where R_{it} is the day t log-return for commodity i of a specific commodity index. One event day is defined as a trading day of the particular commodity. The normal return NR is calculated with the constant mean approach (CRM) or the market model concerning Henderson et al. (2014).

Beginning with the market model approach consists of a linear factor model. To ensure comparability, we use the same factors as Henderson et al. (2014) which are motivated by Singleton (2013) and Tang and Xiong (2012):

$$NR_{i,t}^{MM} = \beta_0 + \beta_{i,EM} \cdot R_{EM,t} + \beta_{i,EM,t+1} \cdot R_{EM,t+1} + \beta_{i,S\&P} \cdot R_{S\&P,t} + \beta_{i,USD} \cdot R_{USD,t}$$

$$+\beta_{i,TBond} \cdot R_{TBond,t} + \beta_{i,VIX} \cdot R_{VIX,t} + \beta_{i,BDI} \cdot R_{BDI,t} + \beta_{i,INF} \cdot R_{INF,t} + \beta_{i,lag} \cdot R_{i,t-1} + \epsilon_{i,t}$$

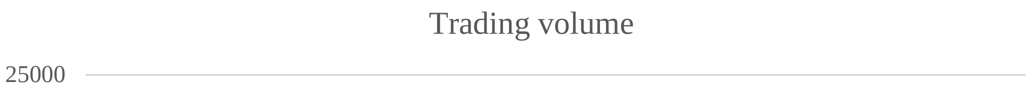
The market is represented by the returns of the MSCI Emerging Markets Asia Index (R_{EM}), the S&P 500 index ($R_{S\&P}$), the U.S. Dollar Index futures contracts (R_{USD}), the JP Morgan Treasury Bond Index (R_{TBond}) and the Chicago Board Options Exchange Volatility Index (R_{VIX}). Additionally, two macroeconomic control variables are used: R_{BDI} (returns of the costs of transport by ship) and R_{INF} (ten-year breakeven inflation rate change). To avoid autocorrelation effects lagged returns of the commodity prices are also included.

Concerning to the CRM-model McKenzie et al. (2004) are pointing out, that the constant mean approach often is more suited to obtain the NR compared to the market model. NR for the constant mean return model is calculated with

$$NR_{i,t}^{CRM} = \frac{1}{L_{Estim}} \sum_{t=T_{Estim}^{Begin}}^{T_{Estim}^{End}} R_{i,t}$$

where L_{Estim} is the length, T^{Begin}_{Estim} the beginning and T^{End}_{Estim} the end of the estimation window.

All parameters for the NR (the βs and the mean return respectively) are estimated in a window preceding the event window. According to Henderson et al. (2014), we use a 60-day-estimation window, which is in line with McKenzie et al. (2004). To cover all other approaches concerning studies about indices the estimation window differs between 113-day and 15-day as well. Additional for the open interest and the volume data we use the final trading peak in November as an estimation window. That can be explained with the cyclicality of commodity future trading as shown in figure 3. Therefore, it is interesting if the pattern with the peak in the beginning of November is not as regular as the peak in the beginning of the year, which is synchronous with the rebalancing of the BCOM and the S&P GSCI. All concerning windows are adjusted separately to this case.



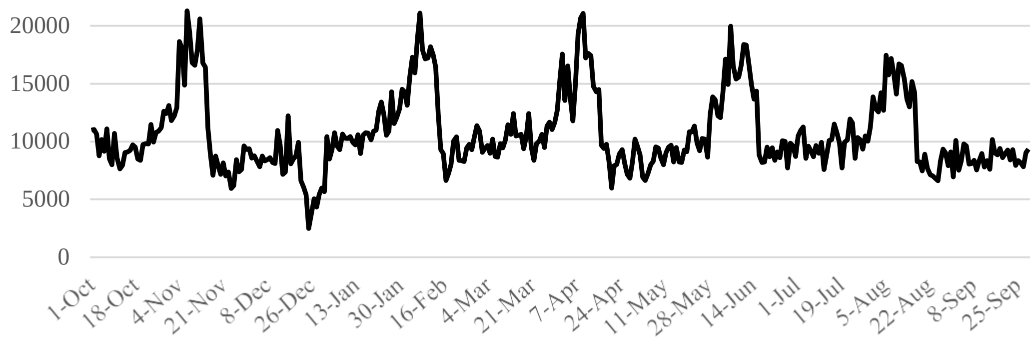


Figure 3 shows the trading volume in contracts for over one year. Each figure is the average volume of 20 years. This figure shows the trading development for cocoa exemplary for all commodities. Noticeable are the five peaks, we matched the peak in November with the increase period from the end of December until mid of January to see possible abnormalities concerning the rebalancing date which takes place in the first trading week of January for BCOM and the S&P GSCI.

The rebalancing day of each commodity index is specified and familiar to all trading groups, so it is not clear when exactly investors hedge their positions. Therefore, it is of interest, if significant abnormal returns are present before the rebalancing. This could be an indication that index investors hedge their positions ex ante.

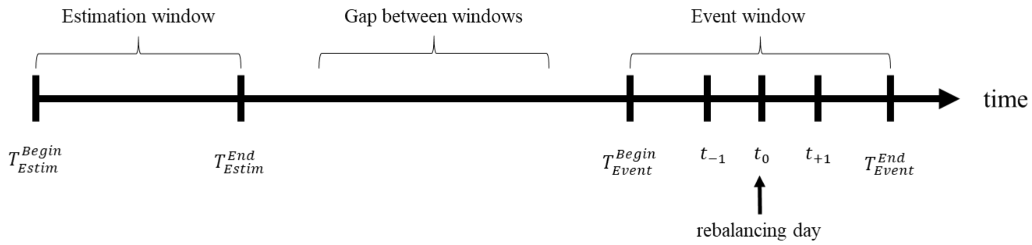


Figure 4: Illustrative timeline of the event study

For these reasons we do not only focus on the single rebalancing day (t_0) and subsequent days (t_{-1},t_{+1}) but also consider a broader event window with days before the rebalancing day (-3, +3). The event window length is always just as long as needed. All AR_i, are calculated with the estimated NR_i, of the issue date itself.

Further problems with the timeline like it is described in figure 4 occur by calculating the estimation window because for the used parameters these variables have the December-Effect. The rebalancing days, which are in the first trading of January are subject to the January-Effect. Both effects have to be taken into account for further analysis. Both effects are recognised with the help of a dummy variable in the calculation of NR_i.

For the analysis of specific days within the event window the non-parametric test of Corrado (1989) is used: Let $K_{i,t}$ be the rank of the abnormal return of the estimation and event window, $L = L_{Estim} + L_{Event}$ the corresponding length. N is the number of events, where $AR_{i,\tau_j} \leq AR_{i,\tau_{j+1}}$ implies $K_{i,\tau_j} \leq K_{i,\tau_{j+1}}$ and $1 \leq K_{i,\tau_j} \leq L$ with $T^{Begin}_{Estim} \leq \tau_j \leq T^{End}_{Event}$. Then the test statistic is

$$\theta(\hat{T}) = \frac{\frac{1}{N}\sum_{i=1}^{N}\left(K_{i,\hat{T}} - \frac{L+1}{2}\right)}{\sigma(K_i)} \sim t_{N-1}$$

with $T^{Begin}_{Event} \leq T \leq T^{End}_{Event}$ and

$$\sigma(K_i) = \sqrt{\frac{1}{L}\sum_{t=T^{Begin}_{Estim}}^{T^{End}_{Event}}\left(\frac{1}{N}\sum_{i=1}^{N}\left(K_{i,t} - \frac{L+1}{2}\right)\right)^2}.$$

Also, we use an additional parametric test a simple t-test according to Brown and Warner (1980). This test needs the assumption of normal distribution but can cumulate the effects of different days. Therefore, it is possible to analyse effects within a window if it is not clear when the effects occur or if effects occur on different dates within a window. As outlined above this may be the case. Furthermore, it is possible to present the data and possible trends with this method in a convenient way.

We apply the cumulative abnormal returns (CARs) to analyse the ARs within the whole event window. The CAR of time T is calculated, following e.g. MacKinlay (1997) via:

$$\overline{CAR}(\hat{T}) = \frac{1}{N}\sum_{i=1}^{N}\left(\sum_{t=T^{Begin}_{Event}}^{\hat{T}} AR_{i,t}\right),$$

with $T^{Begin}_{Event} \leq \hat{T} \leq T^{End}_{Event}$ and $\sigma^2(\overline{CAR}(\hat{T})) = \sum_{t=T^{Begin}_{Event}}^{\hat{T}} \sigma^2(\overline{AR})$ as standard deviation.

5. Results

The basic results are measured with following parameters concerning figure 4. The estimation window has 15 days, the gap between event and estimation window is 35 days, and the event window has three days (one before and one day after the event). The different windows are adjusted related to figure 3 and the last trading peak in November as a benchmark. To measure the significances, we use the non-parametric test. The depending variables are volume, open interest and prices (spot and future prices) of the underlying commodities of both indices (S&P GSCI and BCOM). The rebalancing days are divided in positive and negative ones. The direction is measured cumulative over both indices. This can be seen in table 6 in the appendix. The future prices are adjusted to the rolling strategy of the respective index, and the data is divided into positive and negative rebalancing parts. For the volume and open interest data the CRM method is chosen and for the prices the CRM and the MM method after Henderson et al..

Table 2 shows in two panels the results. Beginning related to figure 1 with the results for volume and open interest data with the CRM method (Panel A). The results show high significance for the event day for all settings concerning open interest and volume. For the open interest one day after the event the results are also significant. Otherwise no further clear significance is visible. Concerning the price data Panel B shows the findings. Related to figure 1 we start with the Future prices which show significances only for positive rebalancing and in this case one day after the event. The other constellations show no significance or no clear result. For spot prices the results are even worse. Therefore further settings have to be tested to quantify the first results.

Panel A – Basic results Open Interest and Volume					
Depending Variable	Weighting	Method	Eventday	CAR	t-Statistics
Open Interest	Positive	CMR	-1 0 +1	0.0029 0.0074 0.0121	0.533778008 1.721864541** 2.083456095**
Open Interest	Negative	CMR	-1 0 +1	0.0043 0.0276 0.0215	0.551553612 1.997849751** 1.850768788**
Volume	Positive	CMR	-1 0 +1	-0.0067 0.0879 0.0096	0.366062788 2.303145039** -0.655862495
Volume	Negative	CMR	-1 0 +1	0.0388 0.1789 0.0943	1.485816202* 2.476360336** -1.171357746
Panel B – Basic results Future and Spot prices					
Depending Variable	Weighting	Method	Eventday	CAR	t-Statistics
Future prices	Positive	CMR	-1 0 +1	0.0042 0.0052 -0.0056	1.221446155 0.237259325 -3.084371226***
Future prices	Negative	CMR	-1 0 +1	-0.0006 -0.0038 -0.0054	-0.190573238 -1.403312026* -0.259872597
Future prices	Positive	MM	-1 0 +1	0.0212 0.0392 0.0454	1.221446155 0.237259325 -3.084371226***
Future prices	Negative	MM	-1 0 +1	-0.0116 -0.0257 -0.0384	-3.605146136*** -5.647545901*** -6.874890104***
Spot prices	Positive	CMR	-1 0 +1	0.0050 0.0036 -0.0019	1.328379421* 0.287587297 -1.328379421*
Spot prices	Negative	CMR	-1 0 +1	-0.0012 -0.0011 -0.0036	-0.112349482 0.022469896 -0.951225617
Spot prices	Positive	MM	-1 0 +1	-0.0102 -0.0268 -0.0475	1.328379421* 0.287587297 -1.328379421*
Spot prices	Negative	MM	-1 0 +1	-0.0252 -0.0492 -0.0758	-0.112349482 0.022469896 -0.951225617

Table 2 shows all results for the basic analysis. The results cover the cumulative weighting for open interest and volume (Panel A) and future and spot prices (Panel B) and a short event window. Positive and negative means the rebalancing direction of the underlying commodities. The table shows the cumulative abnormal return (CAR) and the corresponding t-statistic for each day. Significance level *< 10%, ** < 5%, *** < 1%.

To prove this significant results, we analysed only the weightings for those commodities which were reweighted in the same direction for both indices. In addition, all settings are analysed with a parametric and a non-parametric test. As well with the trading volume fit and a setting for the event, estimation window and the gap between them related to the literature.

Furthermore, the direction of the cumulated abnormal returns does not fit to the theory. The next results are only the weightings for those commodities which were reweighted in the same direction for both indices. Both settings (positive and negative) related to the commodities and the different years show table 12 and 13 in the appendix.

Panel A – Basic results Open Interest and Volume					
Depending Variable	Weighting	Method	Eventday	CAR	t-Statistics
Open Interest	Positive	CMR	-1 0 +1	0.0048 0.0126 0.0186	1.153765364 1.828274345** 1.934775764**
Open Interest	Negative	CMR	-1 0 +1	0.0021 0.0054 0.0108	0.384652926 1.298203624 1.923264628**
Volume	Positive	CMR	-1 0 +1	-0.0308 0.04793 -0.0137	0.37197446 1.363906354* -0.159417626
Volume	Negative	CMR	-1 0 +1	0.1142 0.1997 0.1077	2.132743799** 1.640572153* -1.121057638
Panel B – Basic results Future and Spot prices					
Depending Variable	Weighting	Method	Eventday	CAR	t-Statistics
Future prices	Positive	CMR	-1 0 +1	0.0080 0.0102 0.0002	2.098547601** 1.161332168 -1.935553613**
Future prices	Negative	CMR	-1 0 +1	-0.0032 -0.0115 -0.0116	-0.601427299 -1.777551795** -0.628157401
Future prices	Positive	MM	-1 0 +1	0.0354 0.0650 0.0824	2.098547601** 1.161332168 -1.935553613**
Future prices	Negative	MM	-1 0 +1	-0.0046 -0.0144 -0.0160	-0.601427299 -1.777551795** -0.628157401
Spot prices	Positive	CMR	-1 0 +1	0.0077 0.0030 -0.0079	1.133211225 0.123419044 -1.671767055*
Spot prices	Negative	CMR	-1 0 +1	-0.0018 -0.0048 -0.0030	0.254116955 -0.577538535 0.577538535
Spot prices	Positive	MM	-1 0 +1	-0.0090 -0.0305 -0.0581	1.133211225 0.123419044 -1.671767055*
Spot prices	Negative	MM	-1 0 +1	-0.0302 -0.0615 -0.0881	0.254116955 -0.577538535 0.577538535

Table 3 shows all results for the robustness check of the same weighting direction. The results cover the cumulative weighting for open interest and volume (Panel A) and future and spot prices (Panel B) and a short event window. Positive and negative means the rebalancing direction of the underlying commodities. The table shows the cumulative abnormal return (CAR) and the corresponding t-statistic for each day. Significance level *< 10%, ** < 5%, *** < 1%.

Table 3 shows the results for the commodities which were rebalanced in the same direction (positive or negative). The effects for the rebalancing day itself is clear for the volume and open interest data. The prices show no clear picture. For the future prices we found significances for the days before and after the event but not for the event itself. Therefore, it is difficult to assign the significances direct to the event. For the spot prices we found no or only occasional significances which cannot by assigned. These results for open interest, volume, spot and future prices match our expectations.

Concerning an index effect, we can establish an explicit effect especially for open interest and volume data as shown in table 2. In this cases we can prove an effect for the event day and in some cases one day before and after the event. This effect can be enhanced with the results from the measurement with commodities, which were weighted in one direction (table 3). The results are strengthened because with other event days (table 6 in the appendix) no significances for the event days itself can be measured and also the other significances are reduced. For the overall effect we think it is possible that some traders close their position for those commodities which were rebalanced contrary by both indices. As well it is possible that the compensation of positions takes place between announcement and rebalancing day and therefore if the process is long enough no abnormal return is measurable. In this case, it is also possible that several effects overlap and make a clear result impossible. For prices (future and spot) the results are not so clear. The results are better for the future prices, which matches with our theory concerning figure 1 like all other results. But for the prices we cannot confirm a clear index effect in all cases.

Further results and robustness tests

To consolidate the clear effect, we analysed further settings. First we methodically adjusted the settings for the event study (figure 4) concerning estimation window, gap and event window. The results in relation to the significance did get worse. That means with the clear and short structure around the rebalancing dates the effect could be isolated well. Second we used a normal t-test for the results with no improvement for the results, therefore no normal distribution can be assumed. Third because of a broader dataset for the BCOM from 1999 – 2016 we analysed the whole period. But the results for only one index are not as clear as the aggregated effects for both. Fourth to isolate the effect for the rebalancing of the commodity indices in the beginning of January, we tested possible effects beginning with the fifth business day in March, May and July. The results were clear with an independent behaviour for the January days. For the results concerning March, May and July we proved another effect which is described below. Finally, we also tested the different commodity classes of each index separately. But because of different characteristics of each commodity class like harvest periods the results are not as clear as for the whole index.

Concerning the earlier mentioned other dates of the rebalancing in the beginning of March, May and July. We tested for a monthly pattern like the January-Effect. Also, figure 3 is a reason to look after some seasonality. The test analyses the differences between the various trading month concerning a rebalancing in other months. In doing so, we analysed January (basic rebalancing), March, May, and July. The results show an existing monthly pattern for all months except January.

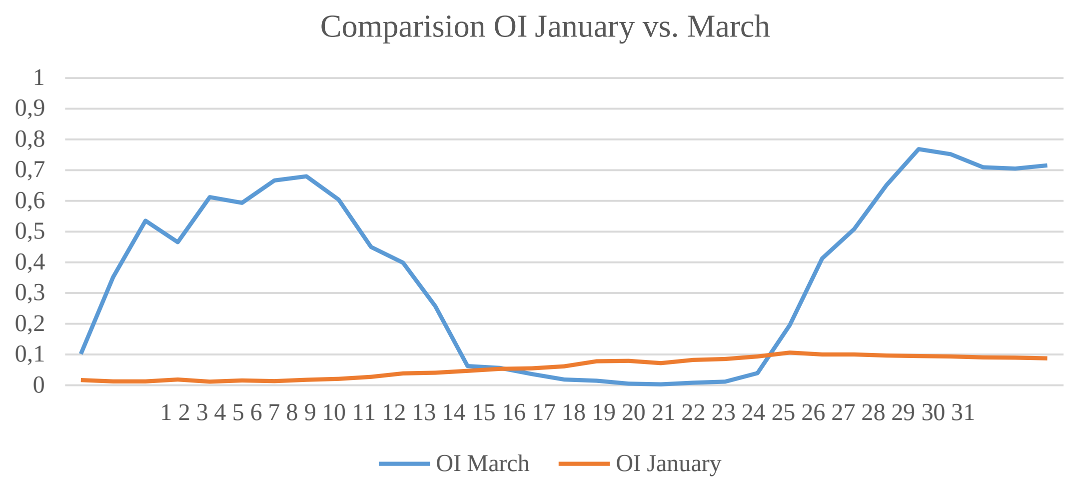


Figure 5 shows the results for the comparison if the event day (day 17 in this case) is in March or January. Therefore, the horizontal axis plots the days and the vertical axis the related p-value.

The pattern shows in particular for the open interest an increase at the beginning and the end of each month. In the middle of each month, the development is flat. These results confirm that in January some unusual events have to happen, but the link between index trader and the influence of the underlying commodities is still unclear or rather cannot be clearly defined. Finally, the whole evaluation period is grouped in many different periods without any significant effect on the results.

Therefore with our results, we can confirm the findings of Milonas (1991) and Chang (1988). Milonas measures seasonality in commodity markets as well as a half month effects. By the used volume and open interest data, we can show an individual pattern for the different commodities. The identified pattern points out that each commodity has its rhythm which correlates with future contracts of these commodities. Also, the differences between the various commodities can be confirmed following the results of Chang. The pattern is similar to figure 3.

6. Discussion

Our idea was to find financialization impacts with the help of reweighting commodity indices. Covering the reweighting process with three influencing factors in particular volume, open interest and the price (future and spot) of each commodity. Based is this idea on proven index effects concerning stock indices. Shleifer, Harris and Gurel, Woolridge and Ghosh, Lamoureux and Wansley, Jain, Dhillon and Johnson, Edmister et al. and Lynch and Mendenhall can confirm an index effect for the S&P 500. This effect was also measured for the introduction of the MDAX by Steiner and Heinke (1997) and Gerke et al. (2001). The focus of the stock index studies is the addition or removal from firms to or from an index like the S&P 500 as well as an introduction of a new index like the studies concerning the MDAX. To transfer this mechanism from stock to commodity indices is difficult. Commodity indices have overlapping effects because of their construction. The rebalancing takes place at a specific date – beginning of January – on which several market activities happen and therefore to isolate one effect is very difficult as described earlier. Therefore, we added the idea of Henderson et al. (2014) who finds evidence for price impact around pricing dates of newly issued certificates and therefore new inflows for the commodity future market. Because the rebalancing and the addition or removal from or to an index should follow a similar mechanism. Based on this idea we draw three different possible mode of action which are illustrated in figure 1. In doing so we can measure clear effects for volume and open interest data. The effect for volume data is also proven for the stock index studies described above. But we cannot support the effect for the price data on the hand like it is proven for stock indices and on the other hand like the results found by Henderson. Therefore, the behaviour of commodity indices is different from the other studies. This approach is supported by the fact of growing investment and in this context financialization of commodity markets like it is proven by Mayer et al. (2017). On this account we analysed the benchmark indices (BCOM and S&P GSCI) with a dataset from 2006 to 2016. Our main results are based on a cumulative effect of both indices that is why we add up the rebalancing of each commodity to obtain an overall effect. This effect should have a better validity for the overall effect and with this effect - specially adjusted to the market in the beginning of January – we can prove an index effect for open interest and volume data.

Like described in the results we also tested the announcement and other days because the theory related to financialization implied concerning prices that the new rebalancing information is handled before the rebalancing day itself.

Also, the general idea behind the compensation of a trading position is based on the concept of a consistent number of positions which has to be balanced. Positive rebalancing entails, therefore, an increase of financial-long position and negative rebalancing a drop of these positions. The following position is the result of these first effects. This behaviour we can proof with the results of the volume data. Furthermore, we can also prove a cumulative effect for the open interest data. Only for both price datasets we cannot prove a clear effect. Moreover, we would like to add that all financial position can be non-financials as well and combinations are also possible (figure 1). Furthermore because of the methodology of the indices an economic influence which causes a reweighting is also possible. The consequence of a reduction is less interest in that commodity and therefore less trading activity for example. Alternative indices present an investment strategy overall, which can influence the reweighting.

Moreover, the importance of commodity indices – especially in the case of prices – is explained with the growing amount of invested money with different financial products. How large this amount is and which rules and information the biggest player have to adjust their position is not clear. That means because the methodology to calculate the weightings is freely available everyone can calculate the new weightings and moreover can adjust the position earlier. Also, it is not clear how many of the invested money is shifted if the new weightings are introduced which raises the question of the comparability from commodity and stock indices in this case. Additional to the proven index effect for volume and open interest data we can confirm the results of Milonas concerning the half month effects and different trading behavior for each commodity concerning different months.

Returning to the unclear results for the prices (spot and future) and the overlapping effects. Each commodity has a different origin that means metal commodities for example, which have no special harvest rhythm can be mined over to the whole year. In contrast, agricultural commodities have their harvest rhythm depending on the cultivation region, and finally the energy commodities, which are subject to market demand related to the time of year, because in winter the demand for heating oil, for example, is higher. Additional to special commodity characteristics takes the rebalancing place in a special time of the year for exchanges. That means our study covers with the event window and the estimation window December and January with special effects like the January- or December-effect because of public holidays and the turn of the year. This problem we have covered with a January-Dummy variable for the Market Model and special setting (for MM and CMR) concerning the trading behaviour of commodities for the estimation and the event window. The dummy variable has no influence on the results, but the special setting delivers clear results for a possible index effect for volume and open interest data. This shows that the trading behaviour has only influence on volume and open interest data, but not on price data and that the prices – future and spot – are subject to other influences.

7. Conclusion

Concluding, with this study, we examine the rebalancing effects of commodity indices on the underlying commodities using volume, open interest, and price (future and spot) data. Based on existing literature in the area of financialization and changes in stock indices, we try to measure an index effect with the help of the rebalancing direction. We used an event study with 86 positive and 99 negative changes for the BCOM and 96 positive and 104 negative rebalancing positions for the S&P GSCI. The analysed period covers the years 2006 to 2016 for both indices.

We can confirm concerning our open interest and volume data an index effect concerning the rebalancing date for both indices. Further we can prove the half month effects related to Milonas and different trading behavior for each commodity concerning different months. Further, we cannot confirm any index effect concerning the commodity prices (future and spot). Analysis with all kind of clustering concerning the type of rebalancing, size of rebalancing, commodity groups and different periods show no significant effect for the prices. On the other hand, the results with the trading volume fit for open interest and volume data shows a clear index effect for the rebalancing. Therefore, concerning the financialization idea the analysis related to volume and open interest data related to the type of commercial positions as described in figure 1 show an evidence in contrast to the price data. Therefore, with this study, we can support the idea of financialization in the commodity market, and we can prove an index effect concerning the rebalancing only for open interest and volume data. However we cannot see a price effect for commodity indices like it is proved for the most stock index studies.

Finally, the first approach concerning commodity indices leads to significant results for open interest and volume data. Concerning prices, no effect is provable. Following the results of the benchmark indices the analysis of further indices to validate the results is necessary. Therefore, further research has to be done regarding the indices and the measured values.

8. References

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Appendix

Commodities	2006/2007		2007/2008		2008/2009		2009/2010		2010/2011		2011/2012		2012/2013		2013/2014		2014/2015		2015/2016	
	S&P	BCOM	S&P	BCOM	S&P	BCOM	S&P	BCOM	S&P	BCOM	S&P	BCOM	S&P	BCOM	S&P	BCOM	S&P	BCOM	S&P	BCOM
Aluminum	-1,02%	-0,05%	-0.52%	0.30%	-0.08%	-0.11%	0.18%	-1.25%	-0.18%	-0.55%	-0.29%	0.67%	-0.12%	-0.96%	-0.02%	-0.19%	2.92%	-0.13%	-1.98%	0.01%
Brent	-0,39%		-1.01%		-0.83%		1.36%		1.94%		1.96%	5.31%	3.84%	0.48%	1.27%	0.00%	-14.76%	0.65%	11.71%	0.37%
Coffee	-0,12%	0,09%	-0.04%	-0.02%	0.20%	-0.03%	0.02%	-0.41%	0.18%	-0.21%	-0.28%	0.22%	-0.20%	-0.13%	0.13%	-0.12%	0.95%	-0.11%	-0.67%	0.08%
Copper	-1,97%	0,31%	-1.04%	0.85%	0.34%	0.27%	0.59%	0.33%	-0.23%	-0.10%	-0.23%	-0.48%	-0.15%	0.21%	-0.05%	0.23%	7.67%	0.03%	-6.87%	0.09%
Corn	1,40%	-0,25%	0.57%	0.04%	0.27%	0.06%	-0.36%	1.37%	1.05%	-0.11%	0.32%	-0.31%	-0.79%	0.38%	-0.81%	0.14%	3.22%	0.05%	-2.26%	0.11%
Cotton	0,04%	-0,02%	-0.05%	-0.67%	0.26%	-0.21%	0.30%	-0.27%	0.27%	0.00%	-0.61%	0.00%	0.04%	-0.23%	-0.01%	-0.19%	-0.10%	-0.07%	0.24%	-0.02%
Gasoline	-0,15%	0,00%	2.76%	-0.27%	0.50%	-0.07%	-0.21%	-0.18%	0.38%	-0.03%	0.24%	-0.09%	0.91%	0.06%	-0.10%	0.16%	-3.51%	0.08%	2.94%	0.06%
Gold	0,08%	0,61%	0.00%	0.57%	1.07%	0.47%	-0.07%	1.25%	-0.06%	1.33%	0.12%	-0.66%	-0.47%	1.02%	-0.22%	0.71%	6.79%	0.37%	-5.91%	-0.52%
Heating Oil	-0,45%	-0,06%	-0.70%	0.03%	-0.88%	-0.17%	0.22%	-0.07%	0.55%	-0.01%	0.06%	-0.12%	1.09%	0.06%	-0.23%	0.20%	-3.78%	0.04%	2.95%	-0.17%
Kansas Wheat	0,26%		-0.32%		-0.11%		-0.15%		0.13%		0.14%		-0.24%	1.32%	0.01%	-0.11%	0.05%	-0.04%	0.12%	-0.02%
Lean Hogs	0,15%	-1,34%	-0.23%	-0.47%	0.39%	-0.15%	0.03%	-0.30%	-0.05%	-0.10%	-0.04%	0.11%	0.16%	-0.21%	0.43%	-0.03%	-0.62%	0.07%	0.85%	0.12%
Live Cattle	0,13%	0,05%	-0.33%	-1.25%	0.76%	-0.60%	-0.28%	-0.73%	-0.13%	-0.19%	0.23%	0.28%	0.03%	-0.35%	0.33%	-0.01%	-0.69%	0.06%	2.36%	0.24%
Natural Gas	-0,34%	0,23%	-0.19%	-0.31%	-2.05%	-0.35%	-0.99%	-0.34%	-1.10%	-0.33%	-0.78%	-0.45%	0.65%	-0.34%	0.41%	-0.98%	5.67%	-0.71%	-5.49%	-0.29%
Nickel	0,38%	0,06%	-0.76%	0.08%	0.03%	0.09%	0.15%	-0.52%	-0.15%	-0.12%	-0.13%	0.33%	-0.07%	-0.34%	0.05%	-0.19%	1.73%	0.07%	-1.57%	0.24%
Silver	-0,09%	0,29%	-0.02%	0.43%	0.11%	0.17%	0.03%	0.40%	0.16%	0.00%	-0.05%	-0.52%	-0.11%	1.13%	-0.05%	0.24%	2.41%	0.13%	-2.33%	-0.06%
Soybeans	0,75%	-0,02%	0.31%	-0.12%	0.54%	-0.03%	-0.42%	0.31%	0.07%	-0.06%	0.37%	-0.77%	-0.15%	-1.59%	0.01%	0.19%	8.34%	-0.00%	-8.04%	0.02%
Sugar	-0,53%	0,15%	0.10%	0.06%	1.14%	-0.19%	-0.01%	-0.10%	-0.07%	0.43%	-0.40%	0.43%	-0.33%	0.13%	-0.02%	0.07%	0.88%	0.04%	-0.70%	-0.37%
Wheat	1,09%	-0,06%	0.22%	-0.01%	0.07%	0.09%	-0.57%	-0.09%	-0.19%	-0.10%	0.18%	0.36%	-0.07%	-1.53%	-0.32%	-0.09%	-0.09%	-0.01%	0.70%	-0.00%
WTI	1,50%	-0,06%	2.14%	0.43%	-1.65%	0.60%	-0.85%	0.59%	-3.52%	0.37%	-1.92%	-5.02%	-4.47%	-0.48%	-0.85%	-0.72%	-14.17%	-0.65%	12.01%	-0.37%
Zinc	-1,00%	0,10%	-0.52%	0.23%	0.15%	0.11%	0.04%	-0.12%	-0.12%	-0.17%	-0.04%	0.27%	0.00%	-0.60%	0.06%	-0.21%	1.73%	0.09%	-1.42%	0.12%

Table 4: Weighting behaviour of S&P GSCI and BCOM 2006 – 2016

Table 4 shows the changes concerning the weightings of the underlying commodities – only for commodities, which are part of both indices – over the period 2006-2016 for BCOM and S&P GSCI. Green spaces mean a growing proportion for the commodity in the following year. Red spaces mean a decreasing proportion for the next year. White spaces mean that the commodity is not part of the index in the related year. The yellow spaces mean that the weighting is not changed for the following year. In each space the size of the rebalancing is shown.

Commodities	2006/ 2007	2007/ 2008	2008/ 2009	2009/ 2010	2010/ 2011	2011/ 2012	2012/ 2013	2013/ 2014	2014/ 2015	2015/ 2016
	Cumulative weighting between BCOM and S&P GSCI									
Aluminum	-1,07%	-0,22%	-0,19%	-1,07%	-0,73%	0,38%	-1,08%	-0,21%	2,79%	-1,97%
Brent						7,27%	4,32%	1,27%	-14,11%	12,08%
Coffee	-0,03%	-0,06%	0,17%	-0,39%	-0,03%	-0,06%	-0,33%	0,01%	0,84%	-0,59%
Copper	-1,66%	-0,19%	0,61%	0,92%	-0,33%	-0,71%	0,06%	0,18%	7,70%	-6,78%
Corn	1,15%	0,61%	0,33%	1,01%	0,94%	0,01%	-0,41%	-0,67%	3,27%	-2,15%
Cotton	0,02%	-0,72%	0,05%	0,03%	0,27%	-0,61%	-0,19%	-0,20%	-0,17%	0,22%
Gasoline	-0,15%	2,49%	0,43%	-0,39%	0,35%	0,15%	0,97%	0,06%	-3,43%	3,00%
Gold	0,69%	0,57%	1,54%	1,18%	1,27%	-0,54%	0,55%	0,49%	7,16%	-6,43%
Heating Oil	-0,51%	-0,67%	-1,05%	0,15%	0,54%	-0,06%	1,15%	-0,03%	-3,74%	2,78%
Kansas Wheat							1,08%	-0,10%	0,01%	0,10%
Lean Hogs	-1,19%	-0,70%	0,24%	-0,27%	-0,15%	0,07%	-0,05%	0,40%	-0,55%	0,97%
Live Cattle	0,18%	-1,58%	0,16%	-1,01%	-0,32%	0,51%	-0,32%	0,32%	-0,63%	2,60%
Natural Gas	-0,11%	-0,50%	-2,40%	-1,33%	-1,43%	-1,23%	0,31%	-0,57%	4,96%	-5,78%
Nickel	0,44%	-0,68%	0,12%	-0,37%	-0,27%	0,20%	-0,41%	-0,14%	1,80%	-1,33%
Silver	0,20%	0,41%	0,28%	0,43%	0,16%	-0,57%	1,02%	0,19%	2,54%	-2,39%
Soybeans	0,73%	0,19%	0,51%	-0,11%	0,01%	-0,40%	-1,74%	0,20%	8,34%	-8,02%
Sugar	-0,38%	0,16%	0,95%	-0,11%	0,36%	0,03%	-0,20%	0,05%	0,92%	-1,07%
Wheat	1,03%	0,21%	0,16%	-0,66%	-0,29%	0,54%	-1,60%	-0,41%	-0,10%	0,70%
WTI	1,44%	2,57%	-1,05%	-0,26%	-3,15%	-6,94%	-4,95%	-1,57%	-14,82%	11,64%
Zinc	-0,90%	-0,29%	0,26%	-0,08%	-0,29%	0,23%	-0,60%	-0,15%	1,82%	-1,30%

Table 5: Cumulative weighting behaviour for BCOM and S&P GSCI between 2006 - 2016

Table 5 shows the cumulative changes concerning the weightings of the underlying commodities – only for commodities, which are part of both indices – over the period 2006-2016 for BCOM and S&P GSCI. Green spaces mean a growing proportion for the commodity in the following year. Red spaces mean a decreasing proportion for the next year. Grey spaces mean that the commodity is not part of the index in the related year.

Panel A – Basic results Open Interest and Volume					
Depending Variable	Weighting	Method	Eventday	CAR	t-Statistics
Open Interest	Positive	CMR	-1 0 +1	0.0057 0.0123 0.0125	1.456187987* 2.107908485** 0.427691577
Open Interest	Negative	CMR	-1 0 +1	-0.0099 -0.0031 -0.0052	1.289900228 1.420339577* 1.376859794*
Volume	Positive	CMR	-1 0 +1	0.2196 0.2558 0.3976	2.372879363** 0.124888388 1.461194134*
Volume	Negative	CMR	-1 0 +1	0.1277 0.1993 0.3974	1.27229285 1.373497963* 2.457838461***
Panel B – Basic results Future and Spot prices					
Depending Variable	Weighting	Method	Eventday	CAR	t-Statistics
Future prices	Positive	CMR	-1 0 +1	-0.0068 0.0003 0.0125	-2.176591926** 0.877773137 2.404955669**
Future prices	Negative	CMR	-1 0 +1	-0.0020 0.0026 0.0122	-1.826002581** 0.104343005 1.56514507*
Future prices	Positive	MM	-1 0 +1	0.0190 0.0522 0.0946	-1.271494585 0.926292436 2.951478381***
Future prices	Negative	MM	-1 0 +1	-0.0154 -0.0251 -0.0284	-0.577104398 0.710282336 2.027264169**
Spot prices	Positive	CMR	-1 0 +1	0.0049 0.0070 0.0121	0.317393443 -0.423191257 0.952180328
Spot prices	Negative	CMR	-1 0 +1	0.0042 0.0056 0.0106	-0.228774846 0.051658836 0.937238887
Spot prices	Positive	MM	-1 0 +1	0.0253 0.0393 0.0607	1.238303677 1.379457464* 1.741966054**
Spot prices	Negative	MM	-1 0 +1	0.0088 0.0110 0.0177	1.355075713* 1.360922857* 1.694210087**

Table 6 shows all results for the first robustness check of the basic analysis related to other event days. These days can be seen in table 11. The results cover the cumulative weighting for open interest and volume (Panel A) and future and spot prices (Panel B) and a short event window. Positive and negative means the rebalancing direction of the underlying commodities. The table shows the cumulative abnormal return (CAR) and the corresponding t-statistic for each day. Significance level *< 10%, ** < 5%, *** < 1%.

Commodity	Minimum	Maximum	Mean	Median	Sigma	Unit
Aluminum	1251.75	3271.25	2127.25	2052.25	433.67	U$/t
Brent	26.01	143.95	84.60	82.69	25.70	U$/Barrel
Coffee	91.03	296.75	145.45	129.10	44.26	Cents/lb
Copper	124.80	462.30	317.81	330.00	64.71	Cents/lb
Corn	189.00	849.00	454.1	381.50	159.78	Cents/Bushel
Cotton	35.93	210.64	72.83	65.11	27.96	Cents/lb
Gasoline	0.79	3.67	2.26	2.23	0.60	U$/Gallon
Gold	516.00	1895.00	1145.20	1183.00	345.73	U$/Troy Oz
Heating Oil	0.82	4.08	2.33	2.23	0.67	U$/Gallon
Lean Hogs	47.97	134.17	76.43	75.30	17.10	Cents/lb
Live Cattle	78.23	171.38	112.00	106.21	25.25	Cents/lb
Natural Gas	1.49	13.31	4.77	4.12	2.15	U$/Million Btu
Nickel	7705.00	54050.00	20017.32	18145	8362.33	U$/t
Silver	8.81	48.55	19.87	17.36	7.96	U$/Troy Oz
Soybeans	504.50	1790	1093.33	1050.00	295.46	Cents/Bushel
Sugar	8.87	32.57	17.19	16.69	5.11	Cents/lb
Wheat	247.50	1194.50	573.42	565.50	161.60	Cents/Bushel
WTI	26.21	145.66	79.70	81.74	22.12	U$/BBL
Zinc	1046.75	4603.00	2223.32	2076.75	645.98	U$/t

Table 7: descriptive statistic spot prices for the years 2006 – 2016

Commodity	Minimum	Maximum	Mean	Median	Sigma	Unit
Brent	41.18	147.05	89.67	91.35	21.98	U$/Barrel
Coffee	94.05	304.90	154.85	138.25	46.09	Cents/lb
Copper	1.27	4.64	3.29	3.35	0.61	Cents/lb
Corn	218.75	831.25	484.98	430.00	151.70	Cents/Bushel
Cotton	34.26	215.15	78.37	71.91	29.76	Cents/lb
Gasoline	1.34	3.35	2.66	2.76	0.41	U$/Gallon
Gold	565.94	1891.90	1161.86	1211.90	363.06	U$/Troy Oz
Heating Oil	1.14	4.12	2.49	2.57	0.59	U$/Gallon
Lean Hogs	43.98	132.65	79.42	78.45	16.19	Cents/lb
Live Cattle	73.12	171.00	109.13	102.05	22.48	Cents/lb
Natural Gas	2.00	13.58	5.14	4.34	2.17	U$/Million Btu
Silver	8.79	48.59	21.17	18.87	8.28	U$/Troy Oz
Soybeans	538.50	1768.25	1137.80	1163.75	277.26	Cents/Bushel
Sugar	8.56	35.31	17.82	17.25	5.80	Cents/lb
Wheat	339.75	1280.00	636.84	628.25	151.79	Cents/Bushel
WTI	35.35	145.94	84.60	87.15	18.98	U$/BBL

Table 8: descriptive statistic future prices for the years 2006 – 2016

Commodity	Minimum	Maximum	Mean	Median	Sigma	Unit
Brent	401038	1911277	947417.61	821658	386371.71	U$/Barrel
Coffee	93025	206362	139382.2	139822.5	22506.39	Cents/lb
Copper	64516	194877	122916.06	130100	34133.1	Cents/lb
Corn	736567	1745453	1230891.09	1234228	190426.11	Cents/Bushel
Cotton	105969	301645	183513.99	181674	34446.74	Cents/lb
Gasoline	23524	392262	240085.87	254046	75174.98	U$/Gallon
Gold	259596	650504	428148.58	415739	78885.9	U$/Troy Oz
Heating Oil	137569	410722	277061.8	291295	55219.42	U$/Gallon
Lean Hogs	113879	333948	211711.83	216335.5	44979.88	Cents/lb
Live Cattle	195389	398748	290711.62	298154	49353.97	Cents/lb
Natural Gas	3677	1594382	885866.52	914331	313172.98	U$/Million Btu
Silver	71359	189931	123913.43	122435	22284.86	U$/Troy Oz
Soybeans	276210	839486	535877.39	541584	123685.22	Cents/Bushel
Sugar	465556	1116544	754308.11	760544	114209.18	Cents/lb
Wheat	245009	562198	410327.77	418825	60840.51	Cents/Bushel
WTI	968540	1973351	1420523.4	1421059	201754.66	U$/BBL

Table 9: descriptive statistic Open interest data for the years 2006 – 2016

Commodity	Minimum	Maximum	Mean	Median	Sigma	Unit
Brent	13814	1456495	392118.26	352871	197372.2	U$/Barrel
Coffee	1345	103131	20795.9	17949	11330.43	Cents/lb
Copper	2670	174606	39916.04	35765	25633.8	Cents/lb
Corn	1119	763023	237583.66	224669	109060.48	Cents/Bushel
Cotton	1360	89294	20464.1	17212	11947.35	Cents/lb
Gasoline	730	285276	113631.25	114834	50401.51	U$/Gallon
Gold	1048	744224	150660.87	141193	72756.04	U$/Troy Oz
Heating Oil	20602	327475	105486.91	100749	39998.76	U$/Gallon
Lean Hogs	5048	119970	35895.78	33844	14806.62	Cents/lb
Live Cattle	318	147566	44435.5	41649	17131.72	Cents/lb
Natural Gas	3122	850456	249201.84	235726.5	134472.21	U$/Million Btu
Silver	616	375905	45644.98	39642	30853.52	U$/Troy Oz
Soybeans	819	484531	135524.6	135946	83896.7	Cents/Bushel
Sugar	6002	396143	105694.9	98945.5	44857.97	Cents/lb
Wheat	410	369339	74941.7	73208	49159.38	Cents/Bushel
WTI	30819	1553485	570400.48	551333	195130.15	U$/BBL

Table 10: descriptive statistic Volume data for the years 2006 – 2016

Year	Date
2007	12.29.2006
2008	12.31.2007
2009	12.31.2008
2010	12.31.2009
2012	01.03.2012
2013	01.02.2013
2014	01.02.2014
2015	01.02.2015
2016	01.04.2016

Table 11: Other rebalancing dates transmitted by Bloomberg adjusted to the trading of the New York stock exchange.

Commodities	Positives rebalancing							
Aluminum	2011/ 2012	2014/ 2015						
Brent	2011/ 2012	2012/ 2013	2013/ 2014	2015/ 2016				
Coffee	2008/ 2009	2013/ 2014	2014/ 2015					
Copper	2008/ 2009	2009/ 2010	2012/ 2013	2013/ 2014	2014/ 2015			
Corn	2006/ 2007	2007/ 2008	2008/ 2009	2009/ 2010	2010/ 2011	2011/ 2012	2014/ 2015	
Cotton	2006/ 2007	2008/ 2009	2009/ 2010	2010/ 2011	2015/ 2016			
Gasoline	2007/ 2008	2008/ 2009	2010/ 2011	2011/ 2012	2012/ 2013	2013/ 2014	2015/ 2016	
Gold	2006/ 2007	2007/ 2008	2008/ 2009	2009/ 2010	2010/ 2011	2012/ 2013	2013/ 2014	2014/ 2015
Heating Oil	2009/ 2010	2010/ 2011	2012/ 2013	2015/ 2016				
Kansas Wheat	2012/ 2013	2014/ 2015	2015/ 2016					
Lean Hogs	2008/ 2009	2011/ 2012	2013/ 2014	2015/ 2016				
Live Cattle	2006/ 2007	2008/ 2009	2011/ 2012	2013/ 2014	2015/ 2016			
Natural Gas	2012/ 2013	2014/ 2015						
Nickel	2006/ 2007	2008/ 2009	2011/ 2012	2014/ 2015				
Silver	2006/ 2007	2007/ 2008	2008/ 2009	2009/ 2010	2010/ 2011	2012/ 2013	2013/ 2014	2014/ 2015
Soybeans	2006/ 2007	2007/ 2008	2008/ 2009	2010/ 2011	2013/ 2014	2014/ 2015		
Sugar	2007/ 2008	2008/ 2009	2010/ 2011	2011/ 2012	2013/ 2014	2014/ 2015		
Wheat	2006/ 2007	2007/ 2008	2008/ 2009	2011/ 2012	2015/ 2016			
WTI	2006/ 2007	2007/ 2008	2015/ 2016					
Zinc	2008/ 2009	2011/ 2012	2014/ 2015					

Table 12: Positive rebalancing of both indices (BCOM and S&P GSCI) in the period 2006 – 2016

Commodities	Negative rebalancing							
Aluminum	2006/ 2007	2007/ 2008	2008/ 2009	2009/ 2010	2010/ 2011	2012/ 2013	2013/ 2014	2015/ 2016
Brent	2014/ 2015							
Coffee	2006/ 2007	2007/ 2008	2009/ 2010	2010/ 2011	2011/ 2012	2012/ 2013	2015/ 2016	
Copper	2006/ 2007	2007/ 2008	2010/ 2011	2011/ 2012	2015/ 2016			
Corn	2012/ 2013	2013/ 2014	2015/ 2016					
Cotton	2007/ 2008	2011/ 2012	2012/ 2013	2013/ 2014	2014/ 2015			
Gasoline	2006/ 2007	2009/ 2010	2014/ 2015					
Gold	2011/ 2012	2015/ 2016						
Heating Oil	2006/ 2007	2007/ 2008	2008/ 2009	2011/ 2012	2013/ 2014	2014/ 2015		
Kansas Wheat	2013/ 2014							
Lean Hogs	2006/ 2007	2007/ 2008	2009/ 2010	2010/ 2011	2012/ 2013	2014/ 2015		
Live Cattle	2007/ 2008	2009/ 2010	2010/ 2011	2012/ 2013	2014/ 2015			
Natural Gas	2006/ 2007	2007/ 2008	2008/ 2009	2009/ 2010	2010/ 2011	2011/ 2012	2013/ 2014	2015/ 2016
Nickel	2007/ 2008	2009/ 2010	2010/ 2011	2012/ 2013	2013/ 2014	2015/ 2016		
Silver	2011/ 2012	2015/ 2016						
Soybeans	2009/ 2010	2011/ 2012	2012/ 2013	2015/ 2016				
Sugar	2006/ 2007	2009/ 2010	2012/ 2013	2015/ 2016				
Wheat	2009/ 2010	2010/ 2011	2012/ 2013	2013/ 2014	2014/ 2015			
WTI	2008/ 2009	2009/ 2010	2010/ 2011	2011/ 2012	2012/ 2013	2013/ 2014	2014/ 2015	
Zinc	2006/ 2007	2007/ 2008	2009/ 2010	2010/ 2011	2012/ 2013	2013/ 2014	2015/ 2016	

Table 13: Negative rebalancing of both indices (BCOM and S&P GSCI) in the period 2006 – 2016

Life in the 4th Industrial Revolution

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Abstract

The Internet has revolutionized how 7 billion people communicate. A person can now Tweet instantly to a nation and, for that matter, to the world with just a few movements of a finger. It has altered the way we live life and perceive life. The internet has changed how we do business, educate our citizens, lead our government, and experience our healthcare. Think what your life would be like without the internet during this pandemic, that is, without Netflix, Zoom, or email. Communication would be limited to the phone (just voice), perhaps supported by letters and faxes or would require more in-person actions, risking lives.

When the pandemic is over, how many will go back to the office full-time or travel across the world for a meeting? What balance will emerge between in-person and online? What will happen to all those college dorms, when students have experienced the advantages of remote learning? What will happen to the vast infrastructure developed to support full-time face-to-face office work? How will cities that were designed to facilitate in-person trade and communication evolve? Will they become greener and smarter or will we shift to a more geographically dispersed model?

Questions such as these would never have occurred to people a decade ago. People were unable to grasp the implications of the changes the internet would bring. Nor did this limited foresight start with the internet. At the end of the 18th century the first industrial revolution brought us mechanization, coal extraction, and steam energy. The second made mass production possible, unlocked the potential of electricity, and introduced the assembly line. The third brought the computer, electronics and other communication devices[1]. The introduction of each new technology fundamentally changed the means of economic production and the fabric of society in unforeseen ways. The fourth revolution, beginning in the early 2000s, has been defined largely as the development of the Internet of Things, which was founded on the third revolution's innovations[2]. The scope of the fourth industrial revolution however, does not only encompass smart connected devices and advanced communication systems, but in fact, consists of a much wider framework of developments.

This paper will explore this framework of new technologies, examine their immediate effect, and will suggest possible implications, based on historical precedent, for the future of society. It will examine breakthroughs in areas including sustainable energy, quantum computing, nanotechnologies, machine learning (ML), artificial intelligence (AI), autonomous robots, holograms, cyberwarfare, video analytics, natural language translation, autonomous driving and autonomous flying vehicles, 3D printing, eco-friendly smart architecture, and innovative habitats (floating, underwater, and in space).

Understanding what the technological advances of past industrial revolutions have brought us and knowing what our cutting edge technology can do for us now, will provide insight into what the fourth and fifth industrial revolution will bring. The internet brought us something far more revolutionary, more expansive, and more powerful than originally imagined, and so will future innovations.

Note: Our past is linear but the future is not… until it becomes the past. To explore the future, will require a nonlinear medium. We will therefore depart from pre-19th century technology (pen and paper) and will develop and present this paper using Twine, a tool used for developing interactive non-linear narratives, delivered via the web.

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Dow Jones Sustainability Indices, Do They Make a Difference? The U.S. and the European Union Companies

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Abstract: Sustainability and corporate social responsibility (CSR) strategies of companies delineate the health and the welfare of the communities across the globe. The two major goals of this study are (1) To explore the relationship between the environmental regulations, market value, and adoption of sustainability and CSR strategies of the publicly traded firms listed on the Dow Jones Sustainability Indices (DJSI) and (2) To examine the impact of being added to or deleted from DJSI per different market sectors for the firms in the U.S. and the European Union (EU). The selected starting window, the year 2015, for studying the impact of addition to or deletion from the DJS indices was the Paris Accord proposal by the EU and strict sustainability regulations of the EU versus the U.S. We used event study methodology and regression analyses to explain the cumulative abnormal returns utilizing firms' characteristics and specific market sectors. In addition, the other focus of the study was on heavy (polluting) industries and investigating if the addition to or deletion of the firms in these industries from the sustainability indices had an impact on the market value. The findings of this study reveal no impact of the environmental rules and regulations on adopting sustainability and CSR strategies by either the EU or the U.S. firms. The novel findings of this study indicate a significant negative impact on the market value of firms in heavy industries, Basic Materials, Energy and Industrial, when added to the DJS indices. The study discusses the underlying reasons for these differences and proposes strategies to enhance the impact of addition to or deletion from the DISI to increase firms' commitments to sustainability and CSR strategies and altering the attitudes of the investors.

Keywords: sustainability and CSR strategies; environmental rules and regulations; Dow Jones Sustainability Indices; market value; EU; U.S.; heavy industries

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1. Introduction

The Dow Jones Sustainability Index (DJSI) was launched in 1999 [1] with the merger of the Standard and Poors (S&P) Dow Jones Indices (DJI) and RobecaSAM (Sustainable Asset Management) [2] partially as an outcome of corporations and investors interested in the triple bottom line: economic, environmental, and social dimensions of sustainability [3]. The DJSI tracks hundreds of leading and publicly traded companies on the S&P Global 1200 Index and their subsets in different regions of the world and publishes an annual list of "Additions" while deleting companies from the previously published list.

In order to create these indices, DJSI focuses on three factors: the economic, social, and environmental performance of the selected companies [4]. The selected firms for the DJSI World are the top 10% of the 2500 largest firms in the S&P Global Broad Market Index (BMI) [4]. The DJS North America Composite Index and the Dow Jones Sustainability European Index consist of the top 20% highest-scoring firms along the measured sustainability dimensions in the selected industries [5,6].

In the past decade, the impact on the financial performance of the firms by being added to or deleted from the DJSI has been the focus of several studies (e.g., [7–24]). The results of these studies are not analogous. The relationship between the addition of the firm to the DJSI and the market value of the firm ranges from positive impact [18], negative impact [9,17], short-term negative impact [16], to no impact [13]. On the other hand, deletion from the DJSI has been shown to be related to a negative impact on the market value of the firm [16], short-term negative impact [18] and no impact [13]. The underlying reasons for such diverse results are attributed to specific markets (e.g., developed countries versus emerging countries) [7], the visibility of the firms [13], the type of investors [15], duration of staying on the addition list [11], environmental rules and regulations [20], and specific industry sector [21].

Governmental rules and regulations and visibility of the sustainability practices, specifically long-term commitment by the firms to sustainable operations, appear to be some of the factors that can influence the value of the firms positively [11,13,15]. The European Union firms are under one of the most rigorous environmental rules and regulations in place by the EU as evident in the European Union net-zero carbon emission goals by 2050 [25]. This study compares the EU versus the U.S firms that are added to or deleted from the DJSI during the years 2015–2018.

In addition, the research focuses on different sectors of the market and explores addition to or deletion to the DJSI and its impact on the value of the firms per each different market sector. This part of the research can shed light on the findings of some of the research in this area that indicate addition to or deletion from the sustainability indices can have a negative impact on the market value of the firms [10,17]. By investigating the impact of being added to or deleted from the sustainability indices per different market sector, this research attempts to explore the underlying causes of the negative impact on the market value of the firms associated with addition to or deletion from the sustainability indices.

2. Literature Review and Research Goals

2.1. Studies on DJSI

In the past decade, the impact on the financial performance of the firms by being added to or deleted from the DJSI has been the focus of several studies (e.g., Cheung [9]; Durand et al. [11]; Hawn et al. [13]; Robinson et al. [18]). Other studies have used different indices, such as Borsa Istanbul, Turkey (BIST) Sustainability Index [7,23] and the São Paulo Stock Exchange Corporate Sustainability Index [19]. The results of these studies across different countries and utilizing different indices indicate a variety of findings.

Some studies have concentrated on the Asia Pacific markets (e.g., Chang et al. [8]; Cheung and Roca [10]). Chang et al. [8] investigated the factors that could influence CSR strategies and appearance on the DJSI list in the airline industry in western countries versus Asia-Pacific countries. The authors concluded that the airlines in the western countries showed more commitment to CSR strategies than the Asia Pacific studied countries [8].

Cheung and Roca [10] studied the impact of addition to or deletion from the Dow Jones Sustainability World Index for the companies from nine Asia Pacific countries over a period of four years. The authors, using event analysis, concluded that a week after the announcement to the addition list or being deleted from the index, there was a significant negative rate of abnormal return for firms and an increase in the volume of trading while idiosyncratic risk increased. However, there was no impact on the systematic risk for both the added and deleted firms [10].

The research by Lee et al. [15] investigated the impact on the market value of the South Korean companies that were added or deleted from the DJSI. The results of the study indicated a significant positive impact on the stock prices of the companies that were added to the DSJI [15]. In addition, the authors utilized the Korea Exchange and investigated the reaction of different classes of investors [15]. According to the results of the study, only the public sector investors had more awareness of the DJSI [15]. The authors concluded that government campaigns regarding sustainability had a limited impact on the Korean stock market [15].

Ates [7] studied the relationship between the market value and the firms listed on the BIST Sustainability Index by considering the size and profitability of the firms as mediating factors. The results of the study indicated a significant positive relationship between the investors in an emerging market and the appearance on a sustainability index independent of the size of the company [7]. In addition, the study found a negative relationship between low level of sustainability practices by the firm and the financial performance of the firm [7]. The author concluded that legislators needed to increase awareness of the investors and the firms about the sustainability practices and appearance on the sustainability indices [7].

Yilmaz et al. [23] also investigated the impact on the performance of the firms when added to or deleted from the BIST Sustainability Index. Their research found no significant impact on the performance of the firms, stock return or systematic risk when added or deleted from the BIST Sustainability Index [23]. The authors concluded that the lack of impact on stock return for the companies that were added to the sustainability index might be due to the belief by the investors that engagement in sustainability could create costs for the firms [23].

Santis et al. [19] studied the relationship between financial performance in regards to profitability and liquidity ratios of the Brazilian firms on the Saõ Paulo Stock Exchange Corporate Sustainability Index. The financial performance of these companies was compared with the other companies listed only on the Saõ Paulo Stock Exchange [19]. The findings of their research did not indicate any differences between the profitability and liquidity ratios of the studied companies on the two lists [19].

Other studies have concentrated on the European market (e.g., López et al. [16]; Oberndorfer et al. [17]; Gómez-Bezares et al. [12]). López et al. [16] studied the European firms that adopted socially responsible sustainability practices as indicated by their appearance on the DJSI compared to the ones that were on the Dow Jones Global Index but did not appear on the DJSI. The authors measured the value of the firms using accounting factors within a seven-year period (1998–2004) [16]. According to the results of their study, the firms on both indices over time did not indicate any positive impact on their performance measures [16]. However, the firms that appeared on the DJSI indicated a short-term negative impact on their performance measures, which disappeared over time [16].

Oberndorfer et al. [17] studied the appearance of German companies on the DJSI World and DJSI STOXX. The results of their event study indicated that there was a negative impact on the firm's value appearing on the DJSI World versus DJSI STOXX [17]. The authors concluded that the negative impact on the firm's value that appeared on the DJSI might be due to the fact that DJSI was a more visible index than the DJSI STOXX [17].

Gómez-Bezares et al. [12] studied the relationship between market returns and sustainability practices of British companies utilizing the Financial Times Stock Exchange Index over a period of six years. The authors conclude that the firms that invested in and practiced sustainability created higher long-term returns and enhanced the wealth of the shareholders [12].

Several studies have concentrated on the U.S. market (e.g., Cheung [9]; Robinson et al. [18]). Cheung [9] investigated the impact of addition to or deletion from the DJSI on the U.S. firms over a period of six years. The author utilized the event study methodology and examined the impact on stock return, risk, and liquidity [9]. The results of the study did not show any significant impact on stock prices, systematic risk, and liquidity except for the day that these companies were added to or removed from the DJSI [9].

The study by Robinson et al. [18], exploring the appearance on or removal from the DJSI for North American companies, concluded that there was a positive relationship between being added to the DJSI and the stock prices of these firms. In addition, their study indicated a short-term decrease (10 days) in the value of stocks of the firms removed from the DJSI [18].

Some studies explored firms across different counties that were listed on the DJSI (e.g., Hawn et al. [13]; Durnad et al. [11]). Hawn et al. [13], utilizing the DJSI World, conducted a longitudinal study over 17 years and investigated the relationship between the sustainability practices of firms and financial performance in 27 countries. The results of their study indicated that being added, deleted or continued on the DJSI list did not affect the investors' reactions toward the firms [13]. However, the authors noted that the increase in the global valuation of sustainability practices might have an impact on the investors when the companies continued to be listed on the DJSI [13].

Durand et al. [11] expanded upon Hawn et al.'s [13] study and investigated the impact of being added, continuously listed, or deleted from the DJSI on the stock prices of the firms. The authors compared the stock value of these firms versus firms that had the same level of sustainability practices but not listed on the DJSI [11]. The results of the study indicated that being listed by the

DJSI had no impact on stock prices, but there might be some long-term benefits due to the visibility of such firms [11].

Waddock and Graves [22], focusing on the S&P 500 firms, indicated that financial performance was linked to better corporate social performance since these companies invested more in socially responsible strategies. Meanwhile, Zhao and Murrell [24] argued that CSR strategies did not necessarily enhance the financial performance of the firms.

Some studies have considered factors other than the financial rate of return in investigating the CSR standing of the firms. Ioannou and Serafeim [14], in their study of the U.S. firms, linked sociological and environmental factors, such as a shift in the perception of the analysts regarding the firms' investments to CSR, and proposed that such factors beyond the financial indicators could influence the CSR standing of the firm. Sharkey and Bromley [20] studied the U.S. public firms and pollution reduction strategies. The authors proposed that several factors, such as peer group rating, regulatory, and competitive environments needed to be considered for adoption of more socially responsible strategies by the firms [20].

Focusing on a particular industry and appearance on the DJSI, Su and Chen [21] studied the impact of addition to or deletion from the DJSI on the hospitality firms in North America versus non-hospitality firms. According to the results of their study, addition to the DJSI showed a longer positive impact on the stock returns of the hospitality firms when they appeared on the addition list and a longer negative impact on their stock returns when deleted from the DJSI [21]. Furthermore, other financial ratios, return on investment and total asset turnover indicated significant differences before being added or after being deleted from the DJSI [21]. The authors concluded that the financial performance of the hospitality firms was more susceptible to being added to or deleted from the DJSI than non-hospitality firms [21].

As evident by the reviewed literature, the relationship between addition to or deletion from the DSJI or other sustainability indices and the firm's value indicates a variety of findings. These findings, in general, do not indicate a significant relationship between appearance on the DJSI or other sustainability indices and increase in the value of the firms [8,11,13]. Some studies have found a negative impact on the market value of the firms by appearing on the sustainability indices [10,17]. There are some indications that several factors, such as environmental rules and regulations [20], increase in global valuation of sustainability practices [8], or continued appearance [8,11,13] on the sustainability indices, may influence the market value of the listed firms.

2.2. Research Goals

As indicated by the reviewed studies, the impact on the market value of the firms by appearing on different sustainability and CSR indices, such as the DJSI, show inconsistent and contradictory results. Consequently, rather than examining a general relationship between addition to or deletion from the Dow Jones Sustainability indices and the firms market values, our study investigates this relationship in regards to two potential causal factors: specific market sectors and environmental rules and regulations as measured by the U.S. and EU indicators.

The goals of the research are presented below:

(1) To explore the relationship between the environmental regulations, market value, and sustainability and CSR strategies of the publicly traded EU and U.S. firms listed on the Dow Jones Sustainability Indices (DJSI).

(2) To examine the impact of addition to or deletion from DJSI per different market sectors and the valuation of the firms by the investors.

3. Materials and Methods

3.1. Selected Years, 2015–2018

The foundation for selecting the year 2015 as the starting year for exploring the relationship between appearing on the addition or deleted from the DJSI list was that the Paris Accord, the first global agreement addressing the climate change and the negative effect of greenhouse gases (GHG), was initiated in the year 2015 [26]. The combination of the Paris Accord and the European Union's goal of achieving a net-zero carbon emission economy by the year 2050 [25] and the European Union Commission's food waste goals [27], place the EU ahead of the other areas of the world as far as sustainability directives and the greening of different industries. In contrast, in 2016, the U.S. government declared leaving the Paris Accord and since 2016, several emission control standards in the U.S. have been eased. As a result, our study examines the relationship between addition to or deletion from the DJSI North America Composite, DJSI European, and DJSI World for the listed U.S. and the EU firms, starting with the year 2015 through the year 2018 as well as different market sectors.

3.2. Selected Companies

In order to explore these relationships, the selected data for this study included the top 10 (by market capitalization) U.S. and the EU firms on the DJS World, DJS North America Composite, and DJS European indices. The selected firms traded on the U.S. (NASDAQ, NYSE, OTC), and their price history (USD) for the years that they were added to or deleted from these indices were available. The event dates for the study were the announcement date of each addition to or deletion from the selected lists starting with the year 2015 through 2018. Within this period, on the addition list, there were 57 firms, 29 firms from the EU and 28 firms from the U.S. As for the deleted firms within the same period, there were 55 firms, 31 firms from the EU and 24 firms from the U.S. Table 1 presents the summary statistics utilized in this study. Tables 2 and 3 present the addition and deletion of the EU and the U.S. firms between the years 2015–2018. In addition, Table 4 shows the market sectors of the utilized data for the selected firms.

Table 1. Summary statistics of the utilized data from 2015–2018: The EU and the U.S. companies listed on the three indices.

	Additions-Number of Firms					**Deletions-Number of Firms**	
Year	**EU**	**U.S.**	**Total**	**Year**	**EU**	**U.S.**	**Total**
2015-2018	29	28	57	2015-2018	31	24	55
2015	8	6	14	2015	7	7	14
2016	8	7	15	2016	5	6	11
2017	6	7	13	2017	10	6	16
2018	7	8	15	2018	9	5	14

As indicated in Table 1, the total firms on the added lists of DSJI were 57 while 55 firms were deleted from the lists within the studied years.

Table 2 provides the names of all those firms added to or deleted from the three indices. Most EU additions were from France (8) followed by German companies with addition of five representatives.

Table 2. The list of the EU and the U.S. companies on the addition list of the World, North America Composite, and the European Dow Jones sustainability (DJS) indices.

EU Additions	2015	U.S. Additions
BNP Paribas SA France		General Motors Co
Societe Gernerale SA France		Goldman Sachs
Sanofi France		Bristol-Myers Squibb Co
Vinci SA France		Ecolab Inc
GDF Suez France		Bank of America Group
Deutsche Telecom Germany		Proctor and Gamble Co
Telefonica SA Spain		
BHP Billiton PLC UK		
EU Additions	**2016**	**U.S. Additions**
Novo Nordisk A/S Denmark		PepsiCo Inc
Nokia OYJ Finland		Merck and Co Inc
TOTAL SA France		Allergan Plc
Essilor Intl SA France		Schlumberger Ltd.
Henkel AG and Co Germany		Adobe Systems Inc
E.ON SE Germany		Cisco Systems Inc
Iberdrola SA Spain		Reynolds American Inc
Royal Dutch Shell Plc. Netherlands		
EU Additions	**2017**	**U.S. Additions**
Capgemini SA France		Visa Inc
Henkel AG and Co Germany		Cigna Corp
Compass Group Plc. UK		Comcast Corp
CRH Plc. Ireland		AT and T Inc
ASML Holding NV Netherlands		Altria Group Inc
British American Tobacco UK		General Motors Co
		Colgate-Palmolive Co
EU Additions	**2018**	**U.S. Additions**
Siemens AG Germany		MasterCard Inc
STMicoelectronics Italy		Johnson and Johnson
Assicurazioni Generali Italy		Schlumberger Ltd.
Banco Bilbao Spain		Salesforce.com Inc
Essily AB Sweden		Anthem Inc
RELX Plc. UK		General Mills Inc
Diageo Plc. UK		Sempra Energy
		Waste Management Inc

Table 3 presents the EU and the U.S. companies that were deleted from the list of the three indices within the selected years.

Table 3. The list of the EU and the U.S. companies that were deleted from the World, North America Composite, and the European DJS indices.

EU Deletions	2015	U.S. Deletions
Novo Nordisk A/S Denmark		United Technologies Corp
Total SA France		Ford Motor Co
Siemens Germany		PepsiCo Inc
Henkel AG and Co Germany		Air Products and Chemical Inc
UniCredit SPA Italy		Schlumberger Ltd.
Diageo Plc UK		Waste Management Inc
Experian Plc		UK
EU Deletions	**2016**	**U.S. Deletions**
Eni SpA Italy		EMC Corp
Banco Bilbao Spain		Target Corp
WPP Plc UK		Spectra Energy Corp
ARM Holdings Plc UK		Allstate Corp
BT Group Plc UK		Halliburton Co
British American Tobacco UK		Baker Hughes Inc
Exxon Mobil Corp		
Intl Corp		
EU Deletions	**2017**	**U.S. Deletions**
Novo Nordisk A/S Denmark		Johnson and Johnson
Sanofi France		Cardinal Health Inc
Vinci SA France		Schlumberger Ltd.
Cie Generale des Est France		Halliburton Co
BASF SE Germany		Autodesk Inc
E. ON SE Germany		Waste Management
BAE Systems Plc UK		
Recitt Benckiser Gr UK		
Rio Tinto Plc UK		
RELX Plc UK		
EU Deletions	**2018**	**U.S. Deletions**
BNP Paribas SA France		PepsiCo Inc
Dassault Systems Se France		Morgan Stanley
BASF AG Germany		Merck and Co
Henke AG and Co Germany		Humana Inc
Telefonica SA Spain		Altria Group Inc
Barclays Plc UK		
Anglo American Plc UK		
Compass Group Plc UK		

As shown in Table 3, the UK companies were deleted more than the firms from the other EU countries. For the U.S., Schlumberger Ltd. was deleted from the index in 2015 and 2017, but was readded in 2016 and 2018.

Table 4 shows the DJSI changes by the market sector by year.

Table 4. The market sectors of the utilized data for the companies on the additions list and deleted from the three indices, 2015–2018.

Additions–Market Sectors	Total = 57	Deletions–Market Sectors	Total = 55
Industrial	3	Industrial	7
Basic Materials	3	Basic Materials	5
Financial Services	8	Financial Services	6
Technology	7	Technology	4
Consumer Defense	11	Conumser Defense	9
Consumer Cyclical	3	Consumer Cyclical	3
Healthcare	9	Healthcare	8
Energy	4	Energy	8
Communication Services	5	Communication Services	4
Utilities	4	Utilities	1

As shown in Table 4, the energy and industrial sectors experienced the largest change with a loss of four for energy and also four for industrial companies on the index. Some sectors indicate more additions than deletions: Technology (3), Utilities (3), Consumer Defense (2), Financial Services (2), Healthcare (1), and Communication (1).

3.3. Event Study and Cumulative Abnormal Returns (CAR) Regression Methodology

Financial theories suggest that capital markets fully and quickly incorporate all available information into a firm's stock price [28]. As such, we can identify the value of new information by examining the impact on the firm's stock price upon the release of that information. Assuming no early leakage, information deemed beneficial by the market should result in positive abnormal stock returns when released [29]. Likewise, released information deemed harmful by the market should result in negative abnormal stock returns [30]. The event study is the methodology developed to investigate the presence of positive or negative abnormal stock returns around the release of new information regarding firms [11,13,15,31,32]. Following these studies, event study was utilized for analyzing the data in this research.

The event study is particularly useful for short-term horizon analysis [31]; although, some research has refined long-term forecasts as well [33]. The event study methodology uses a window prior to the event and estimates what the normal stock returns should be if the event had not happened. Subsequently, the event study evaluates how the stock responds once exposed to the event, which in this case is the listing on the DJSI. Often, prior windows are sized at 120 days [31].

In the event study methodology, an abnormal return is one that is attributed to the new information (i.e., the event). Abnormal returns are calculated by subtracting estimated returns that would have been earned in the absence of the event from the actual return earned in light of the event. The most frequently used method of estimating stock returns sans-event is the market model [34,35,36]. This model uses a stock's correlation with a specific reference market to estimate the stock's normal or expected return on and around the day of the event. Typically, event studies examine a small window around the event for abnormal returns [35,36]. These returns encompass daily abnormal returns (AR), average abnormal returns (AAR), cumulative abnormal returns (CAR), and cumulative average abnormal returns (CAAR).

In this study, the S&P 500 total return index was used as the reference market. The event analysis window was (−5, 5), meaning that cumulative abnormal returns were evaluated 5 days before the DJSI release up until 5 days afterwards. For each firm, stock performance and market model was estimated utilizing S&P 500 Total Return index over a 120-day period. Then, the three coefficients, alpha (risk-adjusted stock performance modeled as the intercept in regression), beta (a measure of risk and the slope of the regression equation), and sigma (a measure of the variation of the regression equation) were estimated to explicate the relationship between the stock and the S&P 500. The regression equation is shown in Equation (1).

$$r_i = \alpha + \beta r_m \quad (1)$$

In this equation, r_i is the stock return of the ith firm, α is the intercept (risk-adjusted performance), β is the slope (risk), r_m is the market return, and e is the error term.

While event studies provide information about stock returns relative to the market and possibly other indices and factors, regression using cumulative abnormal returns provides a more robust way to analyze additional variables specific to the stock returns in question [12,19]. In this study, we model cumulative abnormal returns for (−5, 5) as a function of Tobin's Q (market value divide by asset value), total assets of the company, and leverage (debt to equity). Tobin's Q is an estimation of the replacement value of the company, while total assets provide a measure of size. Furthermore, leverage provides an additional measure of financial health.

4. Results

4.1. EU Versus US Event Study

Table 5 and Figures 1 and 2 present the results of daily cumulative abnormal returns for the U.S. and the EU firms for −5 before and 5 days after the announcement.

Table 5. Results of daily cumulative abnormal return for the U.S. and the EU firms (−5, 5).

	U.S. Additions	U.S. Deletions	EU Additions	EU Deletions
	n = 29	n = 25	n = 22	n = 34
Day	**Cumulative Abnormal Return**			
−5	−0.0182475	−0.0208032	−0.0001171	−0.0147359
−4	0.0125626	−0.0101438	0.0377317	−0.0013163
−3	−0.0036320	−0.0364558	0.0471392	0.0080623
−2	0.0059064	−0.0387933	0.0438605	0.0170888
−1	0.0055572	−0.0705078	0.0270714	0.0202253
0	0.0011186	−0.1069450	0.0268761	0.0286871
1	0.0228153	−0.1385233	−0.0158339	0.0316696
2	0.0241182	−0.1283157	−0.0073473	0.0171266
3	−0.0051642	−0.1448410	−0.0247007	0.0092496
4	−0.0229824	−0.1362925	−0.0031249	−0.0177682
5	−0.0141983	−0.1451793	0.0110849	−0.0217336

Figures 1 and 2 present the results of the event study analysis for the U.S. (Figure 1) and EU (Figure 2) firms when added to or deleted from the DJSI for the years 2015–2018. Figures 1 and 2 indicate the cumulative abnormal returns (CAR) for the U.S. and the EU firms using a symmetric five-day event window (−5, 5).

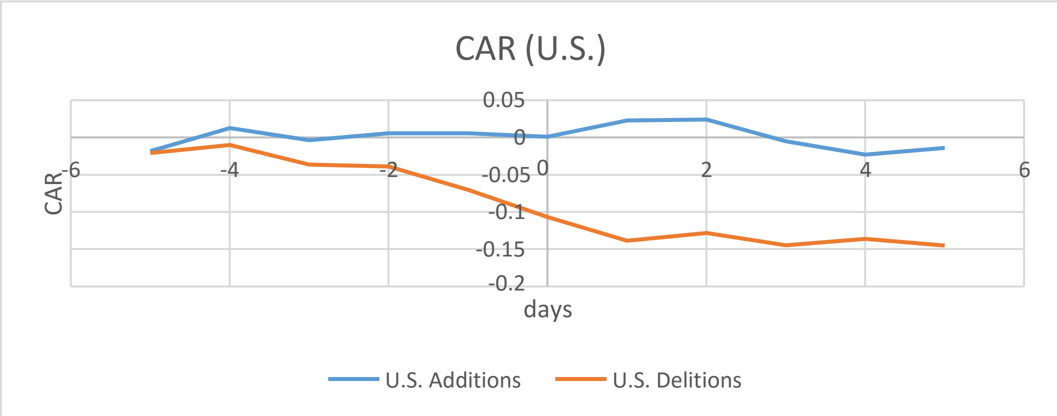

Figure 1. Additions and deletions of the U.S. firms: Dow Jones sustainability indices (DJSI), 2015–2018.

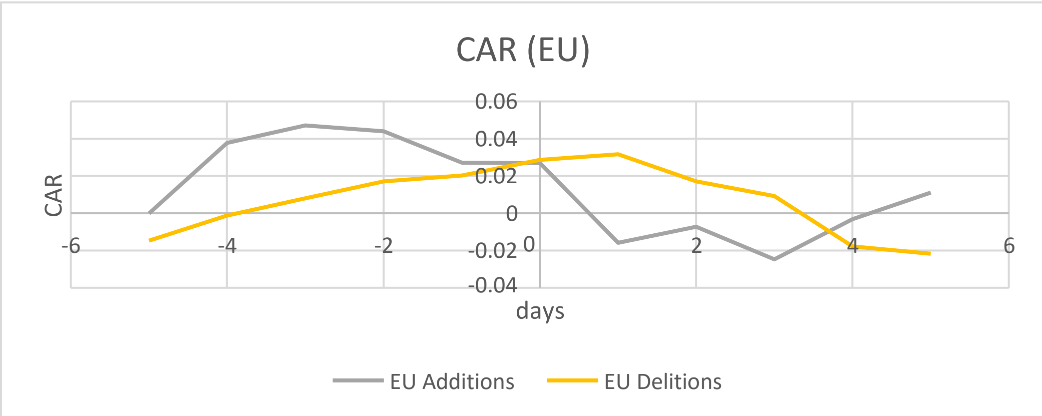

Figure 2. Additions and deletions of the EU firms: DJSI, 2015–2018.

Based on the results presented in Table 5 and Figure 1, there is no statistically significant positive impact on stock returns for the U.S. firms when added to or deleted from the DJSI. These results support the findings of other studies [13,16,19,23] that have found no impact on the financial performance of the firms when added to or deleted from sustainability indices.

Table 5 and Figure 2 indicate evidence of small negative abnormal returns for addition and small positive effects for deletion for the EU firms. However, these effects are not statistically significant. Based on the results of the event study, addition to or deletion from the DJSI with the time-frame CAR (−5, 5) are not statistically significant for either the U.S. or the EU firms.

A major goal of this study was to explore if strict environmental rules and regulations entice investors to value sustainability and CSR practices of the firms. Based on the results of this study, there is no evidence that inclusion or exclusion from the DJSI results in statistically significant cumulative abnormal returns for the U.S. and the EU firms. Despite the stronger commitment to sustainability practices and stricter environmental rules and regulations of the EU, when the EU firms are compared to the U.S. firms, addition to or deletion from the DJS indices does not indicate any impact on the market value for the European firms. Overall, when examining the cumulative abnormal returns (CARs) of both sets of firms, the market does not seem to consider that sustainability and CSR practices impact a firm's value positively or negatively for either the U.S. or the EU firms. The results of this study support the notion that government rules and regulations do not enhance engagement in sustainability activities [15].

4.2. Regression Analysis

In order to strengthen the results of the event study, regression models on the cumulative abnormal returns to evaluate other factors associated with the firm's market performance were utilized as per other studies in this area [21,38]. In these models, the indicator variables included the EU (EU = 0) and the U.S. firms (U.S. = 1) and deletion (deletion = 0) and addition (addition = 1). The interaction terms for both indicator variables were examined utilizing CARs (0, 2) and CARs (−5, 5). Due to the panel structure, we added time fixed effects to the regression to account for the selected years, 2015–2018. The results of this part of the study are presented in Table 6.

Table 6. Regression analysis indicating cumulative abnormal returns for the EU and the U.S. firms.

Variables	CAR (0, 2) Estimate	*p* Value	CAR (−5, 5) Estimate	*p* Value
Log (Total Assets)	0.001	0.550	0.006	0.139
Return on Assets	0.029	0.312	0.015	0.779
Market to Book	0.000	0.649	0.000	0.638
Financial Leverage	0.000	0.398	0.000	0.560
Tobin's Q	−0.003	0.304	0.000	0.913
Indictor (Addition = 1)	−0.005	0.360	0.005	0.634
Indicator (U.S. = 1))	0.012 *	0.066	0.007	0.531
Interaction Variable (U.S. = 1) × (Addition = 1)	0.003	0.761	−0.017	0.291

For both CAR (0, 2) and CAR (−5, 5), only one indictor variable for the U.S. is weakly significant at .10 level as shown by (*) in Table 6. Based on these results, addition to or deletion from the DJSI does not appear to have an impact on cumulative abnormal return for either the U.S. or the EU firms. The results indicate that there is no difference between the U.S. and the EU firms (interaction variables) when they are added to or deleted from the DJSI within the studied time-periods. These results support the findings of the event study reported above.

4.3. Market Value and Market Sector Regression Analysis

Regression analysis was utilized to examine goal #2 of the research, the sector differences. Dependent variables included cumulative abnormal returns, CAR (0, 2) as well as the CAR (−5, 5). The dependent variables were regressed on the same set of independent variables used previously (Tobin's Q, total assets of the company, and leverage). Indicator variables were used for different market sectors. Selected market sectors are from the largest industries in the U.S. and the EU, Basic Materials, Energy, Utility, and Industrial. According to the research, these market sectors are the most polluting industries. A study by Rehfeldt et al. [37] on the Basic Materials market sector, iron, steel, non- metallic, basic chemicals, pulp, and paper, indicates that the pollution by these sectors comprised 64% of the total industrial emission in the EU 28. The study by Fuji and Managi [38], based on data from the World Input-Output Database, shows that the heavy-polluting Industrial market sector produces the most carbon dioxide, methane, nitrous oxide, non-methane volatile organic compounds, and ammonia across the globe. Another study by Fuji and Managi [39] indicates that the relationship between gross domestic product (GDP) and sectoral carbon dioxide emissions are largely due to the fossil-fuel type. According to a study by Shen et al. [40], the cement industry is one of the main contributors to greenhouse gases (GHG), contributing 6–8% of carbon emissions, and its subsectors consume about 12–15% of industrial energy. As indicated by research, the selected market sectors for this study are heavy polluting industries.

Table 7 presents the results of this part of the analyses. According to these results, there was no statistically significant impact of additions to or deletions from the DSJI on the aggregated overall selected sectors for the years 2015–2018. The statistically significant interaction variable indicated abnormal returns when added to or deleted from DJSI for certain market sectors. These sectors included Basic Materials, Energy, and Industrial.

Table 7. Regression models for cumulative abnormal returns (CARs) for different market sectors when added to or deleted from DJSI, 2015–2018.

Variables	CAR (0, 2) Estimate	*p* Value	CAR (−5, 5) Estimate	*p* Value
Log (Total Assets)	0.003	0.18	0.006	0.15
Return on Assets	0.014	0.65	0.001	0.98
Market to Book	0.000	0.27	0.000	0.61
Financial Leverage	−0.001 *	0.10	−0.001	0.50
Tobin's Q	−0.001	0.72	−0.001	0.78
Indictor (Addition = 1)	−0.001	0.77	−0.002	0.84
Indicator (Energy. = 1))	0.008	0.39	−0.003	0.87
Interaction Variable (Energy = 1) × (Add. = 1)	−0.028 *	0.06	−0.017	0.54
Variables	**CAR (0, 2) Estimate**	***p* Value**	**CAR (−5, 5) Estimate**	***p* Value**
Log (Total Assets)	0.003	0.26	0.006	0.15
Return on Assets	0.010	0.72	0.011	0.84
Market to Book	0.000	0.31	0.000	0.72
Financial Leverage	−0.001	0.11	0.000	0.63
Tobin's Q	−0.001	0.78	−0.001	0.90
Indictor (Addition = 1)	−0.004	0.42	−0.003	0.73
Indicator (Industrials. = 1))	−0.001	0.92	0.005	0.76
Interaction Variable (Industrials = 1) × (Add. = 1)	−0.004	0.83	0.009	0.78
Variables	**CAR (0, 2) Estimate**	***p* Value**	**CAR (−5, 5) Estimate**	***p* Value**
Log (Total Assets)	0.002	0.31	0.005	0.21
Return on Assets	0.007	0.79	0.006	0.91
Market to Book	0.000	0.32	0.000	0.76
Financial Leverage	−0.001	0.10	0.000	0.65
Tobin's Q	−0.001	0.76	−0.001	0.85
Indictor (Addition = 1)	−0.001	0.75	0.002	0.85
Indicator (Basic Mat. = 1))	0.011	0.32	0.028	0.16
Interaction Variable (Basic Mat. = 1) × (Add. = 1)	−0.035 **	0.05	−0.058 *	0.07
Log (Total Assets)	0.003	0.25	0.004	0.36
Return on Assets	0.013	0.64	0.008	0.88
Market to Book	0.000	0.35	0.000	1.00
Financial Leverage	−0.001	0.15	0.000	0.89
Tobin's Q	−0.001	0.72	−0.003	0.56
Indictor (Addition = 1)	−0.005	0.25	−0.001	0.86
Indicator (Industrials. = 1))	−0.058 **	0.01	−0.085 **	0.04
Interaction Variable (Industrials = 1) × (Add. = 1)	0.063 **	0.02	0.052	0.27

The notable finding indicated in Table 7 was that when the companies in these market sectors were added to the DJSI, there was a statistically significant negative cumulative abnormal return of these firms. Furthermore, if these companies were deleted, there was a significant positive impact on their abnormal returns. The exception to these findings was the Utility sector since only one company in this sector was deleted from the DJSI, the impact on cumulative abnormal return was negative.

Table 8 presents the results of the heavy polluting sector.

Table 8. Regression analysis for firms in the selected industries.

Variables	CAR (0, 2)	*p* Value	CAR (−5, 5)	*p* Value
Log (Total Assets)	0.002	0.37	0.005	0.29
Return on Assets	0.005	0.87	0.001	0.99
Market to Book	0.000	0.32	0.000	0.72
Financial Leverage	−0.001	0.13	0.000	0.69
Tobin's Q	−0.002	0.54	−0.003	0.57
Indictor (Addition = 1)	0.001	0.87	0.005	0.62
Indicator (Sector group A = 1))	0.003	0.67	0.004	0.72
Interaction Variable (Group A = 1) × (Addition = 1)	−0.017 *	0.08	−0.026	0.14

Again, there is no overall effect. However, another notable finding of the study, as indicted by the results, is that there is a significant negative impact on abnormal returns when a firm in the heavy industry group is added to the DJSI. The stock prices are dropped by about 2%. The results support the findings of other studies that addition to the sustainability indices can have a significant negative impact on the market value of the firms [10,17,23].

5. Discussion

One of the major goals of the study was to examine if the market value of the firms was related to the environmental rules and regulations and adoption of sustainability and CSR strategies. The results of this study show that environmental rules and regulations do not appear to increase the value of the firms that adopt sustainability and CSR strategies. The European Union's strict environmental rules and regulations do not entice investors to value the addition of the firms to the sustainability indices. In addition, the findings of the study indicate that the investors do not penalize the EU or the U.S. firms that are deleted from these indices. Furthermore, the differences in the environmental and sustainability policies and directives between the EU and the U.S. appear to have no influence on altering investors' attitudes. Based on these findings, environmental rules and regulations do not appear to influence the investors' valuation of the firms adopting sustainability practices, nor do the investors penalize the firms that do not adopt such strategies.

Another major goal of the study was to examine the impact of addition to or deletion from DJSI per different market sectors and the valuation of the firms by the investors.

A novel finding of this study is the significant relationship between a firm's value, specific market sector, and the investor's attitude towards sustainability and CSR practices by the firm. Based on the results of the study, investors penalize firms in certain market sectors (Energy, Basic Materials, and Industrial) that find themselves on the addition list of the DJS indices. The results indicate that appearance on the addition list of the DJSI for these three market sectors affects a firm's value negatively.

The firms on the list for these three sectors, Basic Materials (3), Energy (4), and Industrial (3), indicate significant negative abnormal returns during the event window when appearing on the addition list of the DJS indices. Considering that these industries are heavy polluting industries, these findings are alarming. A major factor that may explain the negative impact on a firm's value in these specific market sectors when they appear on the addition list of the sustainability indices may be due to the perception of investors that commitment to and implementation of sustainability strategies are costly to the firms. However, the history of lawsuits against the petroleum companies

In order to increase the attention of investors to sustainability and CSR strategies of the firms and their importance in enhancing the health and the welfare of the communities and the greening of our planet, education and knowledge regarding such strategies are of the utmost importance. Sustainability practices can enhance the efficient use of resources, reduction of costs, and increase revenues for the firms. The oil spills and other lack of sustainability and CSR actions by the petroleum companies have resulted in disastrous impacts on the environment and costly lawsuits against them. The lawsuits against Total [41], Exxon [42], and British Petroleum [43] affected their market values at the time and resulted in tremendous financial losses to the companies. These are examples of the type of information that is needed to educate the public and investors.

Education of the public about the long-term and ultimate benefits of sustainability is a key factor in increasing the valuation of the companies investing in sustainability and CSR strategies. In addition, a responsibility to the health and welfare of the communities and the stakeholders of a firm can enhance the reputation of the firm and lessen the possibility of lawsuits against the firm.

6. Conclusions

Sustainability rules and regulations at the government and state levels are not as effective as when these regulations are decided at the community levels. To enhance the education and information of investors and other stakeholders to sustainability practices and their financial benefits, strategic alliance (public–private partnerships) among municipal agencies, academia, and firms are imperative. Future studies are needed to map such strategic alliances and partnerships to ensure implementation of sustainability and CSR strategies with the potential of conservation of resources, long-term success of the firms, and creation of healthy communities worldwide. In addition, market sector analyses due to the limited number of firms representing a particular sector in this study is a limitation that needs to be further researched. Furthermore, future research can concentrate on utilizing other DJS indices, such as DJSI Emerging Market, Korea, and Australia to examine the generalizability of the findings of this study.

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Innovative Wellness Services for Pain Relieve and Mindfulness

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Abstract

A lot of our busy lives are associated with stress and anxiety which need to be removed from a deeper level. However, existing solutions remain on the surface, escaping the feelings that may not help to release physical, mental and spiritual pain. It is time to explore more to be done and things to get done to make people regain a feeling of pleasant, success and happiness. Flanigan and Ward (2017, p. 143) mentioned that "Evidence for the connection between physical and mental health is growing, as is interest in providing a holistic, mind–body approach to improving mental health and wellness". They further pointed out that an integrated mind–body wellness program included yoga, tai chi, mindfulness meditation, and nutrition education. In order to validate their findings and explore things need to be done, 14 articles related to yoga backpain and wellness have been searched from e-database and internet (2003-2019) via N'vivo content analysis. The key elements identified for pain relieve and wellness enhancement are:

- Exercise modes (1,127 references);
- Pain relieve (933 references);
- Meditation (764 references);
- Integrated wellness (513 references); and
- Mindfulness (142 references)

And, the documents that are of a relevance value of the above are: "Evidence & Feasibility of Implementing an Integrated Wellness Program" (Flanigan and Ward**,** 2017), "Yoga Treatment", (Wieland et al., 2017) and "Psychological Perception to Walking, Water Aerobics & Yoga" (Wei et al., 2006). Wellness service providers are recommended to design programs with a mixture of exercise modes, including meditation, mindfulness and yoga to release physical, mental and spiritual pain for sustainable development in life.

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Digital Twin and its Application in Schools Reopening During the COVID-19 Pandemic

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Abstract

Recent technology advancements in the area of Internet of Things (IoT), Artificial Intelligence (AI), and Building Information Modeling (BIM) has accelerated implementation of Digital Twin technology in the Architecture, Engineering, Construction Management, and Operation (AECO) industry. Digital Twin is a virtual representation of a physical system in which physics, functional behavior, real-time status, and historical information is captured. The complex interrelated characteristic of building systems creates numerous potential use cases for digital twin in the AECO industry, especially in the operation life cycle stage. Digital twin enables owners and managers to monitor the performance of their buildings in real-time and manage their facilities holistically. Management of Indoor Air Quality (IAQ) is one of the digital twin applications for which the demand has dramatically increased during the COVID-19 pandemic. This presentation overviews the status of digital twin and its success stories in various industry verticals. It discusses potentials and challenges of this technology in addressing the needs of the AECO industry. The presentation also disseminates the lesson-learned from implementation of digital twin technologies in school buildings for health and comfort assessment of indoor air.

Fintech and the Promise of Green Finance

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Whatever the domain, there are two major drivers of change in present-day world: the application of new information and communications technologies (NICT) and the expectations of achieving a sustainable development. Finance is also deeply concerned by these two global trends. As regards the application of emerging technologies, the so-called FinTech are indeed disrupting age-old paradigms like the banking financial intermediation. Similarly, the idea that financial institutions can contribute to sustainability is currently being broken down into multiple financial instruments and investing strategies, which commonly abridged under the term “green finance”. Surprisingly, what is quite unusual is to see at work the composite contribution of both. There are indeed some pioneering examples of how the efficiency of FinTech companies can be put at the service of sustainable projects, but despite their huge potential the existing projects in this regard are still quite exceptional. Why is that so? Why most FinTech start-ups have not yet focused on sustainability? Do they really have the potential of transforming the current financial paradigm with a “green touch”?... These are the main questions that will be discussed in this paper when exploring the relationship between FinTech and sustainability.

LORD OF THE RING: DEMYSTIFYING THE MYTH AND MAGIC OF MODERN IoT SECURITY

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Abstract: In *The Internet of Things: How the Next Evolution of the Internet is Changing Everything*, author David Evans estimated there will be 50 billion connected devices on Earth in the year 2020. Broken down, that's approximately a 6.5:1 ratio of devices to person. This number is staggering when compared to the same ratio at the time the whitepaper was written in 2011, 1.8:1 devices to person. This means that, in the last decade, that ratio has more than tripled. Also, during this timeframe, the methods by which we utilize LAN/WAN technologies has multiplied too. The way humans interact using the internet is no longer about simple cause and effect, query and result, or client and server. Humans have shifted to a much more interactive method for utilizing network technologies with the advent of IoT and its associated devices. Want to know how many brush strokes your teenager is completing while brushing his/her teeth? There's an app for that! Want to check on the done-ness of the crust you have baking in your oven? There's an app for that too! Want your water bottle to alert you when it's time to take a sip of water? There's an app for that as well! In fact, there's just about nearly an app for everything that you could ever want and, on the other side of the coin, an app for just about everything that you never wanted. These apps & devices use IoT technologies to permeate every aspect of the users' lives. From the social to the sexual, the personal to the public, the perfunctory use of these devices has cemented their existence into our present and secured their continued creation for the foreseeable future. This presentation will break apart the myths of the security of these devices and educate the participant on what they can do to secure themselves, their families, and their environments as the device to person ratio continues to rise exponentially.

Keywords: Cybersecurity, IoT, Internet of Things, Security

Health Disparities and Cardiovascular Disease

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Abstract: The number one leading cause of death in 2017 for Americans was cardiovascular disease (CVD), and health disparities can exacerbate risks. This study evaluates the 2018 Behavioral Risk Factor Surveillance System (BRFSS) (*n* = 437,436) to estimate population risks for behavioral, socio-economic, psychological, and biological factors. A general linear model with a quasi-binomial link function indicated higher risks for the following groups: smokers (odds ratio, OR = 0.688), individuals with higher body mass index scores (OR = 1.023), persons unable to work (OR = 2.683), individuals with depression (OR = 1.505), workers who missed more days due to mental issues (OR = 1.12), the elderly, males (OR = 1.954), those in race categories "indigenous Americans, Alaskan non-Hispanics", "Black Hispanics," or "other, non-Hispanic," and individuals with lower income. Surprisingly, increased consumption of alcohol was not found to be a risk factor as in other studies. Additional study of alcohol risk factors is needed. Further, Black non-Hispanics were associated with lower rates of CVD/MI (myocardial infarction), a finding that is supported by recent evidence of more unhealthy behaviors in other races. The results of this study highlight 2018 CVD/MI disparities based on the BRFSS and suggest the need for additional policy interventions including education and providing increased access to health care for the disadvantaged. The principles of beneficence and justice require policy interventions such as these.

Keywords: cardiovascular disease; smoking; drinking; underserved; health disparities

1. Introduction

The number one leading cause of death in 2017 for Americans was cardiovascular disease. Cardiovascular disease (CVD) is the leading cause of death globally, taking about 17.9 million lives yearly [1]. Heart disease took the lives of 647,457 people in 2017, and the projected numbers are assumed to increase with the next coming years [2]. Mortality from cardiovascular disease has accounted for 31% of the total deaths in the world [1] and 1 in 4 deaths in the United States [3].

Due to the prevalence of heart disease around the world, measures should be taken to identify individuals with CVD risk factors, particularly those risk factors that might be modified to reduce mortality. Included in that grouping are behaviors such as smoking, body mass index, lack of physical activity, and excessive alcohol consumption [4]. Behavioral risk factors are often related to socio-economic, psychological, and biological factors, so these factors must be investigated as well.

There are many socio-economic factors that affect CVD mortality rates. Lower socio-economic status has been linked to the development of cardiovascular disease [5,6]. Disparities in health care that favor racial and ethnic majority groups are particularly notable for CVD and cancer [7]. Lower-income individuals also have higher health risks associated with CVD, and rural residents have less access to care and more risk factors [8]. For example, food deserts, generally poor areas such as inner cities where individuals have limited access to healthy retail food stores, have been associated with childhood obesity, a known risk factor for CVD [9]. A study in New York City found that the population suffering from higher rates of chronic conditions like obesity and diabetes were black population living in food desert neighborhoods [10].

Behavioral and socio-economic disparities associated with CVD are two important considerations for identifying and reducing morbidity and mortality risks. But other factors, including biological and psychological, must be considered as well. For example, aging has biological impacts associated with heart disease [11] along with race [12], while psychological risk factors include loneliness and isolation [13].

1.1. Behavioral Factors

Behavioral factors have a significant impact on health, including CVD/MI (myocardial infarction, also known as a heart attack) [14]. Addiction is one social determinant of health that is associated with social deprivation [14]. Previous studies have shown that Blacks, Hispanics, Asians, and Indigenous Americans are at a higher risk of addiction [14]. Addiction to tobacco, drugs, alcohol, behavior, or food can severely weaken the body and increase the number of premature deaths, which is also related to low income and unemployment or harsh economic status [14]. Lack of exercise is associated with both increased body mass index (BMI) and CVD/MI [14]. This study incorporates self-reported smoking, alcohol, other tobacco use, BMI, and physical activity as proxies for behavioral factors that may be associated with CVD/MI.

1.2. Socio-Economics

A 2011 study performed by Kucharska-Newton [15] in the United States found that the increase of the probability of heart disease is associated with low-income individuals and neighborhoods where these individuals engage in behaviors such as excessive drinking and smoking. These socio-economic factors affect behaviors synergistically and may be used to predict the risk of cardiovascular disease. In addition, the study indicates that a $10,000 increase in the median income reduces death associated with the cardiovascular disease by 10%. Residents in low-income areas are less likely to receive proper health care for the CVD. This issue might be due to the fact that low-income areas are less likely to be able to afford expensive procedures dealing with heart disease [16]. Even if they were able to afford the procedures, they may not be able to keep up with the needed follow-up and expensive prescriptions. This issue is one of the major contributors to the increased mortality rate for those who have a lower income.

Mortality differences in patients who have a lower income are also due to disparities in the standards of provided health care and decreased access to quality care for the socially disadvantaged. This discrepancy has been shown to lead to an increase in heart failure and hospital readmission rates in the United States [5]. There is also the fact that lower-income patients are more likely to have fewer yearly medical checkups, which can also lead to a higher occurrence of CVD.

The next socio-economic factor regarding cardiovascular disease is educational attainment. A study performed by Woodward (2015) in Australia and New Zealand indicates those who only have primary education are at higher risk of CVD than the ones with tertiary education [17]. The correlation between less education and increased cardiovascular disease might be attributable to behavioral and biological risk factors as well. These factors include smoking, obesity, physical inactivity, and hypertension [5]. In addition, there is a strong correlation between education and health literacy. Individuals who have poor health literacy are less likely to be as compliant with the prescriptions prescribed. This study evaluates educational attainment as a risk factor for CVD.

Unemployment has been seen to increase the risk of cardiovascular events [5]. The detrimental effects of unemployment may be driven by the loss of the job itself. There is also the theory that poor health results in the loss of employment [5]. An explanation for the impact of unemployment on cardiovascular disease could be an accumulation of stress that could lead to overuse of alcohol and tobacco. Employment status is another factor used in this study.

The last socio-economic factor that can increase the risk of cardiovascular disease is environmental factors. A 2015 study by Dubowitz using data on food-purchasing practices, dietary intake, height, and weight from the primary food shopper in randomly selected households illustrates the many effects of living in a disadvantaged region [18]. Obvious issues associated with such regions include lower income, lower educational attainment, and higher unemployment; however, less obvious is that these factors may correlate with the presence of CVD. To account for this factor, geographic location (e.g., inner city) is used in this study.

1.3. Biological Factors

Race and age are biological factors associated with CVD [11,12]. Though age is a common health disparity when it comes to the topic of heart disease, race and ethnicity are important considerations as well. Black and Hispanic communities have experienced many health disparities, including a lower status of health care, lack of access to health insurance, increased use of tobacco, and obesity, among other factors. Being subjected to copious degree of racism and discrimination can cause stress, which in turn can increase the risk of heart disease [14]. This study includes age and race as well as gender to evaluate biological risk factors.

1.4. Psychological Factors

Individuals that live and work in low socio-economic status environments may feel the effects of diminished self-esteem, lower sense of control, and a reduced ability to be productive [5]. The living environment has been associated with the development of a pessimistic outlook on life and the resultant negative psychological effects [13]. These psychological conditions can lead to poor choices and contribute to CVD risk factors. For this reason, the study includes a variable that assesses individual psychological status, specifically depression.

1.5. Research Question

This study examines socio-economic, psychological, biological, and behavioral factors that are associated with CVD using the Behavioral Risk Factor Surveillance System of the Centers for Disease Control and Prevention (CDC) [19]. The research questions are straightforward: What behavioral, socio-economic, psychological, and biological variables are associated with CVD based on the 2018 Behavioral Risk Factor Surveillance System (BRFSS)? The exact relative risks are reported for inclusion.

This study is significant since it updates previous research with the most recent data and investigates multiple variables to assess their relative risks. Hypothetically, one might expect a reduction in disparities given the passing of the Affordable Care Act and the focus on health disparities. The study is based on anonymous, publicly available data from the CDC. No institutional review board was required.

2. Materials and Methods

The 2018 BRFSS provided the data for this study. This dataset includes 437,467 observations and weights. Applying the weights estimates the entire population. Data from the BRFSS are freely available from the CDC [19]. Analysis of the data was conducted both with and without weights.

The dependent variable of interest was a calculated variable from the dataset. The variable was MICHD and defined as "Respondents that have ever reported having coronary heart disease (CVD) or myocardial infarction (MI) [20]." Responses were dichotomous: (0 = No, 1 = Yes). Only 6.89% of the weighted observations were "Yes," resulting in imbalanced data.

The behavioral independent variables of interest included variables that evaluate CVD as a function of behavioral, socio-economic, psychological, and biological predictors. Behavioral variables included smoking, other use of tobacco (dichotomous), and drinks per week (quantitative). Smoking was defined by the categorical variable SMOKER3 from the BRFSS: "Four-level smoker status: Everyday smoker, Someday smoker, Former smoker, Non-smoker [20]." Use of other tobacco products was defined by the variable USENOW3: "Do you currently use chewing tobacco, snuff, or snus every day, some days, or not at all?" [20]. This variable was recoded to dichotomous, as there were few observations of individuals who actually used snuff or chewing tobacco. Drinks per week was a calculated variable from the variable DROCDY3: "Drink occasions per day [20]." Body mass index (BMI) was a quantitative variable generated from BMI5 in the BRFSS. Physical activity was also quantitative and indicates "Adults who reported doing physical activity or exercise during the past 30 days other than their regular job. [20]"

The socio-economic variables included income (categorical), education (categorical), employment (categorical), and urban/rural status (dichotomous). Variable definitions for income, education, and employment are in Tables 1–3, respectively. Urban/rural status was defined by the variable METSTAT: "Metropolitan Status" [20].

Table 1. Variable INCOME2: "Is your annual household income from all sources: (If respondent refuses at any income level, code "Refused") [20]".

Income	Proportion	Standard Error
<$10K	0.044	0.001
$10K ≤ Income < $15K	0.040	0.001
$15K ≤ Income < $20K	0.058	0.001
$20K ≤ Income < $25K	0.073	0.001
$25K ≤ Income < $35K	0.083	0.001
$35K ≤ Income < $50K	0.105	0.001
$50K ≤ Income < $75K	0.124	0.001
$75K or more	0.472	0.002

Table 2. Variable EDUCA: "What is the highest grade or year of school you completed? [20]".

Grade/Year	Proportion	Standard Error
None or Only Kindergarten	0.003	0.000
Grades 1 through 8	0.044	0.001
Grades 9 through 11	0.084	0.001
Grades 12 or GED	0.278	0.002
College 1 to 3 years	0.308	0.002
College 4+ years (Graduate)	0.283	0.001

Table 3. Variable EMPLOY1: "Are you currently . . . ? [20]".

Employed Status	Proportion	Standard Error
Employed for Wages	0.489	0.002
Self-Employed	0.094	0.001
Out of Work ≥ 1 Year	0.024	0.001
Out of Work < 1 Year	0.025	0.001
Homemaker	0.058	0.001
Student	0.055	0.001
Retired	0.184	0.001
Unable to Work	0.071	0.001

Psychological variables included depression (dichotomous) and the number of days in the last month where mental issues affected activities (quantitative). Depression was defined from variable ADDEPEV2: "(Ever told) you have a depressive disorder (including depression, major depression, dysthymia, or minor depression)? [20]." Days lost due to mental issues was based on variable MENTHLTH: "Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good? [20]". The biological variables included age (categorical groups, see Table 4), gender codes as (0 = female, 1 = male), and race (categorical, see Table 5).

Table 4. Variable AGE5YR: "Fourteen-Level Age Category [20]".

Age Group	Proportion	Standard Error
18 to 24	0.123	0.001
25 to 29	0.081	0.001
30 to 34	0.092	0.001
35 to 39	0.078	0.001
40 to 44	0.081	0.001
45 to 49	0.070	0.001
50 to 54	0.086	0.001
55 to 59	0.080	0.001
60 to 64	0.085	0.001
65 to 69	0.083	0.001
70 to 74	0.056	0.001
75 to 79	0.039	0.001
80 or older	0.046	0.001

Table 5. Variable IMPRACE: "Imputed race/ethnicity value (This value is the reported race/ethnicity or an imputed race/ethnicity, if the respondent refused to give a race/ethnicity. The value of the imputed race/ethnicity will be the most common race/ethnicity response for that region of the state) [20]".

Race/Ethnicity	Proportion	Standard Error
White	0.628	0.002
Black	0.117	0.001
Asian	0.054	0.001
American Indian/Alaskan	0.011	0.000
Hispanic	0.170	0.002
Other non-Hispanic	0.021	0.000

The model (in blocks) follows. CVD/MI is a function of behavioral, socio-economic, psychological, and biological variables. The researchers expected to find disparities in all areas. The method for evaluating these variables was the application of a general linear model (GLM) with a quasi-binomial error term. The quasi-binomial distribution does not check for integer status (appropriate for weighted surveys where integers might become fractions) and accounts for variance in the data not explained by a binomial alone [21]. The distribution is often used for surveys which are weighted where the weights may make counts non-integer. This approach is identical to that of logistic regression where the outcome may not be integer. Equation (1) is the quasi-binomial formula, where p is the probability of CVD/MI, N is the number of weighted observations, k is the number of successes (perhaps non-integer due to weighting), and φ is the additional variance not accounted for by the binomial distribution. All analyses were run in R Statistical Software [22]. The survey package in R was used for complex weighting [23].

$$P(X = k) = \binom{N}{k} p(p + k\varphi)^{k-1}(1 - p - k\varphi)^{n-k} \tag{1}$$

3. Results

3.1. Descriptive Statistics

Only 2% of observations were missing from the complete dataset, so simple imputation (mode for categorical and mean for quantitative) was used. All data were made complete for 437,436 unweighted observations. Data were inspected by validating frequencies in the BRFSS codebook and descriptive statistics. The clean and fully populated data were then used in all analyses.

When weighted, only 6.8% (standard error, se < 0.001) of the observations were CVD/MI-positive. About 51.5% (se = 0.002) were estimated to be female, and 62.8% (se = 0.002) were estimated to be white non-Hispanic. The mean BMI was 28.13% (se = 0.0198). An estimated 30.8% (se = 0.002) of the individuals had 1–3 years of college. Only 6.5% (se < 0.001) of the population was estimated to occupy rural areas, and the mode estimated income was greater than $75,000 (47.2%, se = 0.002). About 96.6% (se < 0.001) did not use chewing tobacco or snuff products. Most of the population was estimated to be employed for wages (48.9%, se = 0.002). The estimate for depression was 18.2% (se = 0.001). The average number of days missed in the last 30 due to mental issues was estimated to be 4.0469 (se = 0.026), and the number of drinks consumed per day was 0.331 (se = 0.007). About 75.4% engaged in physical activity in the past 30 days. Tables 1–6 provide the weighted distributions for income, race, education, employment status, age, and smoking status, respectively.

Table 6. Variable SMOKER3: "Four-level smoker status: Everyday smoker, Someday smoker, Former smoker, Non-smoker [20]".

Smoking Status	Proportion	Standard Error
Smokes Every Day	0.102	0.001
Smokes Some Days	0.045	0.001
Former Smoker	0.230	0.001
Never Smoked	0.622	0.002

3.2. *Inferential Statistics*

GLM regression with the quasi-binomial error term identified behavioral, socio-economic, psychological, and biological variables associated with CVD/MI. Table 7 has the complete model with associated odds ratios and confidence intervals.

Table 7. Complete model with associated odds ratios and confidence intervals.

Variable	Estimate	S.E.	t-Value	Pr (>|t|)	Odds Ratio	95% CI Lower	95% CI Upper
Intercept	−4.945	0.534	−9.264	<0.001	0.007	0.003	0.020
Smokes Some	0.127	0.083	1.529	0.126	1.135	0.965	1.335
Former Smoker	−0.002	0.050	−0.039	0.969	0.998	0.905	1.101
Never Smoked	−0.374	0.051	−7.296	0.000	0.688	0.623	0.761
Chewing Tobacco or Snuff?	0.117	0.076	1.533	0.125	1.124	0.968	1.304
Drinks per Week	0.000	0.000	−1.618	0.106	1.000	1.000	1.000
Body Mass Index	0.023	0.002	10.337	<0.001	1.023	1.019	1.027
Exercised in 30 Days?	−0.172	0.030	−5.730	0.000	0.842	0.794	0.893
Income $[10,15)K	−0.103	0.078	−1.321	0.186	0.902	0.775	1.051
Income $[15,20)K	−0.014	0.078	−0.183	0.855	0.986	0.846	1.149
Income $[20,25)K	−0.122	0.081	−1.517	0.129	0.885	0.755	1.036
Income $[25,35)K	−0.201	0.080	−2.518	0.012	0.818	0.699	0.956
Income $[35,50)K	−0.247	0.079	−3.123	0.002	0.781	0.669	0.912
Income $[50,75)K	−0.297	0.075	−3.940	0.000	0.743	0.641	0.861
Income >$75K	−0.400	0.070	−5.758	0.000	0.670	0.585	0.768
Grades 1–8	−0.354	0.465	−0.760	0.447	0.702	0.282	1.747
Grades 9–11	−0.194	0.472	−0.410	0.682	0.824	0.327	2.077
High School Grad./GED	−0.433	0.473	−0.915	0.360	0.649	0.257	1.639
College 1 to 3 Years	−0.392	0.473	−0.828	0.408	0.676	0.267	1.709
College 4+ Year/Graduate	−0.612	0.473	−1.294	0.196	0.542	0.215	1.370
Self-Employed	0.163	0.066	2.477	0.013	1.177	1.034	1.338
Out of Work ≥ 1 Year	0.452	0.085	5.334	0.000	1.571	1.331	1.855
Out of Work < 1 Year	0.304	0.126	2.408	0.016	1.356	1.058	1.737
Homemaker	0.288	0.078	3.687	0.000	1.334	1.144	1.554
Student	0.138	0.321	0.430	0.668	1.148	0.612	2.151
Retired	0.490	0.047	10.518	<0.001	1.632	1.490	1.788
Unable to Work	0.987	0.051	19.219	<0.001	2.683	2.426	2.967
Urban?	−0.121	0.037	−3.234	0.001	0.886	0.823	0.953
Depression?	0.409	0.034	11.940	<0.001	1.505	1.407	1.609

Table 7. *Cont.*

Variable	Estimate	S.E.	t-Value	Pr (>|t|)	Odds Ratio	95% CI Lower	95% CI Upper
Missed Work/Mental	0.012	0.002	7.557	0.000	1.012	1.009	1.015
Age 25–29	0.339	0.200	1.700	0.089	1.404	0.949	2.075
Age 30–34	0.615	0.221	2.784	0.005	1.849	1.200	2.849
Age 35–39	0.829	0.198	4.184	0.000	2.291	1.554	3.378
Age 40–44	1.280	0.179	7.155	0.000	3.597	2.533	5.107
Age 45–49	1.389	0.176	7.896	0.000	4.011	2.841	5.662
Age 50–54	1.794	0.169	10.592	<0.001	6.013	4.315	8.381
Age 55–59	2.077	0.170	12.240	<0.001	7.980	5.722	11.130
Age 60–64	2.420	0.170	14.235	<0.001	11.246	8.059	15.693
Age 65–69	2.596	0.170	15.299	<0.001	13.410	9.616	18.702
Age 70–74	2.898	0.173	16.734	<0.001	18.138	12.917	25.469
Age 75–79	3.118	0.176	17.700	<0.001	22.601	16.004	31.917
Age 80 or Older	3.285	0.175	18.745	<0.001	26.709	18.943	37.659
Male	0.663	0.029	22.919	<0.001	1.941	1.834	2.054
Black Non-Hispanic	−0.162	0.047	−3.416	0.001	0.850	0.775	0.933
Asian Non-Hispanic	−0.017	0.122	−0.142	0.887	0.983	0.773	1.249
American Indian/Alaskan	0.244	0.084	2.918	0.004	1.276	1.083	1.503
Hispanic	0.018	0.067	0.271	0.786	1.018	0.893	1.161
Other Race, Hispanic	0.251	0.071	3.545	0.000	1.285	1.119	1.477

3.2.1. Behavioral

Those who never smoked were much less likely to have CVD/MI, odds ratio (OR) = 0.688, 95% CI = (0.623, 0.761), t = −7.296, p < 0.001), whereas chewing/snuff use had no additional risk even when evaluated outside the GLM. The number of drinks per week had no effect, an interesting finding that will be discussed later. Higher BMI was associated with higher risk of CVD/MI (OR = 1.023, 95% CI = (1.019, 1.027), t = 10.337, p < 0.001), while higher physical activity was associated with lower risk (OR = 0.842, 95% CI = (0.794, 0.893), t = −5.73, p < 0.001).

3.2.2. Socio-Economic

Higher incomes were associated with lower risk of CVD/MI. Those in the highest income groups had an odds ratio of 0.670 (95% CI = (0.585, 0.768), t = −5.758, p < 0.001). Education had no bearing on the presence of CVD, whereas employment status outside of a traditional job increased the risk. Those unable to work were (as expected) more likely to have CVD/MI (OR: 2.834, 95% CI = (2.565, 3.131), t = 19.219, p < 0.001), and all others that were not "employed for wages", except for students, had higher risk. Urban residents were at lower risk than rural residents (OR = 0.886, 95% CI = (0.823, 0.953), t = −3.324, p < 0.001)

3.2.3. Psychological

Depression was a risk factor for CVD/MI (OR = 1.505, 95% CI = (1.407, 1.609), t = 11.940, p < 0.001). Additionally, the number of days an individual was unable to work because of mental issues increased the risk of CVD/MI (OR = 1.013, 95% CI = (1.009, 1.015), t = 7.557, p < 0.001).

3.2.4. Biological

Every increase in age category increased the risk of CVD presence. For 80-year-old individuals, the OR was 26.809 (95%CI = (18.943, 37.659), t = 18.745, p <0.001). Males were more likely than females to have CVD (OR = 1.941, 95% CI = (1.834, 2.054), t = 22.919, p < 0.001). Surprisingly, only indigenous Americans, Alaskan non-Hispanics, and other race Hispanics were more at risk for CVD/MI with odds ratios of 1.276 (95% CI = (1.083, 1.503)) and 1.285 (95% CI = (1.119, 1.477)), respectively. While black non-Hispanics are known to be at higher risk for CVD and MI, this analysis indicates that black non-Hispanics are actually less likely to have CVD with an OR of 0.850 (95% CI = (0.775,0.933)).

4. Discussion

4.1. Behavioral Factors

As expected, behavioral, socio-economic, psychological, and biological variables affect the risk of CVD/MI. Non-smokers were associated with a reduced risk of CVD/MI. This finding is congruent with previous research [24]. Drinking was not associated with reduced CVD/MI, contrary to some prior research. There are conflicting studies about the effects of drinking on CVD/MI. Some studies have shown an effect of drinking on CVD/MI [25], while others have found no such association [26]. This study's findings support no relationship between drinking and CVD/MI. More research is needed specifically to identify the risks of drinking and CVD/MI.

4.2. Socio-Economic Factors

Socio-economic risks included income status (where higher income was associated with reduced risk) and employment status (where those unable to work were associated with the highest risk). Income is associated with better access to care [16]. The results make sense, as those with higher incomes are likely to have access to better health care (preventive and otherwise). Having access to preventive care (e.g., hypertension medicine) likely reduces risk.

4.3. Psychological Factors

The effects of psychological factors are interesting. Both a history of depression and days lost due to mental issues were significant risk criteria for CVD/MI. This finding is congruent with previous studies as well [15]. Depression and days lost are likely to be risk factors, as stress may cause heart issues such as CVD/MI, which exercise may help counteract [27].

4.4. Biological Factors

Age and race were important biological considerations for risk of CVD/MI. Increases in age increase the risk in nonlinear fashion (see Appendix A), while the highest-risk race category was other, non-Hispanic. Race, age, and ethnicity differences make sense given previous research [28]. The directionality of the results associated with age is also reasonable given that increased age results in increased risk. Biological factors are likely to have synergistic effects when combined, and additional studies should focus on these using non-behavioral data.

The question remains, why did Black non-Hispanics not have increased rates of CVD/MI as found in some other studies? The researchers found the results of this analysis to be contrary to the past findings, so the unweighted data were analyzed in Table 8. Those data supported the findings of the weighted analysis. Further, an unweighted analysis of all states and territories supports these findings, with only four exceeding the overall rate of CVD/MI (Table 9). Possible reasons for these findings are discussed later. Even sudden cardiac death (SCD) is not fully explained by other factors such as demographics, socioeconomics, cardiovascular risk factors, and behavioral measures [29]. It is possible that this finding is a result of under-reporting in the BRFSS, as this is incongruent with most previous analyses. Interestingly, however, is the fact that Whites engage in a most unhealthy lifestyle, while the Black population engages in an unhealthy lifestyle. In other words, Whites are higher at risk due to their behaviors [30]. This may be the reason for the findings in this study, although further inquiry is required.

Table 8. Evaluation of Race and cardiovascular disease/myocardial infarction (CVD/MI).

Race	No CVD/MI	CVD/MI	% CVD/MI
White, Non-Hispanic	298,046	31,868	10.69%
Black, Non-Hispanic	33,433	3010	9.00%
Asian, Non-Hispanic	10,347	537	5.19%
American Indian/Alaskan	7509	1025	13.65%
Hispanic	35,084	2235	6.37%
Other Race, Non-Hispanic	12,846	1496	11.65%

Table 9. CVD/MI by state and territory, where green coloring indicates lower than the total percent.

State	White	Black	Asian	Am. Indian/AL Native	Hispanic	Other	Total
Alabama	12.75%	10.44%	4.44%	23.08%	9.78%	12.23%	12.17%
Alaska	7.58%	5.77%	4.62%	10.00%	4.67%	6.29%	7.63%
Arizona	11.14%	6.47%	7.02%	5.69%	6.68%	10.33%	9.84%
Arkansas	15.60%	10.90%	0.00%	19.70%	7.32%	25.29%	14.92%
California	6.48%	6.80%	3.28%	16.52%	4.84%	6.70%	5.78%
Colorado	6.88%	8.80%	8.04%	8.97%	4.57%	7.28%	6.63%
Connecticut	8.59%	5.24%	5.11%	9.23%	4.85%	7.17%	7.96%
Delware	10.67%	6.72%	5.30%	10.14%	2.79%	9.77%	9.14%
District of Columbia	5.34%	8.63%	1.74%	11.59%	2.72%	6.00%	6.74%
Florida	12.65%	9.26%	5.69%	17.51%	6.60%	13.39%	11.65%
Georgia	10.17%	7.61%	3.39%	12.15%	3.58%	11.69%	8.84%
Hawaii	7.08%	1.09%	6.18%	11.76%	5.88%	7.78%	6.86%
Idaho	8.58%	5.56%	2.94%	18.18%	5.64%	17.95%	8.64%
Illinois	8.20%	7.67%	3.54%	10.87%	4.59%	7.45%	7.43%
Indiana	11.20%	9.66%	5.75%	11.88%	5.81%	13.33%	10.91%
Iowa	8.36%	7.69%	4.17%	18.00%	3.23%	10.20%	8.16%
Kansas	9.54%	10.36%	6.29%	13.57%	4.26%	8.29%	9.31%
Kentucky	12.70%	12.73%	2.44%	15.56%	8.94%	18.81%	12.77%
Louisiana	11.26%	7.85%	5.56%	6.49%	7.59%	9.03%	10.12%
Maine	10.99%	14.29%	10.42%	23.21%	9.52%	15.45%	11.21%
Maryland	10.13%	7.09%	6.47%	13.49%	4.41%	10.04%	9.28%
Massachusetts	7.82%	5.67%	3.06%	21.31%	5.21%	8.38%	7.48%
Michigan	9.72%	8.19%	1.73%	17.07%	7.47%	7.14%	9.38%
Minnesota	7.17%	6.63%	2.13%	11.11%	2.81%	6.89%	6.91%
Mississippi	12.19%	9.68%	15.38%	20.93%	3.92%	10.42%	11.19%
Missouri	11.63%	10.80%	5.45%	11.11%	10.62%	12.08%	11.48%
Montana	8.35%	7.27%	19.23%	12.52%	10.00%	13.75%	9.05%
Nebraska	9.10%	4.51%	6.02%	12.83%	3.83%	8.39%	8.69%
Nevada	10.46%	8.57%	4.21%	8.20%	5.38%	11.58%	9.32%
New Hampshire	9.38%	5.36%	9.76%	10.00%	6.17%	8.70%	9.29%
New Jersey	8.21%	7.97%	3.80%	13.33%	5.58%	7.04%	7.58%
New Mexico	9.92%	9.57%	3.13%	6.36%	6.48%	11.36%	8.42%
New York	9.37%	5.75%	5.17%	15.07%	5.96%	12.04%	8.88%
North Carolina	10.66%	7.88%	1.69%	18.75%	2.89%	19.82%	9.78%
North Dakota	10.64%	6.10%	5.13%	15.82%	5.56%	9.09%	10.61%
Ohio	11.26%	9.85%	4.86%	20.51%	9.48%	16.48%	11.27%
Oklahoma	13.24%	8.48%	4.76%	8.57%	5.41%	16.85%	12.31%
Oregon	7.88%	5.63%	6.25%	6.35%	5.92%	10.51%	7.77%
Pennsylvania	8.28%	7.92%	0.67%	2.78%	7.45%	6.34%	7.94%
Rhode Island	9.52%	7.04%	8.65%	15.79%	5.79%	7.65%	9.11%
South Carolina	11.57%	9.92%	3.16%	16.67%	4.11%	15.00%	10.98%
South Dakota	10.18%	12.73%	0.00%	13.24%	6.52%	10.37%	10.53%
Tennessee	11.59%	11.26%	10.53%	17.31%	5.08%	14.86%	11.55%
Texas	11.35%	9.42%	5.49%	14.67%	6.34%	15.41%	10.11%
Utah	5.73%	3.90%	1.72%	7.05%	2.83%	5.82%	5.44%
Vermont	7.44%	3.13%	2.56%	21.28%	5.88%	9.63%	7.64%
Virginia	9.66%	6.67%	5.56%	11.21%	5.25%	11.36%	8.89%
Washington	9.13%	7.14%	4.12%	9.71%	3.91%	7.88%	8.50%
West Virginia	15.04%	11.82%	13.79%	25.00%	10.42%	21.90%	15.12%
Wisconsin	7.89%	8.29%	4.35%	10.20%	4.29%	8.00%	7.83%
Wyoming	8.73%	21.43%	7.41%	16.67%	5.22%	11.76%	8.70%
Guam	3.13%	4.55%	6.15%		14.29%	10.27%	8.50%
Puerto Rico	13.04%	0.00%	0.00%	0.00%	10.70%	7.69%	10.69%

5. Conclusions

The strength and relevance of this study is both its recency and the sample size. It is the first such study to use the BRFSS data from 2018 for this purpose. Overall, behavioral, socio-economic, psychological, and biological variables combine for a fairly comprehensive look at the risk of CVD/MI. However, several limitations exist in this study. First, the CDC's BRFSS is self-reported data only. While the BRFSS is based on self-reporting, the study is widely used for analysis. The prevalence rates of heart disease according to the CDC (6.7%, [31]) are similar to those of the BRFSS (6.9%). There is some slight over-representation or undiagnosed CVD. For this study, the rate of depression was 18.23%. This is similar to the 18.1% reported by the Anxiety and Depression Association of America [32]. In balance, the self-reporting appears to be at least a reasonable representation of reality. Still, the possibility of under-reporting or over-reporting exists. Second, the study focuses solely on the United States. It should not be generalized outside of this country.

A strategy to address the disparities associated with CVD/MI is dissemination of information. Education has the potential of addressing behavioral and psychological components for the underserved population. Local interventions might include increasing access to free or discounted care at local clinics in disadvantaged socio-economic communities. Though some such programs already do exist, expansion and marketing of services as well as increasing quality are all issues for local governments to consider.

Two ethical principles that relate to any policy solutions are the principle of beneficence and the principle of justice. The principle of beneficence is that health care providers have a duty to perform acts that benefit the patients and can assist in improving their health status [33]. This principle, when applied, can help to improve the health of lower-economic-status population and communities that do not receive the same level of health care as population with higher level of incomes. The principle of justice is defined as the ability for health care to be equal and fair for all [33]. These principles should be part of policy decision-making for addressing healthcare disparities.

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Green for the Environment and Green for the Pocketbook: A Decade of Living Sustainably

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Abstract: The question of building sustainable in a geographical locality is inexorably linked to cost. In 2011, one of the authors built a sustainable house that was (at the time) the highest certified sustainable home based on the National Association of Home Builder's standards for sustainable construction. This Texas house has been used for residential and research purposes for the past decade. In this case study, the authors evaluate components of the construction and their effectiveness as well as unseen secondary and tertiary effects. Some of the specific components discussed are home site placement; rainwater harvesting (100% of residential requirements); aerobic septic system; grid-tied solar array power; electric car charging; geothermal heating and cooling; reclaimed wood framing; spray foam installation; selection of windows, fixtures, and appliances; on-demand electric water heaters for guest areas; generator backups; and use of local items. Electric bills and water system improvements are discussed in detail, as improvements were made as part of residential and research requirements. This case study suggests that the financial outlay is worth the extra up-front costs if residents in this geographical area and climate will occupy the residence 7 years.

Keywords: residential construction, rainwater harvesting, solar, spray foam, finger-jointed studs

1. Introduction

Reducing the impact of the built environment is a necessary step to address concerns of climate change as well as population growth. Green building codes have arisen to help provide best practice for green construction. Understanding what codes actually result in effective environmental changes that are positive for the consumer is necessary [1].

In a recent study, electricity, tap water consumption, and employee commuting dominated 10 out of 12 environmental impact categories, categories that included global warming, human health consequences, eutrophication /acidification and use of water, as well as smog formation. For land use impacts, wood products contributed the most (perhaps, unsurprisingly) [2],

Net Zero (or even Net Positive) construction involves the design of facilities that either consume no net energy (demand less supply) or that produce more energy than consumption [3], reducing global warming. Net Zero construction may even power user transportation [4]. Rainwater harvesting removes the stress on below-ground and ground water sources for both residential and business construction (including hospitals) [5, 6].

This qualitative case study analyzes best practice construction design for both the environment and the consumer based on one author's decade of living in a sustainably constructed residence. This residence was the highest-rated house ever certified by the National Association of Home Builders at the time it was built [4]. Both construction successes and failures are analyzed with commentary from both the environmental and consumer perspective. Where possible, cost-benefit analyses are provided.

2. Materials and Methods

In this case study, we evaluate life-cycle costs, environmental impacts, and efficacy of multiple sustainable building innovations to evaluate construction possibilities for residences. The particular 4,800 square foot home studied exists in a semi-arid environment (San Antonio, Texas.) Particularly foci of this qualitative case study include the efficacy of solar panels theoretically sufficient to power the homeowner's electrical demand as well as power an electric car and the utility of a rainwater harvesting system designed to support 100% of the homeowner's needs. The study evaluates home site placement; local materials extraction; reclaimed wood framing; spray foam insulation; window, fixture, and appliance selection; material recycling; rainwater harvesting design and engineering; aerobic septic system; xeriscaping; grid-tied solar arrays; electric car charging and use; on-demand water heaters; wireless switches to reduce wiring requirements; geothermal heating and cooling; and electrical back-up system options. The primary hypothesis is that construction of a large house in a semi-arid environment using sustainable techniques could be green for the pocketbook as well as green for the environment.

3. Results

3.1. Initial Considerations

3.1.1. Site Placement

The residence in the study was designed from the ground up to be sustainable, and the design considerations included geographical placement. The home site (5.3 acres on a hill just North of San Antonio, Texas) was selected to be North facing to maximize solar capture (West, South, and East facing panels and to leverage predominant local winds (South to North) [7]. Further, the site selected minimized tree removal, reducing cost and effect on the environment. Qualitatively, the placement was a success in this construction, as the solar capture is as expected (discussed later), and the cost as well as the environmental impact of excess tree removal was avoided. Figure 1 is the Google Maps satellite image of the house [8].

Figure 1. The residence as constructed

3.1.2. Material Location / Transportation

One of the major sustainability considerations in residential construction is the transportation of materials. As part of the house design, only local materials (those within 50 miles) were selected. For example, local limestone was selected for the exterior (Figure 2). Reducing transportation requirements reduces emissions. While the extent of the carbon emission reduction is unknown, the use of local materials achieved at least some reduction in environmental impact. Further, material overhead for distant transportation of materials was avoided, logically reducing costs. The amount of that reduction is unknown and not estimated.

Figure 2. All construction materials were native.

3.1.3. Waste Collection and Recycling

During construction, bins for waste were used to recycle materials as appropriate (Figure 3). Doing so allowed for reclaimed wood to be reclaimed as engineered lumber and for used paper and metal to be recycled. While this has little to no bearing on cost, it does have an effect on the environment.

Figure 3. Bins established for paper / metal collection during construction

3.2. Engineered Lumber / Finger-Jointed Studs

Finger-jointed studs use reclaimed wood that might otherwise be discarded (Figure 4). They are straighter and result in less wood wasted. Further, they have a strong vertical load capability, with evidence that many species (including pine) have better structural properties when finger-jointed [9].

Figure 4. Finger-jointed stud used in the residence construction

A 20″ diameter tree with 42 feet length of usable wood produces about 260 board feet. The Idaho Forest Products commission estimated that a typical 2,000 square feet house would use 102 trees of that size [10]. Assuming linearity, the 4800 square feet home would have been estimated to require approximately 245 trees. Assuming an offset of even 25% of the wood requirements results in a reduction of about 61 trees. See Table 1.

Table 1. Estimate of trees saved by using engineered lumber (finger-jointed studs) in this case study.

% Offset of Traditional Lumber	Trees Saved
10%	24.5
15%	36.8
20%	49.0
25%	61.3
30%	73.5
35%	85.8
40%	98.0

The cost of finger-jointed studs may be more expensive than regular studs. At one lumber site, retail cost of a 2 x 4 x 104 5/8″ regular pine stud versus the same size finger-jointed stud is listed at $3.62 [11] versus $5.59 [12], respectively. This is a 54.4% cost increase for materials, which might be offset by lower labor costs due to engineered lumber's straightness.

The cost differential is not atypical, as many engineered lumber products have upcharges between 1.5 and 2 times the cost of traditional lumber [13]. HomeAdvisor estimates the total cost of traditional framing between $4 to $10 per square foot for labor and $3 to $6 per square foot for materials [14].

With a 30% reduction of labor costs for engineered lumber, low material costs for standard lumber, and 54.4% higher costs in engineered lumber, there are several ways in which finger-jointed studs actually save money. Table 2 illustrates those combinations (2020 dollars)

Table 2. Regular lumbar versus finger-jointed studs at 1.54 and 0.70 times materials and labor, respectively

Regular Lumbar, $ / ft²		Engineered Lumber, $ / ft²		4800 Sq. Ft.
Materials	*Labor*	*Materials*	*Labor*	*Cost Savings*
3.00	10.00	4.62	7.00	6,624.00
3.00	9.00	4.62	6.30	5,184.00
4.00	10.00	6.16	7.00	4,032.00
3.00	8.00	4.62	5.60	3,744.00
4.00	9.00	6.16	6.30	2,592.00
3.00	7.00	4.62	4.90	2,304.00
5.00	10.00	7.70	7.00	1,440.00
4.00	8.00	6.16	5.60	1,152.00
3.00	6.00	4.62	4.20	864.00
5.00	9.00	7.70	6.30	-

Using the average estimate of $7 for labor and $4 for materials (traditional construction) and 30% reductions in labor ($4.90) with 54.4% increases in materials ($6.18, non-traditional construction) results in comparative estimates of $52,800 (traditional) and $53,184 (non-traditional). The total difference in cost is estimated to be nominal. The total difference in environmental impact is not.

3.3. Spray Foam Insulation

Residential spray-foam insulation (Figure 5) provides a thermal barrier with exceedingly low conductivity (.021 W/mK in one study [15]). Spray foam has reasonable hygrothermal properties and is resistant to moisture migration; however, mechanical extraction and humidity controls were installed because of the tight environmental seal of the house and the requirement to exchange air. The practical relevance of the tight seal around the residence is that during the heat of the Texas summer (in excess of 100 degrees F), the observed temperature in the attic spaces does not exceed 80F/26.7C with the house thermometer set to 76F / 24.4C.

Figure 5. Open-cell spray-foam insulation

The 2020 cost for open-cell spray-foam insulation is about $.35 to $.55 per board foot. Assuming 3.5″ depth of spray converts to $1.23 to $1.93 per square foot. Fiberglass batt insulation runs $.64 to $1.19 per square foot. Assuming average costs of $1.58 per square foot (spray-foam) and $.915 (fiberglass) with 6,000 square feet of attic and walls to be insulated results in cost estimates of $9,480 and $5,490, respectively [17].

The analysis above, however, is incomplete. Spray-foam works as an air barrier, vapor barrier, water-resistant barrier, and insulation. There is no need for attic vents, test ductwork, or air-seal attics. When evaluated in this manner, it is actually 10-15% less expensive than traditional construction. Inflating the estimated cost of $9,480 by 10% to account for all traditional construction requirements results in $10,428 for standard construction.

3.4. Low Solar Heat Gain Coefficient (SHGC) and U-Factor Windows (Energy Star)

Solar Heat Gain Coefficient (SHGC) is defined as the fraction of incident solar radiation admitted through a window. In warm climates, windows should have solar heat gain coefficients (SHGC) less than .25 [18]. Further, the U factor, a factor that express the insulative value of windows, should be .4 or lower. Low emissivity Jeldwen windows and doors with SHGC of .23 and U-Factor of .3 were used throughout the house (Figure 6).

Figure 6. Windows and doors must match environmental considerations

Low emissivity windows are 10 to 15% more expensive than standard windows [19]. The typical cost range in 2020 dollars is $385 to $785 with an average of $585 [20]. The Department of Energy estimates savings of $125 to $465 dollars a year from replacing windows with new windows that have higher Energy Star ratings [21]. Assuming average cost for Energy Star windows ($585), 15% cheaper traditional windows ($508.70), and a total of 25 windows results in acquisition costs of $14,625 (Energy Star) versus $12,717.50 (non-Energy Star). The $1,907.50 difference would be offset in about 6.5 years at the average $295 energy savings.

3.5. Rainwater Harvesting

The decision to install a rainwater harvesting system (RWH) versus a well or city water is one that is entirely dependent on the environment, the availability, homeowner's wishes, and regulations. In this case study, no city water sources were available. After a cost analysis, it was estimated that the cost for an aquifer-draining well and the cost for a rainwater harvesting system would be nearly identical ($20,000). Rainwater harvesting was selected for both sustainability and quality considerations. From a sustainability perspective, RWH requires far less water for the same aquifer demand. Specifically, run-off, absorption / adsorption, and evaporation / transpiration reduce aquifer resupply by at least 30% [22]. On the other hand, RWH systems capture 75% to 90% of rainwater, depending on design and rainfall [23]. The amount of water pulled from the aquifer to supply one gallon is therefore at least 3.333 gallons, whereas well RWH systems capturing only 75% of the available rainfall require 1.333 gallons. The net savings to the aquifer is 2 gallons of water per 1 gallon demanded.

Figure 7 depicts the RWH as currently installed in the residence. The system works as follows. Rainwater falls on the roof and is captured by gutters. The guttered water flows to the cistern where ~100 gallons or so is flushed out through a pipe with a ball float to eject the debris on the roof. This is called the first flush (Figure 8). Once the ball float seals the flushing tube, the water continues into French drain and basket filters (Figure 9) and then into a cistern (Figure10). Parallel on-demand pumps (Figure 11) push water towards the house where it is processed through a sediment filter, charcoal regeneration system, and ultraviolet light which is an effective method for inactivating pathogens through irradiation [24]. The water is then used and exits to an aerobic septic system (not shown).

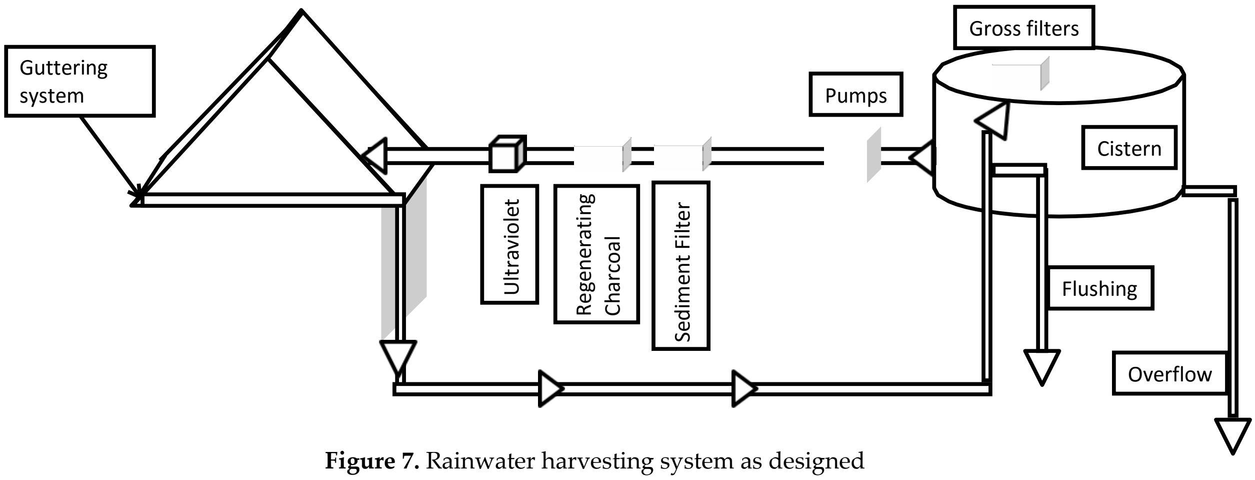


Figure 7. Rainwater harvesting system as designed

Figure 8. First flush system

Figure 9. French drain and basket filter location (inside the black tank lid)

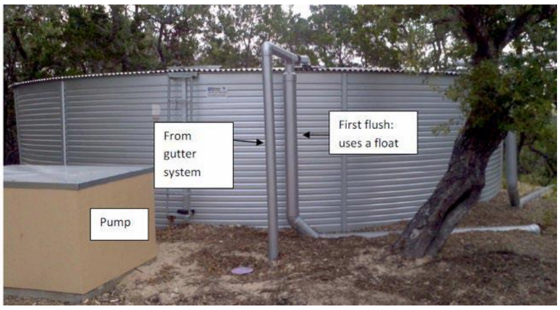


Figure 10. RWH components after installation

Figure 11. Parallel on-demand pumps

Quality considerations for water are significant. Using rainfall for potable house needs requires proper roof selection (ceramic or metal as examples), flushing (first flush), gross filtering (e.g. French drain and basket filters), storage (food-grade butyl rubber), pumping, cleansing (e.g., sediment filter and charcoal regeneration, Figure 12), purifying (ultraviolet purification as one example, Figure 13), and disposal of gray water (aerobic septic system). *The Texas Manual on Rainwater Harvesting* [23] provided the baseline quality construction requirements.

Figure 12. From right to left: sediment filter, charcoal regeneration, ultraviolet filter (spare tank in front)

Figure 13. Ultraviolet purification and example light

Design of an RWH capable of meeting the needs of an entire household required simulation modeling, so that the distribution of the minimum in the cistern (order statistic) would be strictly greater than zero over all supply and demand considerations and all simulation runs. Details of the simulation are available from [5,25] . The final system selected included 4000 square feet of capture space and a 40,000 gallon cistern.

To date, the observed minimum in the tank (the order statistic of most importance) has been 75% by dipstick measurement. The system was over-engineered in a deliberate way. The homeowners estimate that with a full tank, they will retain water in the tank for approximately two years without any rainfall.

Acquisition costs for the rainwater harvesting system (guttering, PVC piping, Pioneer 40K gallon cistern with butyl rubber liner and accessories) cost approximately $25,500 in 2020 [26]. Current well drilling prices in Texas are $30 to $55 per foot [27]. On this property, a 600' drilling depth is required. At the average $42.50 per foot, the drilling cost alone would run $25,500 now.

Cost to maintain the system has been reasonable. Ultraviolet tubes (replaced annually for typical use) as well as sediment filters and other system requirements cost approximately $100 per year. According to the Centers for Disease Control and Prevevntion, wells should also be inspected annually [28] at a cost of $300 to $500 per month [29]. The system is cost effective. Further, the water quality exceeds local and state requirements. Since it is soft, there is no residue when washing anything (Figure 14).

Figure 14. Water clarity and softness

3.6. Water Fixtures

Selection of appliances and fixtures is important for a sustainable house reliant on 100% rainwater. Toilets, shower heads, and other water fixtures were low flow / high pressure (see Figure 15), as the residence sought to sustain itself using only rainwater harvesting. Mayer et al. [30] estimate that toilets use 29% of indoor water consumption, while water used for showering/bathing, dishwashing and laundry consume about 36%, 14%, and 21%, respectively. The Environmental Protection Agency (EPA) shows that high pressure, low flow shower heads reduce flow from 2.5 gallons per minute to 2.0 gallons per minute, a 20% reduction [31]. Costs for low flow fixtures are comparable to standard fixtures. There are no cost savings or increases.

Figure 15. Low flow (dual flush) toilet, installed

3.7 Aerobic Septic

Cradle-to-grave water management requires that black water be treated responsibly and sustainably. In this area, aerobic septic systems are required by regulation. The owner had installed a Jet Biologically Accelerated Treatment (BAT) plant (also termed Biologically Accelerated Wastewater Treatment, BAWT, plant). BAT plants work by treating wastewater physically and biologically in a pre-treatment compartment. Water then flows through the treatment compartment where it is aerated, mixed, and treated by a host of biological organisms (a biomass). The mixture then flows to a settlement compartment where particulate matter settles, returning to the treatment compartment, leaving only odorless and clear liquid (gray water produced by the biomass) which is discharged through sprinkler heads [32]. Figure 16 is the encased BAT system installed at the residence. Aerobic systems break down waste far quicker than anaerobic due to the nature of the bacteria.

Figure 16. Biological Accelerated Treatment plant during installation

There is no cost benefit for installing such a system at this residence. Installing an anerobic system averages $3,500, whereas an aerobic costs about $10,500 [33]. Maintaining the aerobic septic system is about $200 annually [34], which is somewhat more than anaerobic systems [35]. There are, however, benefits to the environment in that 1) pumps for transporting water to wastewater treatment plants are not necessary (and the associated energy costs), 2) treated water returned to the environment is cleaner, 3) electricity for processing water (in this case) is largely if not entirely generated by the sun.

3.8. Tankless Water Heaters

One of the current additions to this research residence has been the inclusion of an on-demand electric water heater for a guest room, guest kitchen, and guest bathroom (see Figure 17). These water heaters take up less space and do not constantly use energy to keep water warm. The acquisition cost of an electric tankless heater is largely dependent on size, capability, and brand and may be larger than traditional tank versions; however, the acquisition cost for the installed unit was identical to the tank unit in this case. Tankless may also last 1.5 to 2 times as long as tank water heaters (20 years) and save 8 to 34% on water, depending on water demand; however, demand flow for multiple simultaneous operations must be evaluated [36].

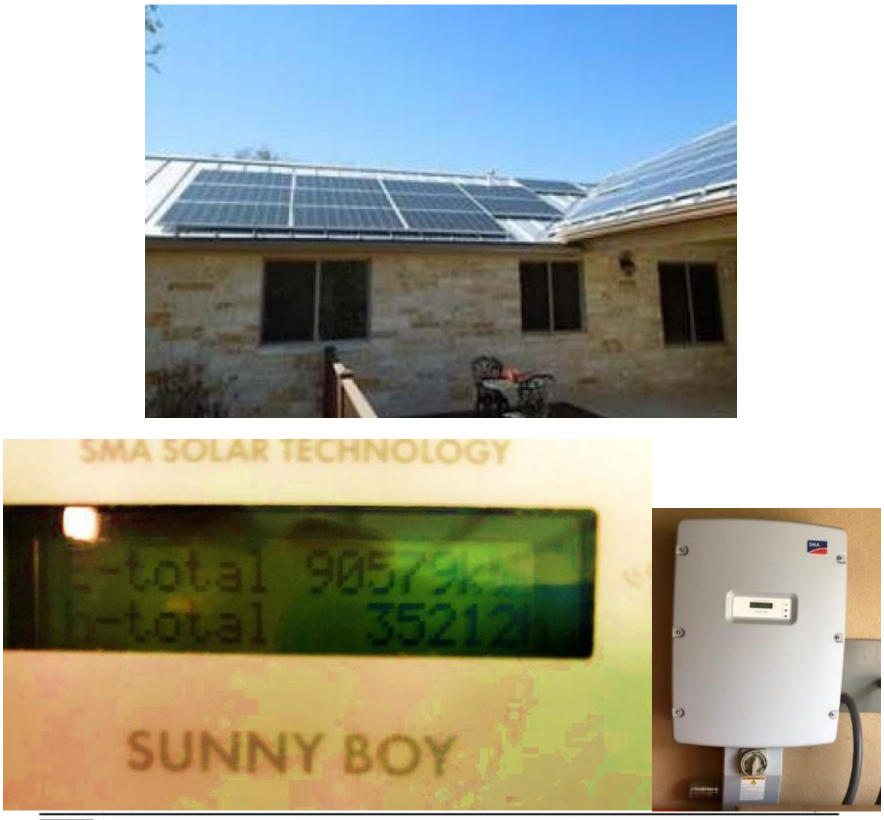
Figure 17. Rheem tankless water heater (image labeled and authorized for reuse)

Comparing the life-cycle of a 50-gallon electric water heater with that of a tankless requires some up-front assumptions. One study indicated that the life-cycle savings over traditional electric storage systems is $3,719 Australian dollars (about $2500 US dollars) [37]. However, that study does not consider the possibility that all electrical power needed is generated by solar. Further, the carbon footprint is much lower, as it is in operation only when demanded. Tankless water heaters may be 99% efficient [38].

The acquisition and installation costs for 2 x 50 gallon tank water heaters during initial construction was nearly $3,000. Under traditional grid power, the yearly costs are $494 per tank or just under $1000. For tankless water heaters under solar, the installation and acquisition costs are $3000 for two units (high end). There are zero annual costs.

3.9. Solar Arrays

In a sustainable home located in semi-arid regions, solar arrays are an obvious solution for producing energy requirements. This residence initially had installed a 7.25 kWh system (32 x 225 watt panels) with a Sunny Boy inverter ($33,600 in 2011, Figure 18) and then subsequently added another 9.585 kWh system (27 x 355 watt panels, $31,317 in 2018, Figure 19) with a Solar Edge inverter after home expansion and capitalization of the original solar power system. The total cost of both systems was approximately $64.917. After 30% federal tax credits, the total cost to the resident was approximately $44,441.90. From installation date until 31 January 2020, the initial 7.25 kWh system has produced 90.579 MWh of power in 35,212 hours of operation for 2.57 kWh per hour, saving 153,984 pounds of CO2 emissions. The 9.585 kWh system has produced 25.86 MWh in about 18,240 hours since installation, saving 40,038.49 pounds of CO2 emissions and resulting in only 1.4 kWh per hour. The low result is due to installation in January and a month wait to replace the initial inverter (faulty) in January to February 2018.

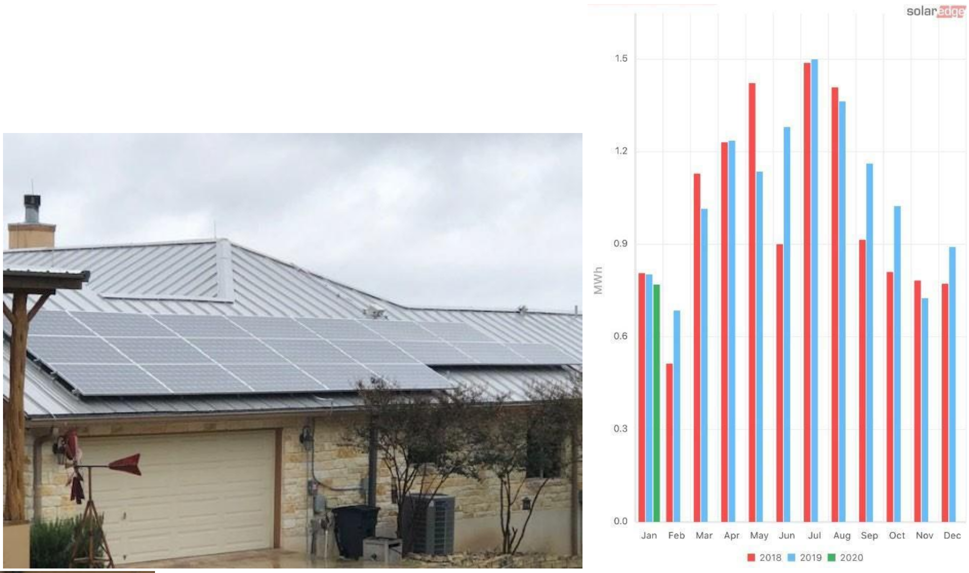


Part II **Residential Energy Efficient Property Credit** (See instructions before completing this part.)

Note. *Skip lines 15 through 25 if you only have a* ***credit carryforward from 2010.***

15	Qualified solar electric property costs	15	33,600.
16	Qualified solar water heating property costs	16	
17	Qualified small wind energy property costs	17	
18	Qualified geothermal heat pump property costs	18	26,500.
19	Add lines 15 through 18	19	60,100.
20	Multiply line 19 by 30% (.30)	20	18,030.

Figure 18. Initial 7kWh system (top left) with inverter (bottom left), total power production (upper right), and acquisition costs (lower right)



Item Code	Description	Price Each	Amount
Solar Installation	$31,317.00	31,317.00	31,317.00
	27 355 watt panels with optimizers		
	solar edge inverter		
	monitoring device to track electrical production from system		
	racking/labor and material to connect to main electrical		
	applicable permits		

Figure 19. 10 kWH SolarEdge system (top left) with inverter (bottom left), power production (upper right), and acquisition costs (lower right)

Initial break-even analysis is based on both acquisition cost and energy cost as if both systems were installed on the expanded house. Figure 20 illustrates the residence usage after power generation for a one-year period. During the six months of April through September, the residents produced or banked more power than consumed. From October through March, the resident consumed more power than produced. The $32.72 bill provided is a connection fee. During this month, the residents consumed 1699 kWh and produced only 1226 kWh. There is, however, no delivery or cost of power charge, as the previous months, the residents produced more than consumed. The total consumption estimate is then about 2925 kWh for a 4800 square foot house in a cool month. When averaged over a single year, total consumption is approximately 3500 kWh per month.

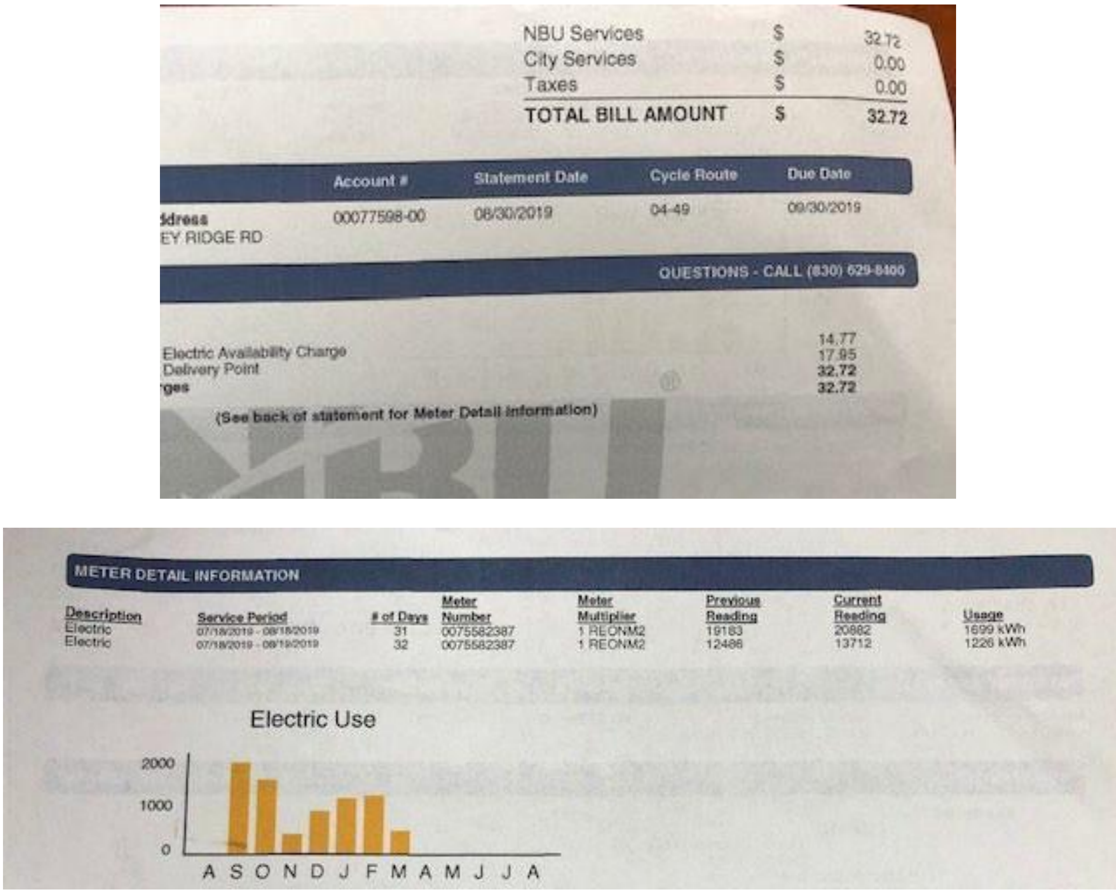


Figure 20. Electric bill, 9/30/2019 (both production, top, and consumption, bottom)

A non-solar house consuming 3500 kWh per month under traditional utility billing at $.07 per kWh with at $14.77 customer charge results in an annual estimated cost of $3,117.24 ($259.77 x 12). The same consumption with solar runs $498.00 ($33 x 6 months + $50 x 6 months). Residential electricity rates are anticipated to be fairly stable over time [39]. The break-even point for both systems is estimated to be about 17 years; however, this does not account for avoidance of automobile gasoline charges assuming the use of an electric car.

From an environmental perspective, the carbon dioxide avoidance by leveraging solar is significant. The footprint of solar is 6 g CO2e/kWh, while coal CCS is 109 g and bioenergy is 98 g. Wind power produces less emissions (4 g each); however, the residence location is a low-production wind area [40].

3.10. Electric Car Charging

Electricity generated from the solar panels was used to charge an electric Nissan Leaf (early adopter, see Figure 21). The gasoline avoidance in doing so was significant. Assuming equivalent acquisition costs for electric versus non-electric cars, a $100 avoidance in gasoline each month and holding all other variables constant, the net annual savings for solar would be $3,117.24 - - $702 = $3,819.24 for a break-even of 11.6 years. Unfortunately, early Nissan Leaf vehicles suffered from battery issues [41]. The owner divested after 3 years due to this issues as well as a change in employment location. Improvements in the batteries of these vehicles as well as extended range models makes this vehicle an attractive option for minimizing gasoline and maintenance costs.

Nissan Leaf ownership costs over 8 years are estimated to be $36,537.82 with total 8-year energy costs (kWh) at $3,969 [42]. When powered by solar that is 100% capable of producing both home and automobile power, there are no energy costs. Thus, the difference in cost between an equal value gasoline car (after accounting for any tax credits and residual) would be the maintenance and energy costs. Assuming a gasoline car experiences the average 13,476 miles driven per year (107,808 over 8 years), 30 miles per gallon, and $3.00 per gallon of gas (while ignoring maintenance costs) results in a fuel cost estimate of $10,780.80, which is 2.72 times that of the electric car option.

Figure 21. Nissan Leaf and final charging station

3.11. Geothermal Heating & Cooling

As part of the construction, the residence was equipped with a closed loop, geothermal system (see Figure 22). Vertical, closed-loop geothermal units are heat exchangers that leverage the fact the temperature 200′ below the Earth remains relatively constant. The system operated with limited success for seven years, as the heat exchange and unit was unable to keep up with greater 100 degree F temperatures in its South Texas location. The cost of the system including wells, unit and ducting (complete) was $26,500. The tax credit was 30% or $7,950, and so the end cost to the resident was $18,550. Climatemaster (the brand installed) estimates a $1000 savings in electrical costs per year over an electric heat pump ($3,135 versus $4,169) [43]. The system was replaced with a 5-ton, 18-seer American Standard Platinum heat pump unit in 2018 at a cost of $16,255, over $10,000 less expensive and fully effective.

Figure 22. Geothermal unit and vertical drilling of wells

3.11. Generator or Other Backup System

The residences have explored many options (from Tesla Powerwall to the Chinese BYD B-box 10) for retaining produced solar energy rather than feeding it back into the utility grid. All options are expensive (between $80 to $110 per kWh storage per year for 10 years) with decay rates that generate lithium ion battery disposal concerns after 10 years for most products [44].

Since the storage technology is still developing, the residents opted for a 22 kWh propane-powered back-up generator, a device sufficient to empower the entire house (Figure 23). Back-up power is necessary to retain water during electrical outages, as the house is still grid-tied. Propane is a green fuel that, when burned, has nominal effects on the environment [45]. The 1,000 gallon propane tank and generator are sufficient to maintain full power to house for about 14 days under reasonable utilization conditions. The cost for this generator, automatic transfer switch, propane tank, underground installation, and connections was $19,668.00. A large portion of expense involved burying the propane tank in rocky terrain.

Figure 23. Generac 22 kWh whole-house generator and propane tank

3.12. Overall Analysis

Sustainable construction can generate a break-even for the pocketbook and for the environment. Figure 24 illustrates the cost comparisons of the sustainable construction techniques discussed in this paper. Costs are inflated based on BLS forecasts [46].

Looking at Figure 24, the breakeven for 2020 construction would be about 2026. The additional cost of sustainable construction is estimated at $54,733, which is much lower than might be expected due to the tax credits associated with solar and geothermal. The use of geothermal, though, was not effective, even after several modifications. Eliminating the geothermal in favor of high-seer heat pump would reduce the tax credit to $19,475 and the acquisition cost to $16,255. The cost of this sustainable construction is $52,438.

Appendix A is a 15-year net present value analysis (NPV) assuming cost of capital is 5%. This analysis suggests a $160,222 savings for sustainable construction with geothermal and a $186,338 savings without geothermal. Total estimated costs are $(2,278,943), ($2,118,721), and $(2,092,604) for traditional, sustainable with geothermal, and sustainable without geothermal, respectively.

If the residents were to begin the construction process all over, every sustainable element would be included except for geothermal. The expansion of the number of solar panels would have been completed when first built in preparation for expansion. Additional considerations for lead-acid batteries, powerwalls, etc. would be included as part of the process.

	BLS Inflation	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*
Traditional House & Car	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Lumber	$ (52,800)	$ -	$ -	$ -	$ -	$ -	$ -
Insulation / Vents	$ (10,428)	$ -	$ -	$ -	$ -	$ -	$ -
Windows	$ (12,718)	$ -	$ -	$ -	$ -	$ -	$ -
Well Water	$ (25,500)	$ (400)	$ (412)	$ (424)	$ (437)	$ (450)	$ (464)
Electricity (100%)	$ -	$ (3,117)	$ (3,211)	$ (3,307)	$ (3,406)	$ (3,508)	$ (3,614)
Gas for Car	$ (1,348)	$ (1,348)	$ (1,388)	$ (1,430)	$ (1,473)	$ (1,517)	$ (1,562)
Anaerobic Septic	$ (3,500)	$ (150)	$ (155)	$ (159)	$ (164)	$ (169)	$ (174)
2 x H20 Tank	$ (3,000)	$ (1,000)	$ (1,030)	$ (1,061)	$ (1,093)	$ (1,126)	$ (1,159)
Heat Pump	$ (16,255)	$ (4,169)	$ (4,294)	$ (4,423)	$ (4,556)	$ (4,692)	$ (4,833)
Tax Credits	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Cash Flows	$ (125,548)	$ (10,184)	$ (10,489)	$ (10,804)	$ (11,128)	$ (11,462)	$ (11,806)
Cumulative Cash Flow	$ (125,548)	$(135,732)	$(146,221)	$(157,025)	$(168,153)	$(179,615)	$(191,421)
With Geothermal	**Acquisition**						
Sustainable House & Car	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Engineered Lumber	$ (53,184)	$ -	$ -	$ -	$ -	$ -	$ -
Spray Foam	$ (9,480)	$ -	$ -	$ -	$ -	$ -	$ -
Energy Star Windows*	$ (14,625)	$ -	$ -	$ -	$ -	$ -	$ -
H20 Harvesting	$ (25,500)	$ (100)	$ (103)	$ (106)	$ (109)	$ (113)	$ (116)
Solar (100%)+Electric	$ (64,917)	$ (498)	$ (513)	$ (528)	$ (544)	$ (561)	$ (577)
Electric Car Gas		$ -	$ -	$ -	$ -	$ -	$ -
Aerobic Septic	$ (10,500)	$ (200)	$ (206)	$ (212)	$ (219)	$ (225)	$ (232)
2 x Tankless on Solar	$ (3,000)	$ -	$ -	$ -	$ -	$ -	$ -
Geothermal**	$ (26,500)						
Tax Credits	$ 27,425		$ -	$ -	$ -	$ -	$ -
Net Cash Flows	$ (180,281)	$ (798)	$ (822)	$ (847)	$ (872)	$ (898)	$ (925)
Cumulative Cash Flow	$ (180,281)	$(181,079)	$(181,901)	$(182,747)	$(183,619)	$(184,518)	$(185,443)
Without Geothermal	**Acquisition**						
Sustainable House & Car	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Engineered Lumber	$ (53,184)	$ -	$ -	$ -	$ -	$ -	$ -
Spray Foam	$ (9,480)	$ -	$ -	$ -	$ -	$ -	$ -
Energy Star Windows*	$ (14,625)	$ -	$ -	$ -	$ -	$ -	$ -
H20 Harvesting	$ (25,500)	$ (100)	$ (103)	$ (106)	$ (109)	$ (113)	$ (116)
Solar (100%)+Electric	$ (64,917)	$ (498)	$ (513)	$ (528)	$ (544)	$ (561)	$ (577)
Electric Car Gas		$ -	$ -	$ -	$ -	$ -	$ -
Aerobic Septic	$ (10,500)	$ (200)	$ (206)	$ (212)	$ (219)	$ (225)	$ (232)
2 x Tankless on Solar	$ (3,000)	$ -	$ -	$ -	$ -	$ -	$ -
Heat Pump	$ (16,255)						
Tax Credits	$ 19,475		$ -	$ -	$ -	$ -	$ -
Net Cash Flows	$ (177,986)	$ (798)	$ (822)	$ (847)	$ (872)	$ (898)	$ (925)
Cumulative Cash Flow	$ (177,986)	$(178,784)	$(179,606)	$(180,452)	$(181,324)	$(182,223)	$(183,148)
*savings in use of solar electric							
**ineffective							

Figure 24. Color-coded break-even analysis

3.13. *Ongoing Sustainable Improvements*

All add-on construction to the residence included mini-splits (both in wall and in roof systems). These systems have more upfront costs but are much more energy efficient, as they do not lose energy through ductwork. Further, they are now inconspicuous and highly effective [47]. See Figure 25 for pictures of in-roof and in-wall systems installed in the residence. In new construction, these systems should be considered due to their efficiency and elimination of ductwork and other requirements.

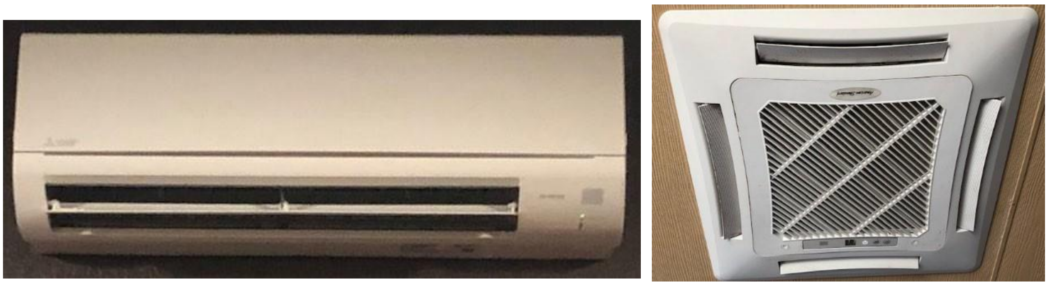


Figure 25. Mini-split units, in wall and in roof

Another new construction consideration is the use of wireless multi-gang light switches. These fixtures can minimize wiring requirements by using a single drop instead of multiple drops. With the advent of 5G, it might be possible to eliminate CAT6 wiring during residential construction in the future as well.

4. Discussion

The results show that building a sustainable house can be green for the environment and green for the pocketbook. The initial up-front costs may be quickly offset by savings depending on construction options. In the case study here, only seven years were required for break-even. Aside from the economic considerations, the environmental responsibility issues are clear. Avoiding carbon emissions is responsible construction.

There are also policy requirements for sustainable construction. That policy push towards sustainable construction is evolving to a universal mandate with penalties for failure to comply. The prime example is in California where a new law passed a solar mandate where all new homes built after 1 January 2020 must be equipped with a solar electric system. That system must be sized that it will offset 100% of the home's electricity usage. This mandate is one aspect of the California Energy Commission's initiative to have 50% of the entire State of California's energy production be from a clean energy source by 2030 [48]. Continuing with the California mandates on sustainability mandates, California passed another law recently signed by Gov. Brown that imposes water usage requirements. The law states that all California residents will be restricted to 55 gallons/day water usage by 2022 and is reduced to 50 gallons/day by 2030 [49]. While both initiatives discuss the mandates, neither has shown the penalty for failure to comply or even specifics on implementation. What is clear is that the mandates on both electric and water usage are the wave of the future and appear to be only the start in California with certainty that other States will adopt similar measures. A proactive approach leveraging the analysis presented here and elsewhere will help both builders and buyers.

Another implication of this analysis shows that the return on investment requires the occupant to live in the home for an extended period to make the up-front costs viable on the back end. An issue that is imperative to ensure economic break-even is the inclusion of accessibility as part of the engineering design process. One reason people must leave their homes is impairment of mobility and access. The solution to this from a policy perspective should be that all homes being built should also be required to meet basic American with Disabilities Act Accessibility Guidelines. The ADA does not apply to private residences, but a significant sustainability policy implication is that it should be extended along with the resource mandates as mentioned on power and water. These guidelines have minimum standards to exterior access, parking, hallway dimensions, bathroom access, as well as reach and appliance access. The International Code Council publishes new

International Building Codes every 3 years, and the current code was published in 2018, known as ICC IBC-2018. The time is now to incorporate the ADA accessibility standards into the new code to be published in 2021, which would require all new construction, both private and public, to meet these standards. In so doing, this would allow individuals to remain in their homes longer, and experience longer ROI on all sustainability aspects of their home. While the residence discussed in this case study is not yet fully ADA compliant, it was designed with the minimum hallway, bathroom, and parking requirements to support future disability of its residents.

5. Conclusions

The study focuses on individual economics and technical components of constructing a net zero family home. The individual commitment and passion implies a vision of long-term survival of our planet and society, a vision which is achievable from a consumer cost perspective. Thus, the study provides both a contribution to the growing sustainability culture in our regional, national, and international communities as well as presents an opportunity to further expand upon sustainability culture indicators. Other authors have presented research on a cultural sustainability index framework [50] to extrapolate and evaluate the effect of making a difference collectively as a society. Including an evaluation of cultural sustainability for multiple individual green family dwellings is a logical next step from the current study.

This green building study and analysis demonstrate attention to cultural vitality and continuity [50]. The researcher created a home to adapt to changing climate and energy structures and created this home to adapt to future energy structures. For example, he attended to the rugged nature of the Texas hill-country geography through inclusion of solar panels, aerobic septic system, and water collection. In addition, the researcher through his personal selection and design attended to aesthetic and creative features of the green dwelling. The home in the current study inspires other citizens in the community to commit to a culture of sustainability.

The individual "green" family dwelling described in the study represents a family's lifestyle, memories, and place of being [50]. In this culture of family being and identity, the green home incorporates a spirit of the natural beauty of the Texas Hill Country, including a minimalistic design. Because the family was involved in the construction, the family has had the opportunity to adapt and be empowered in leading in change relative to sustainable living. A story exists in the needs, learning, adaptation, and success of each "green" family, living in each "green" home. An opportunity exists for future studies to incorporate behavioral assessments and tips for multiple "green" families and businesses.

To develop a culture of sustainability, the beliefs, assumptions, and philosophies must become embedded in many citizens so that as a society, we collectively own green construction, learning, adaptation, and living. Construction best practices and green living must be perpetuated and owned collectively to make a global impact on reducing our footprint and increasing our sustained living on our planet.

Appendix A

	BLS Inflation	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Traditional House & Car	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
Lumber	$ (52,800)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Insulation / Vents	$ (10,428)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Windows	$ (12,718)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Well Water	$ (25,500)	$ (315)	$ (324)	$ (334)	$ (344)	$ (355)	$ (365)	$ (376)	$ (387)	$ (399)	$ (411)	$ (423)	$ (436)	$ (449)	$ (463)	$ (476)
Electricity (100%)	$ -	$ (3,117)	$ (3,211)	$ (3,307)	$ (3,406)	$ (3,508)	$ (3,614)	$ (3,722)	$ (3,834)	$ (3,949)	$ (4,067)	$ (4,189)	$ (4,315)	$ (4,444)	$ (4,578)	$ (4,715)
Gas for Car	$ (1,348)	$ (1,348)	$ (1,388)	$ (1,430)	$ (1,473)	$ (1,517)	$ (1,562)	$ (1,609)	$ (1,657)	$ (1,707)	$ (1,758)	$ (1,811)	$ (1,865)	$ (1,921)	$ (1,979)	$ (2,038)
Anaerobic Septic	$ (3,500)	$ (150)	$ (155)	$ (159)	$ (164)	$ (169)	$ (174)	$ (179)	$ (184)	$ (190)	$ (196)	$ (202)	$ (208)	$ (214)	$ (220)	$ (227
2 x H20 Tank	$ (3,000)	$ (1,000)	$ (1,030)	$ (1,061)	$ (1,093)	$ (1,126)	$ (1,159)	$ (1,194)	$ (1,230)	$ (1,267)	$ (1,305)	$ (1,344)	$ (1,384)	$ (1,426)	$ (1,469)	$ (1,513)
Heat Pump	$ (16,255)	$ (4,169)	$ (4,294)	$ (4,423)	$ (4,556)	$ (4,692)	$ (4,833)	$ (4,978)	$ (5,127)	$ (5,281)	$ (5,440)	$ (5,603)	$ (5,771)	$ (5,944)	$ (6,122)	$ (6,306)
Tax Credits	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Cash Flows	$ (125,548)	$ (10,099)	$ (10,402)	$ (10,714)	$ (11,035)	$ (11,366)	$ (11,707)	$ (12,059)	$ (12,420)	$ (12,793)	$ (13,177)	$ (13,572)	$ (13,979)	$ (14,399)	$ (14,830)	$ (15,275)
Cumulative Cash Flow	$ (125,548)	$ (135,647)	$ (146,049)	$ (156,763)	$ (167,798)	$ (179,164)	$ (190,872)	$ (202,930)	$ (215,350)	$ (228,143)	$ (241,320)	$ (254,892)	$ (268,871)	$ (283,270)	$ (298,100)	$ (313,376)
	$ (2,278,943) NPV @ 5% assumed cost of capital															

With Geothermal	**Acquisition**															
Sustainable House & Car	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
Engineered Lumber	$ (53,184)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Spray Foam	$ (9,480)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Energy Star Windows*	$ (14,625)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
H20 Harvesting	$ (25,500)	$ (100)	$ (103)	$ (106)	$ (109)	$ (113)	$ (116)	$ (119)	$ (123)	$ (127)	$ (130)	$ (134)	$ (138)	$ (143)	$ (147)	$ (151
Solar (100%)+Electric	$ (64,917)	$ (498)	$ (513)	$ (528)	$ (544)	$ (561)	$ (577)	$ (595)	$ (612)	$ (631)	$ (650)	$ (669)	$ (689)	$ (710)	$ (731)	$ (753
Electric Car Gas		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Aerobic Septic	$ (10,500)	$ (200)	$ (206)	$ (212)	$ (219)	$ (225)	$ (232)	$ (239)	$ (246)	$ (253)	$ (261)	$ (269)	$ (277)	$ (285)	$ (294)	$ (303
2 x Tankless on Solar	$ (3,000)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Geothermal**	$ (26,500)															
Tax Credits	$ 27,425		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Cash Flows	$ (180,281)	$ (798)	$ (822)	$ (847)	$ (872)	$ (898)	$ (925)	$ (953)	$ (981)	$ (1,011)	$ (1,041)	$ (1,072)	$ (1,105)	$ (1,138)	$ (1,172)	$ (1,207)
Cumulative Cash Flow	$ (180,281)	$ (181,079)	$ (181,901)	$ (182,747)	$ (183,619)	$ (184,518)	$ (185,443)	$ (186,396)	$ (187,377)	$ (188,388)	$ (189,429)	$ (190,502)	$ (191,606)	$ (192,744)	$ (193,916)	$ (195,123)
	$ (2,118,721) NPV @ 5% assumed cost of capital															

Without Geothermal	**Acquisition**															
Sustainable House & Car	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
Engineered Lumber	$ (53,184)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Spray Foam	$ (9,480)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Energy Star Windows*	$ (14,625)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
H20 Harvesting	$ (25,500)	$ (100)	$ (103)	$ (106)	$ (109)	$ (113)	$ (116)	$ (119)	$ (123)	$ (127)	$ (130)	$ (134)	$ (138)	$ (143)	$ (147)	$ (151
Solar (100%)+Electric	$ (64,917)	$ (498)	$ (513)	$ (528)	$ (544)	$ (561)	$ (577)	$ (595)	$ (612)	$ (631)	$ (650)	$ (669)	$ (689)	$ (710)	$ (731)	$ (753
Electric Car Gas		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Aerobic Septic	$ (10,500)	$ (200)	$ (206)	$ (212)	$ (219)	$ (225)	$ (232)	$ (239)	$ (246)	$ (253)	$ (261)	$ (269)	$ (277)	$ (285)	$ (294)	$ (303
2 x Tankless on Solar	$ (3,000)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Heat Pump	$ (16,255)															
Tax Credits	$ 19,475		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Cash Flows	$ (177,986)	$ (798)	$ (822)	$ (847)	$ (872)	$ (898)	$ (925)	$ (953)	$ (981)	$ (1,011)	$ (1,041)	$ (1,072)	$ (1,105)	$ (1,138)	$ (1,172)	$ (1,207)
Cumulative Cash Flow	$ (177,986)	$ (178,784)	$ (179,606)	$ (180,452)	$ (181,324)	$ (182,223)	$ (183,148)	$ (184,101)	$ (185,082)	$ (186,093)	$ (187,134)	$ (188,207)	$ (189,311)	$ (190,449)	$ (191,621)	$ (192,828)
*savings in use of solar electric																
**ineffective	$ (2,092,604) NPV @ 5% assumed cost of capital															
	$ (2,278,943)	NPV Traditional														
	$ (2,118,721)	NPV Sustainable w/Geothermal			$ 160,222	PV Difference (Traditional - NPV Sustainable w/Geothermal)										
	$ (2,092,604)	NPV Sustainable w/out Geothermal			$ 186,338	PV Difference (Traditional - NPV Sustainable wout/Geothermal)										

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Greenest City in the World: Zurich, Switzerland

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Abstract

This research focuses on Switzerland and investigates how Zurich has become the number one "Green" city in the world. The study concentrates on several aspects of greening an ecosystem within the urban areas, energy, efficient use of land and resources, and waste management. The research explores the concept of multifunctional utilization of land that has been adopted by the city of Zurich, which allows for development of green spaces within the urban areas. In addition, the study explores the development of renewable sources of energy in Zurich and Switzerland. Furthermore, the study examines the municipal solid wastes (MSW) practices in Zurich that differ from many other cities around the world. The MSW produced in Zurich in 2010 was estimated to be 120,000 tones, 314 kilograms per inhabitant per year (Ghesla, et al., 2018). The efficient waste management in Zurich has been based on the infrastructure tax, charge per each business based on its size, and also the bags that are used to collect the wastes to be recycled (Ghesla, et al., 2018). The waste management method in the city has created revenue beyond the costs of operations in recycling the municipal wastes (Ghesla et al., 2018).

Switzerland does not produce fossil fuel. The main sources of energy have been imported natural gas, hydro-electricity, and nuclear energy (Energy Statistics Report Switzerland, 2016). The country's goal is to phase out nuclear plants and dependence on imported fossil fuel. The goal for 2020 has been to reduce the greenhouse gases by at least 20% from 1999 level. (Swiss Climate Policy, 2019). Due to its geographic structure, Switzerland has been heavily investing in hydraulic-energy including the subterranean hydropower plant and solar energy to ensure renewable energy as the main sources of energy in the country. Zurich, as the center of the banking in Switzerland, has heavily contributed to the country's clean energy goals. These contributions include investments in renewable clean energy by Zurich's financial companies (Zurich Clean Energy, 2019). The study highlights the vision, the goals, and strategic alliances that have made Zurich the number one "Green" city in the world and Switzerland the number one "Green" country in the world.

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Alternative Dispute Resolution in Consumer Matters in the EU and Germany

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Abstract

Alternative Dispute Resolution (ADR) can provide fast, creative, and inexpensive solutions to legal disputes. The procedure is private and has the potential to keep the commercial relationship between the parties intact. It saves resources such as money, time, and nerves, and may rightfully be termed a “sustainable” procedure.

Broad ADR in consumer matters is fairly new in Europe. It has existed for quite some time in specialized areas, in Germany for instance in banking, insurance, and transportation, but only recently has the European Union (EU) begun to make ADR accessible on a wider scale. Directive 2013/11/EU of 21 May 2013 (OJ EU 2013 L 165/63) requires each of the 27 member states to make available “out-of-court resolution of ... disputes concerning contractual obligations stemming from sales contracts or service contracts between a trader ... and a consumer”. Harmonization of ADR in consumer matters will level the playing field for traders, and allows consumers to resolve their disputes quickly and inexpensively. This in turn will, so the EU hopes, lead to more consumer satisfaction, and increased cross-border sales. In addition, an Online Dispute Resolution (ODR) platform is being operated by the Commission to make ADR easily accessible for consumers (https://ec.europa.eu/consumers/odr/main/).

Germany’s “Act on Alternative Dispute Resolution in Consumer Matters” (*Verbraucherstreitbeilegungsgesetz*) of 19 February 2016 (Federal Law Gazette 2016 I 254) transposes the EU’s ADR Regulation. It allows existing ADR institutions to become, after an official accreditation, consumer conciliation bodies. These institutions thus continue to do their specialized ADR in areas such as banking, insurance, and transportation. In addition, the Federal government has established, and funds, the General Conciliation Body. It has jurisdiction to resolve any consumer dispute and especially those other consumer conciliation bodies decline to deal with. Thus exists at least one conciliation body in Germany for every consumer dispute stemming from a sales or service contract. 27 consumer conciliation bodies were accredited as of March 2021 beside the Federal General Conciliation Body.

Despite issues of funding around 70.000 consumer disputes were filed with these conciliation bodies in 2018. This is a promising beginning of what can become a widely accepted way of resolving consumer disputes sustainably in the future.

<u>Outline:</u>

1. **Introduction**
   a) Definition of ADR
   b) Deficits of traditional dispute resolution
   c) EU laws on ADR
2. **ADR and European procedural law**

3. Directive 2013/11/EU

a) Access to ADR entities
b) Disputes concerning obligations from sales or service contracts
c) Recognition of ADR entities
d) Natural persons in charge of ADR
e) Procedural principles
f) Rules applied for the dispute resolution

4. Germany's Act on Alternative Dispute Resolution in Consumer Matters of 2016

a) Special and general ADR entities
b) Consumer information by traders

5. Regulation (EU) 524/2013

6. Conclusion

a) Public vs. private law enforcement
b) Future developments

Green Cities and Waste Management: The Restaurant Industry

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Abstract: "Green Cities" are cities with the ultimate goal of achieving a net zero-carbon footprint in energy, transportation, architecture, and the activity cost chain of businesses. These cities define the future of our planet by emphasizing the efficient use of resources and the well-being of communities. This study focuses on "Green Cities" and the restaurant industry. It examines the beliefs of restaurant owners/managers on the positive impact of sustainability practices on financial situation, reputation, and attraction of customers, and the relationship between such beliefs and the extent of engagement in sustainability practices. The research also explores whether declaring a city "Green" enhances the sustainability practices in that city. The results indicate that the restaurant owners/managers in all three studied cities strongly believe that sustainability practices enhance the financial performance, reputation of the restaurant, and attraction of customers, yet a significant percentage of the wastes and by-products of the operations of the studied restaurants are discarded. In addition, the results of the study show no significant impact on sustainability practices in the studied restaurants for the declared "Green" cities of Providence (U.S.) and Nancy (France) versus the city of Springfield (U.S.). The study concludes by highlighting the potential reasons underlying the lack of sustainability practices in the restaurant industry and proposes recommendations that can enhance such practices in this industry.

Keywords: restaurant industry; sustainability practices; Green Cities; U.S.; EU

1. Introduction

Energy, water, health of customers and employees, supply materials, logistics, and the produced wastes place the restaurant industry on the top of the list of industries that have major impacts on greening the planet. The restaurant industry is not only the largest consumer of water and energy, but it also produces a diverse array of wastes and by-products with the most potential for recycling, reselling, reusing, and the possibility of donation. On average, a restaurant produces 25,000 to 75,000 pounds of waste per year [1]. A report by the Food Waste Reduction Alliance [2] indicates that only 14.3% of the leftover food is recycled, 1.4% donated, and the rest, 84.3% of such food, is discarded.

The studies on the restaurant industry and eco-operations across various countries all indicate that green practices do have positive impacts on the performance of the restaurants—the financial situation, resource efficiency, and customer attraction (e.g., [3,4]). In addition, the research indicates that the restaurant owners/managers believe that green practices have significant positive impacts on the financial situation, competitive advantage, and efficient use of resources (e.g., [5,6]).

In order to address the sustainability practices in the restaurant industry, this study expands upon thecurrentresearchbyexploringtherelationshipbetweentheperceptionofrestaurantowners/managers on the impacts of sustainability practices on financial performance, reputation, and attraction of customers, both in the U.S. and the European Union cities. In addition, the study examines the profile of these restaurants including services provided, capacity, and the type of the restaurant. Furthermore, this research investigates how owners/managers treat a comprehensive list of diverse wastes and by-products of the operations of their restaurants along different aspects of the sustainability practices—recycle, resell, reuse, and in appropriate cases, donation. The study also considers other factors, such as the extent of the training of the owners/managers, and their willingness to have training on enhancing the sustainability practices in this industry.

Another area that this study expands upon the current literature on sustainability practices in the restaurant industry is by investigating whether governmental and/or municipal regulations and declaring a city "Green" enhance the sustainability practices in this industry. The selected cities for this study include two declared "Green" cities, one in the U.S. and one in the European Union, versus a non-declared "green" city in the U.S.

Different sections of the study include one that covers the literature review, followed by sections on research goals, materials and methods, results, and discussion. The final section of the study highlights the impediments in practicing sustainability in the restaurant industry and proposes strategies that can enhance waste management in this industry.

2. Literature Review

Several studies on the restaurant industry in Taipei, Taiwan [3,4,7,8] concentrated on different factors, such as the compatibility of the equipment/technology with green practices, the ease of implementation of green practices, the efficient use of resources, and the personal values of customers. These studies concluded that these factors were essential in enhancing green operations in restaurants in Taiwan with positive impacts on the economic situation of the restaurant.

Chiu and Hsieh [3], in their study of the restaurants in Taiwan, concluded that the cost of implementation of green operations in restaurants can be compensated by better economic performance of the restaurants. Chou et al. [4] conducted research on the attitude and perception of restaurant managers towards green practices in the restaurant industry in Taipei, Taiwan. According to the results of the research, several factors influenced the perception of the managers in regard to green practices and positive impacts on the economic situation of the restaurant [4]. These factors included the compatibility of the equipment/technology with green practices, the ease of implementation of green practices, and the more efficient use of resources [4]. The result of the study indicated that the above factors had a positive influence on adopting and implementing green practices by the restaurant managers of the surveyed restaurants in Taipei [4].

Teng et al. [7] studied the relationship between green restaurants and customers' visits in Taipei, Taiwan. The results of the study indicated that the personal values of customers influenced their decision in patronizing green restaurants [7]. The recommendation of the research was that the managers of the restaurants needed to identify and enhance the customers' attitudes in patronizing green restaurants [7].

Chou et al. [8] conducted another study of the restaurants in Taipei, Taiwan, in regard to the "sustainable service innovation". The authors interviewed scholars, restaurant managers, and government experts. The results of their research indicated that for eco-operations in restaurants, several factors were important. These factors included "sustainable service innovation," technology for food service, knowledge, organizational environment, and adoption of innovation [8]. The authors concluded that the above factors were not only essential in enhancing green operations in restaurants, but they also had a positive impact on their financial performance [8].

Llach et al. [9] studied the relationship between "quality and environmental practices "and the performance of restaurants in Madrid, Spain. The dimensions of the performance studied included the efficient use of resources, financial improvement, and enhancing the competitive advantage of the restaurants. The findings indicated that a combination of quality and environmental management practices had a significant positive impact on the financial situation of the restaurants, gaining competitive advantage, and the market success for restaurants [9].

Filimonau and Krivcova [5] explored the green operations of restaurants in the light of consumer's choice in Bournemouth, England. They contended that the menus of restaurants needed to be re-designed to inform customers of environmental and social impacts of their choices [5]. The authors also discussed the restaurant owners' perspective on re-designing the menus. According to their findings, even though the restaurant owners were aware of the importance of eco-operations and re-design of the menu, the lack of resources, complexity in the operations of a restaurant, and inconsistency in customers' demands were the impediments in re-designing the menu for a greener and more responsible food choice [5].

In their study of the restaurants in Brazil, Bossle et al. [6] investigated the eco-innovative practices on the supply and the demand sides in the food industry. The findings indicated that technology, strategies, the mission, and the personal motivation of managers of the companies concentrating on the health of the consumers were important factors in adopting eco-practices [6]. The results also indicated that legislations and regulations were ineffective in enforcing eco-operation practices [6]. In addition, the Brazilian consumers regarded technology as a major factor in producing healthy and eco-friendly food products [6].

Several studies on the restaurant industry in the U.S. focus on the customers along other factors (e.g., [10–12]). Dewald et al. [10] conducted a research of the U.S. restaurant industry. Their research focused on customers frequenting a green restaurant and their willingness to pay more for dining in such restaurants. The results of their study indicated that 90% of the customers in their sample data had eaten in a green restaurant, and more than half were willing to pay more for dining in green restaurants. However, the research indicated that the customers were not clear about the term "green restaurant", and that the word of mouth was the factor in frequenting such restaurants [10].

Another study on 512 restaurants in the U.S. by Namkunga and Jang [11] showed that customers with greater knowledge and information about health and environment cared about green practices of restaurants. As a result, the type of restaurants, upscale casual diners, had more eco-operations than other types of restaurants [11].

According to the research in the fast-service restaurants in the Midwest of the U.S. conducted by DiPietro et al. [12], customers were not willing to pay more for the fast food due to the green practices of the restaurants even though they thought restaurants should adopt green practices. The authors concluded that increasing customers' knowledge through marketing practices was important to enhance patronization of green restaurants [12].

The study by Kim and Hall [13] of Korean restaurants concentrated on the relationship between sustainability practices and customer loyalty. The authors tested several hypotheses concerning the sustainability practices and positive impact on customer "hedonic" and "utilitarian" values. The study concluded that restaurants needed to consider practicing food sustainability and waste management beyond cost reduction since such practices had the potential of increasing the loyalty of the customers and the enjoyment of dining in a restaurant [13].

In summarizing the results of the research in this area, the pronounced impediments to practicing sustainability in the restaurant industry indicate: (1) Lack of adequate knowledge and information on the side of both restaurant owners/managers and customers [6–8,11,13]; (2) the nature of the restaurant industry [11,12]; (3) regular customers and tourists that can impact the increase of food wastes in restaurants [6]; (4) lack of appropriate knowledge and technology in dealing with eco-waste management [4,8]; (5) design of the menus [5]; and (6) complexity in operations of a restaurant [5,6].

This study builds upon the reviewed literature, expands upon the current studies along several dimensions, and examines the sustainability practices of 126 different restaurants in three cities, two in the U.S. and one in the European Union. The analysis is the first of its type in that it assesses whether declaring a city "Green" has an influence on sustainability practices in the restaurant industry.

In addition, the study includes an extensive list of the wastes and by-products of the operations of the restaurants in investigating the proposed hypotheses.

3. The Research Goals

In order to address the sustainability practices in the restaurant industry, this research explores the relationship between the perception of restaurant owners/managers regarding the impact of sustainability practices on financial performance, reputation, and attraction of customers, and expands upon the current studies by exploring the following questions: Do restaurant owners/managers believe that sustainability practices have positive impacts on financial situation, reputation, and attraction of customers? If so, do they engage in sustainability practices? In addition, the study examines the profile of these restaurants, services provided, capacity, type of the restaurant, and how owners/managers treat a comprehensive list of diverse wastes and by-products of the operations of their restaurants along different aspects of the sustainability practices—recycle, resell, reuse, and in appropriate cases, donation. Furthermore, the study considers other factors, such as the extent of the training of the owners/managers and their willingness to have training to enhance the sustainability practices in their restaurants.

Another area that this study expands upon the current literature on sustainability practices in the restaurant industry is by investigating whether governmental and/or municipal regulations and declaring a city "green" enhance the sustainability practices in this industry. The study analyzes the collected data for any differences in sustainability practices between the restaurants in the two declared "Green" cities in the U.S. and the European Union versus a non-declared "green" city in the U.S. The final section of the study highlights different hurdles in practicing sustainability in the restaurant industry and proposes strategies that can enhance waste management in this industry.

4. Materials and Methods

4.1. Selected Cities

The research on waste management concentrates on turning the waste materials into energy or other usable materials [14,15]. Several cities across the U.S., such as San Francisco, Seattle, New York, Denver, Boston, and Providence, have undertaken initiatives for sustainability practices in utilization of energy, land, buildings, transportation, and waste management among other areas. The goals of declaring a city "Green" are achieving not only a green eco-system, but also improving the humanitarian part of the operations management [16]. In order to investigate how the restaurant industry can contribute to the sustainability of the physical environment and human population, the data for this research were collected from three cities, Providence, Rhode Island, Springfield, Massachusetts, and Nancy, France.

The three cities for this study were selected based on the number of restaurants per capita, Green city designation, and accessibility of the locations to the researcher. The two selected cities located in the northeast of the U.S. were Providence, a declared Green city with the largest number of restaurants per capita, and Springfield, not a declared Green city, the fourth largest city in the states of New England. Nancy, in the northeast of France, is a declared Green City, represents an EU city for the comparative base for the study, and it was accessible to the researcher. These three cities have high concentration of restaurants, and since the survey questionnaire was filled out in the presence of the researcher, accessibility to the restaurants was essential. Furthermore, the studied restaurants in these three cities had very similar profiles, such as the capacity of the restaurants, the services provided, and the types of the restaurants.

Providence, a declared "Green" city, is the third largest city in the states of New England after Boston and Worcester [17]. In addition, Providence has the highest number of restaurants per capita in the nation [18]. Some of the current green goals of the city of Providence are incorporated in the following documents—"Collaborative Research and Sustainable Practices" and "Connecting Public Policy & Academic Research for Rhode Island" [19].

Springfield is the fourth largest city in the states of New England [17], but not a declared "Green" city. In Massachusetts, 49 cities and towns are currently declared green communities [20,21]. However, the focus of the green communities in Massachusetts is on "energy" and assisting the communities and cities in becoming more energy efficient and decreasing their carbon footprint.

In the European Union (EU), achieving a net-zero carbon emission economy by the year 2050 [22] and the European Union Commission's food waste goals [23] concentrate on decarbonization of different industries and reduction of wastes to achieve these goals. In addition, the EU has directives per each industry as to its sustainability practices [24]. Nancy, as an EU city, is subject to the European Union Commission goals and directives for the year 2050 to establish a net-zero carbon emission economy [23,24]. Furthermore, Nancy, as a declared "Sustainable Green City," is required to implement the sustainability goals set by the city [25]. Some of these goals include concentration on creating a green environment through reduction of food wastes, recycling, and reusing of the wastes produced by different businesses across the city [25]. As a result, the city of Nancy, with a high concentration of restaurants similar to Providence and Springfield, is selected to further study the operations of the restaurants in an environment that not only needs to meet the directive of the EU, but also the goals of a city that is declared "Green".

4.2. Wastes and By-Products of the Operations of the Restaurants

This research included a comprehensive list of the wastes and by-products produced by the operations of the restaurants. These wastes and by-products included in the study were cardboard, glass containers, plastic containers, metal, and plastic bags. In addition, the study included the following by-products: Leftover cooking oil, leftover trimmings of meat and vegetables, leftover customer food, spoiled food, and the unused prepared food and bread at the end of the day. The list of the wastes and by-products of the operations of the restaurants was compiled based upon a discussion with six restaurant owners/managers in Providence, in addition to the university cafeteria of the researcher.

4.3. Research Hypotheses

A major focus of this study was to investigate the relationship between the perception of restaurant owners/managers as far as the impacts of sustainability practices on financial performance, reputation, and attraction of customers. The following Hypotheses (H1–H3) address this part of the research.

Hypothesis 1 (H1). *Restaurant owners/managers believe that sustainability practices have a positive impact on the financial situation of the restaurant.*

Hypothesis 2 (H2). *Restaurant owners/managers believe that sustainability practices have a positive impact on reputation of the restaurants.*

Hypothesis 3 (H3). *Restaurant owners/managers believe that sustainability practices have a positive impact on attraction of customers.*

Another major goal of the study was to examine if the restaurant owners/managers believed that sustainability practices enhanced the financial performance, reputation, and attraction of their customers, and did they practice sustainable waste management in their restaurants? The following Hypothesis (H4) examines this question.

Hypothesis 4 (H4). *The beliefs of the restaurant owners/managers in regard to the positive impacts of sustainability practices on performance of their restaurants enhance recycling, reusing, reselling, and in appropriate cases donation of the wastes and by-products of the operations of their restaurants.*

In addition, this research explored whether the restaurant owners/managers had any training in sustainability practices and if so, the impact of such training on the sustainability practices by the restaurant owners/managers. Hypothesis (H5) addresses this part of the study.

Hypothesis 5 (H5). *Training of the restaurant owners/managers enhances the sustainability practices in the restaurants.*

Another major goal of the study was to investigate if governmental and municipal rules and regulations set for "Green" cities versus a non-declared "Green" city had any impact on enhancing the sustainability practices in the studied restaurants. Hypothesis (H6) examines this goal.

Hypothesis 6 (H6). *Declaring a city "Green" enhances sustainability practices in that city's restaurants.*

4.4. Sampling Frame and Sample Size

The sampling frame for selecting restaurants within the studied cities was based on the results from the Google search engine, aggregation of the restaurants in different part of the selected cities, and their accessibility. The restaurant owners/manager were then contacted by phone to check the availability and their willingness to participate in the study. To collect the data, a questionnaire was given to the owners/managers, who completed it in the presence of the researcher, who reviewed each question and provided explanation if needed.

In the city of Providence, 110 restaurants were identified as potential subjects and 45 questionnaires were completed, yielding a 40% rate of return. In Springfield, 66 restaurants were identified with 31 questionnaires completed, yielding a rate of return of 46%. For the city of Nancy, the survey questionnaire was translated into French. A total of 78 restaurants were identified, and the data were collected from 50 restaurants, yielding a rate of return of 64%. The total number of participating restaurants was 126.

4.5. Instrument

The questionnaire used in this research included several sections. The first section focused on demographic information—the number of services provided per day (breakfast, lunch, and dinner) and the capacity of the restaurant, from fewer than 25 customers to more than 100 customers. In addition, the restaurants were categorized as fine dining and sit-in, fast food, or coffee shops and delis. The next part of the survey included Likert scaled questions requiring restaurant managers/owners to self-asses their beliefs about the statement that sustainability operations in their restaurants improved financial performance, reputation, and customer attraction.

The following part of the survey was designed to measure the sustainability practices performed by each restaurant. These practices included recycling, reselling, reusing, and in relevant cases, donation of the diverse wastes and by-products from the operations of the restaurants—cardboard, glass bottles, plastic bottles, straws, and containers, metal containers, and plastic bags. The third part of the survey concentrated on the leftover food by-products of the operations of the restaurant at the end of day—leftover cooking oil, leftover meat and vegetable trimmings, leftover customer food, and spoiled food. In addition, the survey measured sustainability practices in regard to the food products remaining unused at the end of the day—day-old bread and unused food. Furthermore, the restaurant owners/managers were asked about any training they had in waste management, as well as their willingness to participate in training sessions for implementation of effective sustainability practices. Both descriptive and quantities analyses were used to study the collected data.

5. Results

5.1. Profiles of the Studied Restaurants

Of the 126 respondents, 75% of the restaurants in the data were from “Green“ cities—Providence: 35%, (45), Nancy: 40% (50), and Springfield (not a declared Green city): 25%. Checking the studied restaurants in Providence and Springfield, none was a member of the “Green Restaurant Association”. As for the Michelin list, only two of the studied restaurants in Nancy were members.

The combined demographic results of the surveyed restaurants as per the number of services provided per day (breakfast, lunch, dinner, the type, and the capacity of restaurants) are presented in Table 1.

Table 1. The number of services provided per day, the type, and the capacity of the restaurants under study.

Number of Service/Day	% of Sample	Type of Restaurants	% of Sample	Capacity	% of Sample
Three services per day	16%	Fine dining & sit-in	64%	>100	39%
Two services per day	64%	Fast food	10%	50–100	28%
One service per day	20%	Coffee shops & Delis	16%	25–49	23%
				<25	10%

The combined demographic results of the surveyed restaurants as per the number of services provided per day (breakfast, lunch, and dinner) and the capacity of the restaurants indicated that 16% of the surveyed restaurants provided three services per day (breakfast, lunch, and dinner), 64% provided two services per day (lunch and breakfast or lunch and dinner), and 20% offered one service per day (breakfast, lunch, or dinner). The combined results of this part of the survey also showed that 64% of the restaurants were fine dining and sit-in restaurants, 10% fast food, and 16% were categorized as coffee shops and delis. In addition, 39% of the restaurants had a capacity of more than 100, 28% had a capacity between 5–100, 23% had a capacity between 25–49, and 10% had a capacity below 25. Figures 1–3 present the results for the services per day, the capacity, and the type of the restaurants per each city.

Based on the results presented in Figure 1, the percentages of the restaurants in each city providing three services per day included (Providence: 9%, Springfield: 29%, and Nancy: 12%), two services per day (Providence: 56%, Springfield: 58%, and Nancy: 76%), and one service per day (Providence: 35%, Springfield: 13%, and Nancy: 12%). As per these results, a majority of the restaurants in each city provided two services per day.

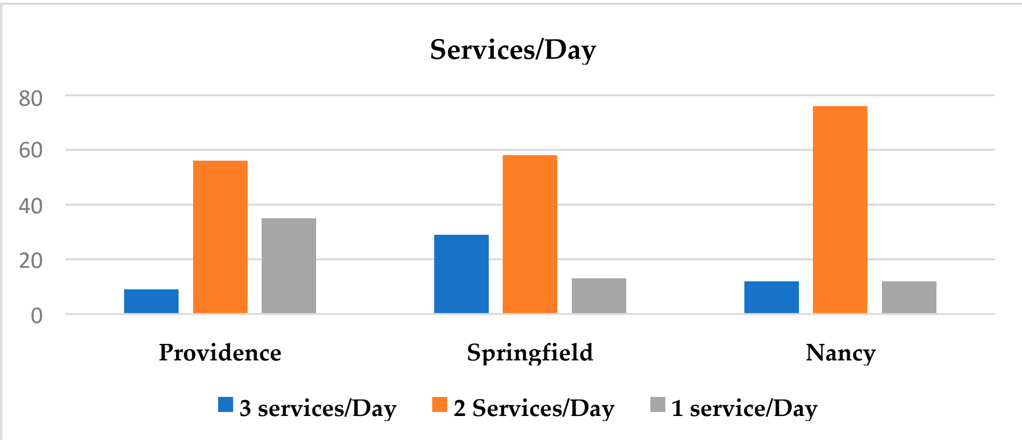

Figure 1. Services per day in the studied restaurant per each city.

The results in Figure 2 for each city show that the majority of the surveyed restaurants in each city had a capacity of 100 or more (Providence: 40%, Springfield: 39%, and Nancy: 40%), a capacity of 100–50 (Providence: 32%, Springfield: 28%, and Nancy: 28%), a capacity between 49–25 (Providence: 16%, Springfield: 19%, and Nancy: 22%), and a capacity below 25 (Providence: 16%, Springfield: 10%, and Nancy: 11%).

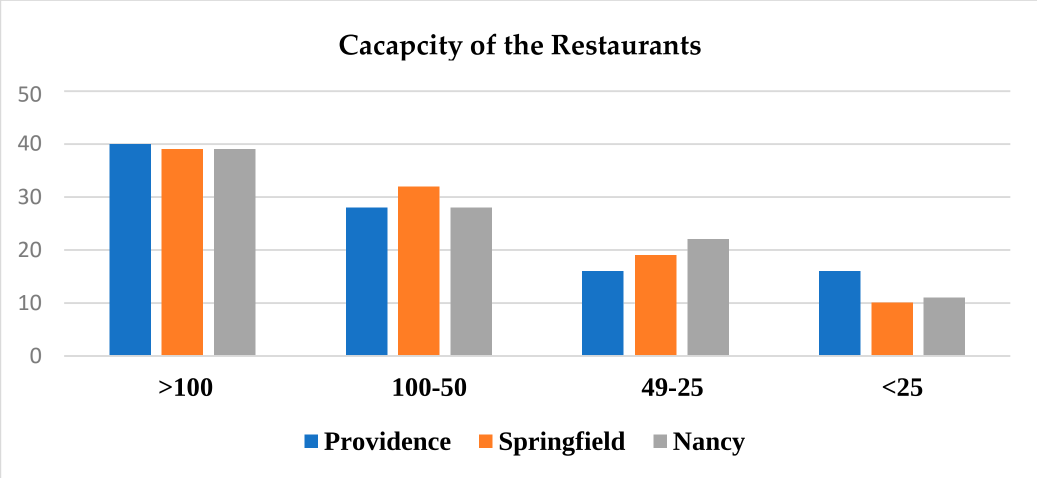

Figure 2. The capacity of the studied restaurants per each city.

Figure 3 indicates that majority of the surveyed restaurants were fine dining and sit-in restaurants (Providence: 46%, Springfield: 51%, Nancy: 74%), the fast food restaurants (Providence: 29%, Springfield: 23%, Nancy: 10%), and coffee shops and delis (Providence: 25%, Springfield: 26%, Nancy: 16%).

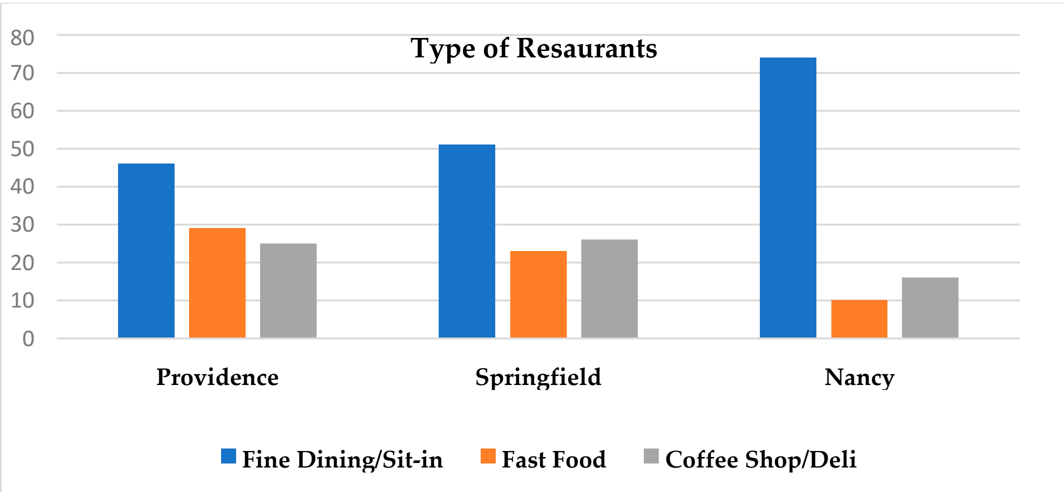

Figure 3. The type of the restaurants: Fine dining/sit in, fast food, and coffee shops/delis per each city.

The results of this part of the survey indicate that the selected restaurants in the three cities have very similar profiles as far as services provided, capacity, and the type pf therestaurants.

5.2. Sustainability and Financial Performance, Reputation, and Attracting Customers (H1, H2, H3)

A main goal of the study was to examine the beliefs of the restaurant owners/managers regarding the impact of sustainability practices on financial performance, reputation of the restaurants, and attraction of customers. The combined results of this part of the survey are shown in Table 2.

Table 2. Belief of the restaurant owners/managers regarding the impact of sustainability practices.

Belief	Positive Impact on Financial Performance	Positive Impact on Reputation	Positive Impact on Attracting Customers
Strongly Agree	42%	47%	38%
Agree	31%	30%	26%
Not Sure	21%	20%	31%
Disagree	5%	2%	4%
Strongly Disagree	1%	1%	1%

As indicated in Table 2, a significant majority of the restaurant owners/managers believe (strongly agree, agree) that sustainability practices have a positive impact on financial performance (42% + 31% = 73%), reputation of the restaurant (47% + 30% = 77%), and attraction of customers (38% + 26% = 64%). Between 20–31% were not sure, a very small percentage (2–5%) disagreed, and only 1% strongly disagreed as to the positive impact of sustainability practices on the three categories under study. Figure 4 presents these results for each city.

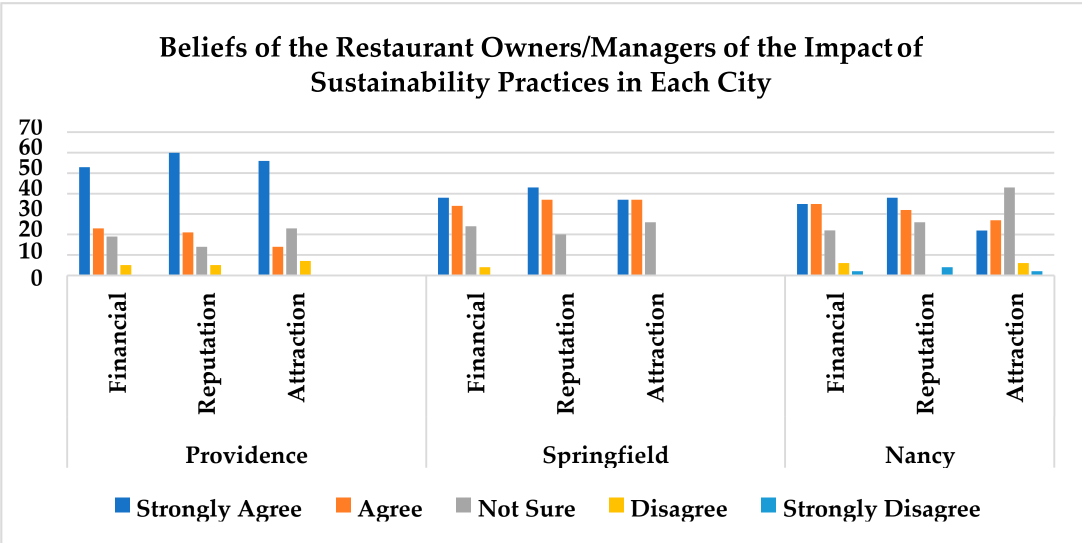

Figure 4. Belief of the restaurant owners/managers on the positive impact of sustainability practices on the financial performance of the restaurant, reputation, and attraction of customers.

As indicated in Figure 4, a large majority of the restaurant owners/managers in each city believe (strongly agree, agree) that sustainability practices have a positive impact on financial performance (Providence: 76%, Springfield: 72%, Nancy: 70%), reputation of the restaurant (Providence: 81%, Springfield: 80%, Nancy: 70%), and attraction of customers (Providence: 70%, Springfield: 74%, Nancy: 49%). The percentages of those that are unsure as to the impact of sustainability practices on financial performance indicate Providence at 19%, Springfield at 24%, and Nancy at 22%, unsure of the impact on reputation of the restaurants: Providence at 14%, Springfield at 20%, and Nancy at 26%, and unsure as to the attraction of the customers: Providence at 23%, Springfield at 26%, and Nancy at 43%. The percentages for disagreement and strong disagreement are low across these cities along the three categories (0% to 12%).

To further validate the findings of this part of the study, consensus was also utilized to analyze the results of this section. Consensus around an issue can be loosely defined as the shared group feelings about that issue, and is often measured using a Likert scale-based question. Tastle and Wierman [26] created a consensus measure (Cns) as shown in Equation (1) [26].

$$Cns(X) = 1 + \sum_{t=1} p_i Log_2\left(1 - \frac{|X_i - \mu_x|}{d_x}\right) \quad (1)$$

In this equation, X_i is the response to the Likert scale question (5-point Likert scale in this study), p_i is the probability (or relative frequency) of X_i, μ_x is the mean of X, and d_x is the width of X (i.e., $d_x = X_{max} - X_{min}$). In using this consensus measure, a Likert scale question requiring responses ranging from 1 = Strongly Agree, 2 = Agree, 3 = Not Sure, 4 = Disagree, and 5 = Strongly Disagree will have a Cns score of 1 if all respondents chose Strongly Agree, and a Cns score of 0 if responses were evenly split between Strongly Agree and Strongly Disagree. All other combinations of responses fall between zero and 1. Table 3 presents the results of this part of the study.

Table 3. Consensus measures (Cns) for all restaurants in the sample on belief of restaurant owners/managers of the impact of sustainability practices.

Belief	Cns(X)
Positive Impact on Financial Performance	0.71
Positive impact on Reputation	0.65
Positive Impact on Attracting Customers	0.64

The consensus measures in Table 3 show that the restaurants polled in this sample collectively feel stronger about the potential positive impact on financial performance (Cns = 0.71) due to sustainability practices, followed by the impact on attracting customers (Cns = 0.65), and the impact on the reputation of the restaurant (Cns = 0.64).

Additionally, the consensus measures for those restaurants operating in the two “Green” cities were examined. The results are presented in Table 4.

Table 4. Consensus measures (Cns) for restaurants in the “Green” cities on belief of restaurant owners/managers of the impact of sustainability practices.

Belief	Cns(X)
Positive Impact on Financial Performance	0.62
Positive impact on Reputation	0.52
Positive Impact on Attracting Customers	0.52

As presented in Table 4, similar results are found for the two “Green” city restaurants. There is a stronger consensus around the potential positive financial impact than either the impact on reputation or attracting of new customers similar to the findings for the entire sample indicated in Table 3.

The results of this part of the survey support Hypotheses H1–H3, restaurant owners/managers very strongly/strongly believe that the sustainability practices have significant positive impact on financial performance (H1), followed by reputation of the restaurant (H2), and attraction of the customers (H3). The findings of this part of the study are aligned with findings of the reviewed research that restaurant managers believe sustainability practices can enhance financial performance of the restaurants (e.g., [4,9]) and attraction of the customers (e.g., [7,10,11,13].

5.3. Sustainability and Recycling, Reselling, Reusing, and Discarding of Wastes and By-Products of the Operation of the Restaurants (H4 Part 1)

In the next part of the study, the owners/managers were asked as to how their restaurant treated the wastes and by-products of their operations using the following categories: Cardboard, glass bottles and containers, plastic bottles, straws, and containers, metal containers, and plastic bags. Did they recycle, resell, or reuse these wastes and by-products or discard them? Table 5 indicates the combined results of this part of the survey.

Table 5. Recycle, resell, reuse, discard: Cardboard, glass, plastic bottles, straws, and containers, metal containers, and plastic bags.

Action	Cardboard	Glass Bottles	Plastic Bottles, Straws, & Plastic Containers	Metal Containers	Plastic Bags
Recycle	71%	56%	34%	31%	14%
Resell	0%	1%	0%	3%	1%
Reuse	5%	6%	1%	12%	6%
Discard	24%	37%	65%	54%	79%

As indicated in Table 5, the waste material with the highest percentage of recycling is cardboard (71%), followed by glass bottles (56%), plastic bottles, straws, and containers (34%), and metal containers, such as aluminum cans (31%). The results show a minimal percentage of resale of the above items (0–3%). In addition, only 5% of cardboard, 6% of glass bottles, 1% of plastic bottles, straws, and containers, 12% of metal wastes, and 6% of plastic bags are reused. Furthermore, a large percentage of these wastes and by-products are discarded (cardboard: 24%, glass bottles: 37%, plastic bottles/straws/containers: 65%, metal containers: 54%). The results also show that the highest percentage of waste materials discarded is plastic bags (79%). A graphical depiction of the data for this part of the survey per each city is shown in Figure 5.

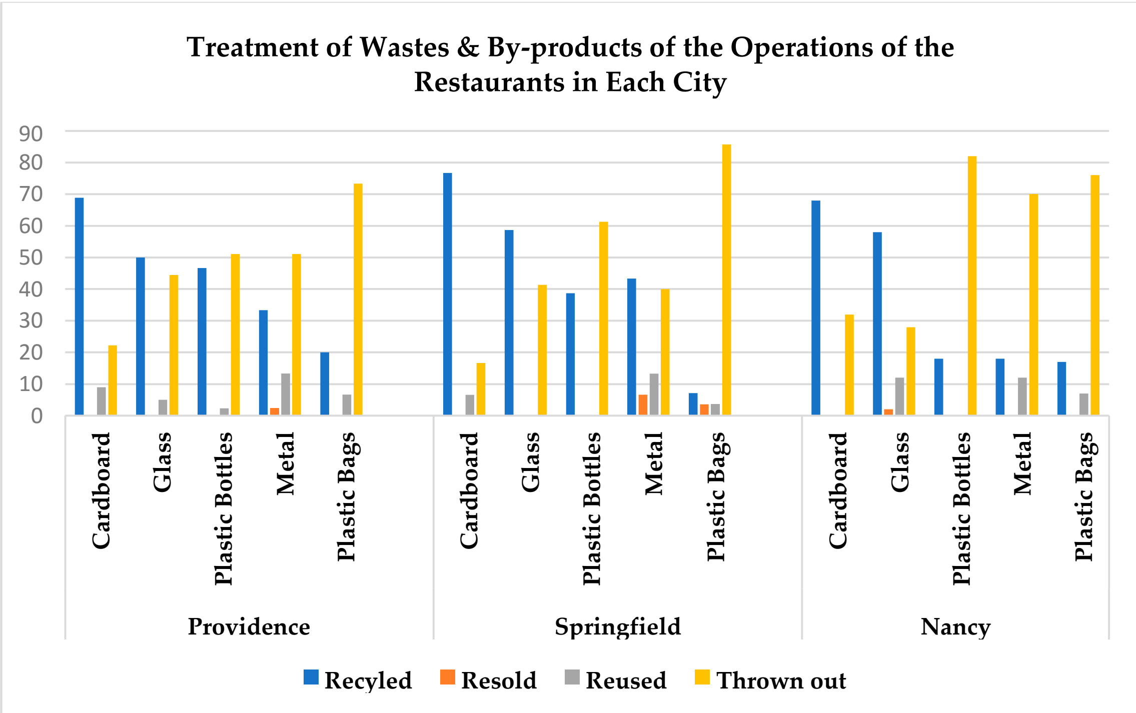

Figure 5. Treatment of cardboard, glass bottles, metal containers, plastic bottles, straws, plastic containers, and plastic bags.

As indicated in Figure 5, the restaurants in Springfield recycle a higher percentage of cardboard (Springfield: 77%, Providence: 69%, Nancy: 68%), glass (Springfield: 59%, Providence: 50%, Nancy: 58%), and metal (Springfield: 43%, Providence: 33%, Nancy: 18%) than the restaurants in the other two cities. The Providence restaurants recycle more of the plastic bottles, straws, and containers than the restaurants in Springfield and Nancy (Providence: 47%, Springfield: 39%, Nancy: 18%), and also plastic bags (Providence: 20%, Springfield: 7%, Nancy: 17%).

Figure 5 shows that there is no reselling of cardboard, glass, and plastic containers by the studied restaurants in Springfield and Providence, and a low percentage (2%) resale of glass containers by the restaurants in Nancy. The Springfield restaurants resell 3% of their metal containers versus Providence (2%), and there is no reselling of such wastes in Nancy (0%). In addition, for the plastic bags, the Springfield restaurants resell 4% of plastic bags versus the restaurants in Providence and Nancy, with no resale of such by-products (0%).

Furthermore, Figure 5 indicatesthatthesurveyed restaurantsinProvidence,Springfield,and Nancy reuse the metal container by-products of their operations at a very similar percentage (Providence: 13%, Springfield: 13%, Nancy: 12%), while the restaurants in Nancy reuse more of their glass containers (12%) than the restaurants in Providence (5%), with no indication of any such reuse in the restaurants in Springfield (0%). However, the reuse of the cardboard by-products of the restaurants is higher in Providence (9%) and Springfield (9%) than the restaurants in Nancy (0%).

As shown in Figure 5, the lowest percentage of the discarded wastes in the studied restaurants is cardboard (Providence: 22%, Springfield: 17%, Nancy: 32%). As for the other items, in each city, large percentages of other wastes and by-products of the operations of the restaurants are discarded—plastic bottles, straws, and containers (Providence: 57%, Springfield: 61%, Nancy: 82%), metal containers (Providence: 51%, Springfield: 40%, Nancy: 70%), and plastic bags, (Providence: 73%, Springfield: 86%, Nancy: 76%). The restaurants in Nancy show lower percentage of glass bottles being discarded (28%) versus Providence (44%), and Springfield (41%).

The next part of the survey concentrated on the treatment of the leftover items from food preparation, leftover cooking oil, meat trimmings, and vegetable trimmings. The combined results of this part of the survey are shown in Table 6.

Table 6. Recycle, resell, reuse, discard: Leftover cooking oil, meat trimmings, and vegetable trimmings.

Action	Leftover Cooking Oil	Leftover Meat Trimmings	Leftover Vegetable Trimmings
Recycle	56%	9%	7%
Resell	14%	0%	0%
Reuse	6%	6%	10%
Discard	23%	85%	83%

As shown in Table 6, 56% of the leftover cooking oil is recycled, 14% is resold, and 6% is reused, while 23% is discarded. In addition, 9% of the leftover meat trimmings are recycled, 0% resold, and 6% reused. As for the leftover vegetable trimmings, 7% are recycled, 0% are resold, and 10% are reused. A large percentage of the leftovers from meat trimmings (85%) and preparing vegetables (83%) are discarded. Figure 6 shows the results of this part of the survey in each city.

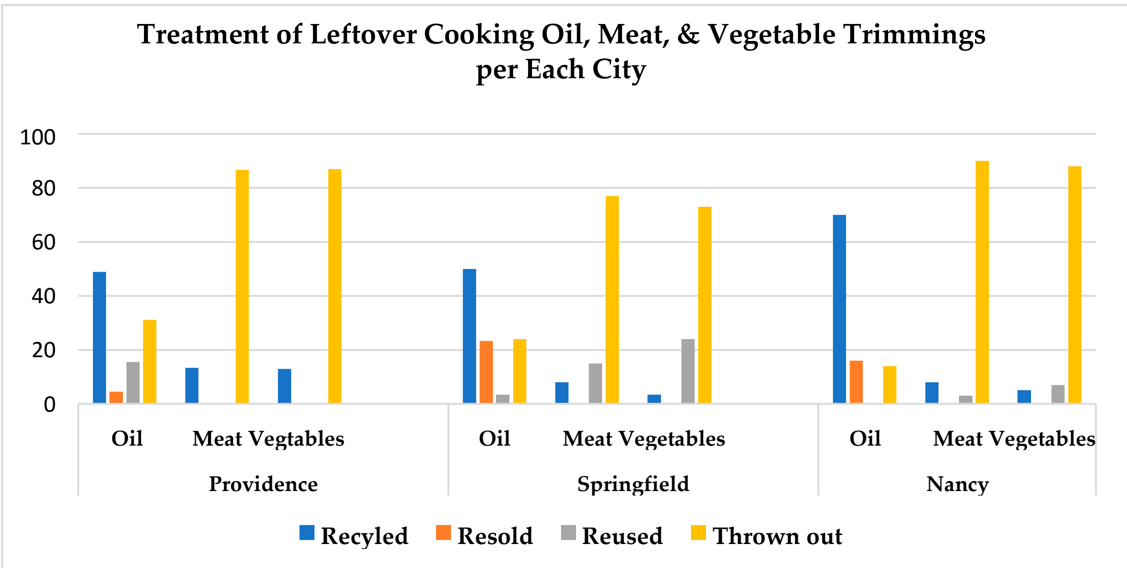

Figure 6. Treatment of leftover cooking oil, leftover meat trimmings, and leftover vegetable trimmings for the studied cities.

As indicated in Figure 6, the leftover cooking oil is recycled at a high percentage in each city (Providence: 49%, Springfield: 50%, Nancy: 70%). As for reselling of the leftover cooking oil, Providence restaurants show a much lower percentage (4%) than the restaurants in Springfield (23%) and those in Nancy (16%). Providence restaurants show a higher percentage of reusing the leftover cooking oil (16%) than the restaurants in Springfield (3%) and Nancy (0%). Meanwhile, 31% of this oil is discarded in Providence, 24% in Springfield, and 14% in the studied restaurants in Nancy.

As for recycling meat trimmings, the restaurants in Providence recycle 13% of the meat trimmings, Springfield 8%, and Nancy 8%. The results show that the restaurants in these cities do not resell any meat trimmings (0%). There is no reuse of meat trimmings in Providence restaurants. Meanwhile, there is a 15% reuse of meat trimmings in Springfield and 3% in Nancy. The results of the study show that a large percentage of the meat trimmings are discarded (Providence: 87%, Springfield: 77%, Nancy: 90%).

As shown in Figure 6, the recycling of the vegetable trimmings indicates that 13% of such trimmings are recycled in Providence, but only 3% in Springfield and 5% in Nancy are recycled. There is no reselling of vegetable trimmings in the restaurants in Providence, Springfield, and Nancy (0%). As for the reuse of the vegetable trimmings, Springfield restaurants show a higher percentage of reusing vegetable trimmings (24%) versus Providence (0%) and Nancy (7%). Again, a significant percentage of vegetable trimmings are discarded (Providence: 87%, Springfield: 73%, Nancy: 88%).

5.4. Sustainability and Donations, Recycling, Reselling, Reusing, and Discarding of the Unused Food of the Day (H4 Continued)

The focus of the next section of the survey was on the unused food of the day (e.g., soups, vegetables, prepared salad, and meat) and the day-old bread and whether they were donated, recycled, reused, resold, or discarded. The combined results of this part of the survey are shown in Table 7.

Table 7. Donate, recycle, resell, reuse, discard: Day-old bread and unused food of the day.

Action	Day-Old Bread	Unused Food of the Day
Donate	13%	12%
Recycle	8%	7%
Resell	1%	5%
Reuse	31%	36%
Discard	47%	40%

Table 7 shows that only 13% of the day-old bread and 12% of the unused food of the day are donated, while 8% and 7% are recycled, respectively. In addition, only 1% of the day-old bread and 5% of the unused food of the day are resold. For the reuse category, 31% of the day-old bread and 36% of the unused food of the day are reused. However, a substantial portion of the day-old bread (47%) and the unused food of the day (40%) are discarded. The results of this part of the survey in each city are shown in Figure 7.

As indicated in Figure 7, the restaurants in Providence donate 15% of the day-old bread and 15% of the unused food of the day, the restaurants in Springfield donate 7% in each category, and the restaurants in Nancy donate 17% and 14%, respectively. The restaurants in Nancy recycle 15% of the day-old bread and only 8% of the unused food of the day. In Providence, the restaurants recycle 7% of the day-old bread and 5% of the unused food of the day, and in Springfield, only 3% of the day-old bread and 10% of the unused food of the day are recycled. The results in each city show that in two cities, Providence and Nancy, there is barely any resale of the day-old bread or unused food of the day (Providence: 0%, 2%; Nancy: 0%, 0%). Springfield restaurants show higher percentages of reselling such items (day-old bread: 3%, unused food of the day: 13%). All the studied restaurants indicate much higher percentages of reusing these items, Providence (day-old bread: 40%, unused food of the day: 51%), Springfield (day-old bread: 30%, unused food of the day: 35%), and Nancy (day-old bread:

23%, unused food of the day: 21%). The results also show that the studied restaurants in these cities throw out large percentages of the day-old bread (Providence: 38%, Springfield: 57%, Nancy: 45%) and the unused food of the day (Providence: 27%, Springfield: 35%, Nancy: 57%).

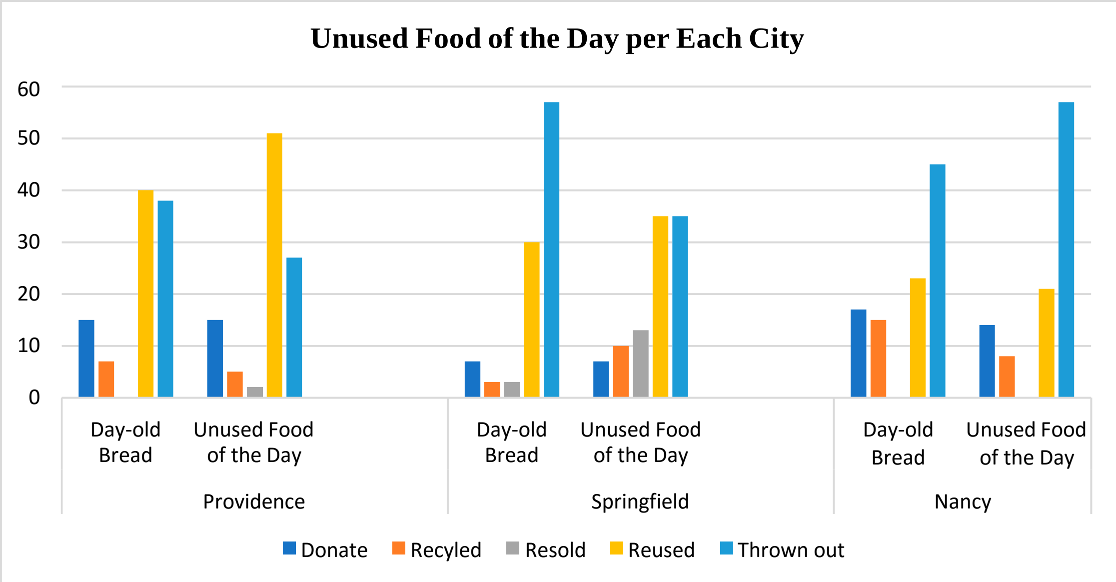

Figure 7. Donate, Recycle Resell, Reuse: Day-old bread and unused food items of the day.

The results of the statistical analyses of this part of the data do not support Hypothesis 4. Even though the restaurant owners/managers strongly believe that sustainability practices enhance the financial performance, reputation of the restaurant, and attraction of the customers, they do not practice sustainable waste management.

To further investigate the extent of engagement of the studied restaurant owners/managers in sustainability practices and the relationship with their belief that such practices have a positive impact on financial performance, reputation, and attraction of customers, non-parametric Spearman's correlation analyses suitable to survey question with Likert scale responses were conducted. Tables 8–10 present these results.

Table 8. Spearman's Correlations: Belief in positive impact on financial performance and waste management.

Category of Wastes	Coefficient (rs)	T-Statistics	*p*-Value
Cardboard	0.111	1.192	0.2354
Glass	0.001	0.014	0.9883
Plastic Containers	0.324	3.645	0.0004
Metal Containers	0.190	2.064	0.0412

Table 9. Spearman's Correlations: Belief in positive impact on reputation and waste management.

Category of Wastes	Coefficient (rs)	T-Statistics	*p*-Value
Cardboard	0.191	2.071	0.0406
Glass	0.023	0.254	0.7993
Plastic Containers	0.265	2.923	0.0041
Metal Containers	0.145	1.566	0.1200

Table 10. Spearman's Correlations: Belief in positive impact on attraction of customers and waste management.

Category of Wastes	Coefficient (rs)	T-Statistics	*p*-Value
Cardboard	0.048	0.518	0.6052
Glass	−0.034	0.362	0.7179
Plastic Containers	0.312	3.500	0.0006
Metal Containers	0.262	2.890	0.0046

As presented by the results in Tables 8–10, the Spearman correlation coefficients, (r_s), do not indicate high degrees of correlation between the belief of the restaurant owners/manager on the positive impact of sustainability practices on finance, reputation, and attraction of customers and engagement in sustainability practices. While there are a few statistically significant relationships (p^*) as indicated in Tables 10–12, the effect size in all cases is small, with the maximum Spearman correlation value being 0.324 between finance and plastic containers. Based on these findings, even though the restaurant owners/managers believe that sustainability practices enhance the financial performance, reputation, and attraction of the customers, there is little correlation with engagement in sustainability practices.

5.5. Waste Disposal and Training (H5)

In the next part of the survey, the owners/managers of the restaurants were asked whether they had any training in sustainability practices. Forty-four percent of the owners/managers in Providence, 47% in Springfield, and 10% in Nancy stated that they had some training. When asked whether they would like to have training in sustainability practices, 56% in Providence, 52% in Springfield, and 89% in Nancy expressed that they would like to have such training.

In order to examine the impact of sustainability training in increasing the likelihood on the waste handling decisions of the restaurant owners/managers, odds ratios and associated 95% confidence intervals were calculated. Training was re-coded as a dichotomous variable on 0 and 1, {0 = No Training, 1 = Training}. All other variables (plastic, metal, glass, and cardboard) were recoded as {0 = Thrown Out, 1 = Not Thrown Out}. Table 11 presents the results of the analysis.

Table 11. Relationship between training and of recycling/reselling/reusing of by-products and wastes of the restaurants.

Model	Dependent Variable	Odds Ratio	*p*-Value	Lower Bound	Upper Bound
1	Plastic Resold, Recycled, Reused	1.388	0.413	0.632	3.047
2	Metal Resold, Recycled, Reused	2.107	0.371	0.973	4.565
3	Glass Resold, Recycled, Reused	0.644	0.059	0.300	1.383
4	Cardboard Resold, Recycled, Reused	1.467	0.260	0.633	3.402

Table 11 presents the odds ratio of our binary logistic regression. Based on this analysis, none of the odds ratios is statistically significant as 1 is in the confidence interval (indicating a 1:1 relationship). Based on these results, the reported training by the restaurant owners/managers had no effect on sustainability practices. When asked about the depth of training received by the owners/managers, the training was mostly along separation of diverse wastes and putting them outside on the curb to be picked-up by the city dump trucks. Based on the results, Hypothesis 5 is not supported, since training at this level appears not to be sufficient to increase the knowledge and information of the restaurant owners/managers about sustainability practices. As to the discussions in other studies (e.g., [4,8,11]), to enhance sustainability practices in the restaurant industry, proper training and knowledge for the restaurant owners/managers and also employees are imperative.

5.6. Governmental/Municipal Rules and Regulations and Declaring a City "Green" in Enhancing Sustainability Practices (H6)

The Freeman-Halton extension of Fisher's Exact Test (F.E.T.) [27] was used to determine if statistically significant differences existed among the cities and the dichotomous classification of "green" versus "not green." When F.E.T. identified the differences, then odds ratios and confidence intervals were calculated in two ways—for "Green" cities (Providence and Nancy) versus Springfield, and for U.S. cities (Providence and Springfield) versus Nancy. Data analysis was conducted in R Statistical Software [28].

From the survey data, F.E.T. was run separately for cardboard boxes, metal containers, plastics, leftover food by-products, unused food, and day-old bread. No statistically significant results were found in this analysis. Further tests were run to see if any intercity differences existed using F.E.T. and post-hoc odds ratios. Two categories were statistically significant at the $\alpha = 0.05$ level: Metal container processing ($p < 0.001$) and plastics processing ($p \leq 0.02$). In the case of metal, the U.S. cities are not statistically different, but Nancy restaurants were much more likely to throw out metal (O.R. = 3.33, 95% CI = 1.57, 7.03). For plastic, the U.S. cities were not statistically different, but again Nancy restaurants were much more likely to throw out plastic (O.R. = 3.14, 95% CI = 1.34, 7.37). The analytical results of this part of the survey does not support Hypotheses 6, that declaring a city "Green" and governmental and municipal rules and regulations enhance sustainability practices in the restaurant industry. Similar finding that sustainability practices are not enhanced by the governmental rules and regulations is also reported in the study in the Brazilian food industry by Bossle et al. [6].

The results of the statistical analyses regarding the proposed hypotheses can be summarized as shown in Table 12.

Table 12. Summary of the results of the survey in support of the proposed hypotheses.

Hypotheses	Supported
H1. Restaurant owners'/managers' belief that sustainability practices enhances the financial performance of the restaurant.	Yes
H2. Restaurant owners'/managers' belief that sustainability practices enhances the reputation of the restaurant.	Yes
H3. Restaurant owners'/managers' belief that sustainability practices enhances attraction of customers.	Yes
H4. Relationship between the belief of restaurant owners/managers (H1–H3) and enhancement of sustainability practices.	No
H5. Relationship between training of the restaurant owners/managers and enhancement of the sustainability practices.	No
H6. Declaring a city "Green" enhances sustainability practices in that city's restaurants.	No

6. Discussion

A major focus of this study was to investigate if restaurant owners/mangers believed that sustainability practices had positive impacts on financial situation, reputation, and attraction of the customers, and if they had such beliefs, did they practice sustainability? In addition, the study examined if training had any impact on sustainable practices, and furthermore, if declaring a city "Green" would enhance sustainability practices in that city.

The results of this research utilizing several different statistical analyses support Hypotheses 1–3, indicating that the restaurant owners/managers strongly believe that sustainability practices have positive impacts on their financial performance, the reputation of the restaurant, and the attraction of customers (Figure 4, Tables 2 and 3).

However, the results of both descriptive and quantitative analyses do not support Hypothesis 4, the restaurant owners/managers even though they believe sustainability practices enhance the performance of the restaurants, the majority of the restaurant owners/managers do not practice recycling, reselling, and reusing of the various categories of the wastes and by-products of their operations in notable percentages (Tables 5–10, Figures 5–7). If the owners/managers of the restaurants believe thatsustainabilitypracticesenhance the performance of theirrestaurantsalongthesedimensions, why are they not practicing them?

As mentioned previously, the data for this study were collected by interviewing the restaurant owners/managers via a questionnaire. During the process of completing the survey and being made aware of the various ways to utilize the wastes and by-products of their operations, a question from the restaurant owners/managers was how a single restaurant could access the resale and reuse markets for the wastes and by-products of its operations.

As shown in Table 11, training did not seem to enhance the sustainability practices in the studied restaurants except for treatment of plastic wastes. Another question posed by the restaurant owners/managers was in regard to the appropriate ways to separate different wastes and by-products in order to have better recycle, resale, and reuse values beyond the simple separation of cardboard, glass, metal, and other wastes, and putting them on the curbside.

On average, a restaurant produces more than 100,000 pounds of waste every year [2]. Five major categories of restaurant by-products and wastes—glass, plastic bottles and containers, metal (i.e., aluminum cans and containers), leftover food items, and leftover cooking oil—have the most resale and reuse market values. However, based on the results of this research, despite their market values, very few categories of the wastes and by-products are resold (Tables 5–10 and Figures 5–7).

The current price for used aluminum cans is about $0.55 per pound or about 2 cents a can [29]. According to The Aluminum Can Association [30], aluminum cans have a higher market value than glass and plastic bottles, and it is easier to separate them from the other wastes and by-products of the operations of a business. The amount of aluminum cans used in the U.S. is more than 1.612 million pounds per year [31]. In addition to the resale value, a significant cost efficiency in using recycled aluminum cans is that the energy used to make new cans from the old ones is 92% less than using raw sheets of aluminum [31].

Another category with notable resale and reuse value is glass. According to data from Joarder [32], 95% of glass used in different products can be made from cullet (crushed glass). Using cullet can reduce water and energy usage and reduce carbon emission; however, the cullet must be made from same color glass. As a result, sorting and delivering the glass requires labor and costs. However, the price of cullet in recent years has increased by 40%, and preparing the glass for cullet can create jobs in the community [32]. In addition, glass bottles have the most reuse options compared to other restaurant by-products and wastes. Products, such as candles, flowers, or light holders and other decorative items can be made from the used glass bottles.

In addition to aluminum cans and glass bottles, the day-old bread and the leftover food at the end of the day can be reused to make other food items, such as pies and soups. They also have tremendous donation possibilities. Furthermore, the leftover customer food and trimmings of vegetables and meat can be resold to pet shops and farmers in addition to being recycled into compost.

The usage of recycled plastic, aluminum, glass, and paper to make new products requires less water, energy, and raw materials, such as silica and pulp [33,34]. In addition, the biofuel market for items such as leftover cooking oil has been growing within the past decade, mostly due to an increase in the production of biodiesel fuel [35,36]. A recent report indicates that the yearly revenue for the leftover cooking-oil industry is around $85.52 billion, and is expected to reach $130.3 billion by 2024 [37]. Research by Miller reported that the restaurants in Salt Lake City, Utah, disposed of around 500,000 gallons of leftover cooking oil every year [38]. At $1 per gallon, the resell revenue would be $500,000 per annum. This oil can be reused for diesel engines in addition to producing grease for several types of machinery. In addition, the usage of leftover cooking oil in place of petrol can reduce greenhouse gases by 86% [39]. Furthermore, the leftover cooking oil has a resell market for feedstock [40].

Based on the data collected in this study, leftover cooking oil is the only by-product of restaurant operations that has a higher percentage of recycling, reselling, and reusing in the restaurants under study. On the other hand, a large percentage of the plastic bags that are considered to be one of the most contaminating and polluting wastes of the operations of a business [41] are discarded.

Most of the restaurants in this study across the three studied cities had similar profiles. They were fine dining and sit-in restaurants with 2, 3 services per day and with the capacity of 50–100 customers. As a result, the volume of wastes produced by these restaurants would be sizable. As mentioned previously, both Providence and Nancy are declared "Green" cities. Thus, businesses in these cities have the potential of having a major impact on development and enhancement of sustainability practices and achievement of the goals of being a "Green" city. However, in several categories—cardboard, glass, and metal—the results of the study indicate that in Springfield, not a declared "Green" city, the restaurants recycle these items at higher percentages than the restaurants in Providence and Nancy. In addition, the restaurants in Springfield resell more metal by-products and recycle more of the cooking oil and the unused food of the day than the studied restaurants in the other two cities.

The results of this survey show the lack of sustainability practices across a very important and waste producing industry. In all three cities, the restaurants throw away a significant amount of the wastes and by-products of their operations. Discarding these wastes and by-products in such high percentages contribute to increasing wastes and carbon emission in the communities where the restaurants are located. Hence, based on these results, declaring a city "Green" does not seem to enhance the sustainability practices across the activities of a business. Considering the number of restaurants in each city and the diversity and the extent of the wastes and by-products that this industry produces, the restaurant industry can certainly contribute to the accomplishment of the goals of creating a "Green" city.

As mentioned previously, a very high percentage of the restaurant owners/managers in these three cities, comprising 126 restaurants, believe that sustainability practices have positive impacts on financial performance, reputation of the restaurant, and attraction of customers; so, why are they not practicing them? To find an answer to this question, research needs to concentrate on methods and strategies that allow a single restaurant to access the recycle, resell, and reuse markets for the wastes and by-products of its operations in addition to the donation of some of the by-products.

Even if a manager indicated that, he or she had received training, that training was not formal. The training was mostly general knowledge and information that they had acquired regarding waste management, separation of different wastes and by-products of their operations, for example, cardboard from plastic. Research in this area (e.g., [4,8]) shows that technical and precise training and information are of the utmost importance in the implementation of eco-practices in the restaurant industry. Such training and instruction for the restaurant employees and owners/managers in addition to educating the customers are some of the key success factors in greening the restaurant industry and realizing the goals of creating a "Green" city.

Previous studies point to training and increased knowledge as the means to enhance sustainability practices in the restaurant industry (e.g., [8]) in addition to the involvement of governmental agencies and other organizations, such as food banks [42].

Therefore, how can we enhance the eco-operations of restaurants? According to researchers [42,43], implementation of sustainability practices in individual businesses is a major challenge, and this challenge is more pronounced in the restaurant industry. A major obstacle in realizing the sustainability practices in the restaurant industry is the fragmentation of this industry. The fragmentation of the restaurant industry makes eco-operation implantation a challenge. In addition, the working hours of a restaurant, the diversity of the produced wastes, the number of customers through the rush hours, tourists versus regular customers, the mixture of restaurant workers, and the lack of appropriate training are other factors that contribute to the complexity of commitment to sustainability practices [4,8,44].

Some of the goals of the United Nations for enhancing sustainability is the reduction of food waste [45]. However, based on the results of this research and other studies (e.g., [6,13]), regulations and policies at the country and state level cannot enhance green operations in fragmented industries and a single business, even in the cities where green goals are set, a large amount of useful by-products of operations of a business are still wasted. To overcome such obstacles, strategic alliances among several entities at the community level are of the utmost importance and the key success factors in gaining competitive advantage for the restaurants.

7. Conclusions

The research presented in this study expands upon the current studies of the sustainability practices in the restaurant industry along several constructs. First, most of the data collected in this study were from restaurants in two cities in the U.S. and a city in France with similar profiles based on the type, provided services, and capacity in the U.S. and the EU. Second, the investigated sustainability practices included an inclusive list of the wastes and by-products of the operations of the restaurants. Third, the sustainability practices were examined along a comprehensive range of actions, recycling, reselling, and reusing, in addition to donation when appropriate. Furthermore, the study compared sustainability practices in declared "Green" cities versus a non-declared "Green" city and explored the impact of governmental rules and regulations on such practices in the restaurant industry.

This study's novel results indicate that declaring a city "Green" and the belief of the restaurant owners/managers that sustainability practices have a positive impact on the operations of the restaurant do not enhance eco-operations. As a result, great percentages of the wastes and by-products with the potential of recycling, reusing, reselling, and donation are discarded.

A major reason for the lack of sustainability practices seems to be the sheer numbers of restaurants scattered across neighborhoods. An important contribution of this study is to indicate that fragmentation of an industry is a key hurdle in implementation of sustainability practices. As indicated by the results of this study, the restaurant owners/managers believe in the positive impact of sustainability practices on the performance of a restaurant along different dimensions. In addition, they are willing to be trained and need training beyond separation of parts of the produced wastes and leaving it outside to be delivered to the dumpsites. A single restaurant needs to have a network of other restaurants and organizations to allow proper and efficient collection and dissemination of the produced wastes and by-products of its operations. Therefore, formation of alliances to create a "Green" city is a necessity. However, as indicated by the results of this study, rules and regulations at the state and governmental levels are not effective. The unit of attention needs to be neighborhood-by-neighborhood and community by community to address the issue of fragmentation of the restaurant industry and providing ways that eco-operations in a single business can be implemented.

In the cities under this study, Providence, Springfield, and Nancy, there are streets in various neighborhoods where large numbers of restaurants are congregated. Through creation of such partnerships with different private and public organizations at the community and neighborhood levels, the wastes and by-products of restaurants in a neighborhood can be separated properly and collected jointly. Such bulk collection from the restaurants in each neighborhood can then be delivered to appropriate destinations for reselling, reusing, recycling, or donation. These partnerships can create jobs across the logistic chain, can enhance the efficient use of resources, generate financial gains for the restaurants, and contribute to creation of an eco-city environment.

As mentioned previously, fragmentation in this industry does not facilitate training and implementation of sustainability practices based on the governmental directives. In conclusion, private-public partnerships at the smallest unit of analysis are needed to enhance the operational efficiency of different businesses, specifically in fragmented industries. Future research needs to explore the creation of such partnerships as well as expansion of the study to other cities. In the case of the restaurant industry, strategic alliances among municipal offices, as well as local community organizations, chambers of commerce, and local academic institutions are critical. Through these alliances, essential knowledge and training can be provided in addition to development and utilization of appropriate technologies to enhance green waste management in one of the largest global industries for conservation of resources and creation of healthy communities.

The mayoral offices in the three studied cities are interested in the study results. These results are going to be shared with them, and we will offer informational sessions for the restaurant owners/managers and relevant municipal offices in the future.

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GreenScenario: A Collaborative Software-Based Decision-Support Tool and Integrated Planning Process for Climate-Conscious and Evidence-Based Design

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1 ABSTRACT

GreenScenario is a software-based, rapid visualisation, parametric design tool developed by Ramboll Studio Dreiseitl for enabling evidence-based climate change adaptation planning and design. This case study summarises the results of utilising the GreenScenario methodology on an urban retrofit project for a private property developer in Vienna, Austria in order to identify enablers and barriers for the use and acceptance of decision-support tools (DST) within the urban planning and design practice. Three main observations from applying the GreenScenario methodology on the project in Vienna are highlighted.

Firstly, a key enabler for the case study in Vienna was **transparency** – whether in the planning process, how calculations or simulations were performed for the various key performance indicators assessed, the credibility of applied data sources or the accuracy of the 3D base model compared to actual site conditions. When stakeholders overcame the barrier associated with a digital tool guiding the planning process, the second key enabler identified was the **visualisation** aspect – both in the speed as well as the graphic depiction of effects and simulations. By being able to rapidly compare four potential planning options, one was selected for further optimisation as part of a co-creation conceptual design process. Lastly, based on a follow-up interview with the private developer, the role of **communication** was deemed to be the most important enabler for DST. Following the visual representation of climate data – clear, understandable, appealing – the private developer could use the arguments for which options performed best, stimulated discussions about opportunities and challenges of each of the proposed solutions, and enabled a targeted optimisation of the selected design option based upon direct feedback from stakeholders.

Especially due to the complexity associated with climate science and its more recent application in the urban planning and design profession, the multi-layered feedback mechanisms embedded in the tool – including geospatial visualisations sourced directly from the 3D model combined with quantitative metrics and integrated microclimatic simulations – simplified communication and processing the results. The effects and consequences of planning with climate adaptation tools versus conventional planning approaches could be more clearly understood between multiple topics simultaneously.

Keywords: climate change adaptation, urban planning and design, decision-support tools, collaborative planning process

2 INTRODUCTION: CLIMATE ADAPTATION

Urban mega-trends pre-COVID-19 predicted that there would be an increase of movement from rural into urban areas thereby increasing land scarcity, natural resource depletion and climate change issues. Globally, it is estimated that by 2050, approximately 70% of the world's population will live in cities (Department of Environmental and Social Affairs, 2017); 80% of global inhabitants could still be living in unplanned settlements with the highest growth rates coming from Africa and Asia (Revedin, 2014: 8); and the largest age group will be senior citizens (+65 years) with population rates predicted to grow by 12% by 2030, resulting in a global population of approximately 8.5 billion people (Stylianidis et al, 2017: 119).

Although cities only occupy 3% of the Earth's land, they generate 80% of global gross domestic product (GDP) while responsible for 70% of global energy use and greenhouse gas emissions (United Nations, 2016: 24). By 2050, the cost of 'doing nothing' to mitigate climate change effects in cities is estimated to incur costs in the EU alone in the range of 100-150 billion Euros per year every year, dependent on the climate scenario (COACCH, 2018).

Mitigating the effects of climate change tend to occur at larger city-wide or country specific scales and primarily refer to methods that reduce greenhouse gas emissions whereas climate change *adaptation* refers to processes, tools or actions that increase resilience, reduce vulnerability or enhance adaptive capacity, and tend occur at regional, local or site-specific scales (IPCC 2018). As Nay et al (2014) indicate: 'Climate adaptation strategies must be implemented at the local level.'

Adaptation measures have become recently more and more associated with *resilience* measures (Carter et al., 2015), and although research shows that mitigation and adaptation tracks can be combined to enable synergies to occur (Landauer, Juhola, Klein, 2019), the focus of this paper is on climate adaptation tools within urban planning practice, and in particular, the concrete application of tools that draw inspiration from natural, managed ecosystems – or nature-based solutions (NBS).

NBS can be defined as 'actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits' (IUCN, 2019). At the end of the 20th century, NBS tools (e.g. green roofs or rain gardens) began to emerge as suitable measures to complement or replace technical solutions that reduced the, particularly within the landscape architecture discipline. Known also under a variety of terms including, green infrastructure (GI), urban green infrastructure (UGI), blue-green infrastructure (BGI), sustainable urban drainage (SUDS), low impact development (LID) or water sensitive urban design (WSUD), terms vary based on country-specific terminology (See Fletcher, 2015; Ghofrani, Sposito and Faggian, 2017) yet all have a foundation in the concept of ecosystem service (see Bürgi et al, 2015).

NBS have the capability to complement or replace grey infrastructure (e.g. pipes) by offering multi-functionality as opposed to mono-functionality (i.e. green roofs or rain gardens not only improve environmental conditions but also satisfy infrastructural requirements while enhancing spatial quality and liveability). Aesthetically, they are planted, visible and offer an open space element in the urban environment, and provide ancillary benefits or 'co-benefits', which are added values that may or may not have tangible economic values associated with their benefit.

Per Urge-Vorsatz et al's (2014) description of co-benefits, or the full combination of direct and indirect measures that have the capacity to improve human health, ecosystem services, macroeconomic conditions, social and environmental equity and justice, they also note that within typical cost-benefit analysis, these hard-to-quantify values of indirect benefits tend to be negated or relegated to known standards such as air pollution or noise. The multi-layered co-benefits of nature-based solutions are diverse, and exemplify how such tools provide the same functional requirements that hidden urban infrastructure (e.g. pipes) provide while simultaneously enhancing the experiential quality of spaces, especially when these elements are visible or tangible (Iwaszuk et al 2019).

Recent studies regarding the effects of COVID-19 have depicted the importance of accessible green infrastructure in cities, especially during global pandemics (Derks, Giessen and Winkel 2020; Honey-Rosés et al. 2020; Venter 2020).

Although several notable research projects related to NBS have been conducted, widespread application of NBS tools is still limited, especially in view of the lack of changes in governmental regulations or construction standards (OECD, 2020).

The implementation of nature-based solutions to support climate resiliency occurs typically at localised, micro-scales; the business case for nature-based solutions has not yet found an accepted standard for calculating and translating economic cost-benefits, as adaptation measures are almost always specifically tailored to site-specific characteristics; and thus, the impact of nature-based solutions has not yet been recognised at a wider-scale, limiting its implementation in policy frameworks for large-scale change (OECD, 2020).

With increasing rates of urbanisation, the subsequent loss of biodiversity and the detrimental effect on ecosystem services, adapting cities to the effects of climate change, rather than simply mitigating climate change's impact and even with the aforementioned tools of NBS, is a major challenge exacerbated by the relative uncertainty, complex data interpolation and extended timespans associated with climate science.

As aging city infrastructure fails and extreme weather events increase in intensity and frequency, it is critical that future planning approaches be climate *resilient, adaptive* and *conscious.* Testing the technical feasibility and economic resiliency of the full range of planning solutions is critical especially at the pre-planning feasibility stage when decisions matter most, as Forziere et al (2018) predict that climate change has the potential to increase damage to infrastructure caused by extreme weather events ten-fold by the end of the 21st century.

As Wilson et al further note: 'Issues as diverse as population growth, transportation, and climate change, all present significant challenges for 21st century cities, and require an approach to urban development that is data-driven, iterative, and most importantly, engages the broadest possible audience of stakeholders' (Wilson et al, 2019).

3 DECISION-SUPPORT TOOLS

One method to tackle the complexity of climate change is the use of digital decision-support tools (DST).

Casual online searches today reveal a variety of decision-support frameworks, systems and platforms that have been created in response to climate resilient planning approaches. Decision-support tools can be defined as methods and resources enabling decision-making, can take the form of analogue or digital measures, and be supported by a process or framework for implementing decisions (Palutikof, Street and Gardiner, 2018).

In their extensive Special Paper, Palutikof, Street and Gardiner (2018) examine characteristic barriers and enablers related to the uptake of such decision-support systems. Specific to climate adaptation, decision-support platforms researched were found to provide convincing, innovative, illustrative delivery of data because adaptation, in contrast to climate change mitigation, are local initiatives and implementation schemes, not necessarily broader policy-based or regionally applicable solutions (Palutikof, Street and Gardiner, 2018).

They note that key barriers to the adoption of decision-support tools related to climate adaptation stem primarily from the complexity associated with climate change science's technical jargon, regional lexicon variables and the resultant confusion (Palutikof, Street and Gardiner, 2018). Palutikof et al (2018) further found less success in the uptake of DST when there was lack of collaboration in the application and development of the system between software developers, (potential) users and the funders, and lastly, proposes that successful systems 'should be tailored to the needs of the user in terms of content, style and presentation and should somehow be legitimised so that the user is confident in using it' (Palutikof, Street and Gardiner, 2018: 471).

4 GREENSCENARIO: DEVELOPMENT AND APPLICATION

Climate change is a complex problem with multiple solutions involved at a variety of global and local scales. Studies have shown that 1) humans have a limited ability to think and visualise the long-term effects (of climate change on their surrounding; 2) visualisations of climate science data into an understandable and contextualised manner can enable cognitive human processing of dynamic, complex information; and 3) in order to increase uptake of climate-conscious decisions in practice, solutions need to be location-specific, understandable and integrated within the local planning process so that they are relevant as well as accepted (Schroth, Pond, Sheppard, 2015).

Scenario planning is a recognised approach as a decision-support methodology and is gaining acceptance for use in urban planning and design, and more specifically, evidence-based climate change adaptation (Star et al, 2016;), especially as it allows for the testing of multiple solutions instead of just one selected outcome. Computational design techniques as they relate to developing digital decision-support systems or platforms, while found to be practical and implementable at building and plot scales, were found to be particularly challenging to apply at urban, regional and city scales due to increased computational expense, difficulty in limiting inputs, and the increase in involved stakeholders involved in the planning process (Wilson et al, 2019).

Successful decision-support tools balance achieving goals with conflicting values; quantitatively *and* qualitatively assess solutions; and are integrated as part of the local community planning process.

4.1 GreenScenario Description

Mitigating the effects of climate change tend to occur at larger city-wide or country specific scales and primarily refer to methods that reduce greenhouse gas emissions whereas climate change *adaptation* refers to processes, tools or actions that In direct response to the growth and maturity of evidence-based design principles and the evolution of digital decision-support and to more fully address the concerns associated with decision-support tools and the complexity of climate science in urban planning, GreenScenario has been developed as a flexible, data-driven evaluation system and a software-based collaboration platform for enabling a transparent and iterative design process. The tool combines site-specific microclimatic simulations, multi-scenario generation, rapid feedback and an interlinked fully 3D parametric design model laden with localised datasets. The tool's three main climate factors (water, open space and green, heat and microclimate) are underpinned by an economic module.

The methodology combines a rigorous, quantitative framework coupled with a rapid feedback system that enables stakeholders to evaluate and compare exactly how solutions perform based on a multi-parameter cross-section of climatic and economic parameters, often with real-time feedback. Utilising a parametric 3D modelling software package of Rhinoceros combined with Grasshopper, GreenScenario uses readily accessible architectural design software. Suitable for early stage concept design and master planning feasibility studies, GreenScenario is not only software but a tech-enabled design process consisting of three iterative steps. See Fig. 1 below.

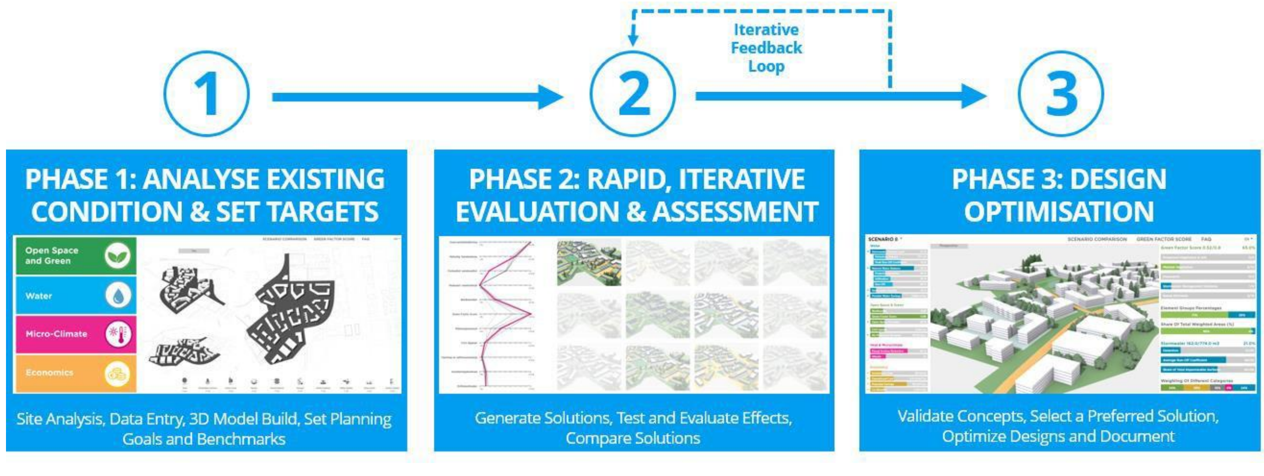

Fig. 1: Description of the three-step GreenScenario Methodology (Source: Ramboll Studio Dreiseitl)

A holistic cross-section of three primary climate adaptation modules (water, heat and microclimate, open space and green) supported by more than twenty key performance indicators (KPIs), and linked to an underlying economics module encompasses the evaluation matrix, and, while the standards and norms utilised conform to local, national and / or best-practice standards, they can be flexibly structured to be appliable across multiple geographies.

4.2 Input Requirements and Key Performance Indicators

Mitigating the effects of climate change tend to occur at larger city-wide or country specific scales and primarily refer to methods that reduce greenhouse gas emissions whereas climate change *adaptation* refers to processes, tools or actions that To create the 3D base simulation model – from which all calculations and tests are derived for both the existing situation as well as options (scenarios), a primary data set is required which can be supplemented based upon available levels of information.

The primary digital inputs for the 3D-model include:

- a site base plan (2D, CAD-based) with delineation of streets, paths, buildings and all related site-relevant parameters, each with a spatial definition and material representation;
- existing context between 50-100m outside of the defined site boundary (3D model with Level of Detail (LOD) LOD-0 or LOD-1, format flexible);
- climate data for the site (e.g. intensity-frequency-duration charts for historical precipitation data; evapotranspiration, infiltration and runoff rates for the site based on a hydrological atlas);
- weather data related to humidity, air pressure, temperature, wind speed, etc. (where possible, either in an EPW format or similar);
- tree placement (2D or 3D digital file);
- and contours or spot elevations (where possible as a digital terrain model or similar; at minimum a site survey in Excel point data format).

Supplementary data can vary based on best known data and can include information related to intended build-out specifications (e.g. type of new development, intended residents or employees foreseen, water consumption rates, etc.); climatic surveys include flood maps, heat maps, risk maps or similar; tax and fee rates for stormwater, potable water and waste water; localised cost rates climate adapted tools for investment (CAPEX) or maintenance (OPEX); geographical conditions (e.g. soil type, groundwater levels, infiltration or evaporation rates); and existing planning frameworks (e.g. approved development plans; local masterplans; infrastructural or transport masterplans; ecological framework plans; conservation areas; restricted development zones or similar).

The key parameters of the evaluation matrix are detailed in Fig. 2 below.

MODULE	ID#	KEY PERFORMANCE INDICATOR
Water	W1	Stormwater Service Level
	W1.1	Detention Volume (m^3)
	W1.2	Peak Run-Off Coefficient (Factor)
	W2	Natural Water Balance (%)
	W2.1	Evapotranspiration (Factor)
	W2.2	Infiltration (Factor)
	W2.3	Run-Off (Factor)
	W3	Stormwater Quality (%)
	W4	Potable Water Savings (m^3/Year)
Open Space and Green	G1	Biodiversity (Factor)
	G2	Green Factor Score (Factor)
	G3	Open Space Provision (%)
	G3.1	Trees (Quantity)
	G3.2	Green Spaces (m^2)
	G3.3	Green Roofs (m^2)
	G4	CO_2 Uptake (Tons / Year)
	G5	Air Pollutants Removal (kg / Year)

MODULE	ID#	KEY PERFORMANCE INDICATOR
Heat and Micro-Climate	H1	Thermal Comfort (% Time between -26°)
	H1.1	Wind Comfort (% Time under 5 m/s)
	H1.2	Solar Irradiation (Wh / m^2 / Day)
	H2.1	Heat Island Effect Reduction (UHI Maximum Temperature °)
	H2.2	Heat Island Effect Reduction (UHI average temp. difference °)
	H3	Paved Surface Rate (%)
	H4	Sun Hours (Hours / Day)
	H5	Albedo (Factor)
Economics	E1	Investment Costs
	E2	Operational Costs
	E3.1	Savings Potential Stormwater Fees
	E3.2	Savings Potential Potable Water Fees

Fig. 2: Modules and Indicators of GreenScenario (Source: Ramboll Studio Dreiseitl)

How GreenScenario has been applied on a specific case study for an urban retrofit site in Vienna, Austria and the resultant observations related to enablers and barriers for decision-support tools (GreenScenario) follows in the next section.

5 APPLICATION OF THE METHODOLOGY ON A PROJECT IN VIENNA

5.1 Background

The project site is located within walking distance of Vienna's Central Train Station (approximately 1.0 km north/northwest) and the historic city centre (1.6 km south), based on a direct assessment via Google Earth. The approximately 1.5 hectare site is set entirely within a built and developed urban context. The primary objective, based upon the goals of the private property developer, was to develop an urban infill residential building as a sustainable and integrative mixed-use concept that would maximise value of the current land while minimising impact on ecological constraints. The timespan for the study occurred over a 2-month period from project inception to final delivery.

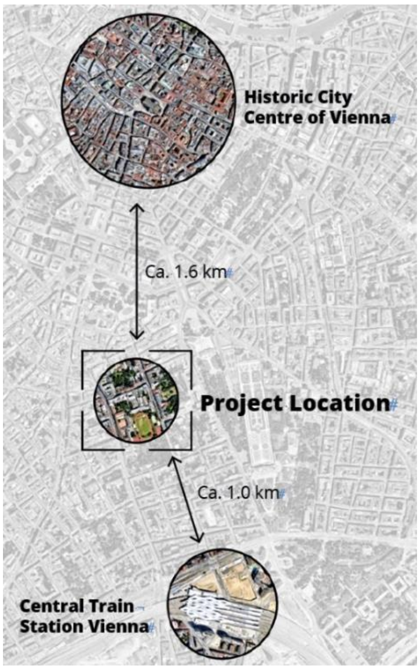

Fig. 3: Location of Vienna Project Site (Source: Google Earth with modifications by Ramboll Studio Dreiseitl)

5.2 Methodology

Methodology: For the evaluation, the existing situation or Baseline - based on a thorough analysis of the publicly accessible Vienna Geodata Catalogue as well as client-supplied data - have been integrated into the GreenScenario System, and subsequently analysed and evaluated with regard to climate adaptation performance parameters. 3D base model for all simulations, calculations and studies has been generated from the base information provided by the client and / or available from online databases and lastly, converted for application within the GreenScenario software analysis system. The Baseline and Planning Scenario(s) were then rigorously assessed and evaluated based on the GreenScenario established evaluation matrix. For clarification, the Baseline is considered the existing state at the time of the study's inception; the Planning Scenario(s) are any potential options generated. The three steps of the methodology were followed.

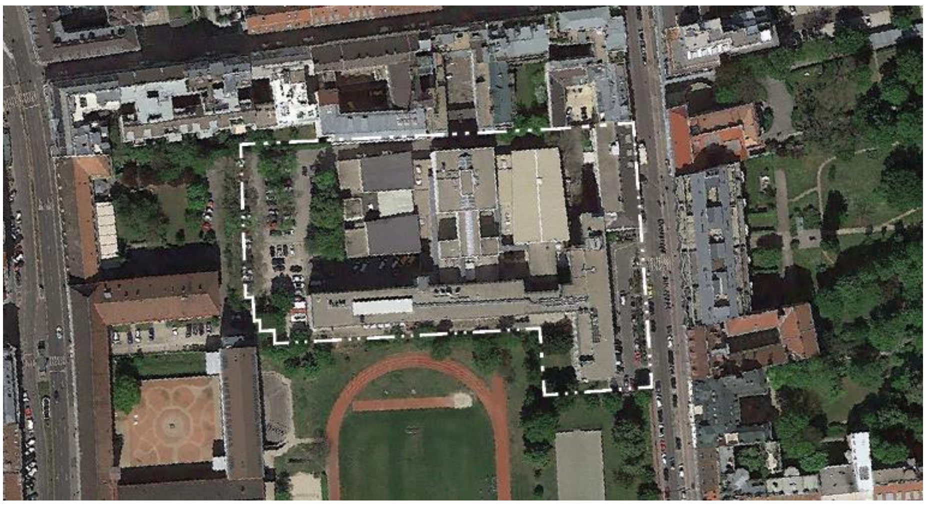

Fig. 4: Google Earth Aerial View (Source: Google Earth)

Fig. 5: Site Photos depicting condition of Bautrakt E – primary use as a parking lot with existing trees (Source: Client supplied)

5.3 Phase 1A Analyse Existing Condition

Current Site Use: The main 1.5 hectare site focused on redeveloping primarily an asphalt-paved area used as a parking lot for residents and workers. Based upon an initial desktop site analysis, a catchment of 3.0 hectares was established as an outer perimeter beyond the site borders for assessing the impact of microclimate conditions. Directly surrounding the site (see Fig. 4 and 5 above) are five pre-defined 'Bautrakt' or building areas labelled A-E. The main development area is considered Bautrakt E with improvements for all other public realm areas and potential building elements expressed by the private property developer (see Fig. 6). North and west are residential developments; south is a private sport field; east is a mix of residential, commercial, office and cultural uses; the main access is along the Argentinierstraße to the east which provides an access route into the development towards Bautrakt E.

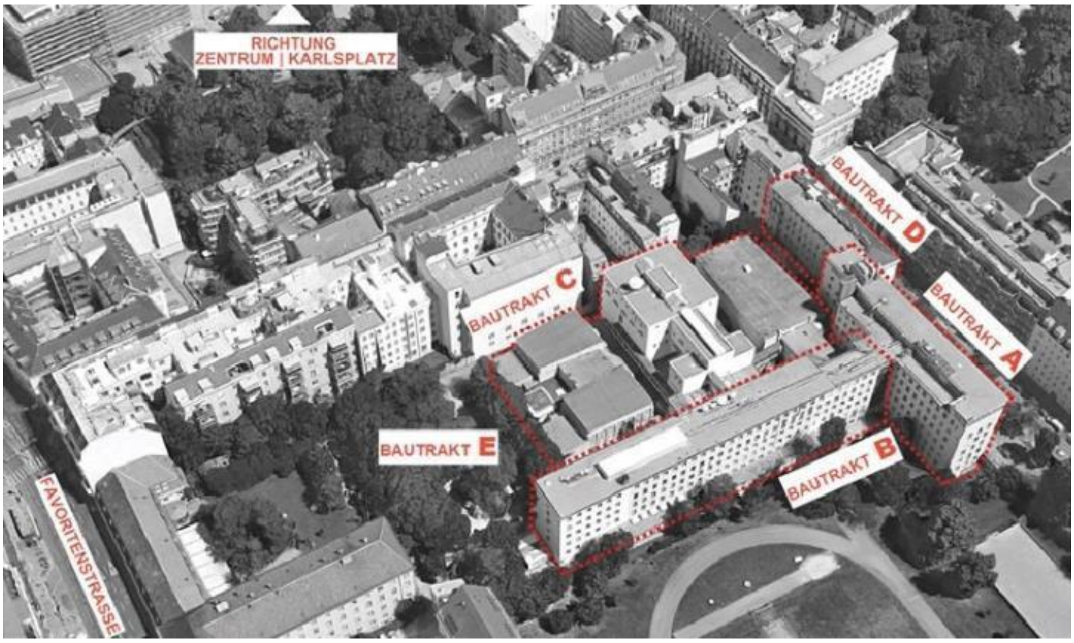

Fig. 6: Definition of Zones; main development to occur in Bautrakt E (Source: Client supplied)

The building areas (Bautrakt) and their uses, function and potential future conversion potential are summarised below:

- Bautrakt A: owned by private property developer; residential and commercial use, building has potential for green roof addition to minimise impact of hardscape material on surroundings; use to continue in the future; potential for improving the public realm areas (sidewalks, parking areas, bicycle lanes, drive lanes, entry sequence) desired
- Bautrakt B: owned by private property developer; currently used for commercial purposes with café use on first floor; can be converted in future based on local planning permits into a residential building; roof has potential to be converted into a green roof similar to Bautrakt A; first floor building extensions can be deconstructed to free up space for open space elements within the southern green area

- Bautrakt C: owned by other entity; current used for commercial and office uses as well as a cultural function; no current plans to add elements on to building structure although future revisions are under consideration (would require a building structure evaluation); current building has a green wall (creepers and vines, primarily) on the northern side that should remain in the future
- Bautrakt D: owned by private property developer; currently undergoing a conversion and update for residential facilities; similar comments to the public open space at ground level (improvements to sidewalks, parking areas, bicycle lanes, drive lanes, entry sequence desired)
- Bautrakt E: primary development site owned by private property developer; currently provides a pocket of green space based on older, established trees that microclimatically limits the impact of heat at a local level; however, the use is as a parking lot, several trees have been considered as needing to be replaced
- Open space surrounding the site Bautrakt C and E: from the entry on the Argentinierstraße (fronting Bautrakt A and D) the function is primarily for vehicular traffic; car parking areas can be converted into a more water permeable pavement; new development can likely cause the removal of some of the trees within Bautrakt E and compensation mechanisms will need to be planned into future development; a fire access lane needs to be secured

5.4 Phase 1B Set Targets

The general aim of the redevelopment of the area was to develop a building layout plan for preliminary approval by the local planning commission in Vienna. Per discussions the private property developer had with the city, should trees be required to be felled in order to build, compensation would need to be provided for based on local regulations. In discussion with the private property developer, the following goals and objectives were subsequently set for the development. Based upon these targets, the analysis via GreenScenario could provide both a qualitative and quantitative assessment if and how the goals were reached, and which optimisation measures would potentially be required should they not be attained.

- Maximise green space potential on site
- Provide an additional co-benefit of increased and accessible public green space (in the form of a playground)
- Limit the effects of the urban heat island effect by reducing pavement and hardscape materials
- Integrate blue-green infrastructure elements into the development to minimise the impact of stormwater
- Develop a concept that would maximise tree use
- Optionally develop the building with a sustainable material (e.g. timber or similar)

The end results and effects of Phase 1B are discussed in section 6 below.

5.5 Phase 2A Rapid, Iterative Evaluation and Assessment

Concept Development Existing compared to Proposal: the following design was agreed upon as the primary measures to be undertaken for the development concept. First shown is the existing condition.

Fig. 7: Existing Condition, Modelled Situation of Baseline in GreenScenario (Source: Ramboll Studio Dreiseitl)

The development concept saw the following improvements as necessary are were analysed within the GreenScenario modules. A description of the modules and analysed indicators follows prior to a comparison of the performance results.

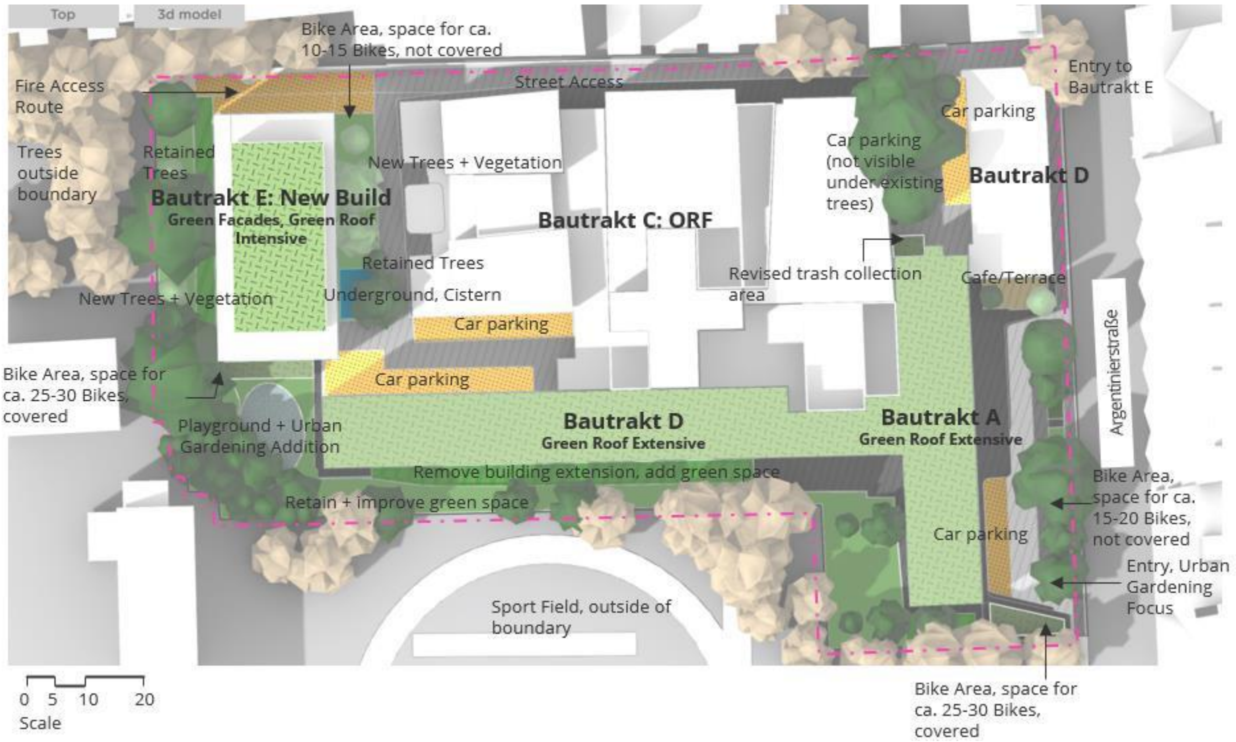

Fig. 8: Proposed Condition, Modelled Situation of Concept in GreenScenario (Source: Ramboll Studio Dreiseitl)

Fig. 9: Reference images for blue-green infrastructure elements (Source: Ramboll Studio Dreiseitl)

5.6 Comparison, Analysis, Performance

The primary design measures for climate adaptation distinguishing the existing condition and the proposed condition:

- The addition of a new residential building with intensive green roofs, green facades, timber construction
- Reduction of paved areas and substitution with porose pavements or green areas
- Increase in green infrastructure for stormwater management such as swales
- Lastly, the compensation of the trees lost to development with the planting of new species.

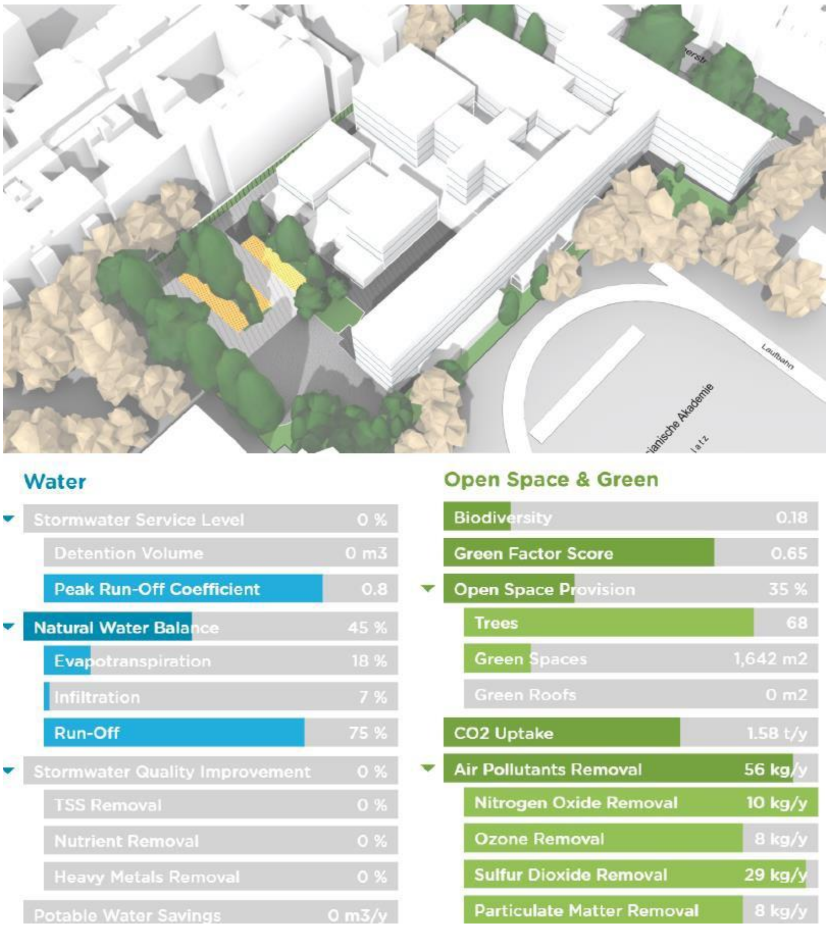

Fig. 10: Baseline results of GreenScenario analysis related to the modules Water and Open Space & Green (Source: Ramboll Studio Dreiseitl)

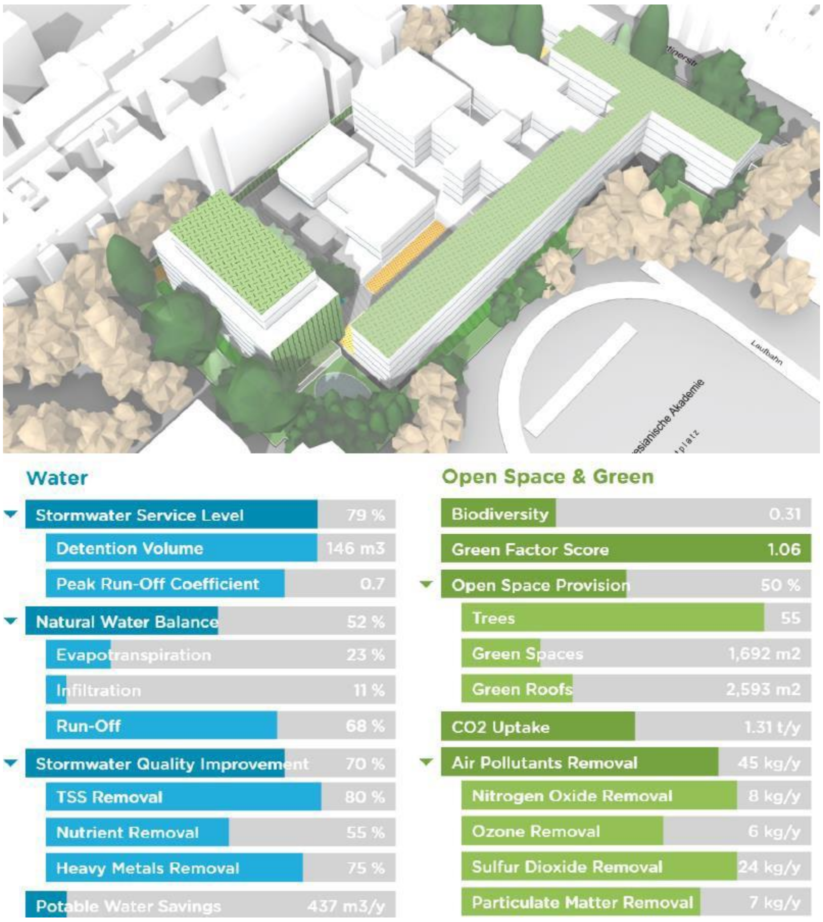

Fig. 11: Proposed Concept results of GreenScenario analysis related to the modules Water and Open Space & Green (Source: Ramboll Studio Dreiseitl)

Fig. 12: Visualisation, info-graphic representation of performance parameters based on two modules (Source: Ramboll Studio Dreiseitl)

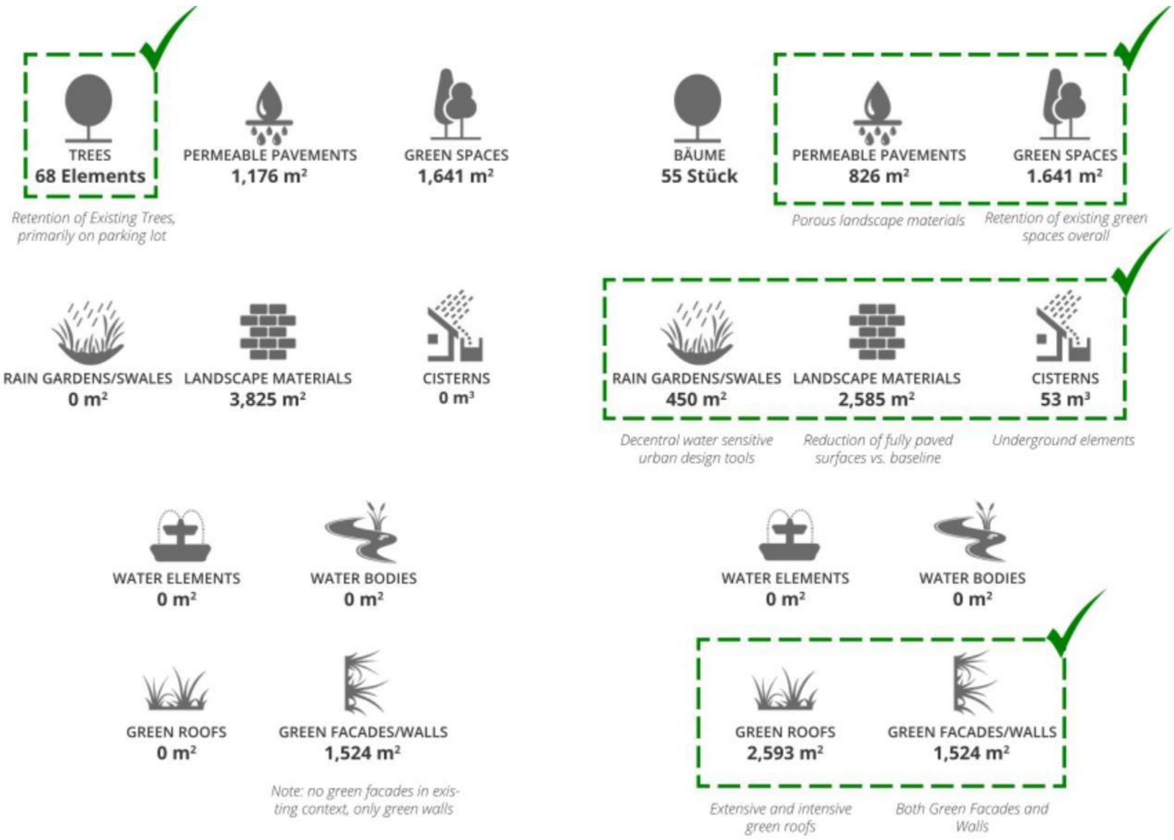

Fig. 13: Tools compared between Baseline (left) and Proposed Concept (right) (Source: Ramboll Studio Dreiseitl)

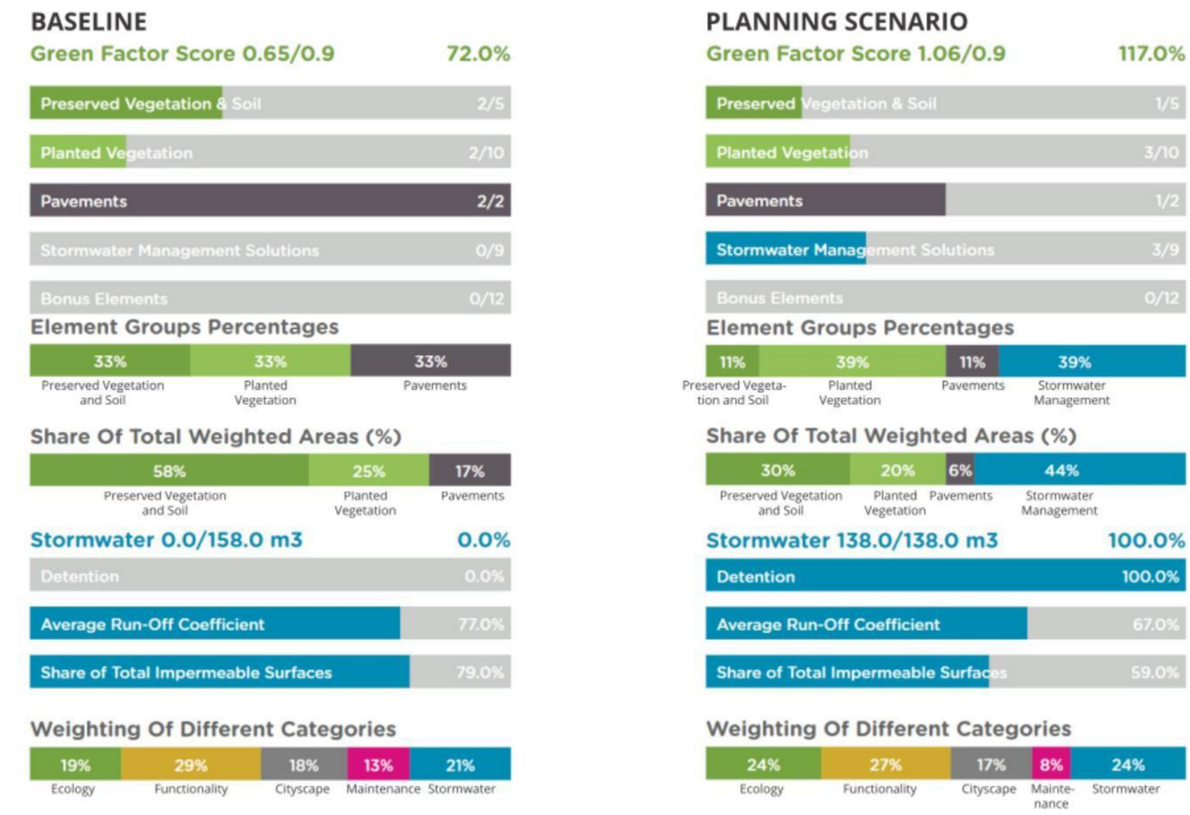

Fig. 14: Comparison of the Green Factor assessment between Baseline (left) and Proposed Concept (right) (Source: Ramboll Studio Dreiseitl)

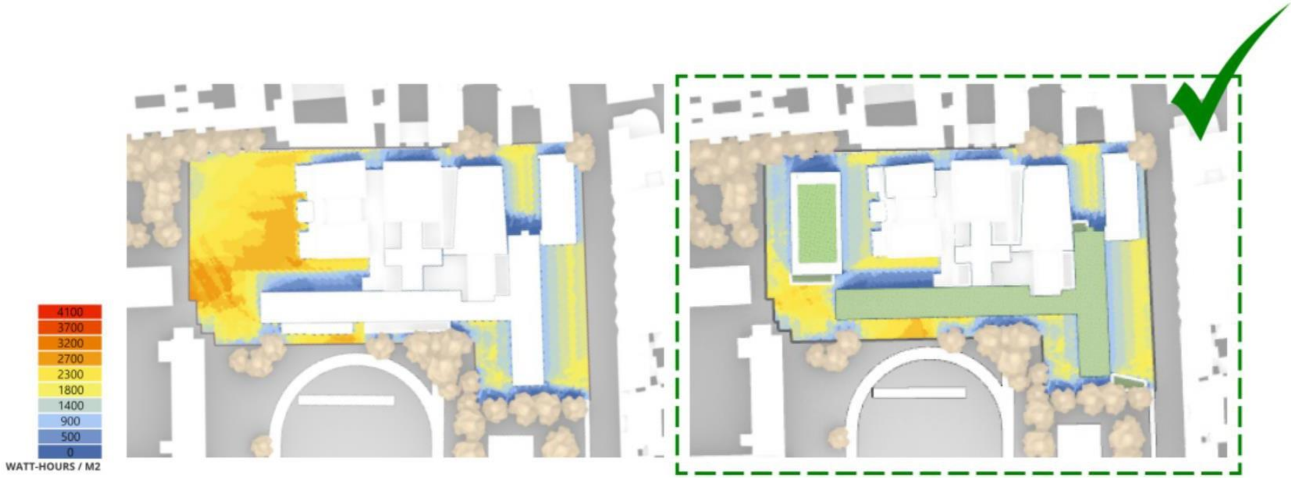

Fig. 15: Solar Irradiation Analysis (Source: Ramboll Studio Dreiseitl)

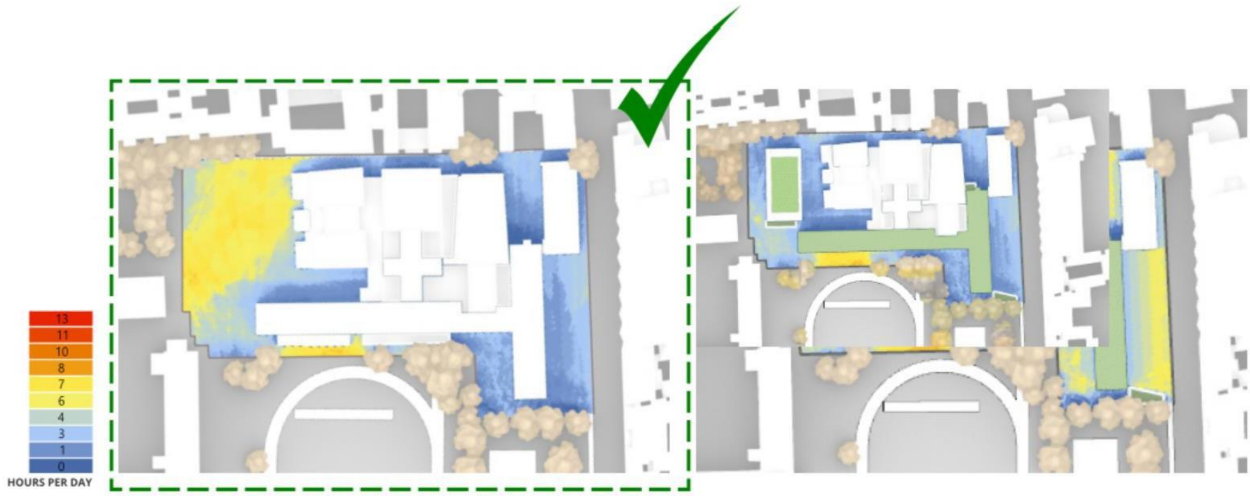

Fig. 16: Sun Hour Analysis (Source: Ramboll Studio Dreiseitl)

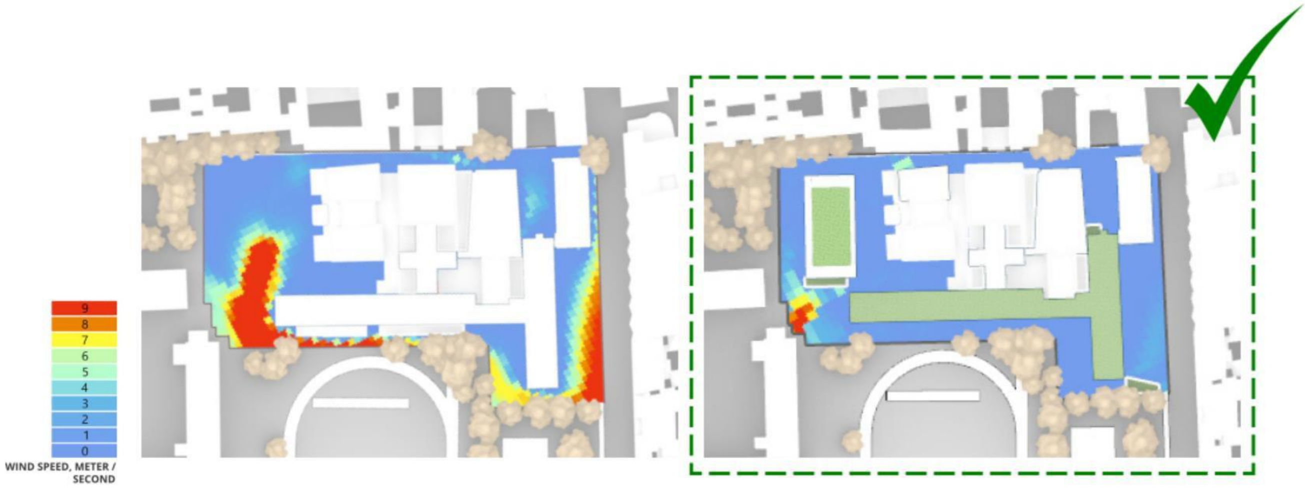

Fig. 17: Wind Comfort Analysis (Source: Ramboll Studio Dreiseitl)

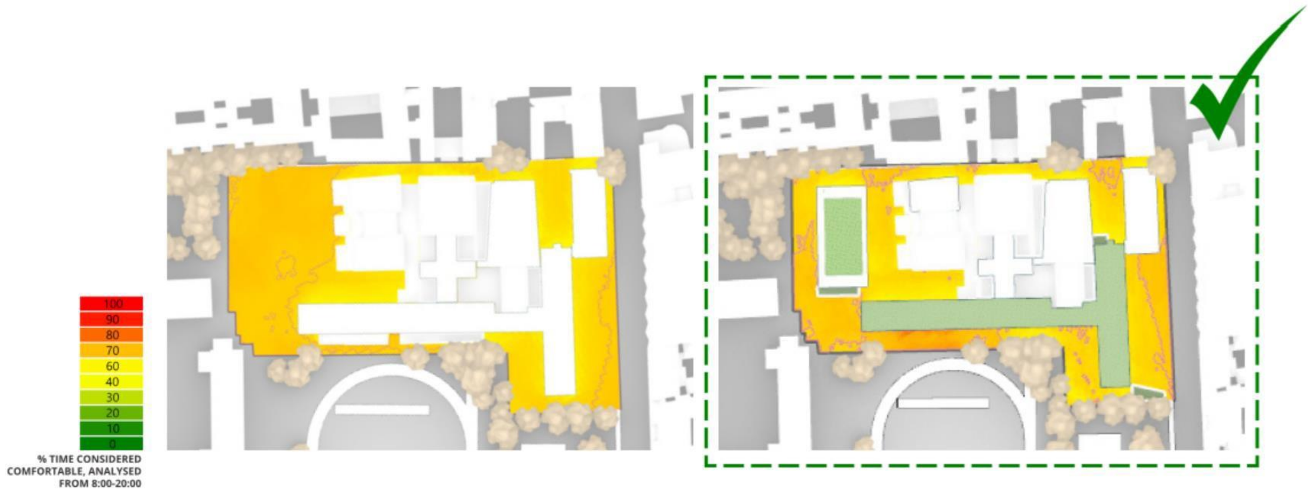

Fig. 18: Outdoor Comfort Analysis (Source: Ramboll Studio Dreiseitl)

6 DISCUSSION OF FIRST RESULTS PRIOR TO OPTIMISATION

When assessing the baseline against the proposed solution developed together with the private property developer, the GreenScenario analysis shows that the proposed concept, due to the increase in blue-green infrastructure including green roofs, swales and green facades, and the reduction of paved surfaces particularly along trafficked areas improves all conditions all KPIs except for CO2 uptake and air pollutant removal. Combined with the building placement, the parameters related to microclimate and heat were also shown to perform better than the existing baseline condition. A summary follows.

6.1 Module Water

The **stormwater service level** increases by 79% as the initial baseline conducted all stormwater into the municipal system. The 30cm depth swales provide a detention volume of 146 cubic meters, reducing the peak run-off coefficient by 0.1 (from 0.8 to 0.7) due to the increase in green space overall. The **natural water balance** subseqeuntly also improves as the run-off potential is decreased, infiltration icnreased, and evaporation as well enhanced. The potential for **stormwater quality improvement,** or treatment of TSS, nutrients and heavy metals, increases as well with the addition primarily of ground-level stormwater BMPs (best management practices). With the addition of underground storage, potable water that could be saved calculated over a period of a year based upon rainfall data given for Vienna is 437 cubic meters. This water could be used for irrigation, toilet flushing or other uses, to be determined at a future date.

6.2 Module Open Space and Green

By purposefully selecting tools related to increasing green infrastructure, biodiversity (based on a spatial assessment known as the **Biodiversity Area Factor** utilised by the German building council DGNB) increased almost 2x compared to the existing condition. A 15% increase in **Open Space Provision** (subdivided into pure green spaces, green roofs as well as trees) as well as an improvement of the **Green Factor** from 0.65 to 1.05 (target range: 0.9, based on the rigorous methodology applied for the Helsinki Green Factor) was also realised. Two areas within the given concept that could not be compensated were parameters related t**o CO2 Uptake** (temporary carbon sequestration via primarily trees and green spaces) and Air Pollutant Removal (via trees). The removal of existing trees has a significant impact on these parameters. The optimisation paths pursued as part of Phase 2B follows in the following section.

6.3 Module Microclimate and Heat

By reducing the quantity of sealed surfaces and replacing them with permeable pavement (e.g. porous pavements, grass gravel, etc.) and a variety of green areas (e.g. lawn, meadows, planted areas for recreation) instead of leaving the parking lot in its given condition, there is an overall improvement to the microclimate parameters analysed. Firstly, a **Solar Irradiation** analysis resulted, due to the placement of the new building and the placement of trees, in a 29% reduction of solar irradiation when measured at ground level (824.79 Wh/m2/day per annum versus 588.14 Wh/m2/da per annum). The existing condition receives more **Sun Hours** (7.03 hours per day averaged over a year) compared to the proposed condition (4.43 hours per day averaged over a year); however, this also results in increased temperatures due to both a higher solar irradiation and sun hour amount. A **Wind Comfort** analysis showed that there was only a minimal area of the site that had the potential to be impacted by reduced wind comfort levels, defined typically as above 5 meters per second (1.6% of the year above 5 m/s in the planning scenario, 3.01 % in the existing baseline condition). While the results were minimal, the visual comparison showed that, with the addition of tree volume and the building mass, wind comfort could be optimised beyond the already optimal state (e.g. the site does not suffer from wind comfort issue problems generally).

With the reduction or shift of paved surfaces to semi-paved or vegetated areas, the average **Albedo Factor** increases by 0.1 / square meters; this slight increase reduces heat as a result of reflectance during the summer. The **Thermal Comfort** indicator, based on the UTCI system simulating the average thermal comfort of a site over a period of a year based on a 9-26° C comfort range, indicates an improvement of 1.5% (48.7% of all days in the planning scenario are considered to be within the optimal comfort range, 47.2% in the existing baseline). Lastly, a statistical simulation of the **Urban Heat Island** potential reduction is conducted by assessing a combination of site and building materials, the urban canyon, vegetation including trees and local weather station data to assess the potential changes in temperature if other developments were to be built as per the planning scenario. With the addition of a new build and the removal of trees, a slight increase in the heat island effect of up to 0.3 ° on average over a year could be expected within the planning scenario (e.g. average + 0.3 ° in summer or -0.3 ° in winter) in comparison to the existing baseline condition. Extreme temperatures, on the other hand, could lead to a temperature difference of up to 3.1 ° in extreme conditions (e.g. + 3.1 ° C hotter in summer, -3.1 ° C colder in winter) in comparison to the existing baseline condition. Further optimisation measures were provided for the private property developer to consider. This is explored in the following section along with the two parameters (CO2 Uptake, Air Pollutants Removal) that did not improve due to the planning scenario.

6.4 Module Economics

For this project, only a preliminary **Investment Cost** indicator was analysed. In future design stages, an assessment of the **Maintenance Costs** and **Potential Savings** can be considered; for the Vienna project, these were determined to either not have enough information at the time of the analysis (e.g. no local maintenance cost factors were provided by the private property developer) or a Potential Savings analysis was not relevant (e.g. Vienna does not have a split stormwater and wastewater tax methodology similar to, as one example, Berlin). For the investment cost analysis, a cost range between approx. 393,300 (min.) € up to 740,800 € (max.) can be expected, equivalent to approx. 26-49 € per square meter for the ca. 1.5 ha planning area. Prime contributors to the variability in costs are a result of the selection of green roofs and green facades/walls (result of these elements alone account for approx. 69% (min.) to approx. 73% (max.). The selection of an intensive green roof and green façade (whether soil or system based) have higher cost implications. For the Investment Cost analysis, a simplified methodology was employed.

6.5 Phase 2B Feedback Loop leading to Phase 3 Design Optimisation – Identifying Optimisation Needs

When assessing the baseline against the proposed solution developed together with the private property developer, the GreenScenario analysis shows that the proposed concept – termed the **Preferred Planning Scenario** – performed in almost all aspects better than the existing condition. The three pprimary reasons for these results include:

1. the increased proportion and diversity of green spaces including the implementation of green areas not only at ground level but also on roofs (e.g. usable green such as lawns or urban gardening).
2. the provision of decentralised stormwater management tools.
3. the reduction of the sealed surface or the unsealing of sealed surfaces.

However, optimisation could still occur via a targeted selection of additional design elements. A summary is below.

- **Option 1 (pursued):** adding trees on the new residential building as part of the intensive green roof.
- **Option 2 (pursued):** additionally planting new trees within the planning boundary at ground level.
  - Note that for Options 2 and 3 that by offsetting the loss of ecological quality due to the new build removing existing trees, new trees will still have less CO2 uptake potential or air pollutant removal than existing trees dependent on their age. Additionally, their contribution to microclimate improvements occurs approximately around year 10-15 dependent on the tree species.

- *Option 3 (not pursued):* Not building and leaving the area as existing. This scenario was not pursued further as it did not coincide with the private property developer's original goals.
- Future options to consider although not pursued in this exercise include:
    - o Reducing the building footprint and saving more existing trees; increasing the green façade treatment; increasing the soil depth for the green roof measures; examining the effect of different material choices as they affect microclimatic or life-cycle costs assessments; or increasing the overall application of green infrastructure tools such as green roofs on top of properties that are not directly owned by the private property developer (Bautrakt C in particular due to its significant exposed, traditionally paved roof area).
    - o Noting above that the measures listed above may result in a significant increase in overall investment or operational costs, or that at the time of the study, proposing concepts beyond the confines of the private property developers legal entities were considered not be pragmatic solutions, they were not simulated or assessed.
    - o Future studies could consider the impact of these theoretical solutions in order to more fully assess the impact of optioneering concepts.

The results of analysing the performance factors of the Baseline against the Preferred Planning Scenario and the two Options (Option 1 and 2) are shown below in Fig. 19.

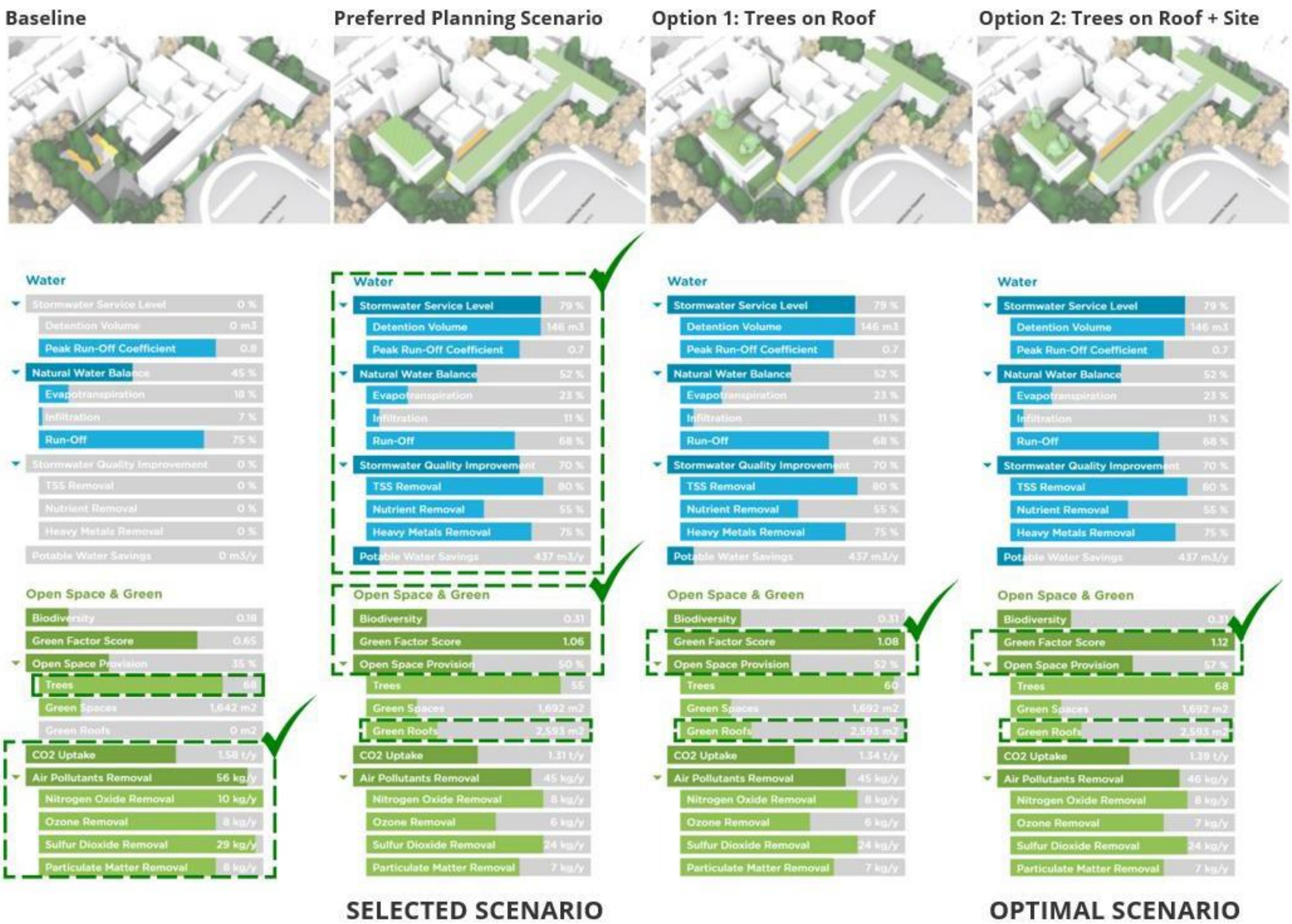

Fig. 19: Cross comparison of three options versus the baseline (Source: Ramboll Studio Dreiseitl)

7 DISCUSSION OF THE GREENSCENARIO PROCESS AND APPLICATION IN VIENNA

7.1 Which process was used to determine which option to select or not select?

Based upon an examination of the performance parameters assessed (see Fig. 19) between all options, Option 2 performed best. When examining the results of the three options compared against the baseline, it was clear that the most optimal scenario (termed 'Optional Scenario' or Option 2 above) performed best and had the potential to harness the most ecological quality in comparison to all other options. In fact, when developing the two additional options (1 and 2), the addition of trees had no impact on the Water Module but did affect the Open Space & Green Module.

The Green Factor score continually improved as well as the Open Space provision. An associated increase in the Biodiversity Area Factor could be expected dependent on the type of tree selected. While CO2 Uptake and Air Pollutant removal did not exceed that of the original existing condition – as the trees on site were significantly older than new trees – by optimising in a future design stage which tree to select or transplanting mature trees – if the private property developer were to theoretically puruse Option 2, they could potentially offset the loss of trees and compensate the adverse ecological impact. Note that due to resource limitations by the private property developer, no additional simulations were created to test the microclimatic effect of the addition of trees; future steps could consider additional simulations as part of a continuous and integrated planning process. Thus, the focus of this discussion is on the optimisation process related to increase green volume mass.

However, the Selected Scenario remained the **Preferred Planning Scenario**. In a follow-up interview with the private property developer to understand the process utilised in determining which option to select, the following points included:

- The preferred planning scenario offered the property developer the opportunity to have a starting point from which, based upon discussions with the city, could be optimised in future detailed design stages.
- Option 1 would require an immediate placement of trees on the roof. Without detailed design or building structure analysis at this early stage of planning, this measure was determined to be too risky to be the preferred direction.
- Further, Option 2 would require confirmation about the legal entities for the green spaces surrounding, in particular, Bautrakt A and B north of the Sport Fields. Trees planted here, dependent on their size and age, could potentially limit the effectivity of green infrastructure (e.g. swales) as a decentralised stormwater measure. They could also potentially limit use options (e.g. additional play areas would require verification of safety and security requirements) if trees covered areas desired for play.

The private property developer lastly indicated that, while the primary solution would remain the Preferred Planning Scenario, dependent on the requirements expressed by the city agencies responsible for planning approval, Options 1 and 2 remained viable options that would be detailed in the upcoming detailed design stages.

7.2 How were decisions made during the planning process? How were stakeholders involved?

After creating the initial baseline model – from which comparisons of performance parameters would be benchmarked against – a co-creation process occurred between the private property developer and the GreenScenario team. While initial constraints were voiced in terms of the maximum building frame and the expert analysis conducted for the existing trees, the first options developed were provided in sketch form in dialogue with the private property developer.

Upon determining a primary direction for the concept of the building's placement, the GreenScenario team ran iterative analysis assessments of various building and open space configurations.

The only option not considered for future development as viable was Option 3 (no building) as this did not coincide with the goals set forth in Phase 1A. Future options as listed in section 6.5 above such as further increase in green facades or a blanket use of green roofs also were not further detailed to resource limitations.

The decision framework could be considered an 'irrational' decision that was conducted as a combination of the result of consultation between the GreenScenario team and the private property regarding the results of the quantitative, objective assessment; a balanced evaluation of the pros/cons of each of the options versus commercial and economic requirements, legal rules and subjective (aesthetic) factors was conducted.

In Vienna, the public was not involved in the decision making process. Currently, the results of meetings with the local municipality in Vienna are ongoing as of May 2021. Although other current projects (notably Zürich, Berlin and Cologne) utilising the GreenScenario methodology will have a more intense public participation process, the results are not available for integration in this paper.

8 CONCLUSION AND FUTURE EXTENSION

The authors aimed to answer the following research question: would the use of the GreenScenario methodology address the fallacies of previously implemented decision-support tools – specifically as they relate to 1) integration within known planning process, 2) the involvement level of stakeholders and 3) the applied methodology in consideration of other methods or software tools – limit barriers and increase acceptance of DST within urban planning?

The use of GreenScenario alone as a decision-support tools and standalone instrument alone did **not** significantly enhance acceptance rates by stakeholders. While the results that could be gained from seeing the effects of scenarios in a numerical way were generally viewed in a positive light – especially in consideration that previous planning efforts often looked at such concepts in qualitative, 'gut-feeling' approaches (e.g. GreenScenario could put a number to increased biodiversity rates while asserting what was considered best-practice per localised standards; previously this was asserted only via 'improved biodiversity rates' but not by 'how much' or 'where') – through further interaction with the stakeholders, further verbal discussion and guidance was necessary to promote acceptance and willingness to utilise the results to optimise solutions, rather than taking them as given conclusions. This was an assertion given by Palutikof et al (2018) and verified preliminarily in Vienna. Simply put, quantitative assessments required a constant level of communication and transparency in the overall planning process, and the results of the analysis did not necessarily determine which solution was considered as a 'preferred' direction. Star et al (2016) notes that in scenario-based planning, specifically those involving participatory approaches from a bottom-up approach, rely less on probabilistic context and instead, approach scenarios as a set of extremes in order to derive solutions, discuss their potential and engage in the planning process.

As each stakeholder had a different interest – whether in terms of ecological, social or commercial aspects – the examination of multiple parameters simultaneously enabled a transparent visualisation of complex topics, even if the resultant decisions did not pick the most optimal solution moving forward. This visualisation of the cross-section of topics acted as a primary communication device for the participants, and, perhaps most importantly, led to the observation of the impact and importance of process for successful collaboration.

It was observed that in Vienna, while the ecological impact showed a clear preference for solutions that maximised green spaces in order to both reduce the microclimatic impacts as well as improve the biodiversity potential, often, more common planning goals receive attention. Affordable, high-quality housing was the primary goal – even beyond the climate goals determined in Phase 1A of the process. Long-term operational requirements also played a factor in the selection of which blue-green infrastructure tools to implement on site. While green roofs and facades are effective measures, they carry with them certain preconceptions related to costs – costs which eventually would be transferred to the end user. Thus, while the most optimal climate adapted scenario was portrayed via the GreenScenario analysis, the selection of a final scenario was not entirely predicated on the evaluation.

Observations of the application of GreenScenario as a rapid, iterative, fact-based decision support tool as an integrated component of planning with climate adaptive design tools reveals a first step and positive portrayal of how a combination of transparency, visualisation and communication are key enablers for future tech-enabled planning processes.

The project-based case study in Vienna illustrated one full example of applying the GreenScenario methodology in practice. It is important to state that this first case study linking a framework for analysing the impact three key parameters for integrated climate adaptation planning (modules for water resources/stormwater, open space and green/ecology, microclimate/thermal comfort and heat) combined with a economic evaluation system is merely a starting a point, and will require several more real world case studies to validate the applicability of the results and the uptake of decision-support tools. GreenScenario has been further applied on other project sites in 2020 and 2021 in Munich, Frankfurt, Basel, Zürich, Cologne, Berlin as well as in Norway and Denmark. Key highlights include:

- Munich (8 hectare mixed-use urban retrofit): the climate analysis supported the urban design development scheme in optimizing outdoor microclimate conditions by assessing the impact of blue-green infrastructure tools implemented within the open space.
- Berlin (2 hectare building mixed-use urban retrofit + new build): the climate analysis revealed the ecological potential of the site by transforming the 95% paved area into a highly green (+60%) site that can contribute to improving microclimate conditions and serve as a prototype for how to build dense, green developments.
- Frankfurt (95 hectare greenfield development): the climate analysis revealed various pros/cons of building on a greenfield site in comparison to the existing conditions, where and how to optimise the initial proposal in regards to blue-green infrastructure, and how to maximise placement of elements in future design stages.
- Zürich (3 hectare plaza and street renovation in an existing context): the climate analysis revealed multiple options for implementing a sponge city concept for two highly paved areas in/near the city centre. Blue-green tools were only available for the open space (e.g. no green roofs or similar) and street areas, involved multiple stakeholders across public and private entities, and a progressive optimisation of design optimisations occurred for the 6 month feasibility study.

These projects showed that the application of the GreenScenario methodology and DSTs were most effective when combined with stakeholder engagement processes, public participation (relevant for the current projects in Berlin as well as Cologne) awareness, and design optimisation (as part of a more holistic design and planning process rather than as an external third party assessment.

Did the application of the GreenScenario methodology as a decision-support mechanism – combining both a working process and software tool for aiding in how to plan with climate adaptive design measures – address the fallacies and limitations of previously applied decision-support tools?

Can data-driven tools provide a new method of approaching planning climate first with tools such as nature-based solutions or blue-green infrastructure aligned with conventional infrastructure to improve our cities today?

The results of the study show a positive start but require further validation through an accumulation of case studies.

Future research in not only necessary for the technical aspects of climate adaptation but also into the application of new forms technology. Addressing points related to new technology such as AR, VR, machine learning and artificial intelligence could aid in smarter, more intelligent option generation. The maintenance of such systems is also a critical aspect in retaining relevancy.

Other topics include:

- More seamless integration of digital tools and working approaches within professional planning practice, regulatory frameworks and local policies
- Use as a mediating method for public participation design processes
- Links to accepted sustainability systems such as the German DGNB (German Sustainable Building Council) or LEED from the US Green Building Council, amongst others
- Seamless interface between GIS and BIM related systems

Lastly, how we ethically utilise the results generated from computational design – in how we influence decisions and support objectively – will be of key consideration:

> The computational process may direct design choices, or it may only discourage certain bold/bad choices. Regardless of the effect, the intent of the active use in computational modelling means increased awareness of climate adaptation performance in practice. What is certain is that the computational process enhances the understanding of design choices (Negendahl, 2019).

We see data-driven decision-making combined with integrated planning processes key to enabling the acceptance of climate adaptation approaches for the future development of our cities and places.

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Appropriate Solution Using a Combination of Colonial Competition Algorithm and Simulated Refund in Unbalanced Directional Wireless Sensor Networks

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Abstract

Directional sensor networks (DSNs) have recently received a lot of attention due to their wide range of applications in various situations. One of the most important issues with DSN is to cover a set of goals in a specific area while maximizing network life. This is due to the limited viewing angle of the sensor and the battery power of the directional sensors. This becomes a challenge when each target needs to cover several different sensors. In this study, this issue is presented as multiple target coverage, which has proven to be an NP issue. This can be considered in two types of environments: one is that we have enough sensors to provide different coverage needs for all targets in the network, which is known as overprovisioned environments, and the other is that we do not have enough sensors to provide co, verage needs for existing goals known as under-provisioned environments. In this article, In order to adapt the network conditions to the real environments, we examine the problem in an under-provisioned environment. To this end, we develop a hybrid algorithm based on colonial competition and simulated repayment that has the ability to provide a balanced coverage for all purposes in an under-provisioned environment. Several experiments have been performed to evaluate the performance of the proposed algorithms. The results show the high ability of the proposed algorithms to solve the problem.

Foreign Bank Account Reporting (FBAR) Current Developments and Enforcement

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Abstract

Foreign Bank Account Reporting (FBAR) Current Developments and Enforcement The amount of Foreign Bank and Financial Account Reporting (FBAR) Cases and recent Federal Court Rulings on Foreign Bank Account Reporting is increasing. FBAR penalties are investigated, assessed and enforced by the IRS but the IRS cannot enforce FBAR penalties in tax court because the penalty is not a tax, instead jurisdiction resides in Federal Court. Section 5321 of title 31 of the U.S.Code establishes penalties for no willful FBAR violations of up to $10,000 but it does not define violation. The issue at the center of dispute is that the government asserts that it may assess the amount per account while the taxpayers argue that the limit applies on a per-form basis. This paper looks at how the courts are ruling on this issue. Key Words: FBAR, penalty, violation

Keywords: FBAR, penalty, violation

Investigating Fraud: The OTC, the NYSE and the SEC

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Abstract

The majority of the recent rash of financial frauds took place at companies that were listed on the over-the-counter (OTC) market, rather than companies listed on the NYSE or NASDAQ. This paper looks at the history of the NYSE and OTC in terms of growth, filing requirements, fraud perpetrated, and regulation by the SEC. Has the time come to strengthen the regulations on the OTC market? In this post Sarbanes-Oxley era is the SEC doing enough to protect the investor in the OTC market or is it simply buyer beware.

Keywords: Fraud, OTC Market, SEC regulation

The Impact of Technology and Culture on Internationalization

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Abstract

In recent years, Information Technology (IT) has been a driving force to internationalization of organizations. Organizations are internationalizing to add value and gain competitive advantage and therefore the impact of IT has been significant in enabling internationalization. The rise of Internet and Enterprise Systems with the power of integration have facilitated many organizations to internationalize. In addition to increase globalization of business, IT has contributed to disruption of old market and creation of new markets. Also, lower trade barriers and the Internet have made outsourcing and offshoring feasible. The economic job market has changed as a result of globalization and technological disruption. The expectation is increase acceleration of globalization in the future with new technologies. The increase internationalization of organizations is an indication of significant increase in the number of virtual teams facilitated by collaboration and communication technologies. More managers are hiring talents from different countries to work on their projects around the clock without relocation. Therefore, the importance of background and culture is more prevalence than ever in teambuilding and teamwork. The literature has emphasized the importance of being a team player and the ability to work in a team. Further, the topics of team, teambuilding and teamwork have received significant research attention. However, the main focus of research has been colocated teamwork and more recently virtual teamwork. The emergence of technology has introduced many collaboration and communication technologies that facilitate working experience of team members co-located or not. There are many factors which determine makeup of the team and consequently determine the team productivity and effectiveness. These factors include background and culture which are the driver of the value and success of a team. The purpose of this research is to examine the perceptions of teamwork and teambuilding amongst members of different cultures. This examination is focused on comparison of co-located and virtual teams. Also, this research will examine the perceptions of cultural importance in organizational internationalizations.

Keywords: Culture, Internationalization, Co-Located Team, Virtual Team

An Econometric Study of Forecasting French Foreign Exchange Rates

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Abstract

This paper studies a diversity of exchange rate models, applies both parametric and nonparametric techniques to them, and examines said models' collective predictive performance. We shall choose the forecasting predictor with the smallest root mean square forecast error (RMSE). The better type of exchange rate model is in the autoregressive model's equation (34), according to the empirical evidence, although none of this data yields an optimal forecast. In our conclusion, the error correction versions of these exchange rate models will be adjusted so that credible long-run elasticities can be imposed on each model's fundamental variables.

Keywords: efficiency, exchange rate determination, exchange rate policy, forecasting, foreign exchange

1. Introduction

A large percentage of economic time series exhibit phases of relatively high volatility followed by periods of relative stability, and therefore avoid displaying any constant mean. Even a cursory examination of time-series data -- currency exchange rates chief among them -- imply that they are heteroscedastic because of the absence of this constant mean and variance. (The presence of such a constant variance with a stochastic variable would define such time series as homoscedastic.) For any such series with that degree of volatility, the unconditional variance could be constant even while also being unusually large at times. The trends of some variables may contain deterministic or stochastic elements, with the analysis of these ingredients influencing the forecasted results of the time series under study.

We may graph different currency exchange rates in order to see their behavior, first noticing their fluctuations over time but then following up these initial impressions with more rigorous and formal testing. One observes, for example, that these series are not stationary, in the sense of the sample means not appearing to be constant while there is also a strong appearance of heteroscedasticity. This deficiency in any specific trend makes it difficult to prove the existence of a time-invariant mean for these time series. For example, the U.S. dollar-to-U.K. pound exchange rate does not show a tendency towards either increasing or decreasing, with the dollar going through long stretches of both appreciation and depreciation without a reversion to the long-run average. This instance of "random walk" behavior is quite characteristic for a nonstationary series.

A shock to any such series shows a tremendous amount of endurance: the dollar/pound exchange rate experienced great upward movement in 1980, remained at this level into 1984, and only returned near to its previous level in 1989. However, the volatility of these series is not constant and, in fact, some currency exchange rate series have at least a partial correlation with other series. Such series are named 'conditionally heteroscedastic' if the unconditional (long-run) variance is constant but also contains localized periods of relatively high variance. For instance, large shocks in the U.S. appear at about the same time as they appear in Canada and Great Britain, although these co-movements' existence can be predicted or anticipated because of the underlying forces affecting the American economy and that of other nations.

The disturbance term's variance is taken as constant in conventional econometric models, although our series changes between periods of unusual amounts of volatility and periods of relative tranquility. Therefore, our assumption of a constant variance or homoscedasticity in such cases is not warranted. As an investor in only one currency, however, one may want to forecast the exchange rate as well as its conditional variance over the life of the investment in such an asset. The unconditional variance, namely, the variance's long-run forecast, would be unimportant if an investor plans to buy such an asset at time period t and then sell it at t+1. Kallianiotis (1985) and Taylor (1995) provide reviews of the literature on exchange rate economics and Chinn and Meese (1995) examine four structural exchange rate models' performance.

This paper is organized as follows. Different trend models are described in section 2. Other linear time-series models are presented in section 3 with multiequation time-series models discussed in section 4. The empirical results are given in section 5 with a summary of the findings presented at the end of section 6.

2. Time-Series Trends

One way to predict a time-series variance is to introduce an independent variable explicitly that helps forecast the volatility of this time series. Consider the simplest case, in which

$$ss_{tt+1} = \varepsilon\varepsilon_{tt+1} XX_{tt} \quad (1)$$

where ss_{tt+1} = the spot exchange rate (the variable of interest), $\varepsilon\varepsilon_{tt+1}$ = a white-noise disturbance term with variance $\sigma\sigma^2$, and XX_{tt} = an independent variable that can be observed at time period t. If $XX_{tt} = XX_{tt-1} = XX_{tt-2} = \dots$ = a constant, then the $\{ss_{tt}\}$ sequence is a standard white-noise process with a constant variance.

If the realization of this $\{XX_{tt}\}$ sequence is not all equal, then the variance of ss_{tt-1} that is conditional on the observable value of XX_{tt} is

$$Var\ (ss_{tt+1} / XX_{tt}) = XX_{tt}^2 \sigma\sigma^2 \quad (2)$$

We may formulate the general solution to a linear stochastic difference equation with these four components in the following equation:

$$ss_{tt} = trend + cyclical + seasonal + irregular$$

Exchange rate series do not have an evident tendency of reverting to any mean. One important function of econometricians is the formation of understandable stochastic difference equation models that can simulate trending variables' behavior, with the distinctive feature of a trend being its permanent effect on a time series. Because the irregular component is stationary, its effects will diminish over time while the trending elements and their effects will persist in long-term forecasts.

2.1 Deterministic Trends

One of ss_{tt}'s basic characteristics is its long-term growth persisting despite its short-term volatility. In fact, ss_{tt} may have a long-term trend that is quite apparent and clear-cut. According to Pindyck and Rubinfeld (1981), Chatfield (1985), and Enders (1995), there are eight models that describe this deterministic trend and can be used in forecasting ss_{tt}. They are the following:

Linear time trend:

$$SS_{tt} = \alpha\alpha_0 + \alpha\alpha_1 tt + \varepsilon\varepsilon_{tt} \quad (3)$$

Exponential growth curve:

$$SS_{tt} = \mathrm{A}ee^{rrtt} \quad (4)$$

or

$$\ln SS_{tt} = \ln \mathrm{A} + \mathrm{rt} + \varepsilon\varepsilon_{tt} \quad (5)$$

or

$$ss_{tt} = \beta\beta_0 + \beta\beta_1 tt + \varepsilon\varepsilon_{tt} \quad (6)$$

Logarithmic / stochastic autoregressive trend (the only function that can be applied for exchange rates):

$$ss_{tt} = \gamma\gamma_0 + \gamma\gamma_1 ss_{tt-1} + \varepsilon\varepsilon_{tt} \quad (7)$$

Quadratic trend:

$$ss_{tt} = \delta\delta_0 + \delta\delta_1\, tt + \delta\delta_2 tt^2 + \varepsilon\varepsilon_{tt} \quad (8)$$

Polynomial time trend:

$$ss_{tt} = \zeta\zeta_0 + \zeta\zeta_1 tt + \zeta\zeta_2 tt^2 + \dots + \zeta\zeta_{nn} tt^{nn} + \varepsilon\varepsilon_{tt} \quad (9)$$

Logarithmic growth curve:

$$ss_{tt} = 1 / (\theta\theta_0 + \theta\theta_1 \theta\theta_2^{tt});\ \theta\theta_2 > 0 \quad (10)$$

or a stochastic approximation:

$$(\Delta ss_{tt} / ss_{tt-1}) = kk_0 - kk_1\, ss_{tt-1} + \varepsilon\varepsilon_{tt} \quad (11)$$

Sales saturation pattern:

$$SS_{tt} = ee^{\lambda\lambda_0 - (\frac{\lambda\lambda_1}{tt})} \quad (12)$$

or

$$ss_{tt} = \lambda\lambda_0 - (\lambda\lambda_1 / tt) + \varepsilon\varepsilon_{tt} \quad (13)$$

where SS_{tt} = the spot exchange rate, t = time trend, and the lowercase letters are the natural logarithms of their uppercase counterparts.

2.2 Models of Stochastic Trend

We can add the deterministic trend models to the lagged values of the $\{ss_{tt}\}$ and $\{\varepsilon\varepsilon_{tt}\}$ sequences; these equations become models with their own stochastic trends and are used here as the following:

(i) The Random Walk Model

The random walk model (itself a special case of the AR(1) process) appears to imitate the exchange rates' behavior as given below. These series neither revert to a given mean nor fluctuate over time.

$$ss_{tt} = \alpha\alpha_0 + \alpha\alpha_1 ss_{tt-1} + \varepsilon\varepsilon_{tt} \tag{14}$$

with $\alpha\alpha_0$ = 0 and $\alpha\alpha_1$ = 1, where ss_{tt} - ss_{tt-1} = Δss_{tt} = $\varepsilon\varepsilon_{tt}$, becomes

$$ss_{tt} = ss_{tt-1} + \varepsilon\varepsilon_{tt} \tag{15}$$

The conditional mean of $ss_{tt+\lambda\lambda}$ for any $\lambda\lambda > 0$ is

$$EE_{tt}SS_{tt+\lambda\lambda} = SS_{tt} + \mathrm{E}\sum_{ii=1}^{\lambda\lambda} \varepsilon\varepsilon_{tt+ii} = ss_{tt} \tag{16}$$

The variance is time-dependent:

$$\mathrm{var}\ (ss_{tt}) = \mathrm{var}\ (\varepsilon\varepsilon_{tt} + \varepsilon\varepsilon_{tt-1} + \ldots + \varepsilon\varepsilon_1) = \mathrm{t}\sigma\sigma^2 \tag{17}$$

The random walk process is nonstationary because the variance is not constant. Therefore, as

$$t \to \infty,\ \mathrm{var}(ss_{tt}) \to \infty. \tag{18}$$

Therefore, the forecast function is:

$$EE_{tt}ss_{tt+\lambda\lambda} = ss_{tt} \tag{19}$$

(ii) The Random Walk plus Drift Model

The random walk plus drift model adds a constant term $\alpha\alpha_0$ to the random walk model above such that ss_{tt} becomes partially deterministic and partially stochastic at the same time.

$$ss_{tt} = ss_{tt-1} + \alpha\alpha_0 + \varepsilon\varepsilon_{tt} \tag{20}$$

The general solution for ss_{tt} is:

$$ss_{tt} = ss_0 + \alpha\alpha_0 \mathrm{t} + \sum\nolimits^{tt}_{ii=1} \varepsilon\varepsilon_{ii} \tag{21}$$

and

$$EE_{tt}ss_{tt+\lambda\lambda} = ss_0 + \alpha\alpha_0\ (\mathrm{t} + \lambda\lambda) \tag{22}$$

The forecast function by $\lambda\lambda$ periods yields

$$EE_{tt}ss_{tt+\lambda\lambda} = ss_{tt} + \alpha\alpha_0\lambda\lambda \tag{23}$$

(iii) The Random Walk plus Noise Model

The ss_{tt} here is the sum of a stochastic trend and a white-noise component

$$ss_{tt} = \mu\mu_{tt} + nn_{tt} \tag{24}$$

and

$$\mu\mu_{tt} = \mu\mu_{tt-1} + \varepsilon\varepsilon_{tt} \tag{25}$$

where $\{nn_{tt}\}$ is a white-noise process with variance $\sigma\sigma^2_{nn}$ and $\varepsilon\varepsilon_{tt}$ and nn_{tt} are both independently distributed for all t. E($\varepsilon\varepsilon_{tt}\, nn_{tt-\lambda\lambda}$) = 0; the $\{\mu\mu_{tt}\}$ sequence represents the stochastic trend, and this model's solution is:

$$ss_{tt} = ss_0 - nn_0 + \sum\nolimits^{tt}_{ii=1} \varepsilon\varepsilon_{ii} + nn_{tt} \tag{26}$$

The forecast function is

$$EE_{tt}SS_{tt+\lambda\lambda} = ss_{tt} - nn_{tt} \tag{27}$$

(iv) The General Trend plus Irregular Model

We replace equation (25) above with the so-called "trend plus noise model,"

$$\mu_t = \mu_{t-1} + a_0 + \varepsilon_t \tag{28}$$

where a_0 is a constant and $\{\varepsilon_t\}$ is a white-noise process.

The solution is this equation:

$$s_t = s_0 - n_0 + a_0 t + \sum_{i=1}^{t} \varepsilon_i + n_t \tag{29}$$

Let A(L) be a polynomial in the lag operator L. We may augment a random walk plus drift process with the stationary noise process A(L) n_t and thus obtain the "general trend plus irregular model":

$$s_t = \mu_0 + a_0 t + \sum_{i=1}^{t} \varepsilon_i + A(L) n_t \tag{30}$$

(v) The Local Linear Trend Model

We construct this model by combining several random walk plus noise processes. Let $\{\epsilon_t\}$, $\{n_t\}$, and $\{u_t\}$ be three mutually uncorrelated white-noise processes. The local linear trend model's equations can be written:

$$\begin{aligned} s_t &= \mu_t + n_t \\ \mu_t &= \mu_{t-1} + a_t + \varepsilon_t \\ a_t &= a_{t-1} + u_t \end{aligned} \tag{31}$$

This is the most detailed out of all the above models because the other processes are special cases of the local linear trend model consisting of the noise term n_t and the stochastic trend term μ_t. What is key for us now about this model is that the change in its trend yields a random walk plus noise:

$$\Delta\mu_t = \mu_t - \mu_{t-1} = a_t + \varepsilon_t \tag{32}$$

The forecast function of $s_{t+\lambda}$ equals the current value of s_t minus the transitory component n_t, added to λ multiplied by the slope of the trend term in *t*:

$$E_t s_{t+\lambda} = (s_t - n_t) + \lambda\,(a_0 + u_1 + u_2 + \dots + u_t) \tag{33}$$

For future projects, we will estimate all of these models and run different tests on both the series and the error terms, ending up with specification and diagnostic tests as a way of gauging the statistical specifications' adequacy and accuracy. We shall then compare the forecasting results from the different models.

3. Some Linear Time-Series Models

In this portion of the paper, we define stochastic processes and some of their properties and discuss their use in forecasting, all done with an eye on developing models that "explain" the movement of the time series s_t. However, this will not be done using a set of explanatory variables as was used in the regression model but by relating it to both a weighted sum of current and lagged random disturbances and its own past values.

The Autoregressive (AR) Model

In order *p*'s autoregressive process, the current observation s_t is generated by a weighted average of past observations going back *p* periods, along with the current period's random disturbance. We define this process as AR(*p*) and write its equation as:

$$s_t = \phi_1 s_{t-1} + \phi_2 s_{t-2} + \dots + \phi_p s_{t-p} + \delta + \varepsilon_t \tag{34}$$

δ is a constant term which relates to the mean of the stochastic process.

The first-order process AR(1) is:

$$s_t = \phi_1 s_{t-1} + \delta + \varepsilon_t \tag{35}$$

Its mean is:

$$\mu = \delta / (1 - \phi_1) \tag{36}$$

and is stationary if $|\phi\phi_1| < 1$, although the random walk with drift is a first-order autoregressive process that is not stationary, however.

4. Empirical Evidence

We provide a summary and analysis of the empirical evidence of different models of foreign currency exchange forecasting.

The data given are monthly from March 1973 through and including December 1994, are coming from Main Economic Indicators of the OECD (the Organization for Economic Cooperation and Development) and International Financial Statistics of the IMF (the International Monetary Fund), and have been applied for Frnce. The exchange rate is defined as the U.S. dollar per unit of the French franc, with direct quotes for the dollar. The lowercase letters denote the natural logarithm of the variables and an asterisk denotes the corresponding variable for France.

The first equations estimated are the deterministic trend models in equations (3), (6), (8), (9), (11), and (13). The results appear in Table 1 and indicate that the exchange rate forecast cannot be supported by these types of models. The second group of equations is the stochastic trend model, from equations (15) and (20); these results, in Table 2, show that this alternative model is much better at interpreting the data and forecasting the currency exchange rate. The final model is of a linear time-series, namely, the autoregressive (AR) model of equation (34) shown in Table 3, but its results are also fairly poor. One may infer that time-series models cannot be used to forecast foreign exchange rates with a great degree of accuracy or confidence for models possessing such relatively high volatility.

Table 1. Deterministic trends

(i) Linear time trend, eq. (3): $S_t = \alpha_0 + \alpha_1 t + \varepsilon_t$		(ii) Exponential Growth Curve, eq. (6): $s_t = \beta_0 + \beta_1 t + \varepsilon_t$	
α_0	23.146^{***}	β_0	3.091^{***}
	(.551)		(.029)
α_1	$-.034^{***}$	β_1	$-.001^{***}$
	(.003)		(.0002)
R^2	.306	R^2	.208
D-W	.110	D-W	.029
SSR	3,915.37	SSR	9.970
F	114.620	F	66.63
RMSE	3.8658	RMSE	.1973
(iii) Quadratic Trend, eq. (8): $s_t = \delta_0 + \delta_1 t + \delta_2 t^2 + \varepsilon_t$		(iv) Polynomial time trend, eq. (9): $s_t = \zeta_0 + \zeta_1 t + \zeta_2 t^2 + ... + \zeta_n t^n + \varepsilon_t$	
δ_0	3.491^{***}	ζ_0	9.803
	(.045)		(12.389)
δ_1	$-.008^{***}$	ζ_1	-.300
	(.0007)		(.599)
δ_2	$2.0\text{-}05^{***}$	ζ_2	.005
	(2.0-06)		(.012)
		ζ_3	-3.8-05
			(.0001)
		ζ_4	9.0-08
			(9.2-07)
		ζ_5	3.2-10
			(3.5-09)
		ζ_6	-2.0-12
			(7.1-12)
		ζ_7	2.7-15
			(6.0-15)

R^2	.445	R^2	.811
D-W	.041	D-W	.118
SSR	6.983	SSR	2.382
F	101.47	F	151.77
RMSE	.1652	RMSE	.0965
(v) Stochastic approximation, eq. (11): $(\Delta s_t / s_{t-1}) = k_0 - k_1 s_{t-1} + \varepsilon_t$		(vi) Sales Saturation Pattern, eq. (13): $s_t = \lambda_0 - (\lambda_1/t) + \varepsilon_t$	
k_0	.037	λ_0	2.732***
	(.027)		(.020)
k_1	-.013	λ_1	15.899***
	(.009)		(1.667)
R^2	.008	R^2	.264
D-W	1.946	D-W	.032
SSR	.286	SSR	9.265
F	1.950	F	91.01
RMSE	.0334	RMSE	.1902

Note. S_t = the spot exchange rate, $s_t = \ln(S_t)$, t = time, D-W = the Durbin-Watson statistic, SSR = sum of squares residuals, RMSE = root mean square error, Data from 03/1973 through 06/1994 inclusive, $***$ = significant at the 1% level, $**$ = significant at the 5% level, $*$ = significant at the 10% level, and Δ = change of the variable.

Table 2. Stochastic trends

(i) The Random Walk Model, eq. (15): $s_t = s_{t-1} + \varepsilon_t$		(ii) The Random Walk plus Drift Model, eq. (20): $s_t = \alpha_1 s_{t-1} + \alpha_0 + \varepsilon_t$	
s_{t-1}	1.000^{***}	α_0	.037
	(.0007)		(.027)
		α_1	$.987^{***}$
			(.009)
R^2	.977	R^2	.977
D-W	1.957	D-W	1.946
SSR	.288	SSR	.286
L(.)	505.92	F	10,931.59
RMSE	.0335	RMSE	.0334

Note. See the previous table. L(.) = log of likelihood function.

Table 3. Linear time-series models

The Autoregressive (AR) Model, eq. (34): $s_t = \phi_1 s_{t-1} + \phi_2 s_{t-2} + \ldots + \phi_p s_{t-p} + \delta + \varepsilon_t$	
δ	2.850^{***}
	(.117)
ϕ_1	$.998^{***}$
	(.063)
ϕ_2	.054
	(.089)
ϕ_3	.017
	(.089)
ϕ_4	.005
	(.089)
ϕ_5	-.066
	(.089)
ϕ_6	-.134
	(.089)
ϕ_7	. 139
	(.089)
ϕ_8	-.010
	(.089)
ϕ_9	-.030
	(.089)
ϕ_{10}	-.040
	(.089)
ϕ_{11}	.037
	(.089)
ϕ_{12}	-.047
	(.063)
R^2	.978
$D-W$	1.995
SSR	.274
F	908.59
$RMSE$	.0327

Note. See the previous tables.

5. Summary

This paper compares the predictive performance of several foreign currency exchange rate forecast models: linear time-series; the balance of payments approach; the transfer function; the vector autoregression model; and various time-series trends. For every such model, we calculate its root mean square forecast error (RMSE) as follows:

$$\sqrt{\sum_{t=1}^{n} (A_t - F_t)^2 / n}$$

where n = the number of observations, A = the actual value of the dependent variable, and F = the forecast value. The forecast model with the smallest RMSE is the best predictor we must choose as part of exchange rate forecasting process.

An exchange rate can be defined as the relative price of two countries' currencies. The most important factors that determine the value of one country's currency relative to another are differences in inflation, the relative money supplies, real incomes, and prices, and interest rate, trade balance, and budget deficit differentials. The empirical evidence for this approach is not satisfactory in general, however. Exchange rate movements may result from either a parametric change in the above determinants or an artificial intervention by governments.

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Direct Assessment of Student Learning: Second-Reader or Teaching Instructor?

A Case Study

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Abstract

To assess student's learning, many colleges use both direct and indirect assessment. Direct assessment collects direct evidence of students' work. A professional then reviews the work and makes a judgement regarding what a student has learned and how well the learning was. Indirect assessment, on the other hand, uses a proxy measure, such as student surveys or exit interviews, to infer what students are probably learning based on their self-reports. In general, colleges tend to rely more on direct assessment than they do on indirect assessment. This is because direct evidence is more objective and measurable, and hence provides more convincing evidence of what students have (or have not) learned. In the context of direct assessment, a question arises regarding who should judge students' performance and decide what was learned and how well it was learned. Some colleges let the teaching instructor be the judging professional (instructor approach), while some colleges prefer other faculty not teaching the course be the judging professional (second-reader approach.) Each approach has its advantages and disadvantages. The purpose of this study is to explore the differences, if any, in assessment results between these two approaches. Using empirical data from one university, this study askes two research questions:
(1) Do assessment results differ between the second-reader approach and instructor approach?
(2) If the results differ, what characteristics are associated with the differences? The sample used in the study contains 782 matched cases in total. Each case has two assessment scores – one from a second reader team, and the other from the teaching instructor. The sample is further partitioned by degree programs, by program learning goals and by teaching instructors. Our preliminary results show that there is no significant differences between second-reader scores and instructor scores in pooled sample. When the sample is partitioned by learning goals, significant differences exist between these two scores for more complex learning goals, where we find a tendency that instructor scores are higher than the second-reader scores.

Additive Manufacturing: A Technology to Watch

Carolyn LaMacchia
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Abstract

Although first invented over two decades ago, additive manufacturing (AM) processes are now realizing significant industrial value. It is anticipated that AM will influence the product and services of many industries; a truly disruptive technology. This research introduces AM technologies then examines the real and expected growth of AM processes in representative industries. The significant industry value is described along with the implementation barriers. A method for quantitatively assessing the value of introducing an additively manufactured product based on its production cost and performance is presented.

Consumers' Social Media Use and Loneliness during the COVID-19 Pandemic

Devon Sarazin, Hannah Goodwin, Ruby Saine
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Abstract

In this research, we aim to explore the complex relationship between consumers' social media use and loneliness (or a lack of desired connectivity) during the ongoing COVID-19 pandemic. We discuss the intricate and sometimes seemingly conflicting findings and explanations regarding the relationship between social media and loneliness as perceived by consumers, for example, FOMO/fear of missing out, phubbing, and PSMU/problematic social media use. We conclude by suggesting managerial implications to businesses, which use social media in promoting their brand massages and engaging with their customers during these challenging times.

An Empirical Study on Consumer Co-creation and Rewards

Miao Zhao, Roger Williams University

Yimin Zhu, San Yat-Sen University

Ruby Saine, Roger Williams University

Zhengzhu Wu, San Yat-Sen University

Abstract

The Internet offers increasing opportunities for businesses to incorporate consumers in the ideation and concept development process. However, getting consumers to engage and interact with businesses has proven challenging, even after incentivizing their participation. In this paper, we explore how product type and consumer-brand relationships moderate the effects of monetary and non-monetary rewards on consumers' willingness to engage in consumer co-creation. We find consumers are motivated more by non-monetary awards when asked to help develop hedonic products, but financial incentives prove more enticing when invited to cultivate utilitarian products. Failing to differentiate whether consumers view their relationship with the company as transactional or communal can undermine the ability of businesses to effectively implement co-creation experiences

Turkey: Trade Partners & the New European Union Policies on Human Rights

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Abstract

Turkey is the 19th largest economy in the world [1]. The European Union (EU) is the largest trade partner of Turkey followed by the U.S. and China [2]. Fifty percent of the trade in Turkey, $99.1 billion, in 2019 was with the EU [2]. The foreign direct investment (FDI) by the U.S. companies in Turkey amounted to around $3.3 billion in 2019 [3]. Turkey is the 16th trade partner of the U.S., receiving more than $95 million worth of exports from the U.S., mostly in information technology industries [3]. China, another major trade partner of Turkey, has invested in every aspect of the Turkish economy [4]. Some of the important import industries of Turkey, agriculture, textile, and plastics, are highly polluting industries. In addition, the FDIs in Turkey in energy industries, such as natural gas and coal, have resulted in extensive desertification in Turkey. Furthermore, there are more than 4 million Syrian refugees in Turkey [5]. This research concentrates on the corporate social responsibility (CSR), sustainability practices, and the new EU policies on human rights, "Due Diligence" and "Responsible Business Conduct (RBC)" and explores Turkish MNCs' and FDIs' activities along these policies.

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South Africa: Green Economy & DEI

Minoo Tehrani, Carlos Cubides, Izaiah Farr, Noah Van Handel
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Abstract

More than fifty-nine percent of South Africa's gross domestic product (GDP) is comprised of international trade [1]. China (number one), Germany (number 2) and the U.S. (number 3) are the largest trade partners of South Africa [2]. China with 88 companies [3] and investment of 14.7 billion [4] is the number one trade partner of South Africa. There are more than 600 U.S. MNCs in manufacturing, finance, insurance, and wholesale in South Africa [5]. South Africa and the European Union (EU) have established a free trade agreement in 2000 called South African Economic Development Community Economic Partnership (SADC EPA) [6]. This agreement includes duty-free products, which has increased the trade between the two regions. However, despite the presence of a large number of MNCs in South Africa and South Africa's mining industry, the rate of the unemployment is around 30.8% [7]. In addition, about 15.8 million people, more than a quarter of the population of South Africa are malnourished [8]. This research concentrates on strategies of South Africa and different FDIs in this country and examines the sustainability practices that are to be implemented to accomplish a green economy while enhancing the equality and inclusion in this country.

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MNCs in Vietnam: Trade Partners, CSR, & Sustainability

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Roger Williams University

Abstract

The main focus of this research is to investigate the corporate social responsibly (CSR), sustainability, and the new European Union policy on human rights and explore how trade partners of Vietnam conduct business with this country. The first part of the research concentrates on the European Union (EU) and the U.S. as major trade partners of Vietnam. In this section, the investment and the trade agreement between Vietnam and the EU are discussed. In addition, we examine the U.S. multinational corporations (MNCs) in Vietnam and the trade along different exports and imports goods and products between the two countries. In the subsequent sections, other major trade partners of Vietnam, Japan and China, are discussed. The final section of the research highlights the approach of different MNCs in Vietnam in regards to CSR, human rights, and the implementation of sustainability practices.

Innovative Wellness Services for Pain Relieve and Mindfulness – UNSDG#3 Wellness

Shirley Yeung
UNESCO HK Association/ Gratia Christian College

Abstract

A lot of our busy lives are associated with stress and anxiety which need to be removed from a deeper level. However, existing solutions remain on the surface, escaping the feelings that may not help to release physical, mental and spiritual pain. It is time to explore more to be done and things to get done to make people regain a feeling of pleasant, success and happiness. Flanigan and Ward (2017, p. 143) mentioned that "Evidence for the connection between physical and mental health is growing, as is interest in providing a holistic, mind–body approach to improving mental health and wellness". They further pointed out that an integrated mind–body wellness program included yoga, tai chi, mindfulness meditation, and nutrition education. In order to validate their findings and explore things need to be done, 14 articles related to yoga backpain and wellness have been searched from e-database and internet (2003-2019) via N'vivo content analysis. The key elements identified for pain relieve and wellness enhancement are:

- Exercise modes (1,127 references);
- Pain relieve (933 references);
- Meditation (764 references);
- Integrated wellness (513 references); and
- Mindfulness (142 references)

And, the documents that are of a relevance value of the above are: "Evidence & Feasibility of Implementing an Integrated Wellness Program" (Flanigan and Ward**,** 2017), "Yoga Treatment", (Wieland et al., 2017) and "Psychological Perception to Walking, Water Aerobics & Yoga" (Wei et al., 2006). Wellness service providers are recommended to design programs with a mixture of exercise modes, including meditation, mindfulness and yoga to release physical, mental and spiritual pain for sustainable development in life.

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A Study on the Impact of Cash Management on the Financial Performance of the Listed Manufacturing Companies from Muscat Securities Market, Sultanate of Oman

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Abstract

Cash is a valuable, yet a scarce resource that all businesses have in limited quantity. As a result, the task of cash management is one of the crucial significance to contribute optimum management of cash resources that would support the businesses liquidity, working capital as well as the financial performance itself. In order to validate the relationships between cash management practices used by Omani manufacturing firms and the results produced on the financial performance, 37 companies that listed in Muscat Securities Market (MSM) had been chosen over a period of time starting from 2014 ending to 2018. For this, the study made use of cash management ratios, which were the Cash ratio, Operating Cash to Debt ratio and the financial performance ratios are Return on Assets (ROA), Return on Equity (ROE) and Net Profit Ratio. The cash ratio has a statistically significant positive correlation with ROA of 0.204, ROE of 0.132 and NPR of 0.238 value. Operating Cash to Debt ratio has also statistically significant positive relationship with ROA (0.478), ROE (0.013), and with NPR (0.419). The R-square value was 17.6% where, NPR is a dependent variable. When Return on Asset has been taken as a dependent variable, the R-square value was identified as 23.5%. But ROE has a limited impact on the independent variables with 2.9%. Overall, the main conclusion drawn is that cash management practices used by the Omani manufacturing firms are explaining a significant amount of the financial performance. because there are other factors such as the amount of manufacturing sales contracts received, the social development status of the business, impact of the financial crisis within the economy on the demand of the goods or commodities and so on.

Keywords: Cash Management, Omani Manufacturing, Financial Performance, Cash Ratio, Cash Turnover Ratio.

Introduction:

All businesses, whether large or small, apply different types of resources to perform their functions and operate. Cash represents one such vital resource that can have multiple effects on the success of the company. Cash is usually represented by all the liquid cash that is available with the business on hand as well as its cash deposits in the bank. In financial terms, cash is a component of the current assets of the business and therefore it is a huge component of the business's working capital that is meant to be used for its day-to-day operations (Schroeder & Kacem, 2019).

Cash is a scarce resource and hence it is necessary for every business to manage it efficiently as well as effectively, which is often done by the practice of cash management (Oluoch, 2016). The term cash management is usually described as the management of cash and the cash equivalents of the business so as to ensure that sufficient cash is available to sustain its operations, to finance investments and to meet all other financial commitments. Cash management invariably involves tasks of managing inflows and outflows of cash, based on the different operations and activities that are carried out by the business. The main goal is pursued by cash management is to manage the cash resources of the business in a way that ensures an optimal cash balance in hand that is not in excess or short of the requirements (Sinclair&McPherson, 2017).

Present research on cash management has focused on its connection with many important areas such as the effect on the liquidity of the business, its financial performance, bankruptcy as well as the overall working capital itself (Sinclair& McPherson, 2017). Among these areas, the connection between cash management and financial performance of the businesses is an area of immediate concern to the shareholders as well as to the management and therefore the specific connection between cash management and financial performance will be attempted to be established through the present study.

Research Hypothesis

- H1: There is a statistically significant positive relationship between Cash Ratio and Net Profit ratio.
- H2: There is a statistically significant positive relationship between Cash Ratio and Return on Assets ratio.
- H3: There is a statistically significant positive relationship between Cash Ratio and Return on Equity ratio.

- H4: There is a statistically significant positive relationship between Operating Cash to Debt Ratio and Net Profit ratio.
- H5: There is a statistically significant positive relationship between Operating Cash to Debt Ratio and Return on Assets ratio.
- H6: There is a statistically significant positive relationship between Operating Cash to Debt Ratio and Return on Equity ratio.

Research Objective

To analyze the relationship between cash management and the financial performance of selected manufacturing companies listed in MSM Oman.

Literature Review:

Within financial management, the term cash is used to refer to all the liquid cash that is available with the business on hand as well as its cash deposits in the bank. Ahmad (2016) writes that within financial statements cash balances or resources of the business are represented by the term cash and cash equivalents and this refers to all the assets that the company has that are cash or can be converted into cash from immediately. Sinclair & McPherson (2017) writes that cash equivalents are also inclusive of the bank accounts and other marketable securities that are also inclusive of the debt securities or which should have a maximum maturity period of 90 days and less than that. Is held as equity or other forms of stockholding are not included in computation of cash balances.

Bekaert & Hodrick (2017) claims that the primary tasks under cash management are inclusive of managing the different cash flows that are going into and out of the business so that the gap is sufficient to meet business objectives. Likewise, Njeru et al (2015) reports that cash management pursue the goal of rendering a sufficient cash that is matching with the business operations as well as with its objectives.

According to Chang (2018), Free Cash Flows theory specifies that cash assets need to be held by the management for the purpose of making the investment decisions that are the best interests of the shareholders. Importantly, it states that only when the business possesses sufficient amount of cash will it be able to control its investments and they take up those investments that can lead to a better or improve financial performance. However, on the downside, excessive holding of cash can result in management taking for ineffective cash investment decisions.

Luo & Shang (2015) explains about cash management by the cash conversion cycle (CCC) theory. He notes that this theory was developed by Gitmanin in 1974 and the concept argues that cash is required to be retained by the company in conjunction with its CCC as this theory refers to the time in which the company invests in raw resources for output and then to the degree until cash inflows are obtained. Hence, if the CCC is of a shorter duration then it is possible to maintain a small amount of cash as compared to those businesses that have a very large cash cycle.

Wanguu & Kipkirui (2015) examined a sample of three large cement manufacturers that are based on Nairobi’s stock exchange during 2000-2014, a total of 15 years. They examined the entire effect of cash management as well as different components of working capital using regression equation and confirmed that the R-Square value was 0.736 which meant 73.6% of variations in the profit for financial performance of the manufacturers were directly correlated to how the components such as cash managed. For in each case there was a linkage with the other variables meaning that cash management will affect the debtors as well as suppliers management and therefore the overall effect.

Miller-Orr theory of cash management primarily applies to those businesses that have uncertain cash flows and therefore he suggests that in such cases the businesses need to set and then a lower limit within which the cash balance can be managed and if it falls to either of the limits then it needs to be brought to the target cash balance. Many tools are suggested as a part of the Miller-Orr theory that suggests of making investments across marketable securities in order to avoid idle cash balances (Bekaert & Hodrick, 2017).

Several researchers have attempted to examine the factors that are needed to be considered during effective cash management. Ahmad (2016), reports that as a starting point of cash management, businesses needs to consider the extent of matching that takes place between the inflows and the outflows of their cash balances because these are collectively responsible for determining the gap as well as the timing of the gap which will be positive or negative requiring borrowing or investments. Also, Schroeder & Kacem (2019) reports that cash policy followed by the business has a significantly done on not only the frequency with which funds will be required also the amount of volume of funds required at different points of time.

Javed (2019) reports that the existing financial status and commitments of the business are essential to its cash management program. Where businesses have already taken sizeable amount of borrowings then cash will be needed to support the repayments of the loans. Likewise, the total amount of loans that have already been taken by the business can affect the way to position and standing correspondingly impact ability to receive more cash funds. Luo & Shang (2015) reports that the attitude of the management is also important in cash management because the amount of cash is available as a direct bearing on the liquidity of the business and therefore it affects the risks faced by the business. Therefore, depending upon management risk preferences, cash management may also vary.

Oluoch (2016) examined cash management practices for 171 SMEs based in the country of Kenya. Using liquidity ratios based on the current and the quick ratio along with the measures of cash conversion cycle for the SMEs and multiple regression. They found that SMEs that had efficient cash management practices benefited from saving on transaction costs because they had cash available internally and therefore, they can avoid the need for external borrowings thereby saving on interest costs.

Thevaruban (2016) examined a sample of 20 manufacturers based in Sri Lanka during 2010-2015 to study a chosen and implemented cash management practices. Using measures of cash ratio, cash turnover along with the ROE & ROA. They identified that cash ratio is sharing a negative impact with the measures of ROE. Hence, whenever manufacturers were holding the cash and cash equivalents as part of their cash management plan it was resulting in excess cash balance and resulted in idle cash balances that was not producing returns but rather generated opportunity cost of the manufacturers thereby reducing negative value.

In contrast, Onchangwa (2015) examined a sample of 32 farming and agriculture based listed companies from 2009-2011. Using cash management and liquidity ratios they found that the efficiency of cash management was directly correlated with the liquidity, which in turn is that the ability of the foreign companies to make investments in machinery, land and other resources. They impact the size of operations and results of the operations that govern the revenue and financial performance.

Bulin et al. (2016) examined a sample of 50 companies listed on Malaysians stock exchange during 2011-2015 using ROA, CCC, and Collection Period and also included the inventory turnover ratio to get a more precise picture on the effects. Correlation value of CCC and ROA was -0.06 confirmed that whenever CCC increased their financial performance of the manufacturers would be lower because for a longer CCC they will need to have more borrowings which adversely affect ROA. They found that CCC and p value of 0.007 meant that the Company had a significant relationship with financial performance or ROA.

Jindal & Jain (2017) examined the indirect effect of cash management through the application of that management practices within heavy vehicle industries in India during 2009-2016. By studying about debtors turnover ratio, profitability and company growth rate, they identified that a strong correlation of 0.415 existing between debtors management, cash and for indicating that the extent to which a business would be able to grow its revenue depends upon application of successful cash management.

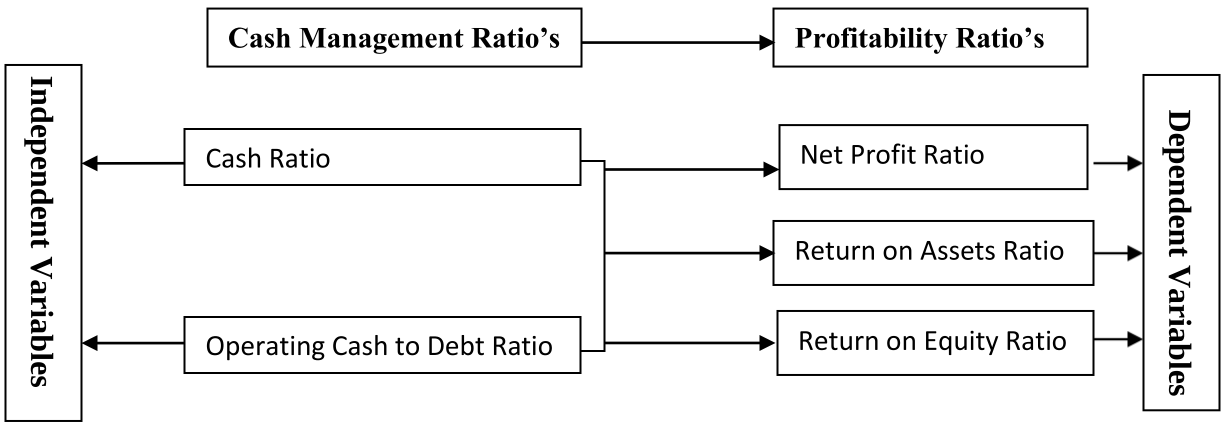
Vuran & Adiloglu (2018) examined a sample of 168 businesses on the Istanbul stock market to investigate the collective effects of cash management represented by CCC during 2017. Using regression, they determined that cash management does not occur in isolation but it is combined to have an effect on the variables as well as on the receivables of the enterprise. They noted that whenever companies face financial difficulties, they tend to focus more on receivables which is on their business will lead to lower sales and therefore lower financial performance due to incorrect management of cash. Importantly, this study also mentioned that the type of sector of operations is more related to the cash and financial performance because cash shortages in sectors such as retail have more drastic or negative financial outcomes.

Kumaraswamy (2016) examined a sample of 23 listed manufacturing companies that were based in the GCC by obtaining data from the website gulfbase.com to know the effects of working capital management on different aspects of the companies and their financial performance for the six-year period 2009-2014. Using the ratios, they found that producers within GCC countries invested heavy cash in their current assets, which in turn was found to affect their financial performance because it was closely linked to cash borrowing, indicating that these dimensions could explain approximately 61.4 percent of operating profits and 34 percent of ROA.

RESEARCH METHODOLOGY

This study used secondary data of 37 manufacturing companies out of 40 manufacturing companies listed in the Muscat Securities Market (MSM) for thelast 5 years. (See appendix 01) Manufacturing companies which have full data for the whole study period from 2014 to 2018. Random sampling method was used to collect from published annual reports of the selected manufacturing Companies listed in the Muscat Securities Market (MSM) web site. Researcher has used SPSS version 23 to analyse the data.

Conceptual Framework: **Figure 1**



Based on the above conceptual framework the following multiple Regression Model has developed for the purpose of analysis.

$$ROA= \beta o+ \beta CR+ \beta OC\text{-}DR+e$$

$$ROE = \beta 0+ \beta CR+ \beta OC\text{-}DR +e$$

$$NPR = \beta 0+ \beta CR+ \beta OC\text{-}DR +e$$

Where,

- ROA = Return on Assets
- ROE = Return on Equity
- NPR = Net Profit Ratio
- CR = Cash Ratio
- OC-DR = Operating Cash to Debt Ratio
- β=Coefficient of variables
- e= Error term

Table 1: Variables measure and notation

Variable Status	Variable Name	Measure	Notation
Dependent Variable	Net Profit Ratio	Net Income after tax/Total Sales	NPR
	Return On Assets Ratio	Net Income after tax/Total Assets	ROA
	Return On Equity Ratio	Net Income after tax/Total Equity	ROE
Independent Variables	Cash Ratio	Cash & Cash equivalents/Current Liability	CR
	Operating Cash to Debt Ratio	Cash from operations /Total Debt	OC-DR

RESULTS & DISCUSSIONS:

Table 2: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
CR	185	0.000	8.473	0.4700	0.9383
OC- DR	185	-0.5819	3.378	0.3254	0.5084
ROA	185	-0.9770	0.7995	0.03208	0.1204
ROE	185	-4.090	0.3900	- 0.06265	0.5561
NPR	185	-1.533	0.5097	0.03793	0.1663

Table 2 observed that the Cash Ratio (CR) ranged from a minimum of 0.000 to 8.473 with a mean of 0.4700, standard deviation of .9383. It also showed that Operating Cash to Debt Ratio (OC- DR) has a minimum of -0.5819 and a maximum of 3.378. The mean was identified as 0.3254, standard deviation 0.5084. It depicts that Return on Assets (ROA) has a range of -0.9770 to 0.7995 with a mean of 0.03208, standard deviation of 0.1204.Return on Equity ratio (ROE) has a range of -4.090 to 0.3900, and the mean was a negative of - 0.06265 and the standard deviation of 0.5561. Net Profit ratio (NPR) ranged from a minimum -1.533 to 0.5097 with a mean of 0.03793. The standard deviation is 0.1663.

Table 3: Model Summary of the Regression Analysis

Model	R	R square	Adjusted R square	Std. error of the estimate
1	.485[a]	.235	.227	0.106

a. Predictors: (constant) Cash ratio, Operating Cash to Debt ratio
b. Dependent variable: Return on Assets

Table 1 explains that the R square of 0.235 indicates only 23.5% of the Return on Asset ratio vary according to the Cash ratio, Operating Cash to Debt ratio. Therefore the remaining 76.5% are affected by other variables.

Table 4: Model Summary of the Regression Analysis

Model	R	R square	Adjusted R square	Std. error of the estimate
1	.170[a]	.029	.018	0.551

a. Predictors: (constant) Cash ratio, Operating Cash to Debt ratio
b. Dependent variable: Return on Equity

Table 2 implies that the R square of 0.029 indicates only 2.9% of the Return on Equity ratio vary according to the Cash ratio, Operating Cash to Debt ratio. Therefore, the remaining 97.1% are affected by other variables.

Table 5: Model Summary of the Regression Analysis

Model	R	R square	Adjusted R square	Std. error of the estimate
1	.419[a]	.176	.167	0.152

a. Predictors: (constant) Cash ratio, Operating Cash to Debt ratio
b. Dependent variable: Net Profit ratio

Table3 indicates that the R square of 0.176 indicates only 17.6% of the Net Profit ratio vary according to the Cash ratio, Operating Cash to Debt ratio. Therefore the remaining 82.4% are affected by other variables.

Table 6: Correlation Analysis

		CR	OC- DR	ROA	ROE	NPR
CR	Pearson	--				
	P- Value	---				
OC- DR	Pearson	0.575	--			
	P- Value	<.001	---			
ROA	Pearson	0.204**	0.478***	----		
	P- Value	0.003	< .001	----		
ROE	Pearson	0.132*	0.163*	0.292***	----	
	P- Value	0.036	0.013	< .001	----	
NPR	Pearson	0.238***	0.419***	0.905***	0.339***	----
	P- Value	< .001	< .001	< .001	< .001	----

* P < .05, ** p < .01, *** p < .001

From the above correlation analysis under Table 4 shows a significant positive relationship (23.8) between Cash Ratio and Net Profit Ratio. It was significant at 1 percent. This interprets that when cash ratio increased; net profit ratio will be increased. It also shows a significant positive relationship between Cash Ratio and Return on Assets (20.4). It was significant at 10 percent. This also interprets as cash ratio increased, the net profit ratio will be increased. There was a positive significant correlation between Cash Ratio and Return on Equity with 13.2. It was significant at 5 percent. The other side there was a significant positive relationship (47.8) been registered between Operating Cash to Debt Ratio and Return on Assets. Furthermore, Operating Cash to Debt Ratio and Return on Equity has also registered a significant positive relationship (16.3). The relationship between Operating Cash to Debt Ratio and Net Profit Ratio (41.9) showed a significant positive relationship as well. Operating Cash to Debt ratio versus Return on Equity was significant at 5 percent, but other two were significant at 10 percent.

Table 7: Coefficient Analysis- Independent Variables (Cash Ratio and Operating Cash to Debt ratio) and Dependent Variable (Net Profit Ratio)

Model		Unstandardized coefficient		Standardized	t	Sig
		P	Standard Error	Beta		
1	(Intercept)	-0.007	0.013		-0.492	0.623
	CR	-8.514e-4	0.015	-0.005	-0.058	0.953
	OC- DR	0.138	0.027	0.422	5.133	< .001

Table 7 explains the coefficients, according to the above model. Here Operating Cash to Debt Ratio was positively significant at 1%. The probability of T test of Operating Cash to Debt Ratio was less than 1%. T test value was 0.001 < 0.05 which illustrated that there was a positive

relationship between Operating Cash to Debt Ratio and Net Profit Ratio (βo= -0.422, T=--5.133, P=<.001). This means Operating Cash to Debt Ratio increased, at that time financial performance has increased. Although Cash Ratio shows a negative relationship (βo= -0.005) it is not significant (p = 0.953) in this model, due to the fact that it is a multiple regression.

Table 8: Coefficient Analysis- Independent Variables (Cash Ratio, Operating Cash to Debt Ratio) and Dependent Variable (Return on Assets)

Model		Unstandardized coefficient		Standardized	t	Sig
		P	Standard Error	Beta		
1	(Intercept)	-0.003	0.009		-0.325	0.746
	CR	-0.014	0.010	-0.105	-1.329	0.186
	OC- DR	0.127	0.019	0.538	6.793	< .001

Table 8 describes the coefficients according to the above model. Here Operating Cash to Debt Ratio was positively significant at 1%. The probability of T test of Operating Cash to Debt Ratio was less than 1%. T test value was 0.001 < 0.05 which illustrated that there was a positive relationship between Operating Cash to Debt Ratio and Return on Assets Ratio (βo = -0.538, T= 6.793, P=0.001).This means Operating Cash to Debt Ratio increased at that same time financial performance had shown an increase. Under this model, Cash Ratio do not show any relationship.

Table 9: Coefficients Analysis - Independent Variable (Cash Ratio and Cash flow to Debt Ratio) and Dependent Variable (Return on Equity Ratio)

Model		Unstandardized coefficient		Standardized	t	Sig
		P	Standard Error	Beta		
1	(Intercept)	-0.125	0.049		-2.574	0.011
	CR	0.034	0.053	0.057	0.641	0.523
	CF TO DR	0.143	0.098	0.131	1.463	0.145

Table 9 defines the coefficients, according to the above model. Here Operating Cash to Debt ratio was significant. The probability of T test of Debt Ratio was more than 10%. T test value was 0.145 > 0.10 which illustrated that there was no relationship between Operating Cash to Debt Ratio and Return on Equity Ratio (βo = 0.131, T= 1.463, P=0.145).This indicates Operating Cash to Debt Ratio has no relationship with financial performance.

Table 10: Hypothesis Testing:

Hypothesis	Result	Tool	p-value
H1: There is a statistically significant positive relationship between Cash Ratio and Net Profit ratio	Accept	Pearson Correlation (0.238)	<.001
H2: There is a statistically significant positive relationship between Cash Ratio and Return on Assets ratio.	Accept	Pearson Correlation (0.204)	0.003
H3: There is a statistically significant positive relationship between Cash Ratio and Return on Equity ratio.	Accept	Pearson Correlation (0.132)	0.036
H4: There is a statistically significant positive relationship between Operating Cash to Debt Ratio and Net Profit ratio.	Accept	Pearson Correlation (0.419)	< .001
H5: There is a statistically significant positive relationship between Operating Cash to Debt Ratio and Return on Assets ratio.	Accept	Pearson Correlation (0.478)	< .001
H6: There is a statistically significant positive relationship between Operating Cash to Debt Ratio and Return on Equity ratio.	Accept	Pearson Correlation (0.163)	0.013

Table 10 shows that the null hypothesis has been rejected and the alternative hypothesis is accepted as the p-value is less than 0.05 in all the itemized hypothesis.

Findings:

The study under correlation matrix has revealed that there was a positive relationship between Cash Ratio (CR) and financial performance of the Sultanate of Oman chosen manufacturing Companies from Muscat Securities Market. It is observed that Cash Ratio’s mean of 47% has surpassed the Industry Averages. It shows that chosen manufacturing firms of sultanate of Oman have the ability to repay the current liabilities. Hence, companies can borrow loans as and when needed from the creditors, since the signal of healthy Cash Ratio indicates the firm’s ability to repay loans. On the other hand, the study revealed that a positive relationship exists between Operation Cash to Debt Ratio (OC-DR) and financial performance of the Sultanate of Oman manufacturing companies. The mean of OC-DR has observed as 32.5%. It indicates that the firms have the ability to meet their current liability with the available cash from operations. This study had revealed that other than cash management income of the Sultanate of manufacturing companies, the financial performance of the manufacturing companies is determined by other factors such as the amount of manufacturing sales contracts received, the social development status of the business, impact of the financial crisis within the economy on the demand of the goods or commodities and so on.

Recommendations and suggestions:

Financial managers of the Sultanate of Oman's manufacturing Companies should focus on cash position at all time. A stable cash position should be maintained by the Sultanate of Oman manufacturing companies that can easily meet its current liabilities with cash or cash equivalents it has on hand. Additionally, effective cash management programs should be constituted, by which the finance manager should prepare cash budget and cash flow statement for effective cash planning and control (Janaki, S. T. 2016) The cash management process should be in agreement with appropriate laws, regulations and professional ethical standards, so as to follow that going concern of business firms will be attained. More qualified accounting professionals should be recruited in order to get adequate support in managing cash to augment further and also to maintain consistent financial performance of Sultanate of Oman's manufacturing companies.

Conclusion:

Cash management has been identified as one of the most important aspect to be effectively managed. A business firm having a sound set of policies regarding liquidity management will certainly improve the returns and reduce the chances of bankruptcy. This study outcome has revealed that Sultanate of Oman manufacturing companies Cash Ratio and financial performance have a positive relationship with each other. In continuation to that Debt Ratio and financial performance have a negative relationship with each other. Cash Conversion Cycle Ratio and financial performance does not have any relationship with each other. All the alternative hypotheses have been accepted as the statistical tools indicate. Therefore management of Sultanate of Oman manufacturing companies need to confirm that there is an adequate cash management control to ensure that all the time there is an optimal cash where there are strategies to be in place during minimal cash in hand and surplus cash in hand.

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Appendix-01

S no	Listed Manufacturing Companies in MSM	Abbreviation
1	Al Safa foods	SPFI
2	Dhofar beverage	DBCI
3	Dhofar cattle	DCFI
4	Dhofar fisheries	DFII
5	Dhofar poultry	DPCI
6	Gulf mushroom	GMPI
7	National minerals	NMWI
8	Oman fisheries	OFCI
9	Oman flour mills	OFMI
10	Oman refreshments	ORCI
11	Omani euro food	OEFI
12	Salalah mills	SFMI
13	Sweets Oman	OSCI
14	National biscuit	NBII
15	Oman cement	OCOI
16	Raysut cements	RCCI
17	Al Hassan engineering	HECI
18	Galfar engineering	GECS
19	Muscat thread	MTMI
20	Al fajar	AFAI
21	Gulf stone	GSCI
22	Oman chromite	OCCI
23	Al Maha ceramics	AMCI
24	Al Anwar ceramic	AACT
25	Al Jazeera steel	ATMI
26	Construction material	CMII
27	National aluminum	NAPI
28	Oman ceramics	OMCI
29	Computer stationery	CSII
30	Majan glass	MGCI
31	Omani packing co	OPCI
32	Packing co ltd	PCLI
33	Gulf international chemicals	GICI
34	National detergent	NDTI
35	Oman chlorine	OCHL
36	Oman cables	OCAI
37	Voltamp energy	VOES

Integrating ISO 9001 and 26000 for Community Enhancement Projects

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Abstract

Establishing a community concept with quality awareness is a growing issue in today's technological world for harmony and relationship building. The aim of this paper is to integrate quality management standards ISO 9000 and corporate social responsibility (CSR) guidelines of ISO 26000 to explore the key elements for community enhancement projects. Related documents, for example, United Nations Sustainable Development Goals (UNSDGs,) and United Nations Principles for Responsible Management (UNPRME), ISO 26000 and ISO 9001 have been reviewed for elements in organizations which are involved in community enhancement projects.

The proposed indicators for measuring the maturity level of organizations involved with community enhancement projects are ISO clauses 5.1 (management commitment), 7.2.1 (determination of requirements related to the services offered for target community), 7.4 (purchase), 8.2.3 (monitoring process) and 8.4 (measurement and analysis). However, more good practices of community enhancement projects are needed for demonstrating UNSDG 4 with transferrable skills, 8 with economic impacts, 9 with innovations via 17 partnership in a measurable way.

Keywords: culture of community enhancement projects, sustainable development goals, ISO 9001, ISO 26000

Building Sustainability through Relationships

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Abstract

This study shares how one course integrated narrative identity approaches to teach students how to build a personalized leadership life-work story in technology rich environments. This talk provides (2) perspectives: (1) how phenomenological concepts were embedded into a multigenerational and multicultural university's public speaking course, and (2) how the classroom learning itself contributed to students increased awareness of self-authorship en route to making career related decisions, all stemming from studying past lived formative experiences. "Who am I?" question (Stryker & Serpe, 1982; Turner, 1985) has been a self- identity question that has played a central role for individuals seeking meaningful work. Modern day workers yearn for such meaning-making workplaces (Towers Perrin, 2003). Students in this class were current police officers, formerly incarcerated individuals, dual enrollment high school (precollege students) students and professionals encountering late-career transitions. All students were aware that over sharing one's life story in workplaces may backfire if hastily done. Self- narrative development is not automatic today. Ibarra and Barbulescu (2010) viewed storytelling a way for individuals to navigate work-role changes and transitions, and Conley (2018) has noted that multigenerational workplaces are now the norm; it is timely, then, that teaching students to self-narrate and build relational bridges happens. Accordingly, this talk will also unveil how a universal method can be introduced to any adult class room population – especially multigenerational and multicultural ones – to enhance narrative identity development and even enhance how individuals tell self-related stories during high stakes interviews, networking events, change initiatives, managing technologically driven changes or leadership moments.

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Making the Most of Rural Residential Land Construction: A Case Study *(Formerly Green for the Environment and Green for the Pocketbook: A Decade of Living Sustainably)*

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Texas State University, Health Administration

Abstract: Intelligent use of rural residential land and sustainable construction is inexorably linked to cost; however, options exist that are eco-friendly and have a positive return on investment. In 2011, a research residence was built to evaluate various land use and sustainable components. This Texas house has subsequently been used for both residential and research purposes. In this case study, the authors evaluate components of the construction and their effect on the environment and pocketbook. Some of the specific components discussed are home site placement (directional positioning); materiel acquisition (transportation); wood product minimization; rainwater harvesting; wastewater management; grid-tied solar array power; electric car charging via a solar array; geothermal heating and cooling; insulation selection; windows, fixtures, and appliance selection; on-demand electric water heaters for guest areas; and backup generator selection. The additional cost of sustainable construction for the research residence is estimated at $54,733 withs savings of between 25 and 90 trees due to the use of reclaimed wood and with a 15-year Net Present Value at 5% capital costs estimating a $160,222 savings for sustainable construction. The total estimated annual difference in carbon emissions is 4.326 million g/CO2e for this research residence. There may be a positive return on investment for intelligent rural land use and construction.

Keywords: rural residential construction, rainwater harvesting, solar, spray foam, finger-jointed studs

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1. Introduction

Sustainable rural land use requires that residential construction be conducted in an environmentally conscious way. Residential (and commercial) construction options have an effect on the water supply [1, 2, 3], the demand for grid electricity [4, 5, 6], the use of land lumber and other materials [7], as well as the entire ecosystem. Improper use of land can accelerate global warming, have impacts on human health, lead to eutrophication / acidification of water, and cause smog formation, and, perhaps not surprisingly, land use impacts are most affected by the use of wood products [8].

Net Zero (or even Net Positive) construction involves the design of facilities that either consume no net energy (demand less supply) or that produce more energy than consumption [9], reducing global warming and taking advantage of intelligent land development. Net Zero construction may even power user transportation, even further reducing the impact of the built environment [7]. Net Zero construction coupled with proper water management and residential construction techniques is feasible [5].

This case study analyzes best practice construction design for both the environment and the consumer based on a rural residence designed in 2011 for research purposes. This residence was the highest-rated house ever certified by the National Association of Home Builders at the time it was built [10]. Both construction successes and failures are analyzed with commentary from both the environmental and consumer perspective. Cost-benefit analyses are provided.

The primary hypothesis is that construction of a rural house in a semi-arid environment using sustainable techniques could be green for the pocketbook as well as green for the environment. The study’s significance is that it investigates how proper land use and construction techniques may produce a return-on-investment while minimizing the effects of development for a particular research residence.

2. Materials and Methods

In this case study, we evaluate environmental impacts, lifecycle costs, and efficacy of multiple sustainable building innovations for rural residences. The research residence used for this study is a 4,800 square foot home (446 square meters) built in a semi-arid environment. The study evaluates home site placement; local materials extraction; reclaimed wood framing; spray foam insulation; window, fixture, and appliance selection; material recycling; rainwater harvesting design and engineering; aerobic septic system; xeriscaping; grid-tied solar arrays; electric car charging and use; on-demand water heaters; wireless switches to reduce wiring requirements; geothermal heating and cooling; and electrical back-up system options.

Specific methods used include break-even analysis and return on investment (ROI) for this particular case as well as environmental impact and a qualitative assessment of utility for specific land use and construction interventions. Break-even analysis investigates at what point up front investment outlays for sustainable techniques with (typically) more expensive up-front costs match the expected outlays for more traditional residential building and land use. ROI includes a cost of capital calculation, as there are opportunity costs missed when higher amounts of money are expended.

3. Results

3.1. Initial Considerations

3.1.1. Site Placement

The rural residence in the study was designed from the ground up to be sustainable, and the design considerations included geographical placement. The home site was selected to be North facing to maximize solar capture (West, South, and East facing panels) and to leverage predominant local winds (South to North) [11]. Further, the site selected minimized tree removal, reducing cost and effect on the environment. Qualitatively, the placement was a success in this construction, as the solar capture is as expected (discussed later), and the cost as well as the environmental impact of excess tree removal was avoided. Figure 1 is the Google Maps satellite image of the house [12].

Figure 1. The residence as constructed

3.1.2. Material Location / Transportation

One of the major sustainability considerations in residential construction is the transportation of materials. As part of the rural residence design, only local materials (those within 50 miles) were selected. For example, local limestone was selected for the exterior (Figure 2). Reducing transportation requirements reduces emissions, although the extent of the carbon emission reduction is unknown. Further, reducing transportation distance may result in a cost reduction as well.

Figure 2. All construction materials were native.

3.1.3. Waste Collection and Recycling

During construction, bins for waste were used to recycle materials as appropriate (Figure 3). Doing so allowed for reclaimed wood to be reclaimed as engineered lumber and for used paper and metal to be recycled. While this has little to no bearing on cost, it does have an effect on the environment.

Figure 3. Bins established for paper / metal collection during construction

3.2. Engineered Lumber / Finger-Jointed Studs

Reclaimed wood (specifically finger-jointed studs) were used in the residential construction (see Figure 4). These studs are straighter and result in less wood wasted. Further, they have a strong vertical load capability, with evidence that many species (including pine) have better structural properties when finger-jointed [13].

Figure 4. Finger-jointed stud used in the residence construction

A 20″ diameter tree with 42 feet length of usable wood produces about 260 board feet. The Idaho Forest Products commission estimated that a typical 2,000 square feet house would use 102 trees of that size [14]. Assuming linearity, the rural residence, a 4800 square feet home (446 square meters, would have been estimated to require approximately 245 trees. Assuming an offset of even 25% of the wood requirements results in a reduction of about 61 trees. See Table 1.

Table 1. Estimate of trees saved by using engineered lumber (finger-jointed studs) in this case study.

% Offset of Traditional Lumber	Trees Saved
10%	24.5
15%	36.8
20%	49.0
25%	61.3
30%	73.5
35%	85.8
40%	98.0

The cost of finger-jointed studs may be more expensive than regular studs. For example, the retail cost of a 2 x 4 x 104 5/8″ (0.6 x 1.2 x 2.7 meters) regular pine stud versus the same size finger-jointed stud is listed at $3.62 [15] versus $5.59 [16], respectively. This is a 54.4% cost increase for materials, which might be offset by lower labor costs due to engineered lumber's straightness.

The cost differential is not atypical, as many engineered lumber products have upcharges between 1.5 and 2 times the cost of traditional lumber [17]. One site estimates the total cost of traditional framing between $4 to $10 per square foot for labor and $3 to $6 per square foot for materials [18].

With a 30% reduction of labor costs for engineered lumber, low material costs for standard lumber, and 54.4% higher costs in engineered lumber, there are several ways in which finger-jointed studs actually save money. Table 2 illustrates those combinations (2020 dollars)

Table 2. Regular lumbar versus finger-jointed studs at 1.54- and 0.70-times materials and labor, respectively

Regular Lumbar, \$ / ft²		**Engineered Lumber, \$ / ft²**		**4800 Sq. Ft.**
Materials	*Labor*	*Materials*	*Labor*	*Cost Savings*
3.00	10.00	4.62	7.00	6,624.00
3.00	9.00	4.62	6.30	5,184.00
4.00	10.00	6.16	7.00	4,032.00
3.00	8.00	4.62	5.60	3,744.00
4.00	9.00	6.16	6.30	2,592.00
3.00	7.00	4.62	4.90	2,304.00
5.00	10.00	7.70	7.00	1,440.00
4.00	8.00	6.16	5.60	1,152.00
3.00	6.00	4.62	4.20	864.00
5.00	9.00	7.70	6.30	-

Using the average estimate of \$7 for labor and \$4 for materials (traditional construction) and 30% reductions in labor (\$4.90) with 54.4% increases in materials (\$6.18, non-traditional construction) results in comparative estimates of \$52,800 (traditional) and \$53,184 (non-traditional). The total difference in cost is estimated to be nominal, but the environmental impact is not.

3.3. Residential Envelope

Residential spray-foam insulation (Figure 5) provides a thermal barrier with exceedingly low conductivity (.021 W/mK in one study [15]). Spray foam has reasonable hygrothermal properties and is resistant to moisture migration; however, mechanical extraction and humidity controls were installed because of the tight environmental seal of the house and the requirement to exchange air. The practical relevance of the tight seal around the rural residence is that during the heat of the summer in this semi-arid region (in excess of 100 degrees F, 38 degrees C), the observed temperature in the attic spaces does not exceed 80F/26.7C with the house thermometer set to 76F / 24.4C.

Figure 5. Open-cell spray-foam insulation

The 2020 cost for open-cell spray-foam insulation is about \$.35 to \$.55 per board foot. Assuming 3.5” depth of spray converts to \$1.23 to \$1.93 per square foot or \$13.24 to \$20.77 per square meter. Fiberglass batt insulation runs \$.64 to \$1.19 per square foot or \$6.89 to \$12.81 per square meter. Assuming average costs of \$1.58 per square foot (spray-foam) and $.915 (fiberglass) with 6,000 square feet of attic and walls to be insulated results in cost estimates of $9,480 and $5,490, respectively [17].

The analysis above, however, is incomplete. Spray-foam works as an air barrier, vapor barrier, water-resistant barrier, and insulation. There is no need for attic vents, test ductwork, or air-seal attics. When evaluated in this manner, it is actually 10-15% less expensive than traditional construction. Inflating the estimated cost of $9,480 by 10% to account for all traditional construction requirements results in $10,428 for standard construction.

3.4. Low Solar Heat Gain Coefficient (SHGC) and U-Factor Windows (Energy Star)

Solar Heat Gain Coefficient (SHGC) is defined as the fraction of incident solar radiation admitted through a window. In warm climates, windows should have solar heat gain coefficients (SHGC) less than .25 [18]. Further, the U factor, a factor that express the insulative value of windows, should be .4 or lower. Low emissivity windows and doors with SHGC of .23 and U-Factor of .3 were used throughout the house.

Figure 6. Windows and doors must match environmental considerations

Low emissivity windows are 10 to 15% more expensive than standard windows [19]. The typical cost range in 2020 dollars is $385 to $785 with an average of $585 [20]. The Department of Energy estimates savings of $125 to $465 dollars a year from replacing windows with new windows that have higher Energy Star ratings [21]. Assuming average cost for Energy Star windows ($585), 15% cheaper traditional windows ($508.70), and a total of 25 windows results in acquisition costs of $14,625 (Energy Star) versus $12,717.50 (non-Energy Star). The $1,907.50 difference would be offset in about 6.5 years at the average $295 energy savings.

3.5. Rainwater Harvesting

The decision to install a rainwater harvesting system (RWH) versus a well or city water is one that is entirely dependent on the environment, the availability, homeowner's wishes, and regulations. In this case study, no city water sources were available. After a cost analysis, it was estimated that the cost for an aquifer-draining well and the cost for a rainwater harvesting system would be nearly identical ($20,000). Rainwater harvesting was selected for both sustainability and quality considerations. From a sustainability perspective, RWH requires far less water for the same aquifer demand. Specifically, run-off, absorption / adsorption, and evaporation / transpiration reduce aquifer resupply by at least 30% [22]. On the other hand, RWH systems capture 75% to 90% of rainwater, depending on design and rainfall [23]. The amount of water pulled from the aquifer to supply one gallon is therefore at least 3.333 gallons, whereas well RWH systems capturing only 75% of the available rainfall require 1.333 gallons. The net savings to the aquifer is 2 gallons of water per 1 gallon demanded.

Figure 7 depicts the RWH as currently installed in the rural residence. The system works as follows. Rainwater falls on the roof and is captured by gutters. The guttered water flows to the cistern where ~100 gallons or so is flushed out through a pipe with a ball float to eject the debris on the roof. This is called the first flush (Figure 8). Once the ball float seals the flushing tube, the water continues into French drain and basket filters (Figure 9) and then into a cistern (Figure10). Parallel on-demand pumps (Figure 11) push water towards the house where it is processed through a sediment filter, charcoal regeneration system, and ultraviolet light which is an effective method for inactivating pathogens through irradiation [24]. The water is then used and exits to an aerobic septic system (not shown).

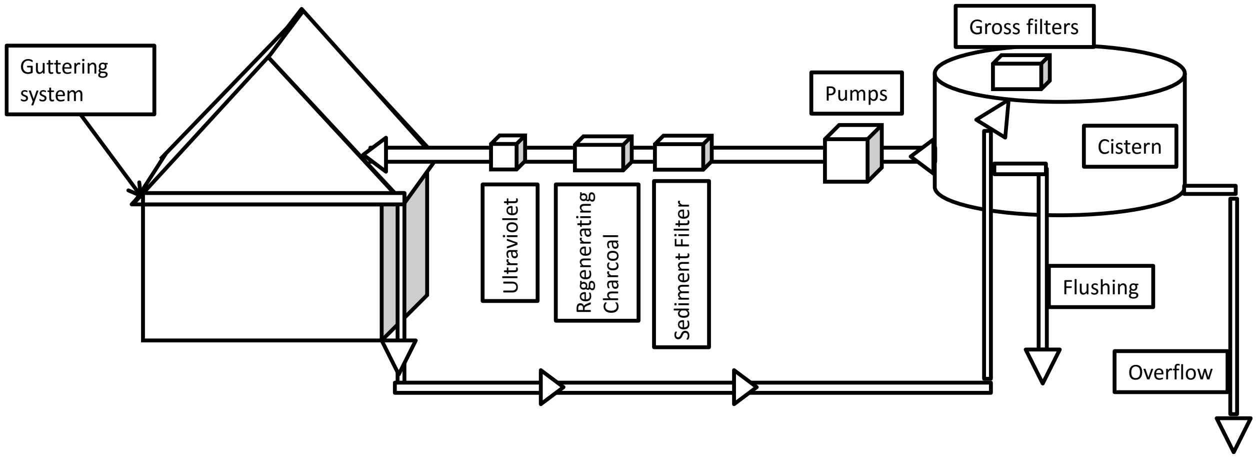


Figure 7. Rainwater harvesting system as designed

Figure 8. First flush system

Figure 9. French drain and basket filter location (inside the black tank lid)

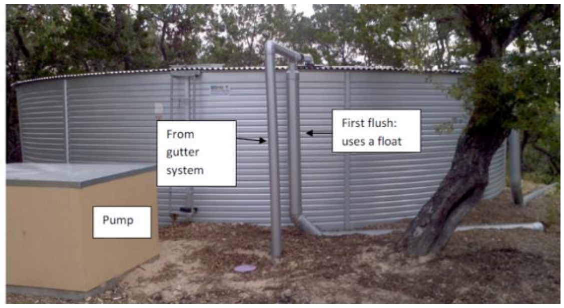


Figure 10. RWH components after installation

Figure 11. Parallel on-demand pumps

Quality considerations for water are significant. Using rainfall for potable house needs requires proper roof selection (ceramic or metal as examples), flushing (first flush), gross filtering (e.g. French drain and basket filters), storage (food-grade butyl rubber), pumping, cleansing (e.g., sediment filter and charcoal regeneration, Figure 12), purifying (ultraviolet purification as one example, Figure 13), and disposal of gray water (aerobic septic system). Baseline quality construction requirements are found in [23].

Figure 12. From right to left: sediment filter, charcoal regeneration, ultraviolet filter (spare tank in front)

Figure 13. Ultraviolet purification and example light

Design of an RWH capable of meeting the needs of an entire household required simulation modeling, so that the distribution of the minimum in the cistern (order statistic) would be strictly greater than zero over all supply and demand considerations and all simulation runs. Details of the simulation are available from [5,25] . The final system selected included 4000 square feet of capture space and a 40,000 gallon cistern.

Acquisition costs for the rainwater harvesting system (guttering, PVC piping, Pioneer 40K gallon cistern with butyl rubber liner and accessories) cost approximately $25,500 in 2020 [26]. Current well drilling prices in Texas are $30 to $55 per foot [27]. On this property, a 600′ drilling depth is required. At the average $42.50 per foot, the drilling cost alone would run $25,500 now.

Cost to maintain the system is reasonable. Ultraviolet tubes (replaced annually for typical use) as well as sediment filters and other system requirements cost approximately $100 per year. According to the Centers for Disease Control and Prevevntion, wells should also be inspected annually [28] at a cost of $300 to $500 per month [29]. The system is cost effective. Further, the water quality exceeds local and state requirements.

3.6. Water Fixtures

Selection of appliances and fixtures is important for a sustainable house reliant on 100% rainwater. Toilets, shower heads, and other water fixtures were low flow / high pressure, as the rural residence sought to sustain itself using only rainwater harvesting. Mayer et al. [30] estimate that toilets use 29% of indoor water consumption, while water used for showering/bathing, dishwashing and laundry consume about 36%, 14%, and 21%, respectively. The Environmental Protection Agency (EPA) shows that high pressure, low flow shower heads reduce flow from 2.5 gallons per minute to 2.0 gallons per minute, a 20% reduction [31]. Costs for low flow fixtures are comparable to standard fixtures. There are no cost savings or increases.

3.7 Aerobic Septic

Cradle-to-grave water management requires that black water be treated responsibly and sustainably. In this area, aerobic septic systems are required by regulation. The owner had installed a Jet Biologically Accelerated Treatment (BAT) plant (also termed Biologically Accelerated Wastewater Treatment, BAWT, plant). BAT plants work by treating wastewater physically and biologically in a pre-treatment compartment. Water then flows through the treatment compartment where it is aerated, mixed, and treated by a host of biological organisms (a biomass). The mixture then flows to a settlement compartment where particulate matter settles, returning to the treatment compartment, leaving only odorless and clear liquid (gray water produced by the biomass) which is discharged through sprinkler heads [32]. Figure 14 is the encased BAT system installed at the rural residence. Aerobic systems break down waste far quicker than anaerobic due to the nature of the bacteria.

Figure 14. Biological Accelerated Treatment plant during installation

There is no cost benefit for installing such a system at this rural residence. Installing an anerobic system averages $3,500, whereas an aerobic costs about $10,500 [33]. Maintaining the aerobic septic system is about $200 annually [34], which is somewhat more than anaerobic systems [35]. There are, however, benefits to the environment in that 1) pumps for transporting water to wastewater treatment plants are not necessary (and the associated energy costs), 2) treated water returned to the environment is cleaner, 3) electricity for processing water (in this case) is largely if not entirely generated by the sun.

3.8. Tankless Water Heaters

One of the current additions to this research residence has been the inclusion of an on-demand electric water heater for a guest room, guest kitchen, and guest bathroom. These water heaters take up less space and do not constantly use energy to keep water warm. The acquisition cost of an electric tankless heater is largely dependent on size, capability, and brand and may be larger than traditional tank versions; however, the acquisition cost for the installed unit was identical to the tank unit in this case. Tankless may also last 1.5 to 2 times as long as tank water heaters (20 years) and save 8 to 34% on water, depending on water demand; however, demand flow for multiple simultaneous operations must be evaluated [36].

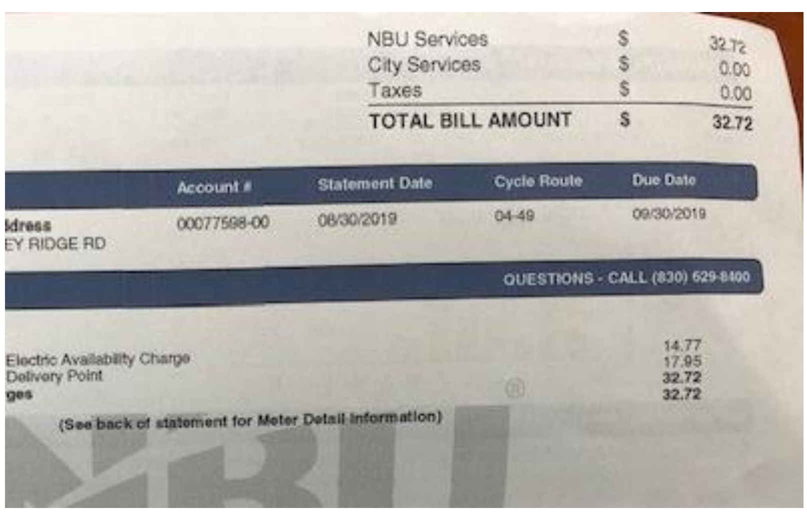
Comparing the life-cycle of a 50-gallon electric water heater with that of a tankless requires some up-front assumptions. One study indicated that the life-cycle savings over traditional electric storage systems is $3,719 Australian dollars (about $2500 US dollars) [37]. However, that study does not consider the possibility that all electrical power needed is generated by solar. Further, the carbon footprint is much lower, as it is in operation only when demanded. Tankless water heaters may be 99% efficient [38].

The acquisition and installation costs for 2 x 50 gallon tank water heaters during initial construction was nearly $3,000. Under traditional grid power, the yearly costs are $494 per tank or just under $1000. For tankless water heaters under solar, the installation and acquisition costs are $3000 for two units (high end). There are zero annual costs.

3.9. Solar Arrays

In a sustainable home located in semi-arid regions, solar arrays are an obvious solution for producing energy requirements. This rural residence initially had installed a 7.25 kWh system (32 x 225 watt panels) with a Sunny Boy inverter ($33,600 in 2011) and then subsequently added another 9.585 kWh system (27 x 355 watt panels, $31,317 in 2018) with a Solar Edge inverter after home expansion and capitalization of the original solar power system. The total cost of both systems was approximately $64.917. After 30% federal tax credits, the total cost was approximately $44,441.90. From installation date until 31 January 2020, the initial 7.25 kWh system has produced 90.579 MWh of power in 35,212 hours of operation for 2.57 kWh per hour, saving 153,984 pounds of CO_2 emissions. The 9.585 kWh system has produced 25.86 MWh in about 18,240 hours since installation, saving 40,038.49 pounds of CO_2 emissions and resulting in only 1.4 kWh per hour. The low result is due to installation in January and a month wait to replace the initial inverter (faulty) in January to February 2018.

Initial break-even analysis is based on both acquisition cost and energy cost as if both systems were installed on the expanded house. Figure 15 illustrates the rural residence usage after power generation for a one-year period. During the six months of April through September, the residence produced or banked more power than consumed. From October through March, the residence consumed more power than produced. The $32.72 bill provided is a connection fee. During this month, the residents consumed 1699 kWh and produced only 1226 kWh. There is, however, no delivery or cost of power charge, as the previous months, the residents produced more than consumed. The total consumption estimate is then about 2925 kWh for a 4800 square foot house in a cool month. When averaged over a single year, total consumption is approximately 3500 kWh per month.



NBU Services	$	32.72
City Services	$	0.00
Taxes	$	0.00
TOTAL BILL AMOUNT	$	32.72

	Account #	Statement Date	Cycle Route	Due Date
ldress EY RIDGE RD	00077598-00	08/30/2019	04-49	09/30/2019

QUESTIONS - CALL (830) 629-8400

Electric Availability Charge	14.77
Delivery Point	17.95
	32.72
ges	32.72

(See back of statement for Meter Detail Information)

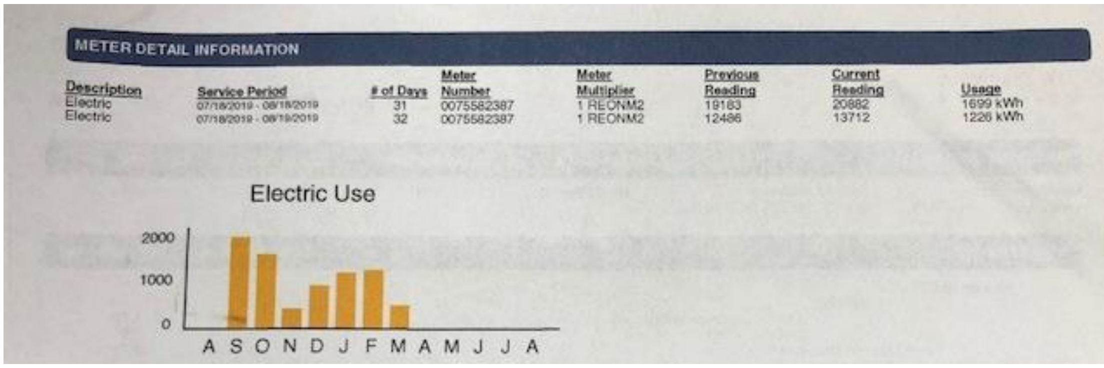


Figure 15. Electric bill, 9/30/2019 (both production, top, and consumption, bottom)

A non-solar house consuming 3500 kWh per month under traditional utility billing at $.07 per kWh with at $14.77 customer charge results in an annual estimated cost of $3,117.24 ($259.77 x 12). The same consumption with solar runs $498.00 ($33 x 6 months + $50 x 6 months). Residential electricity rates are anticipated to be fairly stable over time [39]. The break-even point for both systems is estimated to be about 17 years; however, this does not account for avoidance of automobile gasoline charges assuming the use of an electric car.

From an environmental perspective, the carbon dioxide avoidance by leveraging solar is significant. The footprint of solar is 6 g CO_2e/kWh, while coal CCS is 109 g and bioenergy is 98 g. Wind power produces less emissions (4 g each); however, the rural residence location is a low-production wind area [40]. For 3500 kWh per month (or 42 MWh per year), the total annual difference in carbon emissions is 4.326 million g/CO_2e.

3.10. Electric Car Charging

Electricity generated from the solar panels was used to charge an electric Nissan Leaf (early adopter, see Figure 16). The gasoline avoidance in doing so was significant. Assuming equivalent acquisition costs for electric versus non-electric cars, a $100 avoidance in gasoline each month and holding all other variables constant, the net annual savings for solar would be $3,117.24 - - $702 = $3,819.24 for a break-even of 11.6 years. Unfortunately, early Nissan Leaf vehicles suffered from battery issues [41]. The owner divested after 3 years due to this issues as well as a change in employment location. Improvements in the batteries of these vehicles as well as extended range models makes this vehicle an attractive option for minimizing gasoline and maintenance costs.

Nissan Leaf ownership costs over 8 years are estimated to be $36,537.82 with total 8-year energy costs (kWh) at $3,969 [42]. When powered by solar that is 100% capable of producing both home and automobile power, there are no energy costs. Thus, the difference in cost between an equal value gasoline car (after accounting for any tax credits and residual) would be the maintenance and energy costs. Assuming a gasoline car experiences the average 13,476 miles driven per year (107,808 over 8 years), 30 miles per gallon, and $3.00 per gallon of gas (while ignoring maintenance costs) results in a fuel cost estimate of $10,780.80, which is 2.72 times that of the electric car option. This analysis does not include residual value, which his lower for electric cars. Gasoline cars retain about 45% of their value over 4 years, while electric vehicles retain barely more than 25% on average [5].

Figure 16. Nissan Leaf and final charging station

3.11. Geothermal Heating & Cooling

As part of the construction, the rural residence was equipped with a closed loop, geothermal system (see Figure 17). Vertical, closed-loop geothermal units are heat exchangers that leverage the fact the temperature 200' below the Earth remains relatively constant. The system operated with limited success for seven years, as the heat exchange and unit was unable to keep up with greater 100 degree F temperatures in its South Texas location, despite multiple attempts to improve the system (including adding an additional 200' well for heat exchange). The cost of the system including wells, unit and ducting (complete) was $26,500. The tax credit was 30% or $7,950, and so the end cost to the resident was $18,550. Climatemaster (the brand installed) estimates a $1000 savings in electrical costs per year over an electric heat pump ($3,135 versus $4,169) [43]. The system was replaced with a 5-ton, 18-seer American Standard Platinum heat pump unit in 2018 at a cost of $16,255, over $10,000 less expensive and fully effective.

Figure 17. Geothermal unit and vertical drilling of wells

3.11. Generator or Other Backup System

The residence was awaiting an eco-friendly solar power storage solution (e.g., Tesla Powerwall or the Chinese BYD B-box 10). All options were incredibly expensive (between $80 to $110 per kWh storage per year for 10 years) with decay rates that generate lithium ion battery disposal concerns after 10 years for most products [44]. Since the storage technology is still developing, a 22 kWh propane-powered back-up generator, a device sufficient to empower the entire house (Figure 18), was installed. In well or rainwater harvesting systems that leverage pumps, back-up power is necessary to retain water during electrical outages. Propane is a green fuel that, when burned, has nominal effects on the environment [45]. The 1,000 gallon propane tank and generator are sufficient to maintain full power to house for about 14 days under reasonable utilization conditions. The cost for this generator, automatic transfer switch, propane tank, underground installation, and connections was $19,668.00. A large portion of expense involved burying the propane tank in rocky terrain.

Figure 18. Generac 22 kWh whole-house generator and propane tank

3.12. Break-Even Analysis

Sustainable construction can generate a break-even for the pocketbook and for the environment. Figure 19 illustrates the cost comparisons of the sustainable construction techniques discussed in this paper. Costs are inflated based on BLS forecasts [46]. The first matrix in this figure is traditional construction without environmentally intelligent land use. The second reflects the rural residence as designed. And the third matrix reflects sustainable construction without geothermal for the particular locality and residence.

Looking at Figure 19, the breakeven year for 2020 construction would be about 2026 with or without geothermal installation. The additional cost of sustainable construction is estimated at $54,733, which is much lower than might be expected due to the tax credits associated with solar and geothermal. The use of geothermal, though, was not effective, even after several modifications. Eliminating the geothermal in favor of high-seer heat pump would reduce the tax credit to $19,475 and the acquisition cost to $16,255. The cost of this sustainable construction is $52,438.

Appendix A is a 15-year net present value analysis (NPV) assuming cost of capital is 5%. This analysis suggests a $160,222 savings for sustainable construction with geothermal and a $186,338 savings without geothermal. Total estimated costs are $(2,278,943), ($2,118,721), and $(2,092,604) for traditional, sustainable with geothermal, and sustainable without geothermal, respectively.

	BLS Inflation	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*
Traditional House & Car	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Lumber	$ (52,800)	$ -	$ -	$ -	$ -	$ -	$ -
Insulation / Vents	$ (10,428)	$ -	$ -	$ -	$ -	$ -	$ -
Windows	$ (12,718)	$ -	$ -	$ -	$ -	$ -	$ -
Well Water	$ (25,500)	$ (400)	$ (412)	$ (424)	$ (437)	$ (450)	$ (464)
Electricity (100%)	$ -	$ (3,117)	$ (3,211)	$ (3,307)	$ (3,406)	$ (3,508)	$ (3,614)
Gas for Car	$ (1,348)	$ (1,348)	$ (1,388)	$ (1,430)	$ (1,473)	$ (1,517)	$ (1,562)
Anaerobic Septic	$ (3,500)	$ (150)	$ (155)	$ (159)	$ (164)	$ (169)	$ (174)
2 x H20 Tank	$ (3,000)	$ (1,000)	$ (1,030)	$ (1,061)	$ (1,093)	$ (1,126)	$ (1,159)
Heat Pump	$ (16,255)	$ (4,169)	$ (4,294)	$ (4,423)	$ (4,556)	$ (4,692)	$ (4,833)
Tax Credits	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Cash Flows	$ (125,548)	$ (10,184)	$ (10,489)	$ (10,804)	$ (11,128)	$ (11,462)	$ (11,806)
Cumulative Cash Flow	$ (125,548)	$(135,732)	$(146,221)	$(157,025)	$(168,153)	$(179,615)	$(191,421)
With Geothermal	**Acquisition**						
Sustainable House & Car	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Engineered Lumber	$ (53,184)	$ -	$ -	$ -	$ -	$ -	$ -
Spray Foam	$ (9,480)	$ -	$ -	$ -	$ -	$ -	$ -
Energy Star Windows*	$ (14,625)	$ -	$ -	$ -	$ -	$ -	$ -
H20 Harvesting	$ (25,500)	$ (100)	$ (103)	$ (106)	$ (109)	$ (113)	$ (116)
Solar (100%)+Electric	$ (64,917)	$ (498)	$ (513)	$ (528)	$ (544)	$ (561)	$ (577)
Electric Car Gas		$ -	$ -	$ -	$ -	$ -	$ -
Aerobic Septic	$ (10,500)	$ (200)	$ (206)	$ (212)	$ (219)	$ (225)	$ (232)
2 x Tankless on Solar	$ (3,000)	$ -	$ -	$ -	$ -	$ -	$ -
Geothermal**	$ (26,500)						
Tax Credits	$ 27,425		$ -	$ -	$ -	$ -	$ -
Net Cash Flows	$ (180,281)	$ (798)	$ (822)	$ (847)	$ (872)	$ (898)	$ (925)
Cumulative Cash Flow	$ (180,281)	$(181,079)	$(181,901)	$(182,747)	$(183,619)	$(184,518)	$(185,443)
Without Geothermal	**Acquisition**						
Sustainable House & Car	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Engineered Lumber	$ (53,184)	$ -	$ -	$ -	$ -	$ -	$ -
Spray Foam	$ (9,480)	$ -	$ -	$ -	$ -	$ -	$ -
Energy Star Windows*	$ (14,625)	$ -	$ -	$ -	$ -	$ -	$ -
H20 Harvesting	$ (25,500)	$ (100)	$ (103)	$ (106)	$ (109)	$ (113)	$ (116)
Solar (100%)+Electric	$ (64,917)	$ (498)	$ (513)	$ (528)	$ (544)	$ (561)	$ (577)
Electric Car Gas		$ -	$ -	$ -	$ -	$ -	$ -
Aerobic Septic	$ (10,500)	$ (200)	$ (206)	$ (212)	$ (219)	$ (225)	$ (232)
2 x Tankless on Solar	$ (3,000)	$ -	$ -	$ -	$ -	$ -	$ -
Heat Pump	$ (16,255)						
Tax Credits	$ 19,475		$ -	$ -	$ -	$ -	$ -
Net Cash Flows	$ (177,986)	$ (798)	$ (822)	$ (847)	$ (872)	$ (898)	$ (925)
Cumulative Cash Flow	$ (177,986)	$(178,784)	$(179,606)	$(180,452)	$(181,324)	$(182,223)	$(183,148)
*savings in use of solar electric							
**ineffective							

Figure 19. Color-coded break-even analysis

3.13. Ongoing Sustainable Improvements

All add-on construction to the rural residence included mini-splits (both in wall and in roof systems). These systems have more upfront costs but are much more energy efficient, as they do not lose energy through ductwork. Further, they are now inconspicuous and highly effective [47]. See Figure 20 for pictures of in-roof and in-wall systems installed in the residence. In new construction, these systems should be considered due to their efficiency and elimination of ductwork and other requirements.

Figure 20. Mini-split units, in wall and in roof

Another new construction consideration is the use of wireless multi-gang light switches. These fixtures can minimize wiring requirements by using a single drop instead of multiple drops. With the advent of 5G, it might be possible to eliminate CAT6 wiring during residential construction in the future as well.

4. Discussion

For this case study, the break-even analysis and ROI suggest that sustainable land use and construction efforts can benefit the environment and the bottom line. The initial up-front costs may be quickly offset by savings depending on construction options. In the case study here, only seven years were required for break-even. Aside from the economic considerations, the environmental responsibility issues are clear. Avoiding carbon emissions is responsible construction.

The additional cost of sustainable construction for the research residence is estimated at $54,733; however, the 15-year NPV analysis showed $160,222 savings for sustainable construction with geothermal and $186, 338 without it. There may be a positive return on investment for intelligent land use and construction.

Perhaps more importantly, there is a significant environmental offset for this type of construction. Based on reasonable assumptions, the construction of this house saved between 25 and 90 trees due to the use of reclaimed wood. The carbon dioxide avoidance by leveraging solar is significant. The total estimated annual difference in carbon emissions was 4.326 million g/CO_2e for this research residence. Environmental effects of burning gasoline in a vehicle were reduced to near zero by powering an electric vehicle via solar.

Further, the total water offset per demanded gallon is 2 gallons of water per 1 gallon demanded. A traditional residence consuming 10,000 gallons would require 33,333 gallons of rainfall to supply the ground water sources, whereas a rainwater system would require only 13,333 gallons. In semi-arid regions, that difference is important for sustainability and aquifer preservation. This rural residence illustrates that smart land use and sustainable construction save resources.

4.1. Policy Implications

There are also policy requirements for sustainable construction. That policy push towards sustainable construction is evolving to a universal mandate with penalties for failure to comply. The prime example is in California where a new law passed a solar mandate where all new homes built after 1 January 2020 must be equipped with a solar electric system. That system must be sized that it will offset 100% of the home's electricity usage. This mandate is one aspect of the California Energy Commission's initiative to have 50% of the entire State of California's energy production be from a clean energy source by 2030 [48]. Continuing with the California mandates on sustainability mandates, California passed another law recently signed by Gov. Brown that imposes water usage requirements. The law states that all California residents will be restricted to 55 gallons/day water usage by 2022 and is reduced to 50 gallons/day by 2030 [49]. While both initiatives discuss the mandates, neither has shown the penalty for failure to comply or even specifics on implementation. What is clear is that the mandates on both electric and water usage are the wave of the future and appear to be only the start in California with certainty that other States will adopt similar measures. A proactive approach leveraging the analysis presented here and elsewhere will help both builders and buyers.

4.2. Limitations

This is a single case study of a single rural residence, where some efforts were successful (e.g., solar power arrays and rainwater harvesting) and some were not (e.g., geothermal). The results for this single case study in a semi-arid region are not generalizable to other regions. Further, land use regulations vary from location to location, so what is achievable at this research location may be prohibited elsewhere.

5. Conclusion

This case study illustrates that proper rural residential construction and resource use can provide value to the consumer and reduce the impact of the built environment. There is a positive NPV obtainable for many eco-friendly construction options. Leveraging what works for both the environment and the consumer in a particular region requires dedication and focus of the residential construction industry.

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Appendix A

	BLS Inflation	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*
Traditional House & Car	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
Lumber	$ (52,800)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Insulation / Vents	$ (10,428)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Windows	$ (12,718)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Well Water	$ (25,500)	$ (315)	$ (324)	$ (334)	$ (344)	$ (355)	$ (365)	$ (376)	$ (387)	$ (399)	$ (411)	$ (423)	$ (436)	$ (449)	$ (463)	$ (476)
Electricity (100%)	$ -	$ (3,117)	$ (3,211)	$ (3,307)	$ (3,406)	$ (3,508)	$ (3,614)	$ (3,722)	$ (3,834)	$ (3,949)	$ (4,067)	$ (4,189)	$ (4,315)	$ (4,444)	$ (4,578)	$ (4,715)
Gas for Car	$ (1,348)	$ (1,348)	$ (1,388)	$ (1,430)	$ (1,473)	$ (1,517)	$ (1,562)	$ (1,609)	$ (1,657)	$ (1,707)	$ (1,758)	$ (1,811)	$ (1,865)	$ (1,921)	$ (1,979)	$ (2,038)
Anaerobic Septic	$ (3,500)	$ (150)	$ (155)	$ (159)	$ (164)	$ (169)	$ (174)	$ (179)	$ (184)	$ (190)	$ (196)	$ (202)	$ (208)	$ (214)	$ (220)	$ (227)
2 x H20 Tank	$ (3,000)	$ (1,000)	$ (1,030)	$ (1,061)	$ (1,093)	$ (1,126)	$ (1,159)	$ (1,194)	$ (1,230)	$ (1,267)	$ (1,305)	$ (1,344)	$ (1,384)	$ (1,426)	$ (1,469)	$ (1,513)
Heat Pump	$ (16,255)	$ (4,169)	$ (4,294)	$ (4,423)	$ (4,556)	$ (4,692)	$ (4,833)	$ (4,978)	$ (5,127)	$ (5,281)	$ (5,440)	$ (5,603)	$ (5,771)	$ (5,944)	$ (6,122)	$ (6,306)
Tax Credits	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Cash Flows	$ (125,548)	$ (10,099)	$ (10,402)	$ (10,714)	$ (11,035)	$ (11,366)	$ (11,707)	$ (12,059)	$ (12,420)	$ (12,793)	$ (13,177)	$ (13,572)	$ (13,979)	$ (14,399)	$ (14,830)	$ (15,275)
Cumulative Cash Flow	$ (125,548)	$ (135,647)	$ (146,049)	$ (156,763)	$ (167,798)	$ (179,164)	$ (190,872)	$ (202,930)	$ (215,350)	$ (228,143)	$ (241,320)	$ (254,892)	$ (268,871)	$ (283,270)	$ (298,100)	$ (313,376)
	$ (2,278,943)	NPV @ 5% assumed cost of capital														
With Geothermal	**Acquisition**															
Sustainable House & Car	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
Engineered Lumber	$ (53,184)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Spray Foam	$ (9,480)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Energy Star Windows*	$ (14,625)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
H20 Harvesting	$ (25,500)	$ (100)	$ (103)	$ (106)	$ (109)	$ (113)	$ (116)	$ (119)	$ (123)	$ (127)	$ (130)	$ (134)	$ (138)	$ (143)	$ (147)	$ (151)
Solar (100%)+Electric	$ (64,917)	$ (498)	$ (513)	$ (528)	$ (544)	$ (561)	$ (577)	$ (595)	$ (612)	$ (631)	$ (650)	$ (669)	$ (689)	$ (710)	$ (731)	$ (753)
Electric Car Gas		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Aerobic Septic	$ (10,500)	$ (200)	$ (206)	$ (212)	$ (219)	$ (225)	$ (232)	$ (239)	$ (246)	$ (253)	$ (261)	$ (269)	$ (277)	$ (285)	$ (294)	$ (303)
2 x Tankless on Solar	$ (3,000)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Geothermal**	$ (26,500)															
Tax Credits	$ 27,425		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Cash Flows	$ (180,281)	$ (798)	$ (822)	$ (847)	$ (872)	$ (898)	$ (925)	$ (953)	$ (981)	$ (1,011)	$ (1,041)	$ (1,072)	$ (1,105)	$ (1,138)	$ (1,172)	$ (1,207)
Cumulative Cash Flow	$ (180,281)	$ (181,079)	$ (181,901)	$ (182,747)	$ (183,619)	$ (184,518)	$ (185,443)	$ (186,396)	$ (187,377)	$ (188,388)	$ (189,429)	$ (190,502)	$ (191,606)	$ (192,744)	$ (193,916)	$ (195,123)
	$ (2,118,721)	NPV @ 5% assumed cost of capital														
Without Geothermal	**Acquisition**															
Sustainable House & Car	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
Engineered Lumber	$ (53,184)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Spray Foam	$ (9,480)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Energy Star Windows*	$ (14,625)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
H20 Harvesting	$ (25,500)	$ (100)	$ (103)	$ (106)	$ (109)	$ (113)	$ (116)	$ (119)	$ (123)	$ (127)	$ (130)	$ (134)	$ (138)	$ (143)	$ (147)	$ (151)
Solar (100%)+Electric	$ (64,917)	$ (498)	$ (513)	$ (528)	$ (544)	$ (561)	$ (577)	$ (595)	$ (612)	$ (631)	$ (650)	$ (669)	$ (689)	$ (710)	$ (731)	$ (753)
Electric Car Gas		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Aerobic Septic	$ (10,500)	$ (200)	$ (206)	$ (212)	$ (219)	$ (225)	$ (232)	$ (239)	$ (246)	$ (253)	$ (261)	$ (269)	$ (277)	$ (285)	$ (294)	$ (303)
2 x Tankless on Solar	$ (3,000)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Heat Pump	$ (16,255)															
Tax Credits	$ 19,475		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Cash Flows	$ (177,986)	$ (798)	$ (822)	$ (847)	$ (872)	$ (898)	$ (925)	$ (953)	$ (981)	$ (1,011)	$ (1,041)	$ (1,072)	$ (1,105)	$ (1,138)	$ (1,172)	$ (1,207)
Cumulative Cash Flow	$ (177,986)	$ (178,784)	$ (179,606)	$ (180,452)	$ (181,324)	$ (182,223)	$ (183,148)	$ (184,101)	$ (185,082)	$ (186,093)	$ (187,134)	$ (188,207)	$ (189,311)	$ (190,449)	$ (191,621)	$ (192,828)
*savings in use of solar electric																
**ineffective	$ (2,092,604)	NPV @ 5% assumed cost of capital														
	$ (2,278,943)	NPV Traditional														
	$ (2,118,721)	NPV Sustainable w/Geothermal			$ 160,222	PV Difference (Traditional - NPV Sustainable w/Geothermal)										
	$ (2,092,604)	NPV Sustainable w/out Geothermal			$ 186,338	PV Difference (Traditional - NPV Sustainable wout/Geothermal)										

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Geospatial-Temporal, Explanatory, Demand, and Financial Models for Heart Failure

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Abstract:

Background. About 5.7 million individuals in the United States have heart failure, and the disease was estimated to cost about $42.9 billion in 2020. This research provides geospatial-temporal incidence models of this disease in the U.S. and explanatory models to account for hospitals' number of heart failure DRGs using technical, workload, financial, and geospatial-temporal variables. The research also provides updated financial and demand estimates based on inflationary pressures and disease rate increases. Understanding patterns is important to both policymakers and health administrators alike for cost control and planning.

Methods. Geographical Information Systems maps of heart failure diagnosis-related groups (DRGs) from 2016 through 2018 depicted areas of high incidence as well as changes. Simple expenditure forecasts were calculated for 2016 through 2018. Linear, lasso, ridge, and Elastic Net models as well as ensembled tree regressors including were built on an 80% training set and evaluated on a 20% test set.

Results: The incidence of heart failure has increased over time with highest intensities in the East and center of the country; however, several Northern states (e.g., Minnesota) have seen large increases in rates from 2016. The best traditional regression model explained 75% of the variability in the number of DRGs experienced by hospital using a small subset of variables including discharges, DRG type, percent Medicare reimbursement, hospital type, and medical school affiliation. The best ensembled tree models achieved R^2 over .97 on the blinded test set and identified discharges, percent Medicare reimbursement, hospital acute days, affiliated physicians, staffed beds, employees, hospital type, emergency room visits, medical school affiliation, geographical location, and the number of surgeries as highly important predictors.

Conclusions. Overall, the total cost of the three DRGs in the study has increased approximately $61 billion from 2016 through 2018 (average of two estimates). The increase in the more expensive DRG (DRG 291) has outpaced others with an associated increase of $92 billion in expenditures. With the increase in demand (linked to obesity and other factors) as well as the relatively steady-state supply of cardiologists over time, the costs are likely to balloon over the next decade.

Keywords: heart failure, geospatial, obesity, cost analysis

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1. Introduction

Coronary heart disease (CHD), cardiovascular disease (CVD), and coronary artery disease (CAD) are leading causes of death in the US, taking the lives of 647,457 in 2017 [1]. Heart disease is the leading cause of death in most developed countries, causing the deaths of one third of those over the age of 35 [2] and one quarter of deaths in the US [3]. Heart disease does not discriminate between races: of deaths attributable to heart disease, 23.8% were non-Hispanic whites, 23.8% were non-Hispanic Blacks, 22.2% were Asian or Pacific Islander, and 18.4% were Native American or Alaskan Native [3]. Incidence of total coronary events in the US increases sharply with age [2]. This means that incidence of heart disease increases with age, which makes it even more dangerous for the elderly. An update of heart disease and stroke in 2016 reported 15.5 million people > 20 years old have CHD [4], which is close to 6% of that population in the U.S. [5]. The risk factors for heart disease are high-blood pressure, high cholesterol, and smoking, and 47% of Americans report at least one of these conditions [3]. It affects men slightly more than women: 1 in 4 male deaths (347,879) versus 1 in 5 female deaths (299,578) [6], and food insecurity (associated with poverty) is an obvious correlational factor [7].

Heart disease was not a common cause of death at the turn of the 20th century, but the prevalence of coronary atherosclerosis grew until 1960 [8]. In 1900, heart disease was the fourth cause of death, surpassed by infectious conditions [9]. Longevity in our nation increased after 1900 only due to the decrease in infectious diseases [10]. In 1900, less than 5% of Americans smoked, but in 1960 incidence of smoking was 42% [10]. After the 1950s, Americans decreased smoking and reduced cholesterol levels [8]. Deaths from CHD in 1965 decreased from 466/100,000 to 345/100,000 in 1980: a 26% decrease [11]. From 1980 to 2008, the decrease was 64%: from 345 to 123/100,000 [11]. Since the 1960s, age-adjusted incidence of heart disease has experienced a steady decline, but it is still the number one cause of death in our nation [1]. Mechanisms to track heart disease and predict admissions would be another mechanism to control this killer of Americans: particularly the elderly who are more susceptible to the condition [12].

Heart failure as a subset of heart disease is prevalent in about 5.7 million adults in the United States, and one out of 9 deaths in 2009 were attributed at least in part to heart failure. Approximately 50% of individuals diagnosed with heart disease will die within 5 years, and the annualized cost is estimated to be $30.7 billion per year [13].

A recent study used decision tree algorithms for the prediction of heart disease [14]. Decision tree algorithms are particularly useful when variable directionality is less important than prediction. Other research has used geospatial analysis to look at several aspects of heart disease such as emergency transport and inter-hospital transfer of myocardial infarction [15] as well as individual and contextual correlates of cardiovascular disease [16]. But so far, researchers have not conducted a geospatial-temporal analysis of heart failure with predictive modeling to provide epidemiological and administrative descriptive and inferential insight as well as economic implications for supply and demand. This research does just that.

Despite the national average of 383 people per physician in the United States, the number of people per cardiologist is 14,572 [17]. There is certainly an element of artificiality in those numbers because while all people in the U.S. seek some medical care, a much smaller number need specialty care from a cardiologist. However, the message is the same: The cardiologist is a highly specialized, highly sought area of care.

While the general trend is up for cardiovascular disease (CVD), the growth of those entering cardiology is relatively flat. It is estimated that 40.5% of the U.S. population will have some form of CVD by 2030. This equates to a 3.1% incidence rate and $818 billion in cost of care [18]. A 2018 study of heart failure incidence from 1990 to 2009 revealed that heart failure with reduced ejection fraction (HFrEF) was down, while heart failure with preserved ejection fraction was up (HFpEF) [19]. More recent studies are not readily available.

While the elderly have already been mentioned, it is also important to note the increased risk associated with minorities and economically depressed populations. A hospital's relative payment system for a given Diagnosis-Related Group (DRG) is directly affected by several factors: 1) relative wages in the area, 2) number of low-income patients because it affects the disproportionate share reimbursement, among others. Medicare fee-for-service patients are at greater risk for hospital-based health-care costs. Underserved minority patients and economically repressed areas affect care and cost of care. These populations are less healthy than wealthier, non-minority populations, and less healthy people will take greater intervention to stabilize [20].

This research seeks to understand the geospatial-temporal incidence of this disease in the U.S. and build explanatory models that might account for hospitals' number of heart failure DRGs using technical, workload, financial, and geospatial-temporal variables. Further, the research provides financial and demand estimates based on inflationary pressures and disease rate increases. Understanding patterns is important to both policymakers, epidemiologists, and health administrators alike for cost control and planning efforts.

2. Methods

2.1. Data

Definitive Healthcare provided the heart failure data for this study. Diagnostic-related groups (DRGs) associated with heart failure (DRG 291,292, and 293) were selected for inclusion. The Definitive Healthcare datasets contain the Centers for Medicare and Medicaid Services (CMS) Standard Analytical Files (SAF) [21]. Population data for rate calculations were from the Census Bureau [5]. For years 2016 through 2018, there were {13.66, 13.52; 13.35} thousand hospital observations in the study, respectively. These hospital observations were associated (respectively) with {20.08, 22.74; 23.46} million DRGs.

2.2. Variables

Variables in this study come from the Definitive Healthcare dataset [21]. The primary variable of interest is "heart failure" as defined by Diagnostic-Related Groups 291, 292, and 293. The Diagnosis Related Group 291 encompasses "Heart Failure and Shock with Major Complication of Comorbidity (MCC)"; DRG 292 relates to

“Heart Failure and Shock with Complication or Comorbidity (CC); DRG 293 pertains to “Heart Failure and Shock without Complication or Comorbidity (CC) / Major Complication or Comorbidity”. The dependent variable is measured at the hospital level and aggregated by county for geospatial mapping. Inpatient claims for heart failure provide a measure of the met demand for services and is suggestive of which areas may need additional funding and resources from health policy decisionmakers.

Variable groups evaluated in the explanatory models included four categories: financial variables, workload variables, technical variables, and geo-spatial temporal variables. All variables are measured at the hospital level by year. Table 1 provides the appropriate definitions and scope of the independent variables sans the geo-spatial temporal group.

Table 1. Independent variables

Technical Variables	Defined	Measurement
Staffed Beds	Number of staffed beds operated by hospital	Integer
Affiliated Physicians	Number of physicians affiliated with hospital	Integer
Employees	Number of direct employees of hospital	Integer
% Medicare	Percent of patients reimbursing via Medicare	Ratio
% Medicaid	Percent of patients reimbursing via Medicaid	Ratio
Diagnostic-Related Groups	DRG 291, DRG 292, DRG 293	Categorical
Ownership	Hospital Ownership	Categorical
Medical School Affiliation	None, Limited, Major, Graduate Affiliation	Categorical
Hospital Type	Children, Critical Access, Long-Term, Psychiatric, Rehab, Short-Term	Categorical

Workload Variables	Defined	Measurement
Discharges	Number of patients discharged from admission	Integer
ER Visits	Number of emergency room visits	Integer
Surgeries	Number of surgeries performed	Integer
Acute Days	Number of acute bed days of hospital	Integer
Financial Variables	**Defined**	**Measurement**
Net Income	Profit minus loss	Ratio
Operating Profit Margin	Profit divided by revenue	Ratio
Cash on Hand	Cash available to the organization	Ratio
Equity	Assets minus liabilities	Ratio
Geospatial Variables	**Defined**	**Measurement**
State	Indicator variables for hospital's state	Categorical (Dichotomous)
Urban / Rural	Indicator variable for metropolitan status	Categorical (Dichotomous)
Year	Indicator variables for year of observation (2016 through 2018)	Categorical (Dichotomous)

2.4. Train and Test Sets

For the explanatory analysis, data were divided randomly using a pseudo-random seed for replication and consistency in model comparison into 80% training and 20% test set of sizes 32,419 and 8,104, respectively. Models were built on the training set and evaluated on the test set. The primary model selection metric of interest was the Root Mean Squared Error (RMSE), a metric which penalizes outlier forecasts heavily.

2.5. Geospatial Analysis

Geospatial maps for the rates of heart failure DRGs from 2016 through 2018 were generated at the state level. Rate data adjust for population changes, allowing comparison of incidence rates. Although descriptive in nature only, these maps highlight geographic variation. Heat maps have been used for describing birthing incidence [22], the opioid epidemic [23], evaluating back surgery growth over time [24], and in many other health-related studies. The significance of changes for 2016 to 2018 (DRG rates) are evaluated by a non-parametric Friedman's test. The Wilcoxon non-parametric test is preferable and more conservative than repeated samples ANOVA, as normality, homogeneity of variance, and independence assumptions do not hold [25].

2.6. Explanatory Analysis

Linear regression, lasso regression, robust regression, Elastic Net regression, extreme gradient-boosted random forests, and bagging regressors estimate the DRG heart failure admissions. To investigate the bias-variance trade-off [26], we built multiple models on an 80% training and evaluated on a 20% test set. All models are compared based on Root Mean Squared Error (RMSE), which penalizes outliers. The models are exploratory to see which features (workload, financial, technical, and geospatial-temporal) might be explanatory.

Lasso regression is a constrained regression that penalizes overfitting using an L1-norm penalty function (absolute value), while ridge regression is similar to lasso regression but penalizes using the L2-norm (squared). Elastic Net combines both Lasso and Ridge penalty functions.

While coefficients are easily interpreted in regression-type models, the data, typically need scaling and transformations with no single best solution available. Unlike tree ensemble models (forests), regression models are unable to find polytomous splits of variables automatically and are not scale invariant. To address the concerns of collinearity, multivariate Box-Cox methods are employed on all quantitative variables simultaneously after location adjustments to make them positive definite.

Random forests a ensemble of de-correlated tree models. Every tree produces a forecast, and all trees produced are than averaged to produce the estimate. Trees are "pruned," to prevent overfitting [26]. Figure 1 is an example of a tree with three branches. The tree splits observations by the number of hospital discharges less than or equal to versus greater than or 12,406 initially to obtain the maximum separation (RMSE).

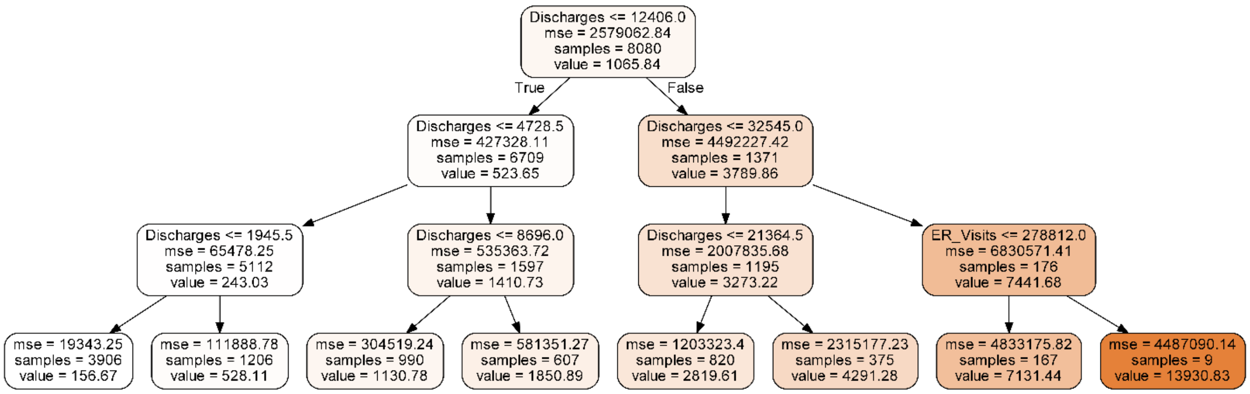

Figure 1. An example of a tree model to classify opioid admissions.

Gradient boosted random forests are a special class of ensembled trees. These models use nonlinear optimization to optimize a cost function based on the (pseudo)-residuals of a given function. Unlike random forests, gradient boosted random forests do not produce uncorrelated trees. Instead, the residuals of each tree are re-fitted with the possible independent variables in other tree models. Essentially, the focus is on the residuals. A more complete discussion of gradient boosting is provided in *The Elements of Statistical Learning* [26].

Gradient boosted random forests are scale-invariant, as they find relationships (splits) which the researcher might miss and generate importance metrics for explanatory purposes. These models will, however, overfit the data if the researcher does not restrict the growth of the trees. Cross-validation is necessary.

A Bagging regressor is an ensemble which fits base regressors on random subsets of the original dataset. The estimates from these regressors are then aggregated by voting or averaging to generate a final prediction. The result reduces variance of other block-box estimators by random sampling and ensembling. A good implementation and discussion of bagging regressors is available from the Python [27] SciKit-Learn module.

2.7. Software

All analysis was performed in Anaconda Python Release 3.7 [27], R Statistical Software (inside of Python using the r2py library) [28], and Microsoft Excel 2016 [29]. Python was used primarily for tree models, while R provided regression analysis. Excel's Bing-based 3D mapping software generated the GIS maps.

3. Results

3.1 Missing Observations

About 2% of quantitative observations were missing, so simple imputation using the mean was employed. This is conservative, as it tends to hide results that might be statistically relevant by reinforcing mean values. For the categorical variables, all but ownership were fully complete. There were only 14 missing observations for this variable, and these were imputed with the mode.

3.2. Descriptive Statistics-Quantitative Data

Descriptive statistics for the quantitative data are provided in Table 2. The average hospital observation during any given year had 1,635.62 observations of DRG 291, 292, and 293 (median of 383). That same average hospital had 146.39 staffed beds (median of 87), 6,996.58 discharges (median of 2,825), 6,348.76 surgeries (median of 4,490), and 34,181.38 acute days (median of 14,051). The average hospital had positive income (in millions) of $17.232 (median of $2.044), significant cash-on-hand ($20.28, median of $1.99), and positive equity. The typical hospital had 1005.53 employees (median of 437) with 231.37 affiliated physicians (median of 104) and was reimbursed 45% by Medicare (median of 42%). Only 9% reimbursement was from Medicaid (median of 6%).

Table 2. Descriptive statistics for the study (dollars in millions)

n=40,523 hospital observations		**Mean**	**SD**	**Median**	**Min**	**Max**
Quantitative Technical Variables	Number DRGs	1,635.62	3330.63	383.00	11	57,461
	Staffed Beds	146.39	171.98	87	2	2,753
	Affiliated Physicians	231.37	352.66	104	1	4328
	Employees	1,005.53	1679.14	437	4	26,491
	Percent Medicare	0.45	0.19	0.42	0	.98

	Percent Medicaid	0.09	.09	.06	0	.87
Workload Variables	Discharges	6,996.58	9,881.39	2,825	1	129,339
	ER Visits	32,865.58	33,893.77	25,236	0	543,457
	Surgeries	6,348.76	7,965.82	4,490	0	130,741
	Acute Days	34,181.38	51,725.31	14,051	5	701,074
Financial Variables	Net Income ($ in M)	$17.23	$117.65	$2.04	-$1.21	$3,31
	Cash on Hand ($ in M)	$20.28	$120.24	$1.99	-$2.51	$3.88
	Profit Margin	-0.03	1.25	-0.02	-15.45	62.07
	Equity ($ in M)	$174.11	$625.76	$33.94	-$3.25	$10.24

Year over year, both DRGs and rates of DRGs per 1000 population increased as illustrated in Figure 2. The significance of the DRG increase is the financial consideration. The significance of the rate of DRG increase is the epidemiological consideration. If the DRG rate is considered a proxy for incidence rate, then there is either a significant increase, a coding issue, or something else. These considerations are found in the discussion section. One might expect the DRG rate graph to remain horizontal (static). Independent variables remained relatively constant year-over-year likely due to repeated measures on the same facilities.

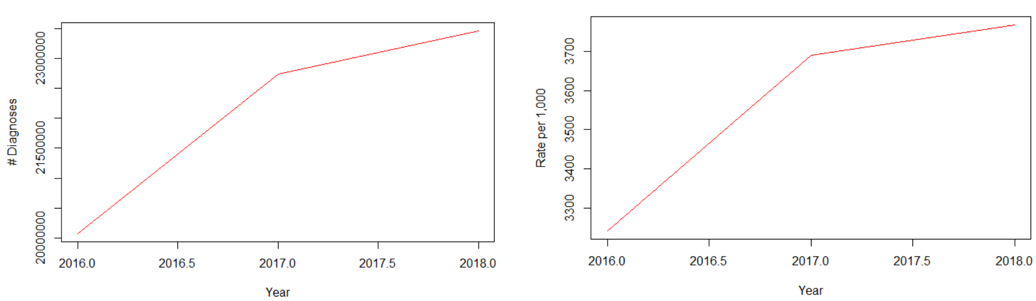

Figure 2. Number and rates of DRGs as a function of year

3.3. Descriptive Statistics-Categorical Data

California, Texas, and Florida had the largest number of diagnoses for all years and year-over-year, largely due to population size, with averages of {1,669,210; 1,631,021; 1,490,983}, respectively. When adjusted per 1000 population, the District of Columbia, West Virginia, and Delaware dominated the with total rates per 1,000 population of {109.47, 102.86, 94.15}, respectively. Utah, Hawaii, and Colorado had the smallest average rates, {26.17, 28.87, 34.74}, respectively. Appendix Aillustrates the rates by state / territory.

Of the hospital observations, 6700 were rural (42%) while 9279 were urban (58%). Most of the hospitals (8342 or 52%) were voluntary non-profits with 29% (4641) proprietary and 18.7% (2996) governmental. The vast majority (11,914 or 75%) had no affiliation with a medical school and were short-term care facilities (9,604 or 60%). Nearly no hospitals were classified as Department of Defense (DoD) or children's hospitals. Figure 3 depicts the categorical breakout by year.

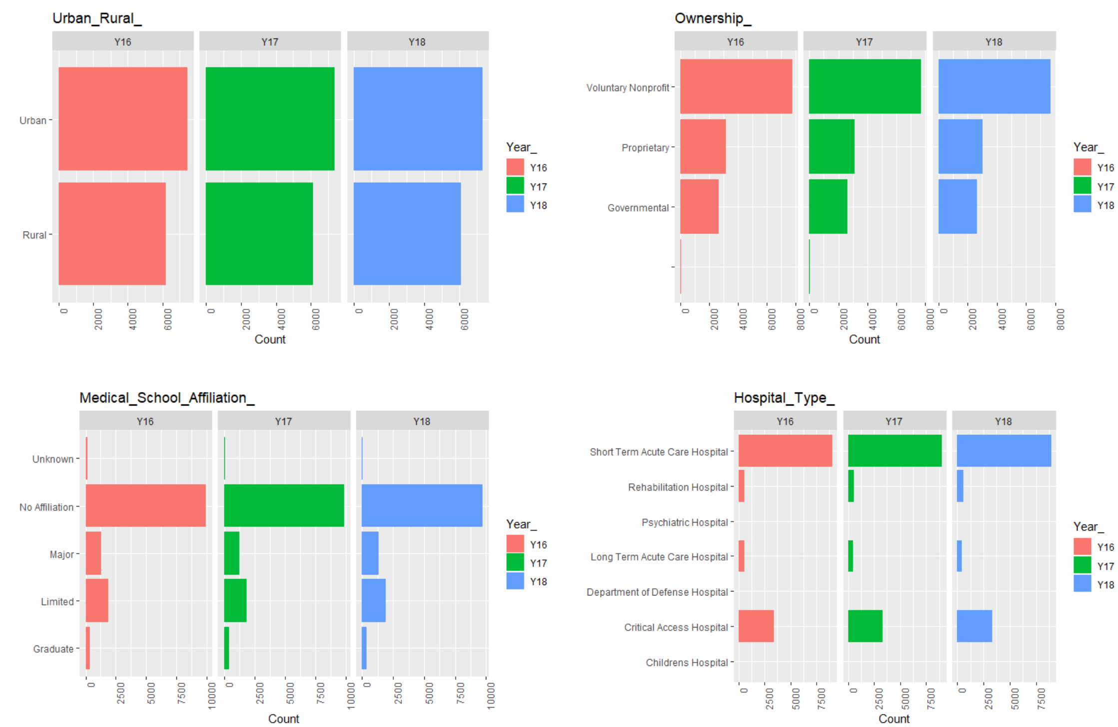

Figure 3. Categorical variables by year

3.4. Descriptive Statistics-Financial Estimates

In FY 2008, the Centers for Medicare and Medicaid (CMS) estimated that heart failure DRGs 291, 292, and 293 national average total costs per case were {$10.235, $6.882, $5.038} thousand, respectively. By FY 2012, CMS increased those estimates to {$11.437, $7.841, $5.400} thousand, respectively. In four years, the accumulation rates (1 plus the inflation rate) were 1.139, 1.117, and 1.072 for the DRGs in ascending order. Using these accumulation rates, estimates for 2016, 2017, and 2018 were generated. Table 3 shows these extrapolated estimates.

Table 3. Estimated total costs for heart failure by DRG in thousands, linear extrapolation method

DRG	**2016**	**2017**	**2018**
DRG 291	$12,780	$13,155	$13,243
DRG 292	$8,934	$9,245	$9,257
DRG 293	$5,788	$5,891	$5,998

Another method for estimating these costs involved the use of the Federal Reserve Bank of Saint Louis (FRED) producer price index for general medical and surgical hospitals [30]. The annual accumulation rates for 2013 through 2018 were estimated as {1.022, 1.012, 1,007, 1.013, 1.018, 1.023}, respectively. Applying these to the 2012 total costs from CMS results in Table 4 estimates for 2016 through 2018.

Table 4. Estimated total costs for heart failure by DRG in thousands, medical inflation rate method

DRG	**2016**	**2017**	**2018**
DRG 291	$12,058	$12,273	$12,582
DRG 292	$8,267	$8,414	$8,626
DRG 293	$5,693	$5,795	$5,491

Both estimates are fairly close. To estimate costs, we used both of these tables separately as upper and lower bounds. Since these total costs represent only CMS costs, the actual financial burden across all payers is likely underestimated as commercial third-party insurers can reimburse up to 90% more than Medicare for the same diagnosis [31]. Figure 4 illustrates the number of DRGs by year, while Figure 5 shows the associated aggregate cost estimates.

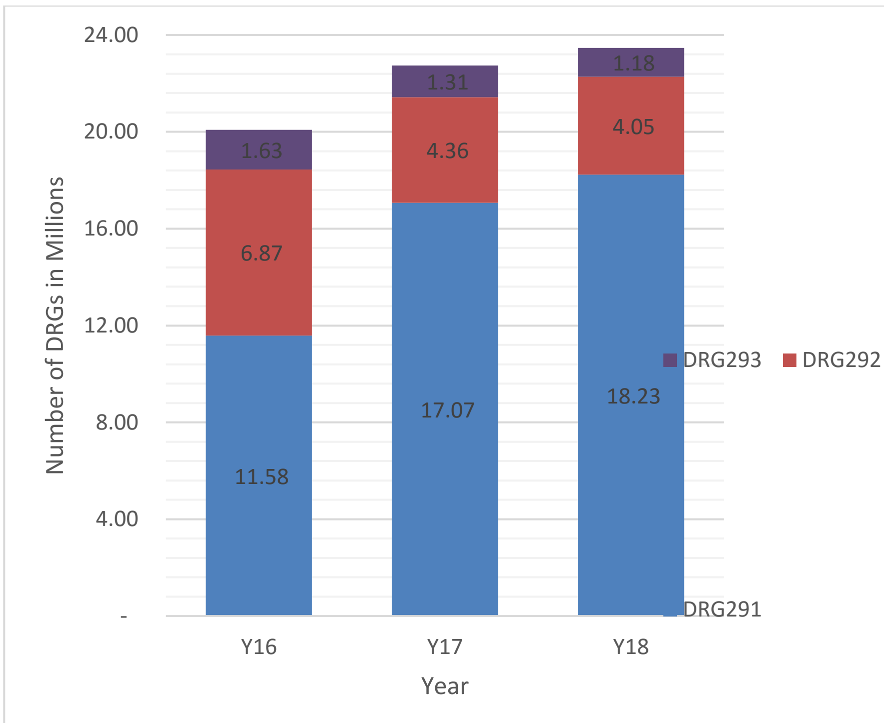

Figure 4. Number of DRGs by type (left axis) and cost estimates by DRG type and total, 2016 through 2018

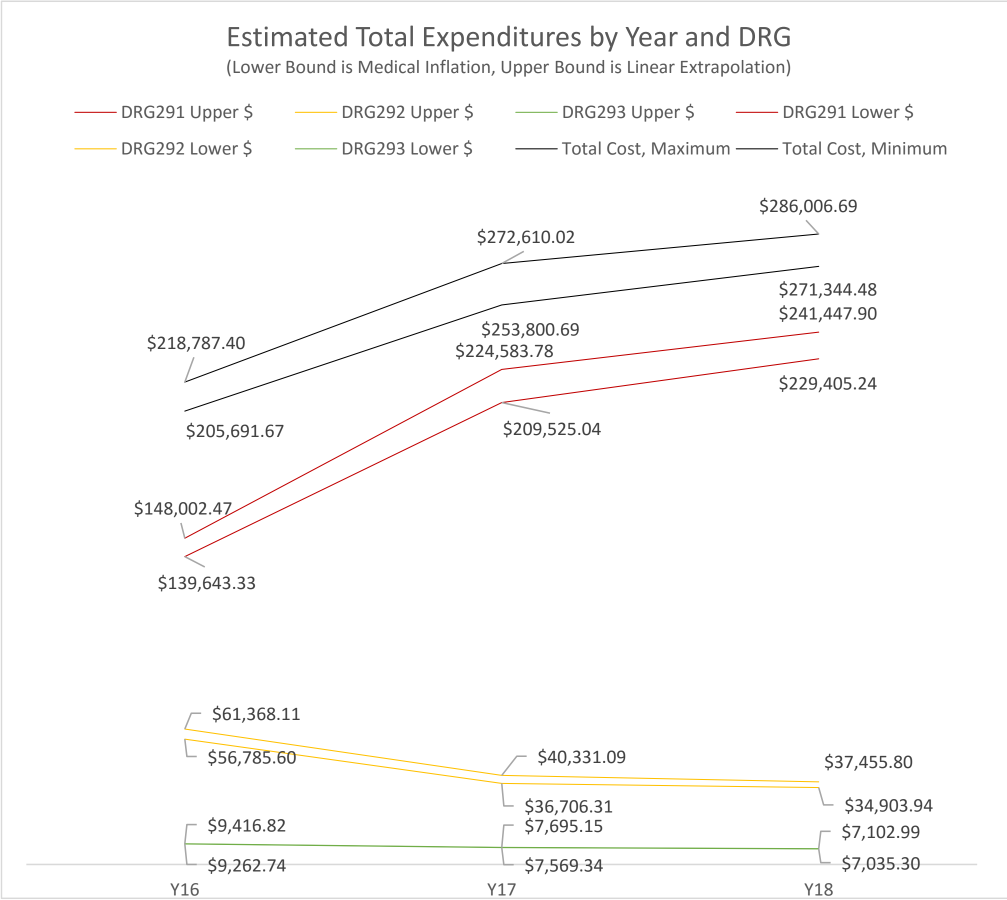

Figure 5. Associated cost estimates in billions (total and by DRG) per year

In Figure 4, it is clear that DRG 291, the DRG with the highest average reimbursement rate per case, has increased nonlinearly, while DRG2 292 has seen a small drop, and DRG 293 is flat. In Figure 5, the total cost estimates for 2018 are nearly $66 billion more than 2016 on average. DRG 291, the most expensive DRG, has seen reimbursement increases of $92 billion on average. Reasons for such an increase are explored in the discussion section.

3.4. Descriptive Statistics-Correlational Analysis

Hierarchical clustered correlation analysis of quantitative variables (Figure 6) illustrate tight relationships among many variables. Hierarchical clustered correlation analysis clusters variables based on distance measures (e.g., Euclidean), so that those which are most highly correlated are close in location. These variables are then placed into a correlation plot or correlogram. Figure 7 illustrates that discharges, acute days, and staffed beds are most closely associated with the number of diagnoses, our primary variable of interest.

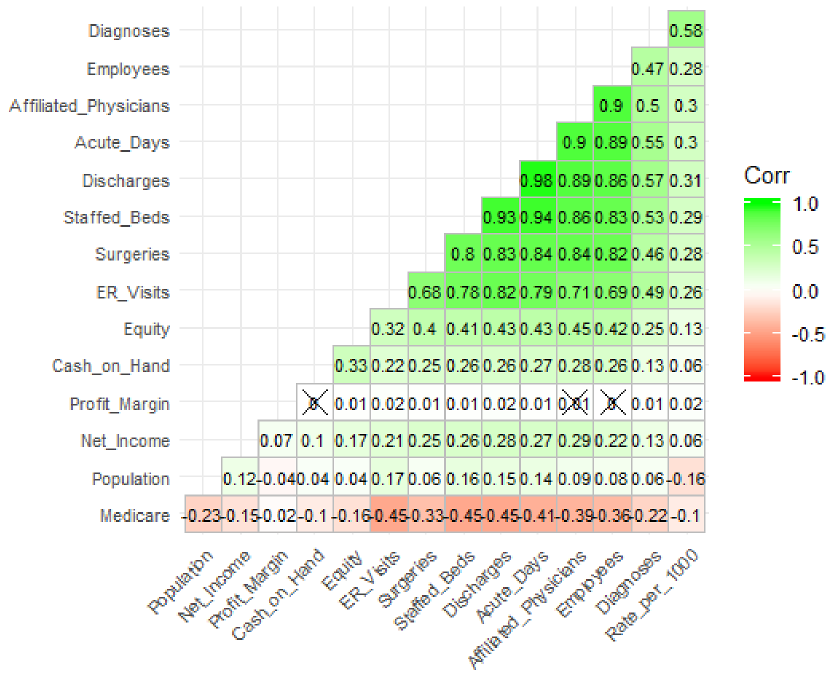

Figure 6. Hierarchical clustered correlation of quantitative variables

Analysis of the relationship between some categorical variables and the number of diagnoses also proved interesting. Notched boxplots by year and medical school affiliation reveal that a major affiliation experiences a larger number of diagnoses at the .05 level a result that is to be expected. (See Figure 6). Further, voluntary not-for-profits see a larger number of diagnoses (Figure 8).

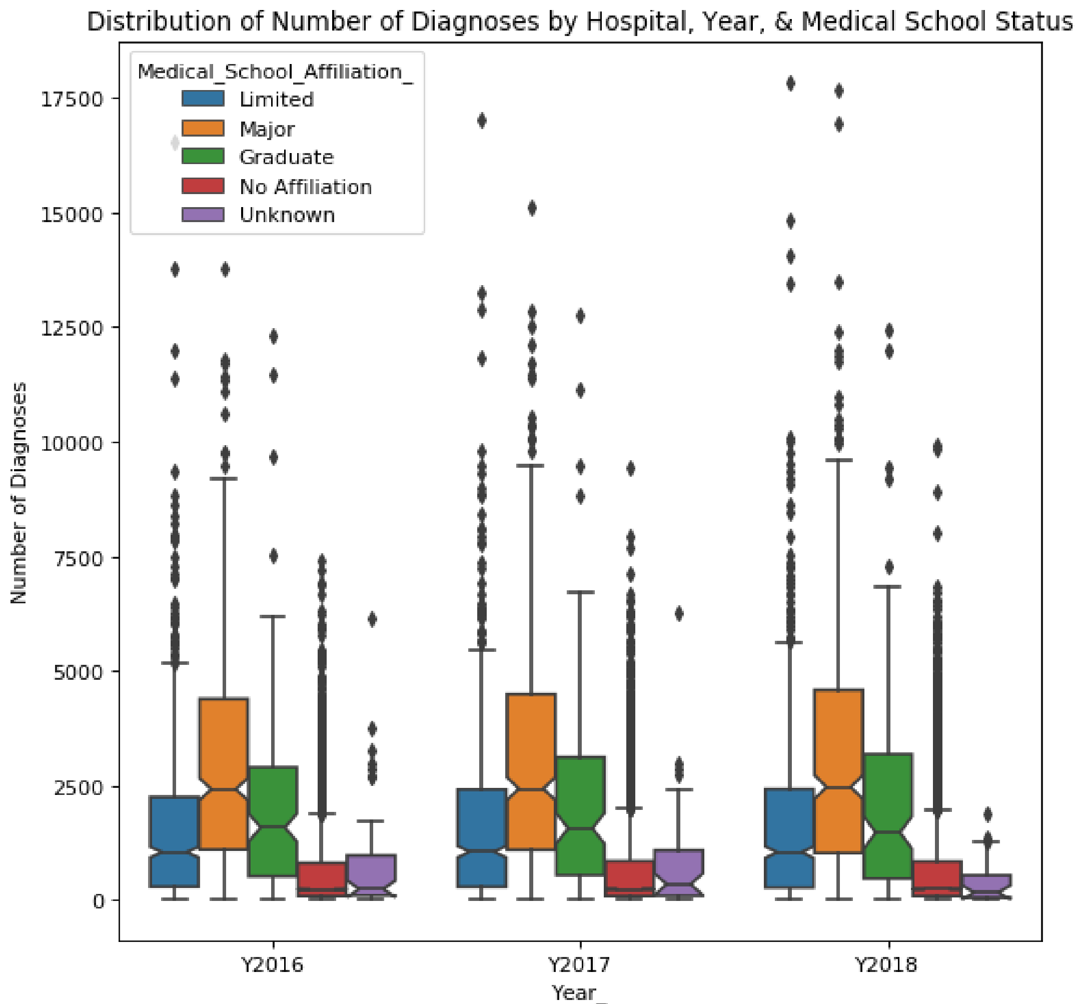

Figure 7. Number of diagnoses by year by medical school affiliation

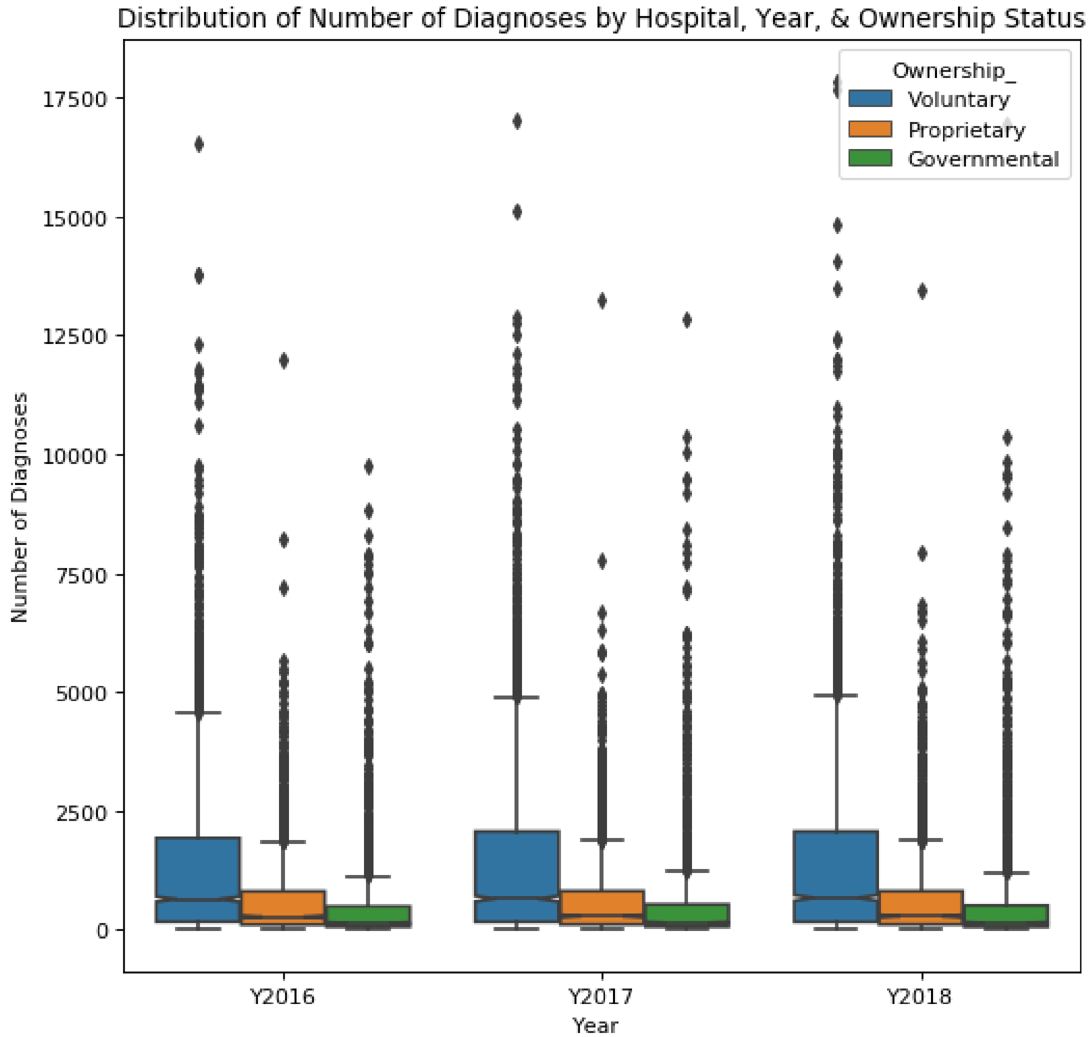

Figure 8. Number of diagnoses by year by type of hospital

3.5 Geospatial Analysis

A descriptive analysis of heart failure over time using geographical informat systems was conducted to evaluate regional differences. Primarily, we were interested in rates per 1000 in the population. Populations over time were based on Census Bureau estimates [5].

While DRG rates per 1000 were not constant over time, the concentrations were fairly consistent. There is a clear bifurcation in the center of the United States separating high and low rates. That bifurcation suggests a clear

West-East difference, favoring the West Coast. Washington, D.C. has had (on average) the highest diagnoses of heart failure followed by West Virginia, Alabama, Mississippi, Michigan, Louisiana, Kentucky, and North Dakota. Of interest is that previous studies indicate these states are also plagued by the opioid crisis [23]. Figures 9, 10, and 11show the diagnoses per 1000 by year 2016, 2017, and 2018, respectively.

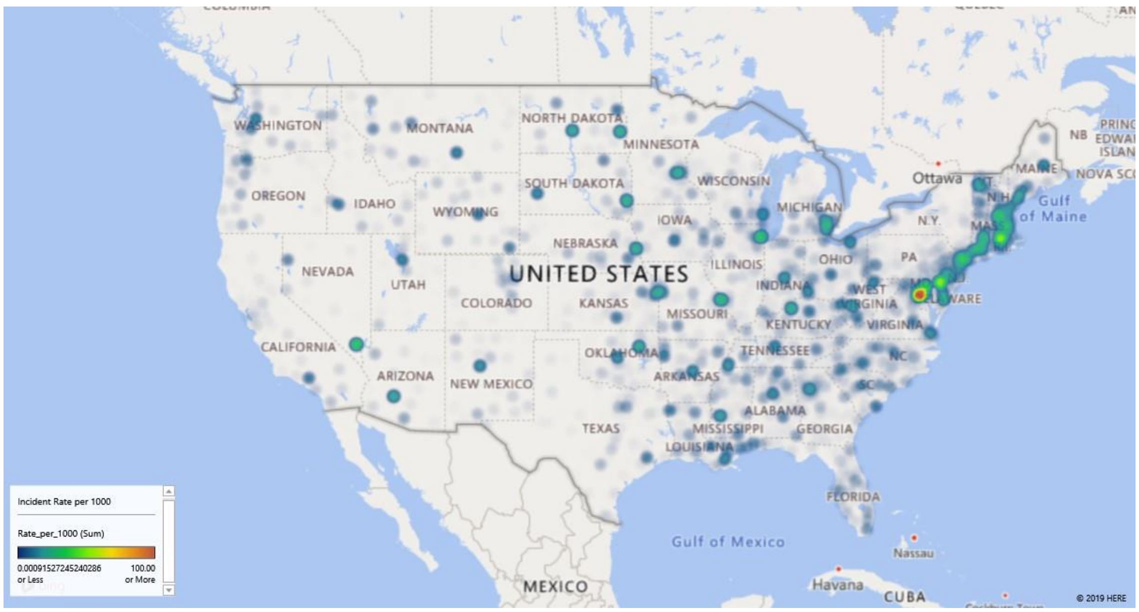

Figure 9. DRG rates per 1000, 2016

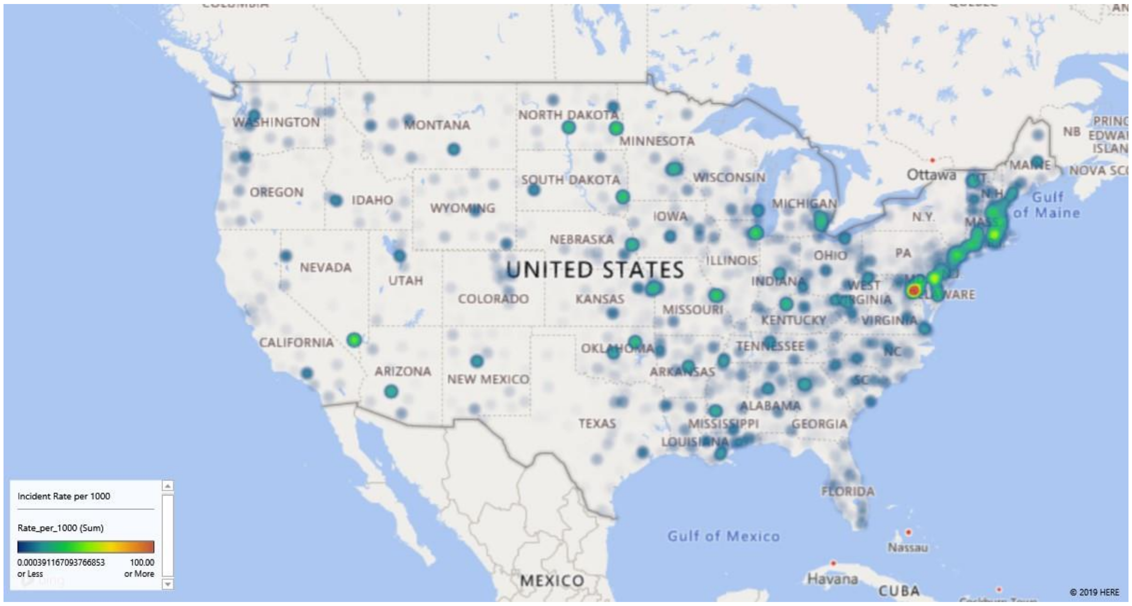

Figure 10. DRG rates per 1000, 2017

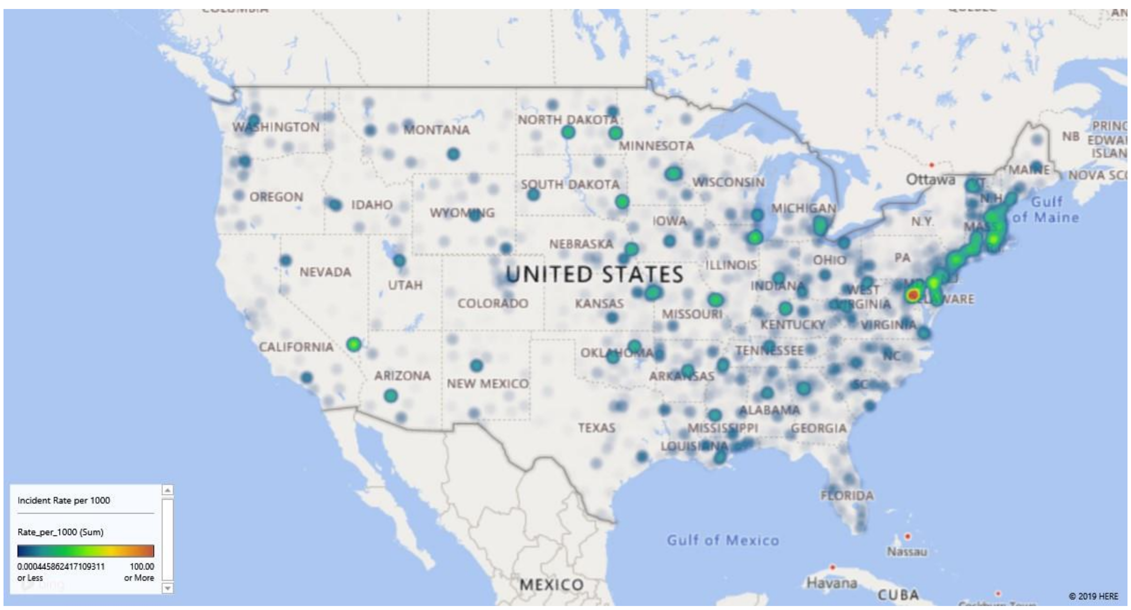

Figure 11. DRG rates per 1000, 2018

From 2016 through 2018, the average rate of diagnoses per 1,000 population increased for nearly all states. A Friedman rank sum test (paired, non-parametric ANOVA) of rates by state by year revealed significantly different rates by year by state (χ^2_2=70.941, p<.001). Figure 12 illustrates the changes by year and by state.

State	2016	2017	2018	% Change ('16 to '18)	Graph
NV	46.34	61.34	64.31	39%	
AK	30.07	37.23	40.15	34%	
ID	31.83	37.51	41.50	30%	
ND	74.73	99.91	97.16	30%	
MN	59.94	69.82	76.69	28%	
DE	81.17	98.61	102.68	27%	
KS	56.97	68.52	71.29	25%	
OR	38.86	44.47	48.61	25%	
AR	66.69	78.31	83.42	25%	
WY	43.58	43.72	54.25	24%	
IA	57.54	69.12	70.93	23%	
CA	37.42	43.71	45.97	23%	
IL	73.25	84.27	89.50	22%	
MO	77.69	90.00	94.66	22%	
OK	62.30	74.34	75.71	22%	
SD	67.77	75.17	82.07	21%	
CO	30.44	37.17	36.59	20%	
NE	56.72	61.91	67.72	19%	
MS	85.84	106.37	102.34	19%	
VT	57.01	67.09	67.66	19%	
GA	61.49	70.82	72.92	19%	
WV	90.56	110.99	107.02	18%	
VA	79.52	90.67	93.84	18%	
NY	52.87	59.33	62.38	18%	
PA	68.97	75.40	81.01	17%	
WI	61.71	68.77	72.24	17%	
MA	79.49	88.86	92.81	17%	
AZ	36.29	39.98	42.21	16%	
IN	79.81	88.98	92.44	16%	
NH	74.27	80.41	85.66	15%	
UT	24.12	26.64	27.77	15%	
NM	36.53	41.69	41.75	14%	
MT	53.48	61.36	61.09	14%	
TX	52.95	59.33	60.39	14%	
SC	68.81	77.83	77.68	13%	
TN	71.75	80.27	80.80	13%	
NC	81.46	92.95	91.59	12%	
CT	73.40	84.00	82.39	12%	
LA	81.38	89.59	91.29	12%	
FL	66.60	72.74	73.86	11%	
WA	49.86	54.90	55.23	11%	
NJ	73.79	79.90	81.64	11%	
KY	88.63	94.82	97.99	11%	
OH	81.70	88.69	89.68	10%	
RI	61.43	69.48	66.79	9%	
MI	88.70	98.58	95.67	8%	
DC	101.68	117.34	109.40	8%	
AL	80.70	86.36	84.15	4%	
MD	81.75	83.44	81.21	-1%	
HI	28.75	29.51	28.36	-1%	
ME	74.71	78.27	72.84	-2%	

Figure 12. Diagnoses per 1,000 by year by state

When 2018 data are aggregated at the state / territory level, the DRGs per 1000 paint a slightly different picture, with high-intensities in Washington D.C., West Virginia, Delaware, Mississippi, Kentucky, North Dakota, Michigan, and Missouri (listed in descending order.) Further, superimposing obesity prevalence intensity from the Centers for Disease Control and Prevention (CDC) shows significant correlation between obesity and DRGs per 1000 [32]. A Spearman's test for correlation of obesity prevalence and 2018 DRGs per 1000 was statistically significant with rho=.689, S=6,867.7, p<.001. Figure 13 provides the map of obesity and DRG rates.

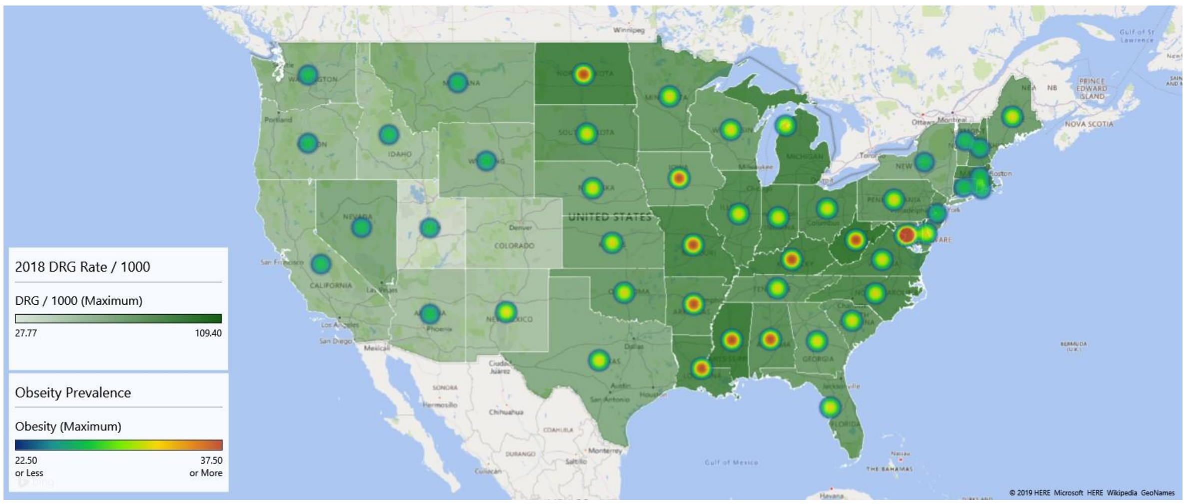

Figure 13. Map of DRG Rates / 1000 versus obesity prevalence

3.6. Explanatory Models

Explanatory models were sought to explain the number of diagnoses by facility. The importance of these models is that we might estimate demand based on workload, technical, financial, and geospatial-temporal variables. A discussion of data preparation and analysis follows.

3.6.1. Box-Cox Multivariate Transformations

To meet required regression assumptions, multivariate transformation using Box-Cox methods was conducted on location-transformed variables. The location transform was necessary to ensure that all variables were positive definite. Box-Cox methods search for the optimal power transform of all variables simultaneously such that the assumption of multivariate normality cannot be rejected. A logarithmic transform is defined as the power of zero. In order to ensure that all possible transformations are feasible, the data must be positive definite.

Thus each variable that was non-positive definite had the absolute value of the minumum added to each observations plus .01. Doing so ensured a positive definite location transform. These transformations are necessary only for non-tree models. (Tree models are location-scale invariant.) To prevent bias from being induced into the unknown test set, the transformations are completed only on the training set. The optimal powers found from the optimization associated with Box-Cox multivariate analysis are then applied to the test set. See Table 4 for the optimal powers.

Table 4. Optimal power transformations, Box-Cox methods

Variable	**Power**
Diagnoses	-.0673
Discharges	0.290
ER_Visits	0.417
Surgeries	0.364
Acute_Days	0.238
Net_Income	0.541
Operating_Profit_Margin	0.530
Cash_on_Hand	0.919
Equity	0.344
Staffed_Beds	0.170
Affiliated_Physicians	0.226
Employees	0.086
Medicare	0.788
Medicaid	0.032

3.6.2. Regression Models

Using the postive definite, Box-Cox transformed data, a regression model was fit hierarchially using the following blocks (in order): technical, workload, financial, geo-spatial. The multivariate transformation assumes that at least some independent variables cannot be fully observed or that we have incomplete observations on variables that might be fully observed. Thus, the transformations from the Box-Cox methods attempt to achieve multivariate normality rather than univariate normality. Hierarchical models attempt to fit obvious (known) variable blocks first followed by those of mmost interest. In our case, all blocks were statistically relevant to the analysis (see Table 5).

Table 5. Hierarchical analysis suggests all blocks are important

Block	Res.Df	RSS	Df	Sum of Sq	F	Pr(>F)
Technical	32404	53.933				
Workload	32400	44.398	4	9.595	1853.223	<.0001
Financial	32396	43.882	4	0.516	99.609	<.0001
Geospatial	32343	41.864	53	2.018	29.416	<.0001

Linear regression on the training set resulted in a reasonable fit that accounted for R^2=.750 or 75% of the sum of squared variability. No collinearity problems were present after transformation. Performance on the training set was insightful; however, the proof of model explanatory power rests in the training set estimates of the test set values. Applying the parameter estimates generated from the training set to the test set resulted in an R^2 of .749, barely any loss.

Given the model's ability to predict, the linear regression model was re-run on the entirety of the dataset after re-estimating the Box-Cost transformations, transformations which were only slight different in magnitude than those produced by the training set. The results again produce R^2=0.749. The actual versus predicted plot is shown in Figure 14.

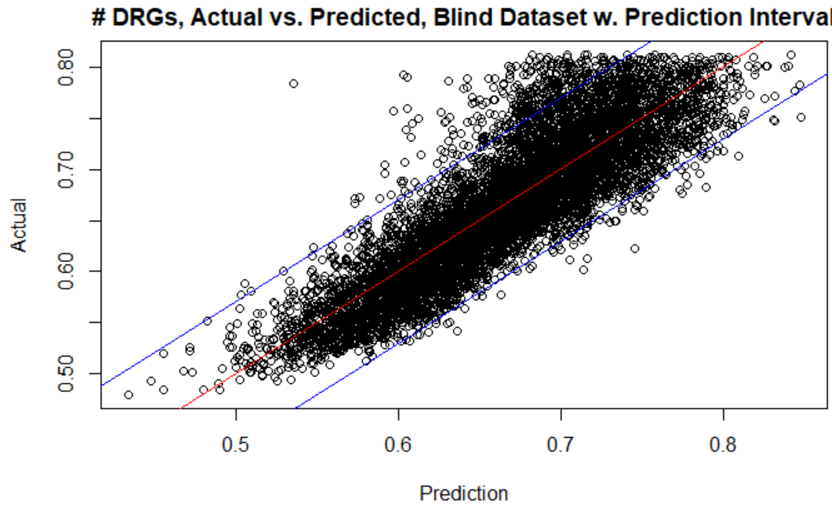

Figure 14. Plot of actual test-set data versus predictions from the training set

Further, we evaluated the coefficients and directions of those coefficients for forecasting the transformed dependent variable based on the number of variables included in the model. The top 1- variables in the regression model with their associated R^2 are shown in Table 6. Discharges, Medicare percentage, and hospital type are the primary variables of interest.

Table 6. Most important variables and associated parameter estimates based on number of variables in the model

# **Variables:**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Intercept	0.790	0.775	0.762	0.760	0.809	0.831	0.831	0.831
Discharges	-0.011	-0.011	-0.011	-0.009	-0.010	-0.010	-0.010	-0.010
DRG 293		0.056	0.069	0.070	0.070	0.071	0.071	0.071
DRG 292			0.026	0.026	0.026	0.027	0.027	0.027
Acute-Care Hospital				-0.025	-0.033	-0.051	-0.050	-0.048
Medicare					-0.065	-0.068	-0.066	-0.065
Critical Access						-0.025	-0.025	-0.025
Major Med. School							0.014	0.013
Voluntary Non-Profit								-0.006
R^2	0.545	0.680	0.703	0.719	0.733	0.741	0.744	0.745

Outside of simple linear regression, we explored constrained regression techniques (lasso, ridge, and Elastic Net). Lasso regression was inferior to linear regression in terms of R^2 (.651 vs. .750) on the test set. Ridge regression and Elastic Net were also unable to beat linear regression in terms of effects with both R^2 nearly identical to that of lasso, {.651, .681}, respectively. In this case, the linear regression model was not overfit.

3.6.3. Tree Ensemble Models

Several tree regressor models were built and compared on an 80% training set. There was no need to use the transformed data for tree models, as these are location / scale invariant. These tree models included a bagging regressor (BR), a random forest regressor (RFR), an extra trees regressor (ETR), a gradient boosted regressor (GBR), and an extreme-gradient boosted model (XGR). Tree models are atheoretic, as each tree developed may be different from the previous one. When ensembled, variable importances emerge that determine which items are most important to determining how to classify or regress in a nonlinear fashion (piecewise). The number of trees used for each estimator was tuned along with the maximum depth of the trees (number of branches). A pseudo-random number ensured that any model improvements were not due to the random number stream. The results of these models on the unseen test set are shown in Table 6. Most importantly, all of these models account for more variance than regression models. The models predict at 97.1% and above in terms of variability capture. (See Table 7.)

Table 7. Coefficients of determination for the five tree ensemble models

Model	R^2
Extreme Gradient Boosting	0.975
Extra Trees	0.975
Gradient Boosting	0.974
Random Forest	0.971
Bagging	0.970

Because of the tight congruence of these models, we ensembled the estimates of the number of DRGs forecast by each to produce importance statistics. The variables of most importance includes discharges, Medicare percentage, acute days, affiliated physicians, staffed beds, employees psychiatric hospital status, ER visits, medical school affiliation status, Puerto Rico status and surgeries. See Table 8.

Table 8. The variables and the importance factors associated with them, averaged over all tree ensemble models

Variable	**Importance**
Discharges	0.331
DRG__DRG291	0.287
Medicare	0.063
Acute_Days	0.035
Year__Y16	0.031
ER_Visits	0.029
Hospital_Type__Short Term Acute Care Hospital	0.026
State__VA	0.023
Affiliated_Physicians	0.023
State__MD	0.017
Hospital_Type__Rehabilitation Hospital	0.017
Staffed_Beds	0.016
State__FL	0.015
Surgeries	0.014
DRG__DRG292	0.011
State__OK	0.011
Medical_School_Affiliation__Major	0.010
State__IL	0.010

State__NE	0.010
State__OH	0.010
DRG__DRG293	0.010
Employees	0.009
State__NC	0.009
State__MI	0.009
Equity	0.008
Medicaid	0.007
Cash_on_Hand	0.007
Profit_Margin	0.006
Net_Income	0.006
State__CT	0.003
Year__Y18	0.002
Year__Y17	0.002

When comparing the regression models with the ensembled forests, we see that the first two terms are congruent (discharges and Medicare percent). Interestingly, no financial models are in the top 10 effect sizes of the regression or tree models. Facility technical and workload variables are the most important determinants of heart failure. In the tree models, there were piecewise linear effects identified for states that were not seen in the regression models.

4. Discussion

With Figure 2 (DRGs per year), we can see that the number of DRGs for heart failure is increasing over time. We do not have sufficient data or monthly data to run time series analyses such as exponential trend seasonality and auto-regressive integrated moving average models. Even without those models, it is clear that there appears to be an increase in heart failure diagnoses and a change in intensity from 2016. What is most interesting is that intensity changes are largely in the North Central while current incidence rates are highest East of the Texas panhandle.

Further, we see variables that explain the number of DRGs of a facility over time. Some of these are logically associated with the size of facility (e.g., number of discharges). One of these is logically associated with age (Medicare, available to those 65 and older.) However, the tree model ensembles suggest a significant geographic component for explaining heart failure. Specifically, Tennessee, Puerto Rico, North Carolina, New York, South Dakota, Hawaii, Arizona, Michigan, Washington D.C., Florida, and California. Further, there is an effect by year noticed in the ensemble of tree models, as 2016 is much lower than 2018.

Considering our findings from a financial perspective, our results clearly indicate there has been a significant shift in cardiology diagnoses since 2016. As we note in Figures 4 and 5, it is clear that DRG 29, Heart Failure and Shock with Major Complication of Comorbidity (MCC), counts and costs have increased nonlinearly. DRG 292, Heart Failure and Shock with Complication or Comorbidity (CC), has seen a small drop and DRG 293, Heart Failure and Shock without Complication or Comorbidity (CC) / Major Complication or Comorbidity, is flat. A DRG is determined by the principal diagnosis, the principal procedure, if any, and certain secondary diagnoses identified by CMS as comorbidities and complications (CCs) and major comorbidities and complications (MCCs) [33]. A comorbidity is a condition that existed before admission. A complication is any condition occurring after admission, not necessarily a complication of care [34]. Although heart failure DRGs represented the largest cause of hospitalizations among Medicare beneficiaries and were among the costliest to Medicare prior to 2016, the results of our study now suggest that total cost estimates for these three diangoses related groups in 2018 are now nearly $61 billion more than 2016 [35-37]. DRG 291, the most expensive DRG, is associated with $91 billion cost increases from 2016.

Although our research has demonstrated substantial reliability in the explanatory factors associated with the longitudinal growth trajectory, it does not explain the reasons why we see such substantial growth in DRG 291 versus DRGs 292 and 293. Given our study results, there are several potential drivers that could meaningfully contribute to the growth in DRG 291 from 2016 to 2018. First, there may have been a significant increase in patients with cardiac conditions with additional major comorbidities. This cannot be simply dismissed given the rapid increase in Medicare eligible beneficiaries – by some estimates as many as ten thousand per day – and the prevalence of obesity, coronary obstructive pulmonary disease, and other age and lifestyle related conditions [38-40]. However, given the relatively flat or declining rate in DRGs 292 and 293, we do not believe this is the only driver of our findings. Our findings support other predictions that soon patient demand will outpace the supply [41,42].

Second, up until October 2018, all extracorporeal membrane oxygenation (ECMO) cases were assigned to DRG 003, which typically reimburses at a rate of roughly $100,000 per case [43]. In fiscal year 2019, which started in October 2018, that reimbursement methodology changed so that every ECMO case would no longer be assigned to DRG 003. Rather, the DRG assigned depends on the path of the cannulation. If the ECMO patient is accessed centrally, DRG 003 is still applied. However, if cannulated peripherally, then it falls into another (lower-paying) DRG, on of which is DRG 291 [44,45]. Although there is only a three month overlap of this change and our study dataset, there is high likelihood this additional volume is reflected in our study in 2018.

Third, since 2010 and the passage of the Affordable Care Act, many cardiologists have sought hospital employment versus private practice. The uncertainty of continued healthcare reform efforts, burdensome electronic health record costs, declining CMS reimbursement rates in physician professional fees for non-invasive testing procedures (e.g., electrocardiograms, nuclear stress tests, etc.), and younger clinicians' different expectations related to work and personal life balance have all combined to prompt cardiology groups to seek ways to stay financially viable. Today more than 70 percent of cardiologists are employed by hospitals or health systems [46,47]. Hospitals, in turn, seek to maximize utilization and reimbursement from the highly resource intensive cardiology service lines. Prior research from the National Bureau of Economic Research found that hospitals responded to price changes by up-coding patients to diagnosis codes associated with large reimbursement increases. These authors indicate hospitals do not alter their treatment or admissions policies based on diagnosis-specific prices; however, they employ sophisticated coding strategies in order to maximize total reimbursement [48,49].

Fourth, we suspect the recent transition from ICD-9 to ICD-10 that occurred in October 2015 is a contributing factor. Starting on October 1, 2015, there were 68,069 valid ICD-10-CM diagnosis codes, representing a nearly 5-fold increase from the 14,025 valid ICD-9-CM diagnosis codes. ICD-10-CM diagnosis codes are structured differently from ICD-9-CM codes and provide more detail [49]. This code expansion allows providers the ability to capture the severity and specificity of the condition in much greater detail – which may prompt increased use of DRG 291.

As we look at the number of times many of the codes are being assigned to any particular patient, we see a significant change in how physicians are diagnosing. Previously, we had an ICD-9 diagnosis code with some generic areas that covered many patients. A very general and generic set of heart failure codes existed under 428.x in ICD-9. There was little specificity as to sidedness of the issue or specifics of the disease. ICD-10 codes allow a very specific diagnosis per codes, and these codes will continue to change over time due to physicians' adaptation of coding in this manner. For example, the I50.8xx codes did not exist in 2016, but they have been used since 2017, with another change adding more subcodes in 2018.

Today, we have very specific codes for very specific diseases and processes which go on within the heart, to include acute on chronic concerns as well. The adjustment to ICD-10 codes has undoubtedly created a learning phase for practitioners on determining the appropriate codes as well as when and how to use them.

We would expect to see some elevation from year to year with the growth of the Baby Boomer population coming into healthcare, without an age adjustment to the population. This is shown in the numbers from 2016-2018 with total diagnoses moving from 5.39M to 5.61M to 5.69M. However, how the diagnosis codes are being applied shows variation from year to year, to include some years of negative numbers in several codes. Many of the negative values for codes are for "unspecified" types of heart disease. This shows that we are moving away from generic diagnoses and towards diagnoses based in specificity instead, which is one of the purposes of moving to ICD-10.

One could draw a conclusion of upcoding: a monetary free-for-all, assigning diagnoses based on what pays the most. However, in many cases the physician is not billing based on a diagnosis code, but on the level of the visit and the type. This is obviously dependent upon insurance types, contracts, and other inputs outside the discussion level of this paper.

Of curious note, we are seeing an interesting trend looking at the GIS information included in this paper to where heart failure diagnoses are being seen. In the areas which are surrounding oil and gas pipelines, we have seen a growth in the numbers of heart failure diagnoses in those areas. For our purposes here, the conclusion is only empirical, however there is a significant change in the heat maps in the areas surrounding pipelines. If the reader will overlay the route of the Keystone Pipeline from Canada to Galveston, Texas, you will not a curious overlap with incidence of heart failure. Recently, one author also noted an increased use of methamphetamine and cocaine by oil field workers [51]. It is certainly beyond the scope of this research, but it might be something to consider for future research because a consequence of the use of these illicit drugs are differing heart disorders, to include heart failure.

5. Conclusions

The policy implications of this analysis are several. First, clearly the need to continue to focus on a population health approach to reduce obesity rates across the country is needed, focusing specifically on the geographic states identified with the highest incidence and prevalence across the study timeline. The large increase in the DRGs 291 – 293 show that shifting funding to prevention from chronic disease management certainly has the financial evidence to support this approach. The argument is certainly made that education is not sufficient to change lifestyle and behaviors contributing to the rise of heart disease shown here, so it is time to begin exploring a punitive annual health assessment requirement for high-risk individuals who fail to make significant risk factor changes. The health administrator will certainly need to analyze both the volume and scope of services within these analyzed DRGs to ensure the evident increase in demand indicated will be available, specifically in the identified high incidence geographic areas. In Certificate of Need (CON) states, this analysis will be beneficial in getting the CON approved based on the increased demand. Evidence shows that CON states for cardiac services, of which most of the high incidence and prevalence states in the study are, have higher mortality rates for cardiac services [51]. Another significant potential policy implication is a continued re-evaluation of the need for CONs in general, as multiple researchers are showing it is in question if they are still needed in today's healthcare environment, and potentially are leading to restriction of services that are in increasing demand and lead to higher mortality [52].

List of Abbreviations.

CC. Complication of Comorbidity

CMS. Centers for Medicare & Medicaid

CON. Certificate of Need

DRG. Diagnostic Related Group

ECMO. Extracorporeal membrane oxygenation

GIS. Geographical Information System

HFpEF. Heart Failure preserved Ejection Fraction

HFrEF. Heart Failure reduced Ejection Fraction

ICD. International Classification of Disease Version (-version)

MCC. Major Complication of Comorbidity

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Climate Justice: Some Observations from a Practicing Lawyer/Economist

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Abstract

Climate Justice is a relatively new term without a universal definition. Each individual and society frame their perception of climate justice through actual experiences. From water, land, and air, the term Climate Justice embraces all natural resources for humanity.

This is one story of an agriculturalist and economist/lawyer's journey in search of the meaning of climate justice. From supervising a large Arizona farm to drafting legislation and litigating water, land, and air issues, climate justice has been a common thread in those pursuits. Water management tools through irrigation practices and technology affect climate. Land use for irrigated farmlands and locating of sewage plants and landfills also affect someone's climate. These experiences, among others, are shared in this presentation that looks into the origin and meaning of climate justice.

Proposed Retirement Policy Changes in the United States: A Green Life?

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Abstract

During the 2020 Presidential Campaign in the United States, President Joseph Biden proposed to eliminate the current income tax deduction for retirement savings contributed to qualified plans and Individual Retirement Accounts (IRAs), and replace the deduction with a newly created tax credit. While details of the proposal have still not been made public, it appears that the amount of the credit may be calculated in a way that would be revenue neutral from the perspective of the Government. A revenue neutral credit percentage would permit the government to implement the change without an anticipated loss of revenue, which may be particularly important in light of current budget constraints and federal spending due to the COVID-19 crisis.

While the stated objective of the proposal is to equalize the tax benefits received by US taxpayers for retirement contributions irrespective of the taxpayer's marginal income tax rate, elimination of the deduction in favor of a tax credit will cause the adjusted gross income of all taxpayers making retirement contributions to increase. As adjusted gross income increases, taxpayers will be exposed to the potential loss of other tax credits and benefits that are dependent on a taxpayer's level of adjusted gross income. This may be particularly impactful for low to middle-income taxpayers, and, as a consequence, will wholly or partially offset the benefits promised by the President as a result of the change. Furthermore, this change will likely increase interest in Roth savings opportunities for wealthier taxpayers, potentially reducing future governmental revenues and may discourage the adoption of qualified plans by small and medium sized businesses due to the loss of anticipated tax benefits for the owners of those businesses.

This article will explore the policy objectives of the proposal, how the proposal will change the calculation of taxable income, and the impact of the proposal on low, medium, and high income taxpayers.