2019

Perceptions of Economic, Health, and Environmental Effects of Hydraulic Fracturing in Indiana

Juliana Bayowa
Walden University

Walden University

College of Health Sciences

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Juliana O. Bayowa

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Dr. David Anderson, Committee Chairperson, Public Health Faculty
Dr. Leslie Elliott, Committee Member, Public Health Faculty
Dr. Vibha Kumar, University Reviewer, Public Health Faculty

Chief Academic Officer
Eric Riedel, Ph.D.

Walden University
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Abstract

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Juliana O. Bayowa

MSc, University of Ibadan, 2008

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Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Public Health

Walden University

February 2019

Abstract

Effects of hydraulic fracturing (HF) have become a controversial public health issue in the United States. The purpose of this qualitative case study was to explore community members' perceptions of economic, health, and environmental effects of HF in Gibson County, Indiana. The conceptual framework was adapted from the health belief model and was named the HF health impact belief model (HFHIBM). Data were collected from stratified purposeful non randomly selected 32 Gibson community members, using semi structured questionnaires, complete observations, and existing documents. Stratification was based on factors influencing perception, such as, gender, race, level of education, age or technology exposure, and level of media use. The observed community showed no economic boom or prevalent diseases, with functional and few abandoned pump jacks located on some of the farmlands. Data collected from the returned questionnaires were analyzed using hand coding and software. The results revealed that 72% of participants lacked awareness of HF, 90.6% reported lack of involvement in the decision-making process to locate HF near their community, and 21.6% of the 40.6% of participants with awareness reported that HF should be continued if the benefits outweigh the negative effects. Based on the constructs of HFHIBM, the low awareness of HF has implications on the community's acceptance of HF, and the use of sustainable and environmentally safe alternatives may result in better acceptance of HF. Increased awareness of HF may lead to the development of environmentally friendly, sustainable preventive actions, better community health outcomes such as reduced morbidity and mortality rates, and improved drinking water quality in neighboring communities.

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Dedication

This dissertation is dedicated to God, the Alpha, and the Omega.

Acknowledgments

I wish to say a special thank you to all who have contributed in one way or another toward the completion of my Ph.D., including my chair and committee member, my faculty at Walden University, my family members, my friends, and my classmates.

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Chapter 1: Introduction to the Study

Hydraulic fracturing (HF) was developed as a result of the desire of the United States to become energy independent to prevent national security risk (Mehamy & Goggemos, 2015). The United States has tended to consume more energy than it has produced, resulting in the need for imported fossil fuel (Mehamy & Goggemos, 2015). According to the U.S. Energy Information Administration (USEIA, 2017a), in 2005, the United States imported 30.197 quadrillion Btu's of energy, produced 69.431 quadrillion Btu's, and consumed 100.18 quadrillion Btu's, making 2005 the year with the highest importation of energy since 1950.

Three approaches have been considered to resolve the issue of U.S. energy dependency: renewable energy sources, reduction of energy consumption especially in the transportation sector, and nonrenewable resources such as oil and shale (Mehamy & Goggemos, 2015). HF is also referred to as shale gas because the oil and gas are recovered from shale rock. Nonrenewable fossil resources, such as shale gas or HF, were chosen and introduced in 1947 (Mehamy & Goggemos, 2015) and became the new unconventional oil and gas extraction method in the United States (U.S. Environmental Protection Agency [EPA], 2017) and some other parts of the world. Oil and gas that flow smoothly through porous rock from existing reservoirs are collected using the natural pressure of wells and pumping or compression operations are termed conventional, while other methods are referred to as unconventional (Department of Environment and Heritage Protection, 2017). HF is an extraction method developed to access fossil energy deposits not previously accessible for drilling operations, through fracturing of rock

formations using sand, millions of gallons of water, and chemicals, some undisclosed, to bring oil and gas to the ground surface (EPA, 2015; Hoffman, 2017).

The effects of HF have been controversial (Hoffman, 2017), although some researchers have found HF beneficial in terms of economic value, others have found HF harmful to the health of the communities where extraction sites are located (Gorman, 2009; Howarth, Ingraffea, & Engelder, 2011; Jackson et al., 2014; McDermott, Kaktins, & Sattler, 2013). The community members in close proximity to HF oil and gas extraction sites have low awareness of the economic, health, and environmental effects of HF in their communities (De Coza, 2012). In research conducted on people's awareness of HF, 38% of respondents could identify HF extracted shale gas from a list, 39% were unaware, and 17% believed that fossil fuel was coal (De Coza, 2012). In addition to low awareness of community members, community members may not be involved in the decisions to locate HF oil and gas extraction sites in close proximity to their communities. Community members should be included in the approval, planning, and management of activities carried out within or in close proximity to their communities (Elnokaly, 2014) because they are most impacted by the consequences of such actions.

Several communities in the United States are located in close proximity to HF sites. Gibson Bottoms, in the southwestern part of Gibson County in Indiana, is an example of such a community that contains more HF operations than the rest of Indiana (Indiana Economic Digest, 2017; Indiana University, 2015). HF has been in existence in the southwestern part of Gibson County from 2011 and may have involved 150,000 to 2 million gallons of fluid per well (Indiana Economic Digest, 2017). Gibson Bottoms had

more HF operations than the rest of the state (Center for Media and Democracy, 2015; Indiana Economic Digest, 2017). Community assessment of HF operations and perceptions are needed to reveal the needs of the Gibson community to the authorities that may assist in meeting those needs. HF operations may result in the decrease of stream flows, overuse of drinking water supply, reduction of the surface water reservoir, and lowered water tables (Network for Public Health Law, 2011). Involving community members in their environmental issues and what concerns them may also expose underlying problems hidden from outsiders.

HF has positive economic benefits despite the negative health and environmental effects (Hoffman, 2017; Howarth, Ingraffea, & Engelder, 2011). HF involves the fracturing of shale using horizontal drilling to reduce the cost of gas extraction. HF may also be economically beneficial by adding natural gas to the domestic resources of the energy portfolio of the United States, which is now primarily coal, as well as reducing natural gas prices and coal demand (Michaels & Simon, 2013) and creating jobs.

During HF, millions of gallons of water are pumped underground mixed with other chemicals, some undisclosed due to a trade secret, resulting in the release of gases like methane into the atmosphere (Howarth, Santoro, & Ingraffea, 2011). According to the EPA, 3.7% to 7.9 % of shale gas production enters the atmosphere through leaking wells, and 1.9 % of the gas production emits as methane (Howarth, Santoro, & Ingraffea, 2011). Methane and other gases may be contributing to global warming. Methane and other gases from HF oil and gas extraction may be contributing to the overall greenhouse gas emission (Ladd, 2015) globally, which is still debatable and controversial. Methane is

a greenhouse gas, with a global warming potential higher than that of carbon dioxide (Howarth, Santoro, & Ingraffea, 2011). The shale gas or HF footprint is higher than conventional gas or oil when viewed over 20 years, and compared to coal, the footprint of shale gas is about 20% greater (Howarth, Santoro, & Ingraffea, 2011). HF may also be responsible for the degradation of physical infrastructure due to the use of heavy vehicles in extraction sites (McDermott et al., 2013). During HF, some chemicals are suspected to be released into the atmosphere, such as particulate matter ($PM_{2.5}$). $PM_{2.5}$ breathed in may deposit deep in the lungs, resulting in heart disease, asthma, premature death, chronic obstructive pulmonary disease, cancer, and premature birth (Natural Resources Defense Council, 2014). Some other suspected negative effects of HF include induced seismic activity, air quality impacts, and water quality impacts (Mehamy & Goggemos, 2015). These effects deprive the neighboring communities of clean air and well water access and contribute to strained infrastructure (Hoffman, 2017).

Increased awareness, involvement, and perceptions of community members in close proximity to HF oil and gas extraction sites may be critical when locating HF sites because HF impacts the community members (Hoffman, 2017). This study addressed the perceptions of Gibson community members regarding HF and the effects of HF on the Gibson community. The results of the study may be used to raise community awareness, to determine whether the community finds HF beneficial to the Gibson community, and to increase the level of involvement of community members in the decision of locating HF in their community. Location of facilities for national benefit without consideration of the communities may result in lack of environmental injustice (National Institute of

Health, 2015). Involving communities in decisions is important, may reduce or prevent litigation, and may contribute to the success of such decisions (Ladd, 2015). According to McDermott et al. (2013), the principle of precautionary approach needs to be applied in locating HF extraction sites. The precautionary principle is taking preventive action in uncertain situations, shifting the burden to the proponents of the activity, exploring alternatives to harmful actions that may evolve, and increasing the participation of the public in decision-making (McDermott et al., 2013).

Activities carried out in communities may be beneficial to the general good of a country and may have negative effects on the communities where such activities are processed. Access to clean air and uncontaminated well water are public goods. A public good is a service provided without profit to all members of the population with two distinct characteristics: nonexcludability and nonrivalrous consumption (Cowen, 2008). HF, though beneficial to the United States, may be harming the health of the local communities where extraction sites are located (McDermott et al.).

There is the need for further research to determine whether HF is beneficial or detrimental to communities in close proximity to the extraction sites. In the current study, the diverse perceptions of community members were used to determine whether HF was beneficial or detrimental. These perceptions may be used to inform the decision on whether to locate HF close to communities. This study evolved from the need for further research on HF to clarify existing controversies on the effects and to fill the gap created by low awareness of communities, including lack of involvement or participation in HF decisions (Haggerty & McBride, 2016). This study focused on the perceptions of the

effects of HF on community members in close proximity to HF using Gibson County as a case study. Findings may clarify the consequences of locating HF near communities in the United States.

My study aligned with the recommendation of Powers et al. (2015) that oversight of technology, better participation of the public in decision-making, and improved analysis of the risks involved during HF may further expose the consequences of HF from the point of view of the public or community. Findings from the current study may contribute to better policies and guidelines in the practice of HF, resulting in better economic and health outcomes of community members in close proximity to HF oil and gas extraction sites, and in a cleaner, less toxic environment. The study may assist in better involvement and participation of community members in locating HF sites, increased awareness of HF, and the creation of new guidelines and policies (Tyrell & Lawrence, 2013) on HF oil and gas extraction in the United States. The study may also benefit the U.S. population and organizations in charge of health and environment, such as the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), and the EPA. Findings may contribute to long-term health and environmental benefits resulting from increased awareness of HF effects and the mitigation of future negative HF effects among the U.S. population.

Problem Statement

HF is a controversial issue in the United States (Boudet et al., 2014; Hoffman, 2017). HF is located in close proximity to many communities in the United States.

Gibson Bottoms in the southwestern part of Gibson County in Indiana is an example of such a community in the United States (Indiana University, 2015).

HF may have positive economic benefits, but it also has negative health and environmental effects (Hoffman, 2017; Howarth, Ingraffea, & Engelder, 2011). Some suspected negative effects of HF are induced seismic activity, air quality impacts, and water quality impacts. Ecosystem fragmentation has caused seismic activity in Oklahoma, which has resulted in 518 earthquakes of 3.0 or higher in magnitude in 2016 compared to nine quakes between 2004 and 2008 before the oil boom (Wethe, 2016). One recent earthquake on November 6, 2016, in Cushing, Oklahoma, was 5.0 magnitude and caused damage to several buildings (Juozapavicius, 2016).

HF may have contributed to global warming as a result of chemicals, such as methane, released into the atmosphere (Ladd, 2015). In addition, the large volume of water used during HF is suspected to reduce the water supply to communities (Juozapavicius, 2016) while chemicals used during HF have leaked into neighboring wells, resulting in negative effects on the sensory organs, skin, eyes, gastrointestinal and respiratory systems of affected individuals (Geological Society of America, 2015; Hoffman, 2017; Natural Resources Defense Council, 2014; Rabinowitz et al., 2015;). The EPA (2016) also found evidence that HF may have had an effect on drinking water resources during water acquisition, chemical mixing, well injection, water handling, wastewater disposal, and reuse stages of HF. An example of the negative effects of HF on community water is the spill of 3 million gallons of brine that contaminated two creeks and polluted some drinking water (Indiana University, 2015).

There is the need for further research to determine whether HF is beneficial or detrimental to communities in close proximity to the extraction sites. According to Mehamy and Guggemos (2015), the process of HF has both benefits and threats, with argument between the economic and energy stability benefits, against the environmental sustainability threats. In the current study, the diverse perceptions of community members were used to determine whether HF was beneficial or detrimental. These perceptions may be used to inform the decision on whether to locate HF close to communities

Purpose of the Study

This study addressed community perceptions of the benefits and challenges of HF in terms of economy, health, and the environment. Community members should have a say in the approval, planning, and management of activities carried out within or in close proximity to their communities (Elnokaly, 2014) because they are impacted by the consequences of such actions. Involving communities in decisions is important and may contribute to the success of such decisions (European Commission, n.d.)

Nature of the Study

Researchers have examined the different effects HF has on communities in close proximity to oil and gas extraction sites. Although many researchers have argued for the economic benefits of HF, others have argued against the negative effects of HF on health and the environment (Hausman, 2015; Jackson et al., 2014; Nunez, 2013). Gaps exist in understanding whether HF as a method of gas and oil extraction is beneficial or detrimental to communities. I employed a qualitative research design using the Gibson

County community as a case study. Data were collected using semi structured questionnaires, observations, and examination of existing documents. Findings may be used to determine whether the process of locating HF near communities is acceptable.

Research Questions

The research questions were the following:

RQ1: How do the Gibson community and its members perceive HF in the neighborhood, regarding economic, environmental, and health effects?

RQ2. Considering the diverse perceptions of the positive and negative effects of HF on the Gibson community, which effects (if any) justify the continuation of HF in the community?

RQ3. Based on the approach used in the location of HF oil and gas extraction sites for national benefit, is the Gibson community considered in alignment with environmental justice?

Theoretical and Conceptual Frameworks

The conceptual framework of my dissertation was based on the principles of the health belief model (HBM; Glanz, Rimer, & Viswanath, 2015). HBM predicts behavior and was developed to explain the failure of the members of the population to use free, preventive treatment or screening programs (Glanz et al., 2015). In the current study, I adopted certain concepts of HBM, namely perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy (see Glanz et al., 2015) to develop a conceptual model on HF called the HF health impact belief model. According to Oltra, Boso, and Prades (2014), developing a broader attitude-based model

similar to the HBM, including several independent and dependent variables and the items for the measurement of these variables, is needed. In the questionnaire used in the study, I included questions to determine Gibson community members' awareness of these six constructs.

Definitions

British thermal unit (Btu): The quantity of heat needed to increase the temperature of 1pound of water by 1degree Fahrenheit when the temperature of the water is at the greatest density of about 39 degrees Fahrenheit. Btu is used to measure the heat content of energy sources or of fuel (USEIA, 2017b).

Carbon footprint: The total amount of greenhouse gases emitted into the atmosphere yearly, which may be produced by a person's greenhouse gas emissions from fuel, such as from riding cars and home heating; organizations during production, such as greenhouse gases from goods or services of power plants from electricity; factories making products; and landfills (EPA, 2016b).

Climate change: Any significant change in climate over a long period of time, which includes major changes such as wind patterns, temperature, precipitation, and others (EPA, 2016b).

Emissions: The release of substances such as a gas into the atmosphere (EPA, 2016b).

Fossil fuel: Organic materials produced as a result of decaying plants and animals, which are converted to crude oil, natural gas, coal, or heavy oils due to heat exposure and pressure in the earth's crust occurring over millions of years (EPA, 2016b).

Global warming: Global average temperature increase close to the Earth surface (EPA, 2016b).

Greenhouse gas (GHG): Gases that absorb infrared radiation from the atmosphere, such as methane, carbon dioxide, ozone, nitrous oxide, chlorofluorocarbons, perfluorocarbons, hydrochlorofluorocarbons, hydrofluorocarbons, and sulfur hexafluoride (EPA, 2016b).

GHG footprint: The total GHG emissions from developing and using the gas, expressed equivalent to carbon dioxide, per unit of energy during combustion.

Hydraulic fracturing (HF): An extraction method developed to access fossil energy deposits not previously accessible for drilling operations through fracturing of rock using sand, millions of water gallons, and chemicals, some undisclosed, to bring oil and gas to the ground surface (EPA, 2015; Hoffman, 2017).

Ozone layer: The layer of ozone approximately 15 km above the Earth surface that thins to an almost negligible amount at about 50 km, shielding the Earth from harmful ultraviolet radiation from the sun (EPA, 2016b).

Particulate matter (PM): Pieces of solid or liquid matter that are very small, such as particles of dust, soot, fumes, mists, or aerosols (EPA, 2016b).

$PM_{2.5}$: Fine inhalable particles with diameters generally 2.5 micrometers and smaller (EPA, 2017b).

Pump jacks: The beam pumping method used in creating artificial lift, including equipment composed of a long, heavy beam that is moved by some external power source below and above ground to push oil to the surface (Hanania, Stenhouse, & Donev, 2015).

Unconventional: Alternative methods different from the conventional method of oil and gas flowing easily across porous rock from an existing reservoir using the natural pressure of the wells and pumping or compression operations (Department of Environment and Heritage Protection, 2017).

Assumptions

I assumed that the perception of community members in Gibson county represented the average view of other community members through which meaningful conclusions could be drawn.

Scope and Delimitations

The data and information used in my research were based on documents written in the English language, including publicly available peer-reviewed documents; literature documents; health, economic, and environmental data; or documents on HF.

Limitations

My research was based on the perceptions of the Gibson community members and may not be representative of all communities in close proximity to HF oil and gas extraction sites in the United States.

Significance

Researchers have conducted studies and written articles on the different effects HF has on communities in close proximity to oil and gas extraction sites. Although many argue for the economic benefits of HF, others argue against the negative effects on the health and environment of HF oil and gas extraction sites (Hausman, 2015; Jackson et al., 2014; Nunez, 2013). A gap exists in determining whether HF as a method of gas and oil

extraction is beneficial or detrimental to communities. The current study focused on whether the negative effects of HF outweigh the benefits according to the perceptions of community members who are exposed to HF.

Summary

Sustainability of the Earth's energy resources is important. Findings from the current study may be used to increase community members' awareness of the effects of HF and the efforts being made in the reduction of the negative effects of HF. The findings from this study may inform policies related to HF operations near communities, potentially leading to better practices, improved drinking water quality in HF neighboring communities, reduction of greenhouse gas effects, and reduction in negative health and environmental impacts.

Chapter 2: Literature Review

Hydraulic fracturing (HF) may be classified a public health issue as a result of the potential effects on the health and environment of neighboring communities (Qingmin & Ashby, 2014; Ross, 2012; Srebotnjak & Rotkin-Ellman, 2014). Most articles addressed the controversies surrounding HF (Hoffman, 2017; Jain, 2015; Boudet et al., 2014). The controversies evolved from those who benefited and those who were negatively impacted during HF oil and gas extraction (Jain, 2015). Researchers emphasized either the positive (Mehamy & Goggemos, 2015) or the negative effects of HF (McDermott et al., 2013), while others emphasized both the positive and negative effects of HF (Gorman, 2009; Howarth, Santoro, & Ingraffea, 2011; Jackson et al., 2014; McDermott et al., 2013), without any consensus view. The implication of these conflicting views is the need for further research to determine the impact of HF on the population.

HF occurs in an environment characterized by secrecy and lack of transparency (Chen, Al-Wadei, Kennedy, & Terry, 2014), especially regarding the chemicals used during oil and gas extraction, referred to as a "trade secret" (Jain, 2015). The lack of full disclosure of chemicals used during the HF process may result in difficulty in assessing the health and environmental impacts (Chen et al., 2014). Researchers have not reached a consensus on the environmental (Barth, 2012) and health effects of HF, or the economic benefits. HF has raised concerns among individuals and environmentalists, such as government leniency of HF regulation, nonclassification of HF waste as hazardous, inappropriate documentation/registration/reporting systems of HF, lack of environmental inspection of HF oil and gas wells for wastewater disposal, and lack of reporting of the

volume when HF wastewater spills occur (Chen, 2014; Srebotnjak & Rotkin-Ellman, 2014).

In the use of HF for oil and gas extraction, it is not clear whether the social costs are ignored in exchange for goods and services (Jain, 2015). Addressing this issue was the purpose of the current study. This literature review reflects the different findings of researchers, and the need for further research on HF to reach a consensus view (see Brasier et al., 2013; Hays & Shonkoff, 2016; Jain, 2015; Mehamy & Goggemos, 2015; Tustin et al., 2016).

Literature Search Strategy

I adopted the inductive approach, which is the bottom-up approach to a literature review. An inductive literature review is conducted when limited literature exists on a study, which may lead to a conceptual framework or (conceptual) model development (Imenda, 2014). In the organization of my literature review, my topic was broken down into the historical background of HF, how and what affects perception and awareness of individuals or communities, the economic effects of HF, the environmental effects of HF, the health consequences of HF, the existing gap in the literature, the assessment of Gibson County in Indiana and what the existing data revealed, and the conceptual framework guiding this study. Existing literature on HF was gathered from the Walden University library databases, including EBSCO, ProQuest, SAGE, MEDLINE, Academic Search Premier, ProQuest Dissertations and Theses, and ProQuest Central. I also searched the Journals, Science Journals, and Health Sciences Collection. I searched for all articles containing the words *hydraulic fracturing* without any restriction on location,

with priority on articles published within the last 5 years in English. I also searched for publications such as evaluation reports, descriptions, and interviews on HF, and I reviewed the reference lists of articles for additional sources. Existing peer-reviewed articles, trusted media, or news articles on HF were reviewed for the gathering of data from the Internet and other sources due to the recent occurrence of HF.

HF Development in Oil and Gas Extraction

HF oil and gas extraction may be traced to an exploding torpedo in April 1865 by Col. Edward A. L. Roberts (American Oil & Gas Historical Society, 2017). Roberts was awarded U.S. Roberts Torpedo Patent No. 59,936 in November 1866, which increased oil production in the use of individual wells (American Oil & Gas Historical Society, 2017). Torpedo is a submarine explosive device initially used for destroying hostile ships. HF may also be linked to the discovery of oil in the United States by detonating downhole dynamite or nitroglycerin to increase production in an oil well. Ira McCullough from Los Angeles in 1939 later invented the multiple bullet-shot casing perforator by shooting perforating elements or projectiles through the casing into rock or soil or rock formation. The method of fracturing using hydraulic pressurization known as HF was developed in 1947 (Gallegos & Varela, 2015). McCullough's patent improved the flow of oil to become HF on March 17, 1949, in an oil well about 12 miles east of Duncan, Oklahoma, described as the first commercial HF application systems (American Oil & Gas Historical Society, 2017; Fracfocus, 2017; Gallegos & Varela, 2015). Halliburton and Stanolind Company staff fractured another oil well near Holliday Texas, which was initially patented by Stanolind but later referred to as Pan American Oil Company (Gallegos &

Varela, 2015). HF license was opened to any qualified service company by 1953, and by 1988 HF had been used nearly one million times (American Oil & Gas Historical Society, 2017; Fracfocus, 2017). Most of the HF treatment used in vertical wells for oil production stimulation between 1947 and 1953 included explosives (14%), acid (12%), water (32%), and oil (30%), aligning with the initial use of explosives or acid etching instead of using proppants that injects sand and oil-based fluids to open fractures created during HF oil and gas extraction (Gallegos & Varela, 2015). Proppants are sand or ceramic pellets or other small particles that are not compressible and used to hold open created fractures (EPA, 2017).

Between 1953 and 1999, after the use of water as HF treatment fluid base, gelling agents such as guar gum and cellulose derivatives were used to increase viscosity (Chen et al., 2014) at low pH with potassium pyroantimonate and aluminum to increase the weight of water-soluble polymers for the solutions to suspend proppants at low temperature, or borate at high pH (Gallegos & Varela, 2015). Potassium chloride served (Chen et al., 2014) in 1960 as clay stabilization, lowering the surface tension in water-sensitive formation (Gallegos & Varela, 2015). Foam-based fracturing fluids (Chen et al., 2014) evolved in 1970, including pressurized nitrogen or carbon dioxide additives for the stimulation of shallow low-pressure zones and fluid for gas-lifting liquid back to the surface (Chen et al., 2014; Gallegos & Varela, 2015). Slickwater treatment fluid type evolved in 2008 to increase the surfactant additives added to water. Slickwater is about 99% water with additives such as friction reducers, surfactants, polyacrylamide, biocides, electrolytes, and scale inhibitors in different quantities to increase fluid-flow velocity and

sand transport through the borehole casing into the formation (Gallegos & Varela, 2015). Other additives used were biocides such as glutaraldehyde, chlorine dioxide, ozone, ultraviolet light, chlorophenates, quaternary, amines and isothiazoline; breakers such as sodium chloride; corrosion inhibitors such as Nn-dimethylformamide; ammonium used as oxidizers, potassium, and sodium salts of peroxydisulfate, and enzymes such as hemicellulose; friction reducers such as petroleum distillate or polyacrylamide; iron control such as citric acid, 2-hydroxy-1,2,3- propane tricarboxylic acid, and acetic acid; scale inhibitors such as ethylene glycol, phosphonate and polymers; and oxygen scavengers such as ammonium bisulfite (Gallegos & Varela, 2015).

Wells numbering 986,600 were drilled between 1947 and 2010 in the United States, with over 1,763,800 HF treatments; however, not all states were required to or had record keeping of HF treatments (Gallegos & Varela, 2015). Texas recorded the highest level of drilling activity using HF because 1947, followed by Oklahoma, Pennsylvania, Ohio, and New Mexico (Gallegos & Varela, 2014). According to Fracfocus (2017), technology on HF continues to improve, and about 35,000 wells ranging from vertical to horizontal oil and natural gas are fractured annually (Fracfocus, 2017). HF is carried out in some communities or states in the United States, resulting in members of these communities having diverse perceptions of the impact.

Communities, Perception, and Awareness

The diverse perceptions of the impact of HF by community members result from several factors. Perceptions may be described as an individual's sensory experience of his or her environment, the recognition of the environmental stimuli, and action taken

responding to the stimuli (Kerry, 2017). Perceptions not only create the experience of the world but also allow individuals to act within their environment. The perceptual process allows for the acquisition of information about the environment critical to survival, including the cognitive process required to process the information (Kerry, 2017). Information recalled easily is used more often in decision-making; affective images are likely to influence the perception of risks and benefits and the support or opposition when responding to issues of negative or positive impacts and are a function of the images that may be associated with such impacts (Boudet et al., 2014).

The U.S. population has low awareness of HF (Boudet et al., 2014; De Coza, 2012; Toledo Area Human Resource Association, 2012). Engaging community members in close proximity to HF effectively and enacting appropriate policies may be influenced by insights from the public perceptions of HF (Boudet et al., 2014). Several factors may influence the perception of community members regarding the risks of HF, such as technology risk (Brasier et al., 2013, race referred to as the white male effect, gender, and level of education. Minorities and women are more likely to oppose the siting of nuclear, coal, natural gas, and wind power in close proximity to their community, while White men tend to be more accommodating and report lower perceptions of risks than others (Boudet et al., 2014). Women tend to perceive greater risks and are less accommodating of emerging technologies than men (Boudet et al., 2014). Higher level of education is associated with better awareness of HF issues (Boudet et al., 2014).

The trust of community members in institutions also affects their perception of risks (Brasier et al., 2013). Trust may also be influenced by complex social and

psychological processes affected by the type of technology used and the economic, environmental, and health risks associated with HF (Brasier et al., 2013). Schafft, Borlu, and Glenna (2013) found strong positive associations between perceptions of risk and opportunity associated with gas extraction, which complicated the framing of HF gas extraction in the Marcellus Shale region. Boudet et al. (2014) carried out a survey in 2012 and found out that little or no knowledge of HF existed in most of U.S. population. Most participants were undecided about opposing or supporting HF, and those with opinions were split equally (Boudet et al., 2014). The participants in the study who supported HF were educated, older, and politically conservative, and they focused only on the economic or energy supply advantages of HF (Boudet et al., 2014). The perceived risks associated with HF included air emissions, truck traffic, and population growth and other risks based on social, environmental, and economic effects of HF, demographic characteristics, mineral rights ownership, and state of residence (Brasier et al., 2013).

The perceptions of extraction of HF oil and gas vary globally. Papatulică and Prisecaru (2015) identified underlying factors for limited HF oil and gas extraction sites in Europe. Socioeconomic net benefits of HF were influenced by compromises because HF is capital intensive rather than labor intensive, with mostly short-term jobs; by the limited benefits of HF due to the conflict between environmentalists and HF organizations; and by HF being in the early stage of development (Papatulică & Prisecaru, 2015). Papatulică and Prisecaru suggested that HF is not viable in a low carbon economy unless substituted on a large scale in Europe, to reduce the cost of gas and reduce lack of transparency of HF oil and gas organizations.

The population of countries such as the United States has raised concerns about the effects of HF on their health, environment, and economy (Powers et al., 2014). In 2014, Powers et al. analyzed 215 letters between January 1, 2008, and June 8, 2013, written to the editor of *The Daily Review* in Pennsylvania (Bradford County) to investigate risks associated with a perceived environmental threat and to determine residents' concerns (Powers et al., 2014). The themes which evolved from the study identified four major issues, namely, population growth and implications socioeconomic impacts, perceived threats to water and changes to communities' rural landscape. The concerns of the citizens included economic growth, environmental, health, and social concerns (Powers et al., 2014).

HF oil and gas extraction has raised controversy on the economy, health, and environment of nearby states, residents, or communities (Brasier et al., 2013). Powers et al. (2014), expatiated each impact category of the four groups from the letters received from residents. Brasier et al., Papatulică and Prisecaru, Powers et al., summarized the effects of HF as, socio-economic, changes to the rural landscape, perceived threats to water, and population growth in addition to the implications (Brasier et al, 2013, Papatulică & Prisecaru, 2015; Powers et al, 2014).

The effects of HF on neighboring communities were coded into themes in the studies by Brasier et al (2013), Papatulică and Prisecaru (2015), and Powers et al. (2014), and aligned with, and hypothesized that the health and environmental implications of chemicals used during HF oil and gas extraction may be harmful to the lungs, skin, brain, blood, kidneys, and livers(Brasier et al, 2013, Papatulică & Prisecaru, 2015;

Powers et al., 2014). According to environmental scientists, HF may also be harmful to wildlife, and, result in groundwater contamination as a result of the effects on water, air, and soil (Brasier et al.., 2013, Papatulică & Prisecaru, 2015; Powers et al.., 2014). The other effects of HF may include chemical spills, movement of methane or HF fluids through the rock formation into groundwater, treatment, and disposal of the wastewater, earthquakes, noise, and truck traffic (Brasier et al.., 2013; McDermott-Levy, Kaktins, & Sattler, 2013).

Economic Effects of HF

HF is perceived to have economic benefits and may have contributed nearly 70% increase to the oil and gas development in North America. The development made the price of energy such as propane to reduce to about $620 per ton in the U.S. when compared to $1000 per ton in China (Jain, 2015). According to BoomTown impact model, HF has short-term and long-term economic benefits on rural areas with energy resources, which may be beneficial and detrimental (Jain, 2015). The positive effects of HF include lower fuel prices, domestic business growth, job creation and improved employment rates (Boudet et al., 2014; Jain, 2015; Mehamy, & Goggemos, 2015), in addition to the reduction of trade deficit which resulted from the United States. becoming an exporter of oil and gas (Jain, 2015). Ecological and economic consequences of HF are reduced property values, drilling failures, and violation of HF regulations (McDermott, Kaktins & Barbara, 2013). Socioeconomic effects and consequences of HF may be broken down into job creation and mistrust in shared financial gains from HF companies, benefits of increased cash flow into the community's economy from businesses such as

landlords' rental buildings, restaurants, hotels, doctor's offices, car repair shops, which may result in toxic and uninhabitable wasteland; concern on the allocated disbursed fees from HF, such as the "impact fee" and whether the funds generated will be equally shared; and abandonment of the active drilling sites (Powers et al., 2014). The economic benefits of HF mentioned by Boudet et al., (2014) included wealth for community members which signed gas leases on their private lands, better opportunities for local businesses servicing HF industries directly and indirectly, and higher tax revenue.

Economic consequences of HF on neighboring communities include strains on the community's public services as a result of the increased inflow of people. Additional social impacts of HF include the ability to accommodate increased activities due to HF development boom. The boom may impact, the quality of life, ties of community members, and affect mental and physical health, which may lead to more social problems (Boudet et al., 2014). In the study by Institute for Energy Research [IER] (2014), the benefits of HF which emerged were, increased shale oil production from 0.75 to 4.78 million barrels daily by 2013, increased job creation from 2.1 million jobs in 2012 to a projection of 3.9 million jobs by 2025, and515,000 manufacturing jobs (IER, 2014). The increase in job creation as a result of HF in the U.S, resulted in projected savings of $3,500 per year, by 2025 per household (I.E. R, 2014).

The growth of production and well completion could add $145 billion to the U.S. economy, and nearly $25 billion increase in private equity investment by 2011 (Ross, 2012). The increase in domestic natural gas supplies has resulted in the lowest prices for natural gas in 10 years, with consumer savings of $16.5 billion on home energy bills, and

approximately $145 in household savings, (Ross, 2012). Investigation in 2015 by Greenpeace, highlighted the influence of EPA's study which was based on HF's impact on groundwater by shale industries (Greenpeace, 2016). The states may face difficulty when setting up long-term economic considerations for royalty and tax policy from the financial rewards of increased HF production (Ross, 2012).

Environmental Effects of HF

HF oil and gas extraction processes impact the environment (Haggerty & McBride, 2016; Howarth, Santoro, & Ingraffea, 2011; Jain, 2015; McDermott Kaktins & Barbara, 2013; Mehamy & Goggemos, 2015; Qingmin &Ashby, 2014). The perceived negative effects of HF on the environment may include induced seismic action, the release of methane and other gases, the release of particles to the atmosphere, contamination of underground water (Hoffman, 2017; Jain, 2015; Rabinowitz et al., 2015). Other environmental effects of HF may have with negative health consequences on the sensory organs, skin, eyes, gastrointestinal and respiratory systems (Hoffman, 2017; Rabinowitz et al., 2015), and radioactivity (Jain, 2015). Increased noise, water, and air contamination, increased intensity of truck traffic volume, occupational hazards, stress, and increased demands on health care and social infrastructure were highlighted as negative consequences of HF (McDermott, Kaktins, & Barbara, 2013). Methane migration in drinking water as a result of HF is suspected to contribute to climate change (McDermott Kaktins & Barbara, 2013). Perceived threats to water by methane migration and/or the HF processes may result in loss of access to potable water consumption (Brasier et al., 2013; Prisecaru & Papatulică, 2015; Powers et al., 2014; Ross, 2012),

affecting population growth (Powers et al., 2014). Change in existing rural landscape and loss of farmland and farming style may result in inactivity, threats to local ecology, and wildlife populations were other environmental effects of HF (Brasier et al., 2013; Powers et al., 2014; Prisecaru & Papatulică, 2015). EPA (2016), in a report on the relationship HF activities has on drinking water resources in the U.S, highlighted the following five effects:

- During HF water acquisition. HF may cause water scarcity in areas where low water availability exists, such as areas of limited groundwater resources (Chen et al., 2014; EPA, 2016; Jain, 2015).
- Mixing of chemicals with groundwater during HF. Water mixed with chemical additives during the preparation of HF fluids may result in spills and high concentrations of chemicals in groundwater (Chen et al., 2014; EPA, 2016).
- HF fluid, when injected into the production well, fractures the shale rock, and releases gases such as benzene, toluene, ethylene, and xylene (BTEX). or Liquid in groundwater resources and inadequate mechanical application may occur (Hoffman, 2017; U.S. EPA, 2016; Chen, 2014).
- Collection of wastewater returning through the well after injection may result in the discharge of inadequately treated HF wastewater which may mix with surface water (U.S. EPA, 2016).
- Management of wastewater disposal, or reuse, HF wastewater is disposed of in unlined pits, contaminating groundwater resources (EPA, 2016).

The report by EPA highlighted that under some circumstances, there is scientific evidence that HF activities may impact drinking water resources. The report had gaps and uncertainties, which limited the full assessment of the impacts of HF on drinking water resources locally and nationally (EPA, 2016). During HF, 428 operators in 20 states reported 698 ingredients (chemicals) with 14 median number of additive ingredients per disclosure EPA, 2016). The analysis revealed 65% of disclosures had methanol, hydrochloric acid, and hydrotreated light petroleum distillates, 70% of the disclosures included at least one ingredient classified as confidential business information (CBI), and 11% of recorded ingredient recorded were CBI (EPA, 2016). Water was the base fluid in more than 93% of the disclosures, which ranged from 30,000 to 7.2 million gallons (EPA, 2016) The water was described as “fresh” in 29% of the disclosures without identification of the source of the water to be either surface or groundwater (EPA, 2016).

Pennsylvania transports HF wastewater to neighboring states for treatment, and there are concerns of increased leaks or spills during wastewater transportation (Chen et al., 2014). Living in close proximity to HF drilling operations may increase health risk (Hoffman, 2017), This was reinforced by McKenzie et al. (2012), in a study which residents living less than ½ mile from wells. had higher negative health risks from the effects of natural gas drilling, than those living more than ½ mile from wells (McKenzie et al., 2012). People living less than ½ mile from HF wells had a prevalence of cancer risks of 10 per million, and 6 per million for those living more than ½ mile from HF wells. According to McKenzie et al., Benzene exposure resulted in a higher health risk. In 2011, the Wall Street Journal in an article by Gold and Campoy highlighted the diversion

of water to HF wells resulted in a serious threat to ranchers and other businesses in Texas (Gold & Campoy, 2011).

Hoffman (2017), reported that the environmental and health risks of HF included exposure to toxic chemicals, contamination of groundwater, methane pollution and its impact on climate change, blowouts due to gas explosion, waste disposal, large volume water used in water-deficient regions, air pollution impacts, HF-induced earthquakes, infrastructure degradation, and workplace safety (Hoffman, 2017). HF requires between 2 and 4 million gallons of water which may reduce, available drinking water, water tables, stream flow, and surface water (Hoffman, 2017). Methane has 25 times more global warming risk than carbon dioxide and is released during HF completion, processing, and transportation of gas to consumers (Hoffman, 2017). HF may result in seismic activity or low-magnitude earthquakes (Hoffman, 2017), during oil and gas extraction significant noise has been noticed within 1,000 feet of well site, and EPA report showed that HF industry has eight times more occupational problems (Hoffman, 2017) yearly than the rate for all U.S. workers (Dachille, 2011). Occupational health deals with health and safety in the workplace, with the primary intention of preventing hazards, which include risk factors in the workplace. The risk factors may cause cancers, musculoskeletal diseases, accidents, respiratory diseases, circulatory diseases, hearing loss, stress-related disorders and communicable diseases, and others (World Health Organization [WHO], 2017). The truck traffic transporting water during HF exceeds the type and quantity anticipated during road design and construction, which may result in road deterioration and discomfort due to traffic flow interference (Dachille, 2011). Impact on infrastructure

(roadways), due to heavy trucking, breaking down of roads, and increased traffic congestion may also result from HF (Hoffman, 2017). In Denton, Texas, a single HF well site had about 364 truck trips that transported water to the site, an equivalent of 3.5 million car trips. In Lycoming County, Pennsylvania, about 77 tractor-trailer truckloads were used for the drilling equipment, in four to five weeks per community, and some communities had 8 sites (Dachille, 2011). Substantial growth resulting from HF may stress the infrastructure of small communities by increasing traffic, worker housing demands, and the nature of the industry referred to as "cyclical boom-bust" (Ross, 2012).

Health Effects of HF

Different articles reviewed highlighted the health consequences associated with people living close to HF oil and gas extraction sites. The negative health effects of HF are fatigue, burning eyes, headache, the risk of endocrine disruption, dermatologic irritation, upper respiratory gastrointestinal sensory problems, change of quality of life and sense of well-being, which may result from oil and gas exposure, and particles from HF process (McDermott et al., 2013). The pollution from HF exposure may cause nose, eye, throat irritation, respiratory illnesses, birth defects, central nervous system damage, cancer, or premature death (Srebotnjak & Rotkin-Ellman, 2014). The children living close to HF sites are more at risk of having asthma, and older people are more vulnerable to the effects of climate change (McDermott et al., 2013). Out of the 350 chemicals used in HF, 75% affect the respiratory and gastrointestinal systems. Chemicals such as methane and benzene were found in groundwater close to HF sites (McDermott et al., 2013). Hoffman (2017), mentioned health risks resulting from HF as exposure to

resultant toxic chemicals injurious to humans; chemicals exposure from HF having negative effects on the skin, eyes, other sensory organs, the respiratory and gastrointestinal systems, immune and cardiovascular systems, kidneys, the brain/nervous system; the endocrine system causing cancer; and mutations (Hoffman, 2017).

The Pennsylvania Department of Environmental Protection found high concentrations of dissolved salts such as bromide in treated water; the dissolved salts have proved harmful to water quality and public health (Ross, 2012). Tustin et al. (2016), found out in cross-sectional research of 23,700 adult patients in Pennsylvania that HF is associated with chronic rhinosinusitis, migraine headache, and fatigue symptoms (Tustin et al., 2016). HF sites use sand which may have crystalline silica when inhaled by workers in the form of sand may cause silicosis (Hoffman, 2017). In a study carried out by the National Institute for Occupational Safety (NIOSH), the collection of air samples in 11 HF sites, in the U.S., all the sites exceeded the occupational health criteria for respirable crystalline silica exposure, 31% of the samples collected exceeded the NIOSH exposure limit by a factor of 10, implying that wearing proper respiratory equipment, may still not protect the workers (Hoffman, 2017).

Gaps in Existing Literature

The effects of HF, the concerns or perception of neighboring communities, and the influence of HF were examined in the existing literature. The recommendations that evolved were, the need for more researches to resolve the controversies, and increased awareness of the negative impacts of HF on health and environment, despite the economic gains. Some articles emphasized that the cost/benefit analysis of HF operation

should be evidence based, rather than exaggerations. This will determine if, and how HF should be practiced, how requirements for HF should be monitored for operators to control production on the surface, the surrounding area, and underground; and the need for constructive dialogue on the risks of HF, to develop mutual respect and participation between the experts and the people, for the advancement of knowledge and trust building (Brasier et al.., 2013; Powers et al., 2014; Prisecaru & Papatulică, 2015;;). According to Boudet et al. (2014), HF is becoming the future of oil and gas, and members of the public need to be involved in the dialog on the potential benefits and risks (Boudet et al., 2014). Tustin et al. (2016), in their research, added to the clarification on the risk HF has on communities, for better understanding and to try to ameliorate these risks, but concluded with the need for further researches in what determines the variability of the outcomes observed from HF on communities (Tustin et al., 2016).

Hays and Shonkoff (2016), reviewed existing literature between 2009 -2015 on the potential impacts of HF on public health, water quality, and air quality. Hays and Shonkoff stated that the literature reviewed, indicated hazards and elevated risks of HF on human health, and the associated adverse health outcomes. The two researchers concluded that there is the need for quantitative epidemiological research on HF in the scientific community, which may be difficult to conduct until exposure parameters are better determined, and reported cases of health outcomes are analyzed (Hays & Shonkoff, 2016). According to Jain (2015), a Consensus Building Policy Paradigm that includes joint fact-finding, effective environmental regulations, science-based decision-making, and externalities through mediation board for third-party compensation may be necessary

to resolve the controversies surrounding HF (Jain, 2015). Chen et al. (2014), in their literature review, concluded that full disclosure of HF chemicals will allow future research to fill the gaps to better understand the impacts of HF on human health, and the environment (Chen et al., 2014). Hoffman (2017), suggested that more stringent regulations need to be passed at the national level, such as the repeal of oil and gas exemptions from the Safe Drinking Water Act, prohibiting violators of clean water and air laws from obtaining federal and state land drilling leases, regulating more strictly natural gas flaring, and adopting precautionary principle. Precautionary principle may be achieved by placing the proof of the impacts of HF on HF oil and gas extraction industries, instead of the current practice of victims getting into a legal battle with the richest and politically influential companies (Hoffman, 2017).

Assessment of Gibson County, Indiana Data

Community involvement in environmental issues and matters concerning community members may expose underlying problems from people outside the community. Communities without adequate community health assessment (CHA) or noninvolvement in the location of facilities within their jurisdiction may result in opposition from community members. Assessing the needs of communities expose the needs. Assessing the needs of Gibson County in my study, exposed the needs of the community and community members, after HF oil and gas extraction. In Indiana, more than 77,000 wells are in existence, although all are not active, most of the active wells are found in southwestern Indiana (Slavin, 2015). Gibson County is located in the southwestern part of the county (Indiana Economic Digest, 2013). Gibson County covers

an area of 487.4 sq. miles, with a population of 33,503 as at 2010 census, population and housing density of 68.7, and 30.0 per square mile average respectively (U.S. Census Bureau, 2012). Gibson County was created in 1813 with the county seat in Princeton and includes the Evansville, Indiana-Kentucky Metropolitan Statistical Area. The county comprises 10 Civil Townships of Barton, Center, Johnson, Columbia, Patoka, Montgomery, Union (formed from Johnson & Patoka), Washington, Wabash and White River (Gibson County Indiana, n.d.).

HF sites in Gibson County are on the Wabash Valley Fault System associated with Missouri's New Madrid fault zone, and about 27.1 million gallons of fluid were used for HF processes in Indiana in the past eight years (Indiana Economic Digest, 2013). HF in Indiana is suspected to use more than 150,000 to 2 million gallons per well, with the highest use of 2,095,128 gallons of fluid in Gibson County (Indiana Economic Digest, 2013). The implication is that the consequences of HF may be more noticeable in Gibson County.

Sociodemographic characteristics. Gibson County is predominantly rural, with several hundred more females than males (American Fact Finder, 2010). The races of the county as at 2010 census were, 0.2% American Indian, 0.5% Asian, 1.8% African American, 95.5% white (Whites), 1.6% from two or more races (Bi-racial), 0.5% from other races, and 1.3% of the population are Hispanic origin (American Fact Finder, 2010). Princeton, the county seat, is a white-collar society. Gibson County has a dependency ratio of 54.1, compared to Indiana state of 50.4, and U.S., 49S (Center for Business and Economic Research, 2012). Gibson County with a dependency ratio (DR)

of 54.1, implied that out of every 100 community members, 54.1 members are not in the working age group (Center for Business and Economic Research, [CBER], 2012). The higher the DR of a community, the more vulnerable the community members, and the lower the economic growth (CBER, 2012). Gibson County has higher than average DR when compared to the whole of the U.S.

Below is a table showing the comparison of Gibson County's sociodemographic data to that of Indiana and some of the U.S. data, to deduce the effects HF may have on the health of the community members in Gibson County.

Table 1

Gibson County's Sociodemographic Data

	Sociodemographics	Gibson County	Indiana State	United States
Economic status				
	Median income/ family	$61,652	$62,982	
	Median household income	$47,697	$51,914	$53,889
	Dependency ratio	54.1	50.4	49
Health status				
	Health outcomes rank in Indiana	41st		
	Health factors rank in Indiana	20th		
	Mortality rate/100,000	908.7	820.4	823.7
	Cancer deaths/100,000	153.4	179.4	166.1
	Premature death prior to 75yrs/ 100,000	7,704	8,129 (AHR,2015)	6,997 (AHR,2015)
	Diabetes death/100,000	55.4	24.4	20.9 (CDC,2014)
	Chronic lower respiratory disease deaths/100,000	59.8	54	40.5 (CDC,2014)
	Heart disease/100,000	197.4	181.9	167(CDC,2014)
	Renal disease/100,000	22.4	18.7	1.9%
Morbidity				
	% Poor health status in adults over 18yrs	14.6	18.5	17.5

% Premature births (< 37 weeks)	8.1	9.7	9.6 (CDC, 2017)
% Births prenatal care during the first trimester	80.8	67.5	74.1
% New born with low birth weight (<2,500g)	8.1	8	8.1 (CDC, 2017)
% Adults older than 18yrs with diabetes	12.6	10.7	9.1 (CDC,2017)
Cancer new invasive cases/ 100,000	441.6	470	442.7
Heart disease admission/10,000	99.5	81.5	31
Asthma emergency room (AER)	59.4	49.1	9.2
AER visits among children 5-17yrs /10,000	70.6	66.4	75.7 (CDC, 2013)
Asthma hospital admissions/ 10,000	5.1	10.5	14.1 (CDC, 2017)

Note. Table 1. Extracted from Indiana State Department of Health, 2016; Indiana Indicators, 2016; National Cancer Institute {based on 2010-2014 cases and deaths}, (n.d.); U.S. Bureau, V2016; American Health Ranking (AHR), 2015; Centers for Disease Control and Prevention {CDC},2013; 2014; 2015;2017.

From the data in the above table, Gibson County has higher morbidity rates than Indiana and the United States. in chronic lower respiratory disease, AER visits, heart disease, and diabetes. These data may imply that the environmental contamination in Gibson County is higher than the rest of Indiana, and the U.S. There is the need for further research is before logical conclusive evidence is drawn after all confounders are eliminated. The implication of higher DR in Gibson County when compared to Indiana,

and the U.S. is contrary to the economic benefits of HF. Diabetes death is 55.4 per 100,000 in Gibson County when compared to 24.4 in Indiana State and 20.9 in the U.S., diabetes among 18 years and above in Gibson County is 12.6 per 100,000 compared to that of Indiana State of 10.7 and 9.1 in the U.S. Researches have shown that diabetes is directly related to low economic status (Funakoshi et al., 2017; Hwang & Shon, 2014; Lee et al., 2011), which may explain the high incidence of diabetes in Gibson County in comparison to the average rate in the state of Indiana

The CHA data revealed that cancer deaths (all sites) per 100,000 population in Gibson is 153.4, and in Indiana, cancer deaths are 179.4 per 100,000; the number of premature births (<37 weeks) in Gibson is 8.1% and in Indiana 9.7%. Cancer deaths and premature births are not higher in Gibson County when compared with Indiana State's average, which is contrary to what existed in some studies or articles. From the similarities and contradictions in the CHA data in the above table and literature review, more researches are needed on the effects of HF oil and gas extraction in Gibson County to make a logical conclusion.

Theoretical Foundation

Theory may provide the framework for clarifying what is observed, by fitting unconnected or irrelevant data or variables or research questions to one another (Maxwell, 2004). Researchers adopt more than one theory because no theory guides all elements of research. Theories inform the research design by aiding researchers in the assessment and refinement of goals, selection of appropriate methodology, development of realistic and relevant research questions, and in the identification of future validity

threats to research conclusions (Maxwell, 2004). According to Maxwell, (2004), a theory may illuminate one area but fail to illuminate other areas of the research (Maxwell, 2004). Theory may explain the phenomena in a study to give insights and broaden the researcher's view on the phenomenon (Maxwell, 2004). Similar to theory, the concept map entails the concepts and the relationships (Maxwell, 2004). Conceptual framework may be visual or written, in graphical or narrative form, representing key factors in research, such as concepts, or variables and the assumed relationships (Maxwell, 2004).

HF is a recent public health issue (EPA, 2017), with limited available data. Tavallaei and Abu Talib (n.d.), claimed that some theorists who perceive theory as inductive, adopt qualitative method when there is limited information on the study, or no theory exists. This adoption may create an appropriate theory that relates to the topic using inductive method (Tavallaei & AbuTalib, n.d.) and inductive approach-based literature review that may lead to the development of a conceptual framework or (conceptual) model (Imenda, 2014). Several theories and frameworks have been used in HF studies, such as Boom town effect, consensus paradigm, cost-benefit analysis, theory of acceptance and use of technology and perceived risk, precautionary principle, (Hoffman, 2017; Jain, 2015) and others, but none may be described as perfect. The concepts of the health belief model (HBM) was adapted to form the conceptual framework on HF termed "HF Health Impact Belief Model", for my dissertation. According to Oltra, Boso and Prades (2014), the development of broader attitude-based model similar to the HBM, and adapting many independent and dependent variables, and the items to measure these variables is needed (Oltra et al., 2014).

The constructs of HBM are perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, self-efficacy. HBM was developed in 1950 by social psychologists in the U.S. Public Health Services named Godfrey Hochbaum, Irwin Rosenstock, and Stephen Kegels in response to the failure of people to take free tuberculosis (TB) health screening (Resource Center for Adolescent Pregnancy Prevention [ReCAPP], 2016). Hochbaum noted that perceived risk of disease and perceived benefits of action were crucial factors motivating people to come for screening (ReCAPP, 2016). HBM aligns with the belief that a person may take health-related action if a negative health condition will be avoided; if the positive expectation of avoiding a negative health condition existed; and if one may successfully take a recommended health action (ReCAPP, 2016).

HBM is based on a Cognitive theory which affirms that rather than reinforcement influencing behavior, reinforcement influences expectations (Glanz, Rimer &Viswanath, 2015). HBM has been applied to several health behavior interventions, mostly in health promotion and education (Glanz et al., 2015). HBM was developed initially, based on tuberculosis screening study. Several studies have adopted HBM in their application, such as, in colon cancer screening, between 1997 to 2007, HBM was applied in the use of colonoscopy and fecal occult blood testing (FOBT) (Glanz et al., 2015). HBM was applied in HPV vaccine adoption, and, between 2006 and 2011, 15 interventions applied HBM constructs (Glanz et al., 2015). HBM has been applied in tobacco cessation programs, such as in the motivation for tobacco cessation and improvement of attitude, knowledge, and behavior of tobacco users by Renuka and Pushpanjali in 2014 (Renuka &

Pushpanjali, 2014). HBM was adopted in a global warming study to determine the predictors of risk perception using a heat wave scenario and identifying the constructs of the HBM that could predict adaptive behaviors during a heat wave (Akompab, et al., 2013). HBM constructs had been applied to other public health issues such as guiding the use of modern contraceptives, unintended teenage pregnancies, and other health behavior interventions.

Perceived susceptibility is the belief of one's chances of getting a disease or adopting a health behavior, (Glanz, et al., 2015; ReCAPP, 2016). Perceived severity is the belief in how serious a condition is and the consequences (Glanz, Rimer &Viswanath, 2015; ReCAPP, 2016). Perceived benefits are the belief in the efficacy of the action to be taken in reducing the risk or seriousness of the effect (Glanz, Rimer &Viswanath, 2015; ReCAPP, 2016). Perceived barriers are the beliefs preventing a person from taking action or the psychological costs of taking action (Glanz et al., 2015; ReCAPP, 2016). Cues for action are steps taken towards action against disease or health behavior (Glanz et al., 2015; ReCAPP, 2016). Self-efficacy is the confidence and maintenance of the action taken against a disease or health behavior (Fertman & Allensworth, 2010; Glanz et al., 2015).

Despite the economic benefits of HF in reduced energy cost, greener energy, bridge between the initial carbon-based energy systems and a cleaner, increased oil production with increased annual revenue, job creation, less reliance on the Mideast for oil, the population still react to the location of HF close to their communities (British Broadcasting Corporation [BBC], 2015; Earthjustice, 2017a & b). Similar to the situation

where people did not turn up for TB screening even when offered for free, despite the benefits, HBM was adapted to my HF study, to understand why communities in close proximity to HF sites are reacting against HF through protests, litigation and other means (BBC, 2015; Earthjustice, 2017), despite the associated benefits. The constructs of HBM was adapted to HF health impact belief model (HFHIBM), for the development of a conceptual framework from my research questions and to determine the population's perception of HF, the impacts, and why HF is being rejected, as used by Akompab, et al. (2013) for global warming (Akompab, et al., 2013). The constructs of HBM adapted to HFHIBM was used as inductive, because there exists minimal information, or no theory on HF. The six constructs of HBM was adapted to HFHIBM as:

- Perceived susceptibility is the belief of community members' chances of having negative health consequences from HF siting in the community
- Perceived severity is the belief in how serious the consequences of HF are in the community
- Perceived benefits are the belief in the efficacy of the action to be taken in reducing the risk or seriousness of HF consequences
- Perceived barriers are the beliefs preventing the community to act, or the psychological costs to take action against HF impacts
- Cues for action are steps taken towards action against impact/ consequences of HF
- Self-efficacy is the confidence, and the step was taken in maintaining an action against HF impacts in the community

The six constructs of the HBM adapted to FHIBM were adopted to find out the level of awareness of community members on HF; weigh the benefits of HF against the risks to determine the type of action to take against HF. Adapting the principle of HBM to HFHIBM to as the conceptual framework of my dissertation guided my research and questions.

Frameworks guide the research and are used to verify the research findings at the end of the research. According to Imenda (2014), theoretical perspectives guide researchers in the derivation of research questions, leading to a better literature review, selection of research methods and result interpretation (Imenda, 2014). Adaptation of HBM to HFHIBM was the foundation that guided my literature review, influenced my research questions, and the interpretation and analysis of the data collected for conclusive research result.

Chapter 3: Research Design and Data Collection

Methodology

After review and approval by Walden's institutional review board (IRB), I conducted a qualitative study using interviews and observations. Qualitative research in public health focuses on obtaining culturally specific information about the values, opinions, behaviors, and social contexts of a population, making the qualitative approach appropriate for data collection in my study because the purpose was to find out community members' opinions or perceptions about HF. Five main types of qualitative methods are available: phenomenology, narrative, grounded theory, ethnography, and case study. Methods used for data collection in qualitative studies are interviews, observations, examination of existing documents, and voice or video recording. Interviews may be conducted as structured, semi structured, unstructured, or focus groups. I examined existing data, distributed semi structured questionnaires, and observed relevant cases. I protected the participants' information and data and coded the data to identify themes.

Research Design

Case study research provides a deep understanding of processes, events, entities, communities, and organizations (Creswell, 2009). The need to understand perceptions of phenomena by a group of people made the case study design appropriate for my research. I collected data from community members using semi structured questionnaires to determine whether HF is economically beneficial or detrimental to the health and environment and whether HF should be discontinued based on the constructs of HBM

adapted into the HFHIBM. Semi structured questionnaires were used to gather data from community members to determine the positive and negative effects of HF.

Sampling Techniques

In carrying out qualitative research, researchers use a sample from the relevant population. Sampling is the selection of individuals, units, or settings for a study (Patton, 2001). Sampling is the systematic selection of research participants from the population of interest, based on what is being examined in the study (Patton, 2001). Qualitative design sampling is defined by the objectives, budget, time, and other resource constraints. Qualitative research involves nonprobability sampling because the aim is not to produce statistically representative results. Qualitative studies are often purposeful, or criterion based through the adoption of samples with characteristics relevant to the research questions and the population under study (Patton, 2001). Purposive nonrandom sampling is used in qualitative research because the criteria for selection are more important than the number of people interviewed. The characteristics of participants influence selection, to reflect diverse population. Qualitative research sampling is often characterized by small size.

Random sampling is appropriate in quantitative studies but may not be appropriate in qualitative research because the samples are usually small and random selection may result in an inappropriate sample size. Sampling in qualitative research is determined by the time frame of the study, the research questions or purpose, and the available resources (Patton, 2001). Several sampling strategies are used, the following were considered for my research:

- Homogeneous sampling is the selection of people with similar experiences or backgrounds to simplify analysis for reduction of variation and to facilitate group interviewing (Patton, 2001).
- Typical case sampling involves the use of what is normal or typical when the need arises to present a profile of one or more cases (Patton, 2001).
- Snowball or chain sampling selection is made from interesting cases, such as individuals identified to have knowledge of cases that are information rich (Patton, 2001).
- Theory-based or operational construct or theoretical sampling is used for grounded theory studies, and samples are selected from those possessing the identified interest of the theoretical construct (Patton, 2001).
- Stratified purposeful sampling is focused on a particular subgroup's characteristics to facilitate comparisons (Patton, 2001.
- Opportunistic or emergent sampling is the technique of selecting new leads during fieldwork to be flexible and to take advantage of the unexpected, which may be necessary as new participants are detected (Patton, 2001).
- Combination or mixed purposeful sampling is the combination of strategies of two or more qualitative sampling methods (Nastasi, n.d.; Patton, 2001).

Stratified purposeful sampling was the most appropriate for my study because the method focuses on sampling selection from a particular subgroup's characteristics to facilitate comparisons as revealed in my literature review.

The use of a case study design for my study was appropriate because I selected a case, Gibson County, for my research. Gibson County in Indiana has more HF operations than the rest of the state (Center for Media and Democracy, 2015; Indiana Economic Digest, 2017), making Gibson County appropriate for my case study. Samples or participants were selected from Gibson County community members. The purpose of my study was to find out how members of communities in close proximity (within a 5- to 10-mile radius) to an HF site perceive the oil and gas extraction sites in their communities.

According to Mason's (2010) investigation of 560 studies including qualitative methods and interviews, the average sample size was 31 for the nonrandom distribution, with the groups in multiples of 10 for sample sizes. This precedent informed the basis for my data collection and sample size. I intended to gather responses from 31 participants made up of subgroups, unless saturation was reached before all 31 participants were interviewed. A total of 32 questionnaires were returned, and I took notes and photographs from observations. I approached participants based on groupings resulting from the research questions and factors affecting community perceptions as indicated in the literature review. Some factors affecting the perception of HF from the existing literature were gender, race, level of education, age or technology exposure, and level of media use.

Data Collection

In qualitative research, different methods are used when collecting data. Data may be collected through interviews, audiovisual materials, observations, and documents reviews (Thomas, Nelson, & Silverman, n.d.). The most frequently used method in health

care research interviews. Interviews are conducted in qualitative research using semi structured, structured, and unstructured protocols. Highly structured interviews are used in gathering sociodemographic data (Gill, Stewart, Treasure, & Chadwick, 2008). In structured interviews, questionnaires are administered verbally with predetermined questions, minimal variation, and no laid-out scope for questions to responses. Structured interviews are easy to administer, allow for limited participant responses, and lack of depth. Unstructured interviews have no preconceived theories or ideas, have little or no organization, are time-consuming, and may be difficult to manage due to lack of predetermined interview questions for guidance on what to discuss (Gill et al., 2008)

Semi structured interviews include key questions to elicit a detailed response (Gill et al., 2008). Semi structured interviews are appropriate when significant depth in a study is needed and are used in health care because they guide participants on what to discuss. Semi structured interviews address information important for participants not initially identified by researchers (Gill et al., 2008), which prompted my choice for semi structured questions for the questionnaires in my study. Conducting good interviews requires skill and experience, including being able to ask questions in a way that participants can talk freely. Practicing may involve the researcher videotaping during interviews, observing good interviewers, role-playing, and critiquing peers (Thomas et al., n.d.). The interviewer must be clear, ask meaningful questions, be easily understood by participants, and be a good listener. Interview data are recorded by taking notes or using a digital recorder. Focus groups are used for interviews on topics that involve small participant groups. Focus groups are similar to less structured interviews. Focus groups

may be described as a group discussion that is a monitored, guided, or recorded by a facilitator or researcher. Focus groups generate information and meaning on collective views and are useful in understanding participants' experiences and beliefs (Gill et al., 2008).

Semi structured interview questions in the form of questionnaires were administered to each participant in my study. Questionnaires are an effective data collection method that requires less time to distribute and are less expensive when data are needed from a larger sample. I also observed some oil and gas sites in Gibson County. Observation in qualitative research focuses on what researchers see, which includes taking notes or using digital recordings. Observation may be time-consuming. Observation may be considered obtrusive by participants, undermining the purpose of qualitative research where the participants are expected to be relaxed and familiar with the researcher to release useful information. Saturation was used to conclude data collection. Saturation is used to ensure that data are adequate to support the findings. Saturation in my data collection was reached when no new information was gathered from research participants.

Researcher's Role

My role in the study was to identify participants, conduct observations, and distribute semi structured questionnaires. Letters of consent were signed by individual participants before the completion of questionnaires, and I ensured that the rights and welfare of my research participants were protected by following the guidelines of Walden University's IRB. I used a maximum of 30 minutes for completing the questionnaires by

each participant. Participants were provided a thank-you gift of either a bottle or a coffee mug, and I informed them that a copy of the study result would be delivered.

I checked for errors in the questionnaires by the removal of participants' names and all other identifiers when found in any of the returned questionnaires, for the privacy and security of my selected participants before transcribing. Other data-gathering methods such as self-reports of knowledge and attitude using descriptions of situations or pictures, using other recording devices such as dairies, narrative field logs for concerns, reactions; printed materials like evaluation reports, photographs and participant notes of situations are alternative ways for carrying out qualitative researches. I used photographs and dairy to gather my data

Data Analysis

Data management included the development of semi structured questions for questionnaires, transcribing participants' answers, storing data in a password-protected computer, and uploading data into NVivo. NVivo is useful for data organization and management and was used for data analysis, in addition to hand coding. Data were aggregated into categories and analyzed using three themes (health, economy, and environment) identified in the literature review. The results of my analysis were used to determine the alignment with the HFHIBM. The constructs of HBM/HFHIBM were used to determine the Gibson community's perceptions based on the economic, health and environmental impact of HF, and to identify the measures to be taken on HF in Gibson County.

Chapter 4: Results

Purpose of the Study

Researchers have studied the effects of HF with conflicting interpretations, resulting in controversies. Some researchers emphasized the economic benefits of HF while other researchers highlighted the negative consequences on the health of the population and the environment. According to Dodge and Metze (2017), three basic interpretive approaches enable researchers to understand the dynamics of energy controversies over HF and explain why different countries respond differently to HF: understanding, contextual explanation, and policy design of HF as an interpretive problem. The controversies surrounding conflicting interpretations among researchers prompted my study.

Gibson County, HF, Oil Wells, and Landowners

I designed my study to explore the perceptions of community members regarding the economic, health, and environmental effects of HF to understand the controversies from the point of view of the population most exposed to and affected by the phenomenon. I chose Gibson County, Indiana, for my case study because of the high number of oil wells and HF oil and gas extraction sites located in the county. Gibson County is located in the southwestern part of Indiana (Figures 4&5) and houses coal mines (Figure 18), oil pump jacks, and HF sites. Gibson County has 10 townships, including Washington, White River, Patoka, Central, Columbia, Montgomery, Johnson, Barton, Union, and Wabash. Wabash and Montgomery townships, located in the southwestern part of Gibson County, house most of the oil Pump jacks (Figures 16&19)

and HF sites, with the HF (Figures 8&9). sites predominantly located in the Wabash township (Figure 6). Wabash township houses the covered Red Bridge (see Figures 9-12). Of the oil and gas wells located in Indiana, 16% receive HF treatments, but this percentage may increase to 100% in some limited cases (McDivitt, 2013).

Landowners in the townships where oil wells are located lease their farmland (see Figure 15&17) or land, to private oil-producing companies or firms, and individual landowners negotiate private agreements (Rupp, 2017). Landowners are compensated with rental fees, depending on the number of acres in the lease, and a one-eighth royalty payment on the value of the oil or gas production (Rupp, 2017). Natural gas is also stored underground in Indiana in two basic forms: as liquefied petroleum gas and as gas in storage fields. Rupp (2017) noted that these reservoirs are filled in times of low demand (summer) and drawn down during peak demand (winter).

The new era oil well may be either a shale well and/or a horizontally drilled and completed well. Horizontally drilled wells have pumps with a vertical section which may at times result in excessive gas problems such as gas locking or gas interference depending on where the pump intake is compared to the perforations (Patrakov, West, Shulyatikov, & Kinnaird, 2017). The frank sand and debris during pumping may clog the traveling and standing valves or accumulate inside the pump, resulting in a decline of pump efficiency and loss of production (Patrakov et al., 2017). This may be the reason why many abandoned pump jacks exist in Gibson County. Several pump jacks are in operation on farmlands along some major routes in the southwestern part (Figures 13 &14) of Gibson County.

Research Questions

The three primary research questions of my study were as follows.:

RQ1. How do the Gibson community and the members perceive HF in the neighborhood, regarding economic, environmental and health effects?

The survey questions for the first primary question focused on Gibson County members' perceptions:

- How did you get to find out about hydraulic fracturing (HF)?
- What is your perception of HF in terms of the benefits or consequences? Considering the diverse perceptions of the positive and negative effects of HF on the Gibson community, which effects (if any) justify the continuation of HF in the community?

The survey questions for the second primary question focused on the perceptions of the community regarding the health, economic, and environmental effects of HF; their proximity to HF sites; and HF effects on their way of life:

- What are the health effects of HF in the Gibson community?
- What are the economic effects of HF in the Gibson community?
- What are the environmental effects of HF in the Gibson community?
- How do you think living within 5 to 10 miles from HF oil and gas extraction sites impacted your way of life?
- How has HF changed the way you live in Gibson community?
- How severe do you think these effects of HF are on Gibson community? Based on the approach used to locate HF oil and gas extraction sites for

national benefit, how was the Gibson community considered in alignment with environmental justice?

The survey questions for the third primary questions focused on the perceptions of the community members regarding the location of the HF site in Gibson County:

- What ways do you feel Gibson community members should be made to be more involved in the location of HF sites or all other facilities in the future?
- What type of improvement as a result of HF effects would you like to be made, to live more sustainably?
- What action should be taken to make HF process more beneficial to Gibson community?
- What are the barriers that may prevent the Gibson community from taking action against HF?
- What suggestions should be implemented to sustain the actions taken?
- Do you have any other questions or suggestions?

I designed the structured part of my questionnaire to show the sociodemographic data of the participants, the proximity to HF sites, the factors that may influence participants' perceptions, and confounding effects such as smoking. Research participants included 32 adults above 18 years of age who resided in Gibson County. I showed the demographic characteristics of my study population in Table 2. Most participants were in the 30-49 age group, most participants had post-high school education, and most participants were White and female. Most of the 32 participants were employed in non-HF companies, used computers and smartphones, listened to daily news on TV/radio and

computer, or listened to computer news alone. Most participants claimed to live within 0-5 miles of HF sites and did not smoke.

Table 2

Demographic Data of Research Participants

Column A	Characteristics	Number	Percentage
Age	18-29	8	25%
	30-49	11	34.3%
	50-64	10	31.3%
	65-above	3	9.4%
Gender	Male	11	34.4%
	Female	21	64.6%
Ethnicity	White	26	81.3%
	African American	2	6.3%
	Native American	1	3.1%
	Asian/ Pacific	1	3.1%
	Hispanic	1	3.1%
	Bi-racial	1	3.1%
Education	High school	4	12.5%
	High Sch/diploma	7	21.9%
	Some college credits	8	25%
	Trade/tech/vocationa	2	6.3%
	l	5	15.6%
	Associates' degree	4	12.5%
	Bachelor's degree	1	3.1%
	Master's degree	1	3.1%
	Doctorate		
Employment		3	9.4%
	HF Org.	29	90.6%
	Non-HF Org.		
Technology use		4	12.5%
	Smartphone only	2	6.3%
	Computer use only	25	78.1%
	Computer/smartpho	1	3.1%
	ne		
	None		
Media use		6	18.8%
		5	15.6%
	Daily news/	5	15.6%
	Radio/TV	6	18.8%

	Radio/TV/comp/news	9	28.1%
	TV/ radio/ news	1	3.1%
	TV/ Radio/ Computer	12	37.5%
Proximity to HF sites or oilfield	Computer	9	28.1%
	No Media use	8	25%
		3	9.4%
	0-5 miles	24	75%
Smoking status	5.1-10 miles	8	25%
	10.1- above		
	No response		
	Non-smoker		
	Smoker		

Note. The sociodemographic data of research participants (N = 32).

Number of Participants

The number of participants that took part in my interview procedure was 32. All participants resided in Gibson County, and nobody living in the county was excluded from taking part in the research. Most of the participants resided in the southwestern part of Gibson County where most of the oil wells and HF sites were located.

Location and Duration of Data Collection

I recruited participants by inviting residents of Gibson County to take part in my data collection by answering interview questions. Previous to going to Gibson County to conduct these interviews, I sought permission from the Walden University IRB. The IRB approval for my research was obtained on April 20, 2018, with approval number 04-20-18-0501438 and expiration date of April 19, 2019. Questionnaires were distributed non randomly to participants selected by approaching community members from Gibson

County or introduced by another community member informing them of my study. Participation was voluntary and consent was requested. I found my initial participants in a Catholic church and the Montgomery Clerk Office. I asked for the participants' preference between completion of questionnaires or taking part in semi structured interviews. All the participants preferred to complete the questionnaires in my presence, or completed in confidence, and returned by an agreed date. I distributed the questionnaires to reach saturation at the return of 31questionnaires. Thirty-one questionnaires were distributed either to participants or through participants who collected extra questionnaires to distribute to people who might be interested in the study within Gibson County. I administered the questionnaires where people congregated, such as township centers, churches, health facilities, offices, coffee shops, restaurants, and malls. Out of the 31 questionnaires I administered to participants, four were not returned by participants who collected extra questionnaires, which implied that 27 participants (87.1%) returned their completed questionnaires. I administered eight new questionnaires, and five were returned, which made the final sample size 32. Wabash township, where the HF sites were predominant, is a small township inaccessible at my first attempt to visit, because of the recent flood. The second attempt to visit the HF site was also unsuccessful because of the loss of satellite connection due to the remoteness of the area.

All the participants who took part in my study signed consent forms before completing the questionnaires. I collected the first set of data from April 26th, 2018, to May 5th, 2018, and the second set of data from June 18th to 21st, 2018. All my study

participants completed the same questionnaires with the same semi structured research questions (Appendix A). I informed the employee in the County Clerk's office that a summary of my study result will be sent to the office, after the completion and approval.

Data Collection

I gathered data through the participants' completed questionnaires (Appendix A), field notes, photographs, and observation protocols (Appendix B & C). All the participants were given a five-dollar gift of coffee mugs or bottles, on completion and return of the questionnaires, for their time and participation in my research. I recorded my data through hand-written notes and photographs, and the summary of the participants' responses was transferred to Microsoft Excel for accurate transcription. NVivo was also used as a second transcription tool. I used hand transcription and NVivo to develop codes and themes for my data collection.

I assigned codes in form of numbers to the participants for confidentiality and privacy, to replace their names on the returned questionnaires. All the summary sheets and electronic files were stored in a password protected documents and computer. The paper files such as completed questionnaires, observation protocols, and field notes, remained stored in a locked file box. I intend to keep the files for five years in a secured location in accordance with IRB approval guidelines, with the data accessible to my Chair and me. The locked-up files will be destroyed after five years, as stipulated in my IRB approval.

Variation from Original Data Collection Plan

I intended the data collection to be either the completion of questionnaires or semi structured face-to-face interviews from my study participants. All the participants opted for the completion of questionnaires. The sample size for the study was 31, but 32 questionnaires were returned. Several pump jacks were located in Gibson County, and most participants mixed up pump jack sites with HF sites, which may have confounding effects on farmland, and the environment. The HF sites in Gibson County, during the period of data collection for my study, were inaccessible.

Barrier to Data Collection

The participants who completed the questionnaires were reluctant because of their minimal knowledge of HF, but I explained to them that my research topic was on their level of perception, and their lack of knowledge or their minimal knowledge was part of the research intent. I had difficulty in administering questionnaires to diverse races, such as African Americans and Asians because Gibson County was mostly populated by Whites. Gibson community members were reluctant to have HF discussions and to escort me to HF sites. I had an escort the first time I visited Gibson County to collect data, but the road condition made the site inaccessible. I made subsequent efforts to book appointments with my escort without success.

Data Analysis

Coding Process

Coding may be open or precoded. In open coding, information emerges from the original goals and interests of the research (Benaquisto, 2013). In precoding, codes or

categories are determined and extracted from theoretical model or literature, and precoding is used in the health sciences (Creswell, 2013). The advantages of pre-coding are, revealing the concepts and themes that are communicated in the data gathered, setting out data organization and code, and giving the basic structure for the coding scheme (Center for Evaluation and Research, n.d.). The disadvantage of pre-coding is that it may limit the researcher and prevent open-mindedness. Pre-coding strategy was adopted in the analysis of my research to enable me to have the basic structure required for the collection and analysis needed, before final analysis.

My data were both handcoded and coded with NVivo. The first part of my questionnaire had 9 structured questions dealing with inclusion criteria, perception factors and confounders that may affect research results. The second part of my questionnaire had 17 semi structured survey questions on community perceptions of the effects of HF and application of HBM (See Appendix A).

The second main semi structured interview question and the survey questions were for Gibson County members' perceptions of HF justification on the oil and gas extraction in the community, the health, the environmental, and the economic effects of HF, the effects of the proximity to HF sites on community members, and the severity of HF effects. The third main semi structured interview question and the survey questions tested for how Gibson community members were considered during the location of HF in the community, how Gibson community members could be more involved in the location of HF in the community in future, what may make the effects of HF more sustainable, the actions to make HF more beneficial for Gibson community members, the barriers that

may prevent Gibson County from taking actions on HF, and how to sustain the actions taken, and any other suggestions participants may have.

My questions reflected community perceptions on the effects of HF, by applying the constructs of HFHIBM adapted from HBM, in Gibson County. I applied the constructs of perceived susceptibility, perceived severity and perceived benefits of HFHIBM on the community's perceptions of HF for the survey questions in the first main/central research question. Some survey questions in the second main/central question were designed on the two constructs of HFHIBM, perceived severity of HF and perceived barriers to taking actions, to explain underlying causes of the community's reaction to HF. I designed the survey questions in the third central/main question on the underlying causes of HF based on outcome expectation and sustaining the recommended actions are taken, the last two constructs of HBM.

Codes, Categories, and Themes

Data which I collected from the participants in the Gibson community were coded and categorized into themes. Figures1.0 -1.2 showed 42 NVivo codes for the first main question and survey questions. Responses from the first central/main question "How does the Gibson community and its members perceive HF in the neighborhood, in terms of economic, environmental and health effects" were: I have no perception, paid no attention to HF, no idea, not well informed, large amount of oil wells, HF important to area, four participants felt there were negative effects on water supply, three participants felt there was positive economic value/income for the local economy, more harm than good, advanced, from newspaper, okay, two participants did not answer the question,

while twenty-one participants did not know the answer to this question. Responses from the survey question “How did you get to find out about Hydraulic Fracturing (HF)” were: seven participants found out from (me) the researcher, three from the news alone, a research paper in high school, five participants did not know about HF, limited knowledge, television and physically, newspaper and television, heard about the negative effect on water resources, heard about it, internet, looked it up, three participants either had pump jacks in their neighborhood pumping oil, or heard through the Pastor, and one participant said HF was okay.

Responses from the survey question “What is your perception of HF in terms of the benefits or consequences” were: three participants answered not applicable, two participants answered to none, limited knowledge, bad for environment, okay if HF does not get into water, okay, I like HF, better income while it might ruin oil wells and produce salt water, benefits for HF companies and terrible consequences on County, it is good, safe on the environment, no view/no idea/ don’t know, no-win situation because there is a need for oil wells/more gas, coal mines result in pollution of water and air, two participants were not sure, large profit for companies while ignoring consequences, negative health effects but make HF better, benefit outweighs negative effects but the media is biased, death of workers in HF sites and pollution in community, fair, two participants felt they were not educated enough on HF.

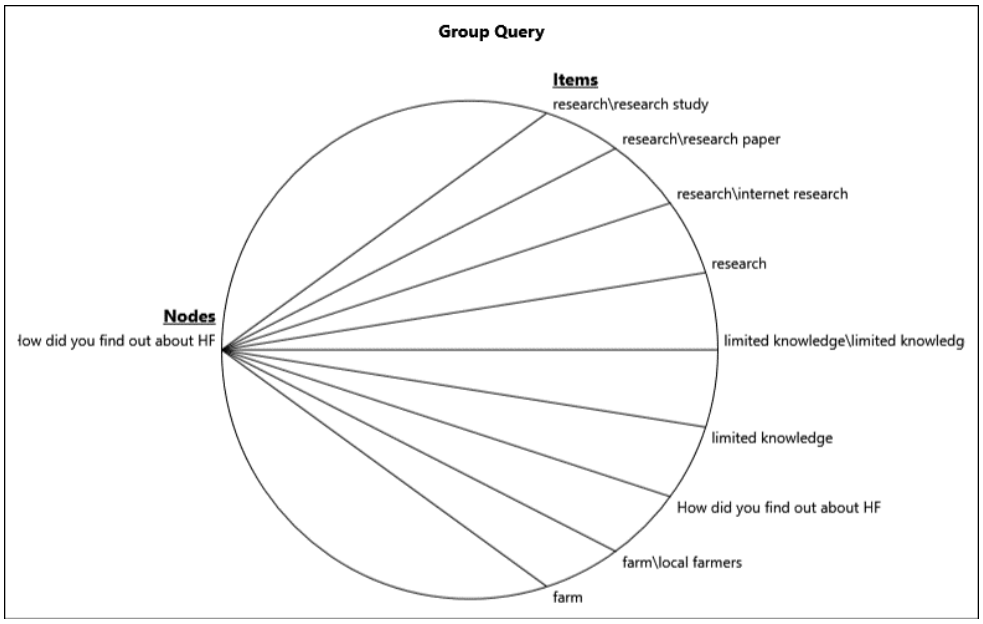

Figure 1.0. Codes emerging from node–How did you find out about HF?

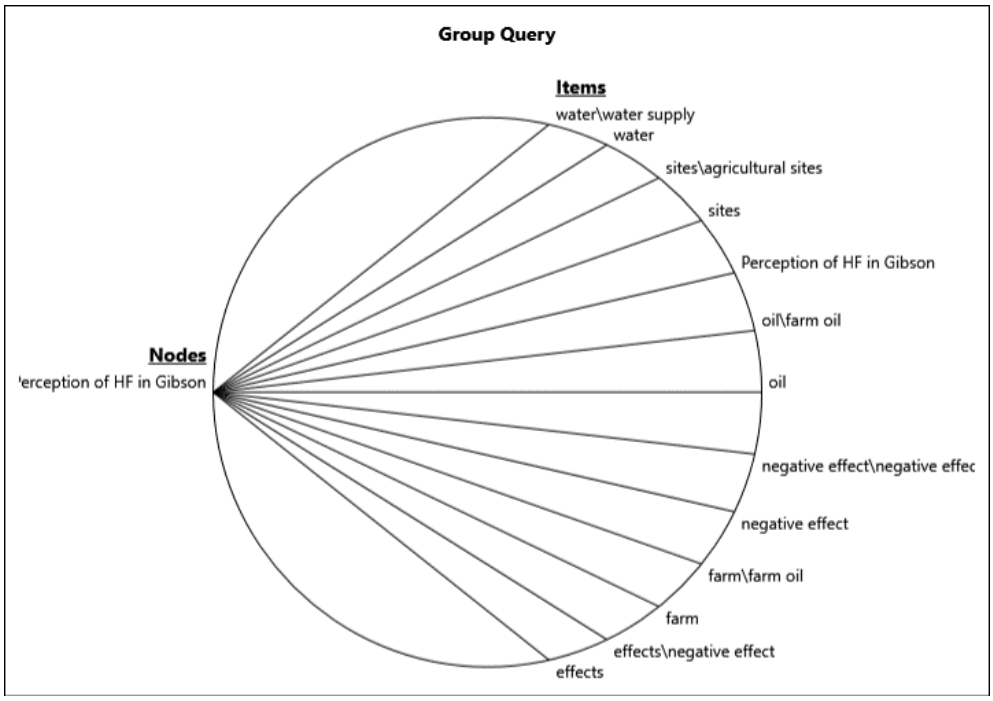

Figure 1.1. Codes emerging from node–Participants perception of HF in Gibson County.

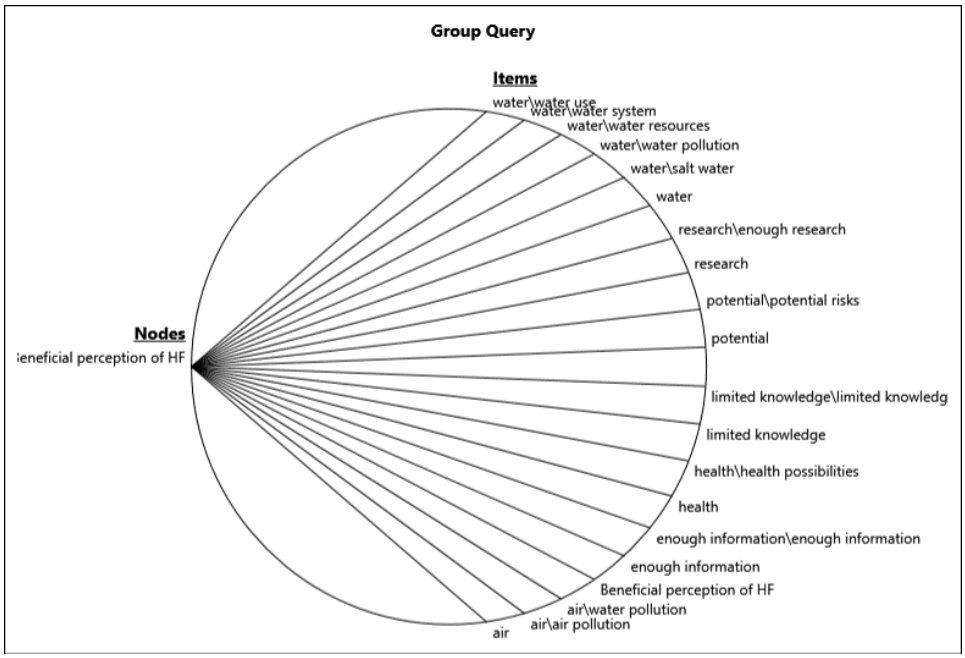

Figure 1.2. Codes emerging from node–Participants' perceptions of the benefits of HF.

The second central/main question "Considering the diverse perceptions of the positive and negative effects of HF on the Gibson community, which effects (if any) justify the continuation of HF in the community" generated 67 NVivo codes has shown in Figures 2.0 -2.5, and responses such as fifteen participants had no idea, three participants were not sure, more tax money for County, no negative effects improved oil production, no contamination by HF, good outweighs bad effects, keeps money in County, more money for County farmers/ more income, if ill effects then no justification for HF but more research needed, and easy to provide accessories needed. Responses that emerged from the survey question "What are the health effects of HF in Gibson community" were: eight participants had no idea/ don't know about HF, six participants felt there was no effect, three participants were not sure, two participants found the question not applicable, three participants either mentioned cancer or high cancer rate in Gibson

County, gas leaks/explosion/loss of house, not much, allergy, need for reduction of coal pollution producing nitrogen oxide/sulfuric oxide, illness, death, human error, average, improved quality of life, no conclusive proof of HF effects and better than what we have.

Responses from the second survey question "What are the economic effects of HF in the Gibson community" were: five participants answered not applicable, twelve participants had no idea, four participants said none/ unable to answer, bad health, okay, bring jobs, no economic effect known, landowners make money, taxes, employment, more money less work, more oil production for landowners/oil producers, maybe bring jobs, might help oil and gas prices, help farmers, air pollution, water pollution, land damage, any job good/more jobs, helping farmers, and overwhelmingly positive impacts.

Codes (Figure 2.3) and responses from the third survey question, "What are the environmental effects of HF in Gibson community" were: eight participants neither had no idea nor knowledge nor did not know, two participants answered none, two participants mentioned potential earth tremor/ water contamination/water damage, two participants cannot answer/ no answer, do not know any negative effects, three participants wrote no answer, four participants were unsure, four participants wrote not applicable, earth settling, more money, speculation of HF and fear of contamination but chemicals to run off when treating farmlands to streams/river/ lakes affecting fish and wildlife, we will have areas that you cannot write home about, coal mine not pretty to talk about except light on top, drab not good, not substantial. Responses to the fourth survey question "How do you think living within 5 to 10 miles from HF oil and gas extraction sites impacted your way of life" were: five participants had no idea, four participants

answered none, no impact, water well may cause harm, sinkhole, and destruction of homes, two participants claimed HF has not impacted them, two participants felt the question was not applicable, air pollution, gas emission/pollution, smell of oil pump jacks causes migraine, negative effects, none but well water needs to get tested, living close to coal mine ruins infrastructure, if there is error I will be the first to experience gas leak or flammable water, economic effects, not good, okay, provides oil that is needed, I don't think anything extracted from the earth affects future land/ climate.

Responses from the fifth survey question "How has HF changed the way you live in Gibson community" were: eleven participants answered no/none/no idea, seven participants felt HF has not impacted/ no knowledge/not noticed a difference in their way of life, three participants felt the question was not applicable, not sure, no idea, staying abreast of issue but not sure, filled out survey, don't know, don't need to travel far. The codes for the sixth survey question 'How severe do you think these effects of HF are on Gibson community' were; eight participants had no knowledge/no idea, don't know, much severity if found in water, three participants said no/none/not at all, slight, no clue, somewhat severe, not more severe than coal, risk of oil leakage, does not feel effects are high, serious, just heard about it but cannot be bad, not sure how severe but can affect the environment.

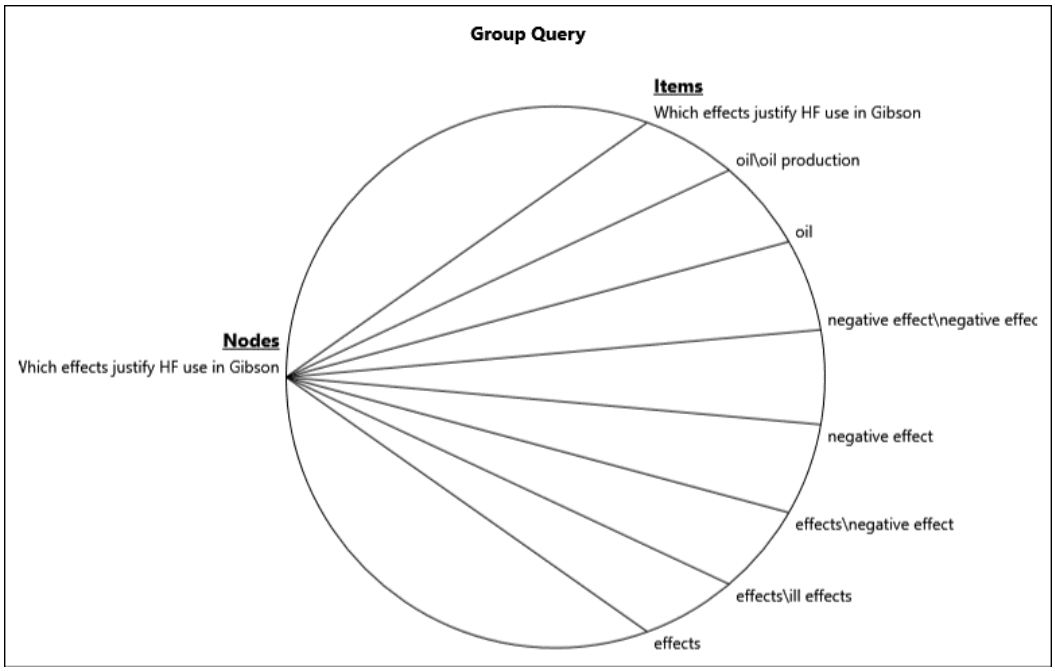

Figure 2.0. Codes emerging from node–Which effects justify the continuation of HF in Gibson County.

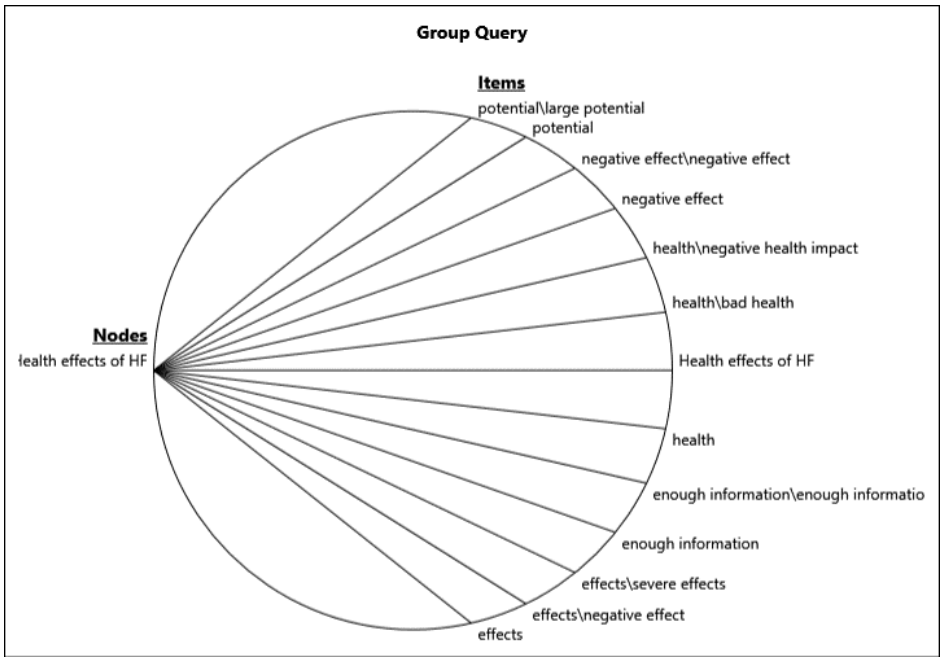

Figure 2.1. Codes emerging from node–Health effects of HF in Gibson County.

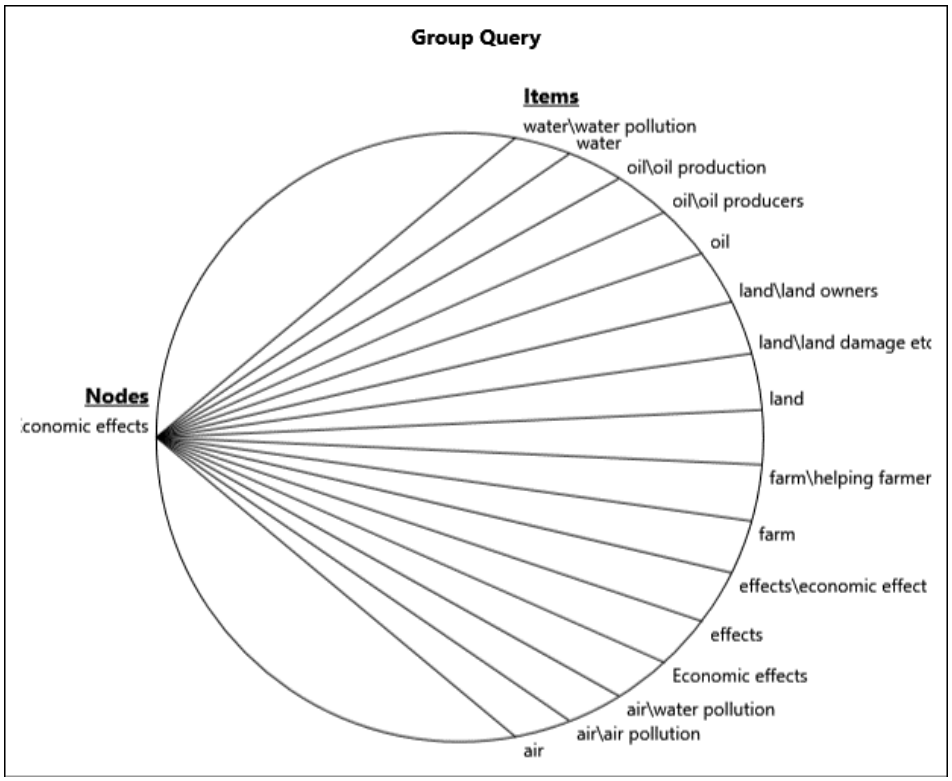

Figure 2.2. Codes emerging from node–Economic effects of HF in Gibson County.

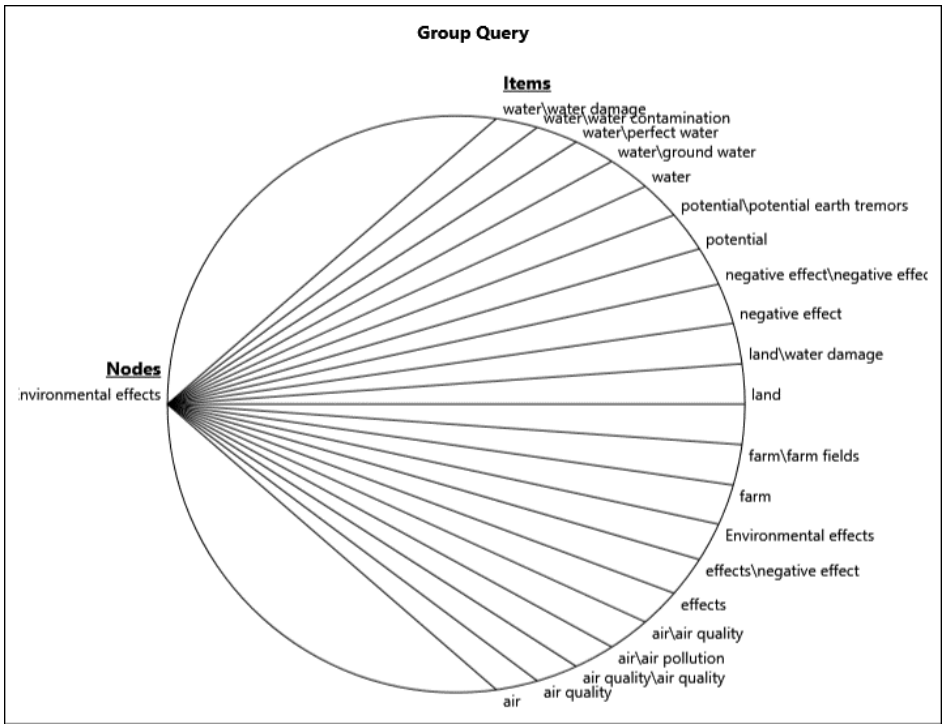

Figure 2.3. Codes emerging from node–Environmental effects of HF.

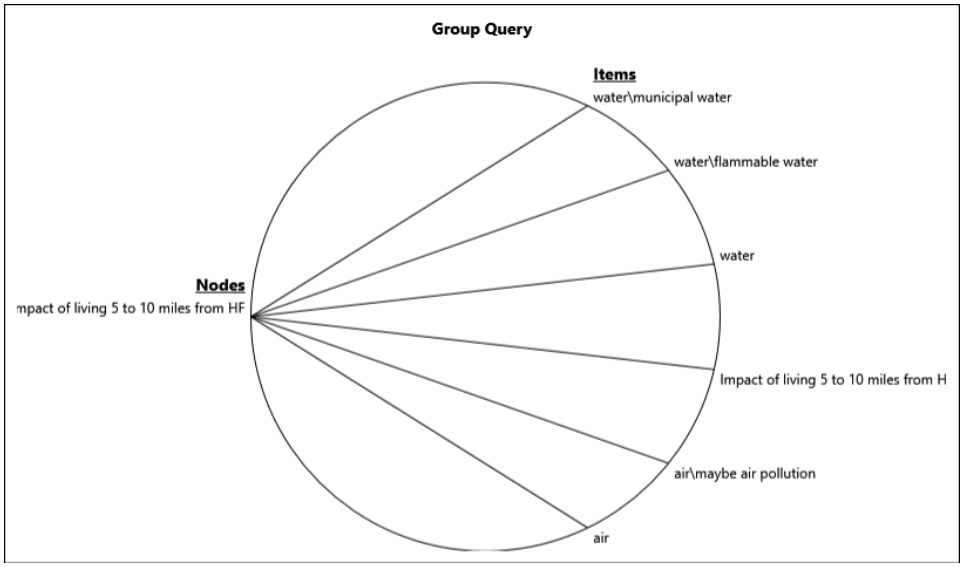

Figure 2.4. Codes emerging from node–Impact of living 5 to 10 miles from HF site.

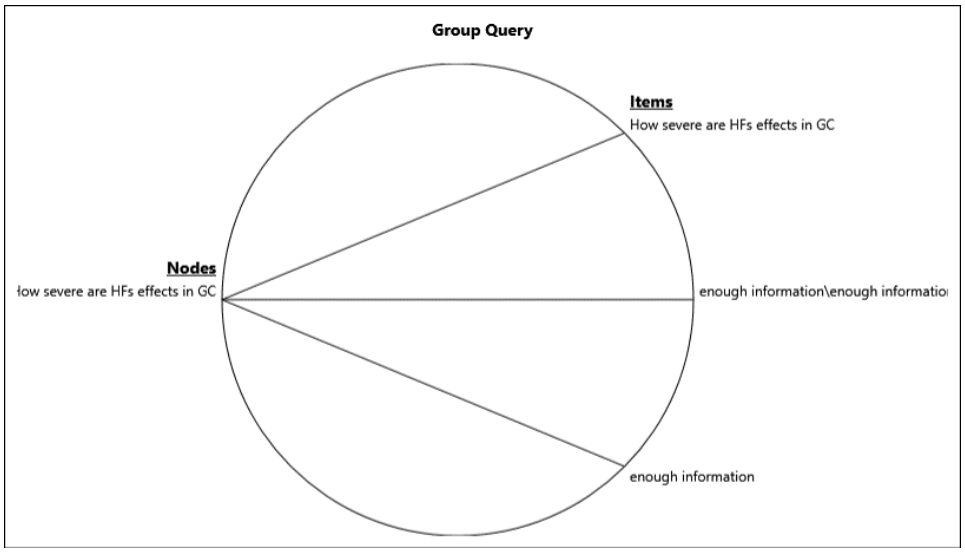

Figure 2.5. Codes emerging from node–Severity of HF effects in Gibson County.

Figures 3.0 - 3.5 showed 37 NVivo codes generated from the third main question and survey questions. Responses from the third central/main question, "Based on the approach used in the location of HF oil and gas extraction sites for national benefit, how was the Gibson community considered in alignment with environmental justice" were: thirteen participants neither did not answer or, had no idea/did not know, two participants answered no, four participants felt the question was not applicable, six participants were not sure, probably not good, don't factually know, government have burden of looking after the citizens but instead they look after their own interest, commended local/state leaders for not allowing rumor mongers dissuade them from locating HF in County.

Responses from the first survey question "What ways do you feel Gibson community members should be made to be more involved in the location of HF sites or all other facilities in future" were: through television, computer websites, two participants wrote that they could not answer the question, four participants felt by passing HF

information through County members, two participants claimed passing information through newspaper/ television news, three participants claimed through town hall meetings, HF should not be near homes, public listing of sites and public forum, County members inform community members of the effects, job opportunities, three participants did not know/wrote no, two participants found question not applicable, educate community members on chemicals used, air quality, members informed on current and future use of HF, access to explore HF more and the continuation in County, newspaper/news, yes, voting while a participant felt more information is needed.

Responses from the second survey question "What type of improvement as a result of HF effects would you like to be made, to live more sustainably" were: six participants were not sure, six did not answer the question, cannot answer, solar panel/wind rather than HF to reduce environmental impact, more water testing, two participants had no idea/none, fencing around oil pump jacks to protect animals, need to be educated on issue, use HF more responsibly, for HF to work successfully with no illness/ reduced smooth living in the future, HF is sustainable, health safety, HF to make clean water/air, unaware of what to do. The codes for the third survey question 'What action should be taken to make HF process more beneficial to Gibson community' were: four participants were unsure, four participants wrote no, two had no idea, cannot answer, need for more drinking water, two participants would want to learn more about the positive and negative effects, use our own resources, HF companies should follow rules and regulations, good companies to handle HF oil and gas extraction, neighbors of HF extraction sites should be informed, research on the pros and cons of HF and

communicate to residents, caution to ensure community safety, make HF oil and gas extraction sites more available without bureaucracy hiding progress, voting.

Responses from the fourth survey question “What are the barriers that may prevent Gibson community from taking action against HF” were: five participants had no idea/no answer, two found question not applicable, four participants were unsure, due to landowners’ benefit, money, lack of zoning, lack of enough information, lack of knowledge, money hungry politician, number of farmers, people uneducated and wrongly informed by rich HF farmers, boss/money, ignorance/limited knowledge/no knowledge, Federal Government, lack of knowledge if for or against, a participant felt the question was biased. The codes for the fifth survey question ‘What suggestions should be implemented to sustain the actions taken’ were: four participants were unsure of suggestions, three participants had no suggestions, seven participants had no answer, better understanding of HF, information given to community members, four participants answered no/not applicable, more information on HF, cops should listen to community members to address concerns leading to less resistance and negative actions, make public aware, HF is doing excellently. The codes for the last survey question ‘Do you have any other questions or suggestions’ were: eighteen of the participants had no suggestions, two claimed not to answer at this time, seven participants gave no answer, keep members informed, two participants claimed not applicable/did not know and a participant claimed questionnaire was worded negatively with bias.

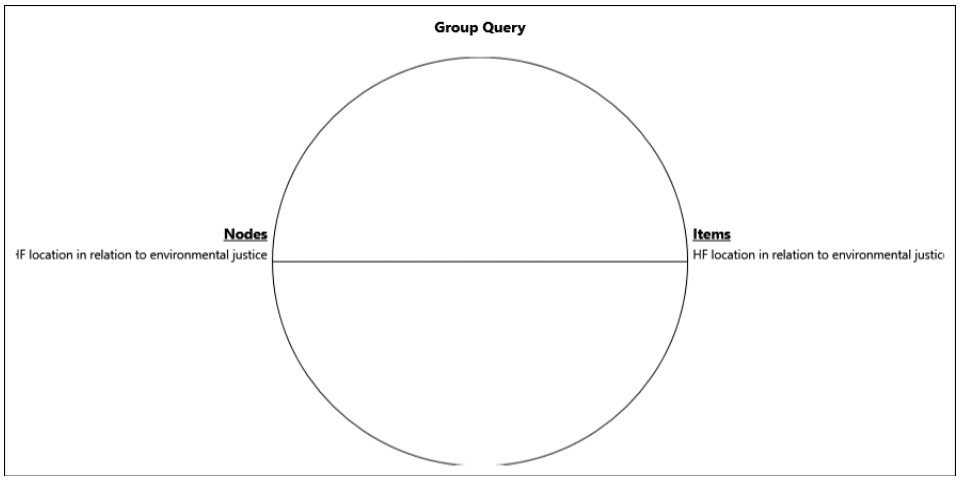

Figure 3.0. Codes emerging from node–HF location and environmental justice.

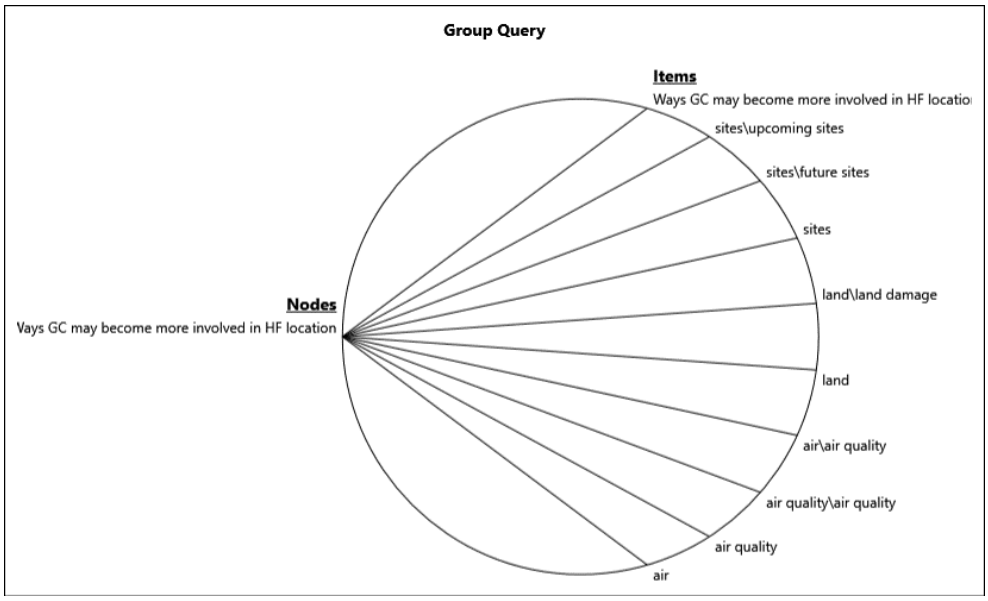

Figure 3.1. Codes emerging from node–Ways Gibson County can be more involved in HF location.

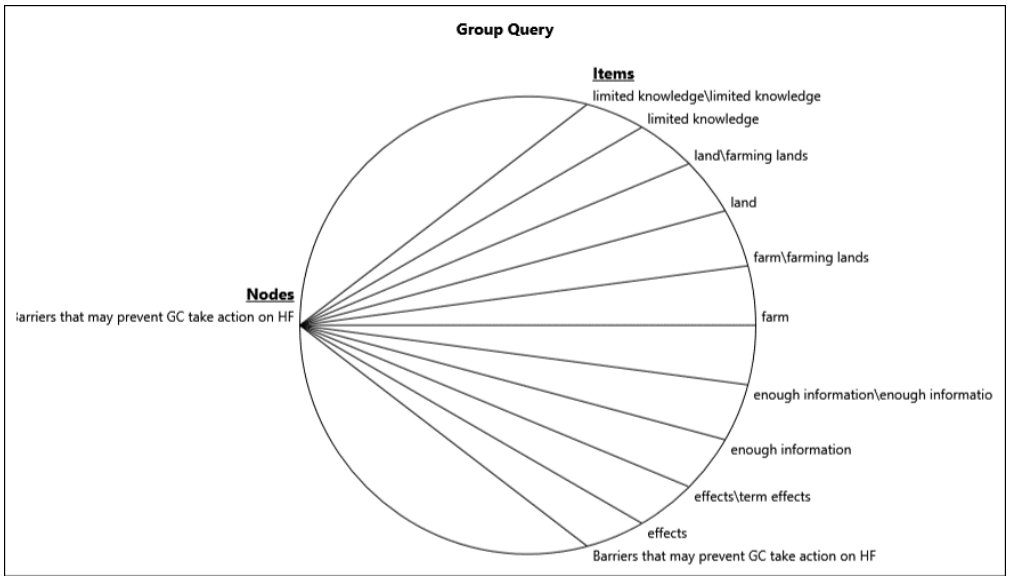

Figure 3.2. Codes emerging from node–Barriers to taking action on HF.

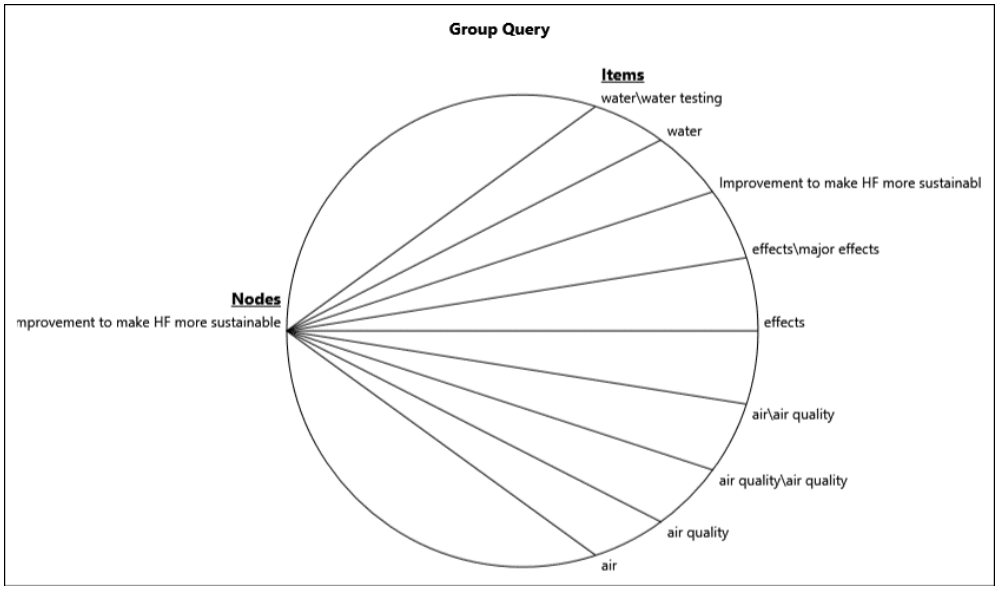

Figure 3.3. Codes emerging from node–Improvement to make HF more sustainable.

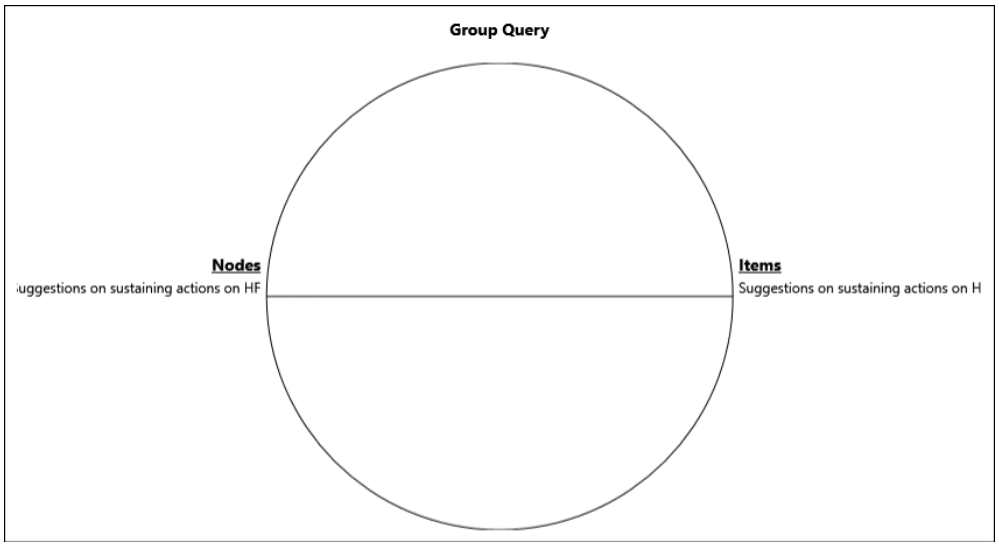

Figure 3.4. Codes emerging from node–Suggestions on sustaining actions on HF.

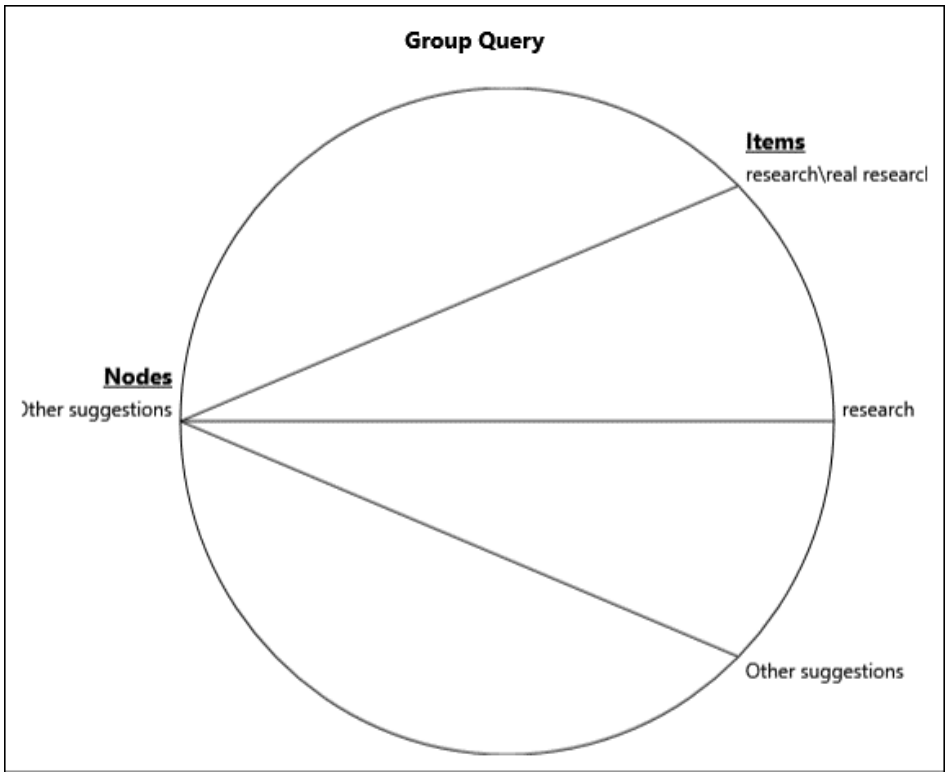

Figure 3.5. Codes emerging from node–Any other suggestion.

Precodes in Existing Literature

In the literature review some existing codes or precode emerged. During precoding, codes or categories are determined and extracted from a theoretical model, or literature review, and are used in the health sciences (Creswell, 2013). Precode in the perceptions of HF showed that low awareness is influenced by gender, race, level of education, age or technology exposure, and level of media use. Themes from the effects of HF in existing literature were categorized under economic, health and environmental effects.

Precode generated under the economic effects of HF were beneficial and detrimental. The positive impacts were: increased oil and gas development, reduced oil price, business growth, job creation, improved employment rates, reduction of trade deficit, wealthy farmers that signed oil leases and higher tax revenues for communities. The negative economic effects pre-coded in my literature review were; reduced property value, drilling failures, violation of HF regulations, mistrust in HF companies in sharing financial gains, toxic inhabitable wasteland whenever HF is relocated, concern on disbursement of ‘impact fee’ from HF abandoned oil fields, strain on community public services because of increased population and social problems.

The precodes generated from the environmental effects of HF existing in the reviewed literature were codes such as, depletion of ozone layer resulting from chemicals and gas emission, change in existing rural landscape, loss of farmland, farming style inactivity, threats to local ecology and wildlife, degradation of physical infrastructure resulting from frequency of heavy vehicles, chemicals release particulate matter (PM2.5)

into lungs causing asthma, seismic activities, air quality impact, pollution of underground water reducing water quality, lack of clean air and well water access, high volume of water used may lower water table and reduce water accessibility in communities, increased noise, increased demand on health and social infrastructure. The pre-code categorized under the health impact of HF were: fatigue, headache, burning eyes, dermatological irritation, upper respiratory gastrointestinal sensory problems, risk of endocrine disruption, throat irritation, birth defects, brain/central nervous system damage, cancer, premature deaths, immune cardiovascular systems defect, effects on kidney, mutations, chronic rhinosinusitis, migraine headache, occupational hazards, and stress.

Results

Structured Questions on Perception of Gibson Community Members on HF

The structured questions that formed the first part of the distributed questionnaires generated codes from the factors that may affect Gibson community members' perceptions on HF that were categorized into themes: gender, ethnicity/race, age, level of education, technology use and media use.

Perception and gender. Of the 32 participants, 9 (28%) indicated awareness of HF, and 23 (72%) lacked awareness of HF. Perceptions of HF based on gender (Table 3), showed that 81% of the twenty-one females that filled the questionnaires were unaware of HF and 20% indicated awareness. Out of the eleven males that filled the questionnaires, 55% were not aware of HF, while 45% of the men indicated awareness. The result showed that in comparison, men in Gibson County were more aware of the perceptions of HF than the women.

Table 3

Data on Perception and Gender

Sex	Number	HF Perception	No Perception
Female	21	20%	80%
Male	11	45%	55%

Note. Summary of participants' perceptions of HF and the effect of gender (N = 32).

Perception and ethnicity/race. HF Perception based on ethnicity/race (Table 4) revealed that the only Asian/Pacific participant that took part in the study was not aware of HF in the community. The two African Americans, the only Hispanic and the only Native American/Indian among the participants were also unaware of HF in the community. One Bi-Racial participant took part in the research and indicated awareness of HF in the County. The Caucasians formed 84% of my research participants. Out of the 26 Caucasian participants, 29.6% indicated awareness of HF in the Gibson community while 81.4% had no awareness of HF. The deduction was that the comparison of perception of HF based on race/ethnicity differed, although diverse numbers existed within and per group. The Bi-Racial and Caucasian participants were more aware of HF in Gibson County compared to other races in the study.

Table 4

Data on Perception and Ethnicity/Race

Ethnicity	Number	HF Perception	No Perception
Asian/Pacific	1	0%	100%
African American	2	0%	100%
Hispanic	1	0%	100%
Native American/Indian	1	0%	100%
Bi-Racial	1	100%	0%
White	26	29.6%	71.4%

Note. Summary of participants' perceptions of HF and the effect of ethnicity (N = 32).

Perception and age. Perception of HF based on age (Table 5), showed that perceptions of HF differed by age group with age group 30-49 having more awareness of HF in Gibson County.

Table 5

Data on Perception and Age

Number	Characteristics	HF Perception	No Perception
18-29	8	25%	75%
30-49	11	36.4%	63.6%
50-64	10	20%	80%
65-above	3	33%	67%

Note. Summary of participants' perceptions of HF and the effect of age (N = 32).

Perception and level of education. HF perceptions based on the participants' level of education (Table 6) showed that out of the five participants with an associate degree, 60% indicated awareness of HF and 40% lacked awareness. Four of the participants had a bachelor's degree, all four indicated unawareness of HF in their community. Participants that completed high school were four out of the 32 participants, 25% indicated awareness of HF in Gibson County, 75% were unaware. The only participant with a doctorate degree had no awareness of HF in Gibson County. Seven participants had high school and diploma, 71.4% of the group indicated unawareness of HF and 28.6% were aware of HF in Gibson County. The only participant with master's degree lacked HF awareness in Gibson County. Participants with some college credits/no degree were eight, with 75% unaware of HF while 25% were aware of HF in Gibson County. The two participants with trade/technical/vocation level of education lacked

awareness of HF in Gibson County. From the data, perceptions varied based on the level of education, with a higher level of awareness indicated by the participants with an associate degree.

Table 6

Data on Perception and Education

Number	Education Level	HF Perception	No Perception
5	Associate degree	60%	40%
4	Bachelor's degree	0%	100%
4	High school	25%	75%
1	Doctorate	0%	100%
7	High Sch and Diploma	28.6%	71.4%
1	Master's degree	100%	0%
8	Some College credits	25%	75%
2	Trade/Tech/Vocation	0%	100%

Perception and technology use. Technology use from the precode existing in literature affected perception (Table 7). In the study, two of the participants used the computer alone, 50% indicated HF awareness, and 50% were unaware of HF. Both

Computer and Smartphone were used by 25 (78%) out of the 32 participants. Out of the 25 participants, 28% indicated awareness of HF and 72% were unaware of HF.

Four participants used Smartphone only and 25% were aware of HF, 75% lacked awareness. One of the participants did not use any form of technology and also was unaware of HF. Perception of HF varied based on technology use, but using more than one form of technology may not increase people's awareness of HF in Gibson County.

Table 7

Perception and Technology Use

Number	Characteristics	HF Perception	No Perception
2	Computer	50%	50%
25	Computer/Smartphone	28%	72%
4	Smartphone	25%	75%
1	No Technology Use	0%	100%

Note. Summary of participants' perception of HF and the effect of technology use (N = 32).

Perception and media use. Perception of HF based on media use (Table 8), showed that perceptions of HF in Gibson County did not increase based on the number of media used.

Table 8

Perception and Media Use

Number	Media for News	HF Perception	No Perception
9	Computer	22.2%	77.8%
6	Television	0%	100%
6	TV/Computer	33%	67%
5	Newspaper/TV	20%	80%
5	Compt/TV/News	20%	80%
1	None	100%	0%

Note. Summary of participants' perceptions of HF and the effect of media use (N = 32).

Semi structured Main Question 1: Perception of HF

The question generated codes (Figure 1.0 - 1.2) from the perceptions of Gibson community members on the economic, health, and environmental effects of HF. The response of the participants on the overall perception of HF in Gibson County showed 28% of the 32 participants that took part in the survey were aware of HF in the County and 72% were unaware of HF in the County. The result aligned with literature that the communities near HF oil and gas extraction had low awareness of HF as showed in Table 9.

Table 9

Perception of Gibson Community Members

	Number	HF Perception	No Perception
	32	28%	72%

Note. Summary of Gibson community members' perception of HF (N = 32).

Survey Question 1 generated codes (Figure 1.0) on how community members in Gibson County found out about HF. Seven of the participants learned of HF through this research, eight did not know/ had no knowledge of HF, six participants found out about HF through the media (television newspaper computer), one participant learned about HF through school research, four participants learned about HF from other community members, HF companies, or oilfields; four did not disclose the mode; one participant wrote okay; and one participant learned about HF besides and from the television. The responses revealed that before my study was conducted, as shown in Table 10, 15 participants (46.88%) did not know about HF, 16 participants (50%) found out about HF through media, oilfields, or someone else, and one participant wrote okay.

Table 10

How Community Members Heard About HF

	Number	Percentage	Heard about HF	Never heard of HF
	15	46.88%	YES	-
	16	50%	-	NO
	1	3.12%	-	-

Note. Summary of Gibson community members that heard about HF (N = 32).

Survey Question 2 addressed the perceptions of Gibson community members on the benefits and consequences of HF. The codes (Figure 1.2) and responses (Table 11) showed that out of the 32 participants that filled the questionnaires, four participants (12.5%) perceived HF to benefit their community, six participants (18.75%) perceived HF as having consequences on Gibson community, two participants (6.25%) felt there was neither benefit nor consequence, fifteen participants (46.9) have no perception of the consequences and benefits, while five participants (15.6%) perceived HF as both beneficial and detrimental. The deduction is that majority of the community members lacked perceptions of the benefits and consequences of HF in Gibson County.

Table 11

Is HF Beneficial or Consequential?

Both	Neither	HF Beneficial	HF with Consequences	No Perception
15.6%	6.25%	12.5%	18.75%	46.9%

Note. Summary of Gibson community members' perceptions of the benefits and consequences of HF (N = 32).

Main Question 2: Effects of HF Justifying the Continuation of HF

In the second main question, the codes (Figure 2.0–2.5), and responses revealed nineteen participants (59.4%) out of the thirty-two participants in my study had no idea or knowledge of any justification of HF, two participants (6.2%) felt nothing justified the continued practice of HF in Gibson County, three participants (9.4%) indicated that if there were negative effects such as ill health, then HF should not be continued in the community, seven participants (21.9%) would want HF continued if good effects such as better economy, more money, more tax money outweigh the bad while one participant (3.1%) felt HF was okay for the community. Codes such as, wanted better practice of HF to continue extraction method, felt the economic benefits justify the continuation, if negative effects exist then more research needed for justification, better future for community members, no justification if HF results in ill health, if good outweighs bad, and not aware of the negative effects of HF. One participant felt HF was okay and two other participants did not support HF continuing in Gibson County. The deduction is that more than half of the participants had no perception of HF or the justification for

continuation, but more than half of the participants that had some level of perception of HF, felt economic benefits may justify HF in the county.

Table 12

Data on Justification of HF in Gibson County

Nothing Justifies HF	Okay	No Justification if negative effects	Justification if positive effects	No Perception
6.2%	3.1%	9.4%	21.9%	59.4%

Note. Summary of Gibson community members' perceptions of the justification of HF in their community (N = 32).

Survey Question 1 addressed the perceived health effects of HF by community members in Gibson County by generating codes (Figure 2.1) categorized as the health effect theme. Out of the 32 participants, 16 (50%) had no idea or knowledge of the question or health effects of HF, five participants (15.63%) perceived none or unaware of any health effect of HF, one participant (3.12%) indicated that the health effect was okay while the remaining 10 participants (31.25%) indicated the health effects perceived in their community, such as, cancer; HF could reduce, coal emission (see Figure 18) such as nitrogen oxide and sulfuric oxide; human error due to failed equipment; illness; death; improved quality of life resulting from the positive economic effects of HF; negative health effects not proven; air pollution; bad health; high cancer rate blamed on close proximity to large power plants; gas leaks effect; explosions and loss of houses; large health effect potential in existence; health effect better than what we have around; and average health. The deduction is that 50% of the community members lacked perception

of the health effects of HF while the remaining 50% had perceptions of the health effects, but there may be confounding effects from the coal and power plants located in Gibson County.

Table 13

Data on Perceived Health Effects of HF in Gibson County

None	Okay	Health effects	No Perception
15.63%	3.12%	31.25%	50%

Note. Summary of Gibson community members' perceptions of the health effects of HF (N = 32).

Survey Question 2 addressed the perceptions of Gibson community members on the economic effects of HF formed the basis of this question to generate codes (Figure 2.2) categorized in the economic effect theme. Twenty participants (62.5%) were unsure or did not have an idea or knowledge of this question. One participant (3.1%) perceived no economic benefit of HF while the remaining 11 (34.4%) participants perceived economic effects such as, helping farmers, overwhelming economic benefits, more oil production for landowners and producers, more money less work, landowners make more money but those that do, live outside the county; taxes and employment; reduced gas prices, more money; air pollution; water pollution; land damage; more jobs for the local economy; and successful extraction of resources. The result revealed that 62.5% of Gibson County members had no knowledge of the economic effects of HF, and the remaining 37.5% had perceptions of the economic benefits of HF, which as mentioned by a participant may not be felt because the farmers who received financial benefits from HF did not stay, or lived in Gibson County.

Table 14

Data on Perceived Economic Effects of HF in Gibson County

None	Perceived Economic Effects	Unsure/ No idea
3.1%	34.4%	62.5%

Note. Summary of Gibson community members' perceptions of the economic effects of HF (N = 32)

Survey Question 3 was used to generate codes (Figure 2.3) for the environmental effects of HF as perceived by Gibson community members. Out of the 32 participants, 22 (68.75%) had no knowledge or idea of the environmental effects of HF, the remaining 10 participants (32.25%) had perceptions of the environmental effects. The response of the participants were: not sure if HF has to do with air quality and earth settling, an area not to talk home about in addition to the coal mine, drab, not good, none substantial, air pollution, not perfect water, potential earth tremor, water contamination, water damage, fewer animals, no effect will convert to living without utilities HF brings more money, groundwater contamination which may also result from the treatment and spraying of chemicals on farmlands that may run off and contaminate streams rivers lakes affecting fish and wildlife. The data revealed that 68.75% of the participants did not have knowledge or idea of the environmental effects of HF, the remaining 32.25% had perceptions of HF effects, but a participant mentioned that the contamination of streams, rivers, and lakes may result from chemicals sprayed for treatment of farmlands as the confounding effect, another participant mentioned coal plants/mine as a confounder.

Table 15

Data on Perceived Environmental Effects of HF in Gibson County

Perceived Environmental Effects	No Knowledge
32.25%	68.75%

Note. Summary of Gibson community members' perceptions of the environmental effects of HF (N = 32).

Survey Question 4 generated codes (Figure 2.4) for the Gibson community members' perception of living in close proximity to Gibson County. Four participants (12.5%) did not perceive living close to HF sites would impact their lives, 13 participants (40.63%) did not have an answer to this question, nine participants (28.13%) believed living close to HF may impact their lives negatively through air pollution, gas leaks/ emission, flammable water, oil pumping smell causing migraine, smell; three participants (9.37%) felt living close to HF sites may impact their lives positively through accessibility to oil needed daily, economic opportunities, potentials, one participant (3.12%) mentioned living close to coal mine may ruin infrastructure and two participants (6.25%) answered okay/sometimes to the question. The code generated implied that 40.63% of the participants did not have knowledge of living close to HF sites, and 28.13% perceived living near HF may result in negative effects.

Table 16

Data on Perceptions of Living in Close Proximity to HF

No perceived impact	Okay	Negative impacts	Positive impacts	Coal mines' impact	No Perception
12.5%	6.25%	28.13%	9.37%	3.12%	40.63%

Note. Summary of Gibson comm. members' perceptions of living close to HF oil and gas extraction sites (N = 32).

Survey Question 5 generated codes (Figure 2.4) to answer how living in close proximity to HF impacted the participants' way of life. Twenty participants did not feel HF had any impact on their way of life, nine participants had no knowledge or answer to the question, one participant wrote that 'we live here', one participant mentioned that HF impacted the life by not having to live far, and one participant mentioned filling the survey. The deduction is that 62.5% of the participants felt no impact of HF in their lives while 28.13% had no knowledge or answer to the question, or answered incorrectly.

Table 17

Data on the Impact of HF in Gibson County

No impact on the way of life HF	No Knowledge	Okay/Void
62.5%	28.13%	9.37%

Note. Summary of Gibson community members' perceptions of the impact of HF on their way of life (The N = 32).

Survey Question 6 generated codes (Figure 2.5) on the perceptions of the severity of HF on Gibson County. Eighteen (56.25%) of the 32 participants had no knowledge or

idea of the severity of HF, four participants (12.5%) mentioned the severity of HF, such as severe, much severe if found in water, serious, severe but not as much as coal; four participants (12.5%) felt HF effects were not severe, five participants (15.63%) felt severity was slight, and one participant (3.12%) felt the time was too early to answer. The participants' responses implied that 56.25% had no knowledge or answer to the question while 12.5% felt HF was not severe, 15.63% felt the severity was slight, while 12.5% felt HF was severe.

Table 18

Data on the Perceived Severity of HF in Gibson County

Perceived Severity of HF	No Perceived Severity of HF	Slight Severity	Too Early to Determine	No Perception
12.5%	12.5%	15.63%	3.12%	56.25%

Note. Summary of Gibson community members' perceptions of the severity of HF (N = 32).

Main Question 3

The third main question, generated codes (Figure 3.0). Responses showed 29 participants indicated, I do not know, no idea, no, n/a, not sure, unknown, implying the community members were not aware or made part of the decision process before HF location. The four remaining participants wrote, the government had to face the burden of taking care of County members, probably good, commended the government for HF extraction in County, did not hear about HF until completion. Four participants answered the question with three leaning towards trust in the government for locating HF for the benefit of the community, and a participant indicated non awareness of HF location until

completion, implying not being part of the decision process. Out of the 32 participants, 29 or 90.6% were not aware of the location or had no idea of HF in their community. The deduction based on the response of participants (Table 18) is that Gibson community members were not part of the decision-making process, or the approach used in the location of HF oil and gas extraction sites for national benefit, in alignment with environmental justice. According to EPA, Environmental justice (EJ) is when all people irrespective of color, race, national origin, or income, are fairly treated and meaningful involvement, with respect when developing, implementing and enforcing environmental laws, regulations, and policies (EPA, 2018).

Table 19

Data on Gibson County Members' Part in the Decision-Making of Locating HF Sites

Responses	Not Part of Decision-making to site HF	Void
No. of Participants	29	3
Percentage %	90.6%	9.4%

Note. Summary of community members' involvement in the location of HF in Gibson County (N = 32).

Survey Question 1 coded (Figure 3.1) ways Gibson community members should become more involved in the location of HF sites, or all other facilities in the future. Ten of the 32 participants did not know/were unsure of how to make HF more sustainable, 22 participants made suggestions, such as having townhall meetings on HF; inform Gibson community members on HF presence, current and future locations, long-term effects on chemicals used, land use, and proximity of HF sites from community members' homes;

should not be near a home with a water well; maybe list upcoming sites and hold a public forum; voting; choice for community members to accept and decide if more HF sites were needed, job possibilities; information of HF on television and newspaper; website where HF permits were displayed for community members; educate community members on the long-term effects of HF such as chemical used, land damage; air quality; and information on HF availability and objectively explained without political, financial or otherwise slant. The data revealed that 31.25% of the participants were not sure of the question, and 68.75% wanted Gibson community members to be more involved through a public forum, town hall meetings and informed through television, newspaper, computer websites on the effects of HF, on homes near the sites.

Table 20

Data on How Gibson Community Members May Be More Involved in Decision-Making

Not Sure	Suggestions on decision-making
31.25%	68.75%

Note. Summary of suggestions on better involvement of community members' in the future decision-making process (N = 32).

Survey Question 2 was for coding (Figure 3.3) improvements on HF effects that would make Gibson community members live more sustainably. Out of the 32 participants that completed the survey, 20 participants (62.5%) did not know/ had knowledge of how to make HF more sustainable, twelve participants (37.5%) had suggestions such as, use wind or solar energy instead of HF, make ways to make HF produce clean air and water, better road maintenance, better practice of HF to reduce

illness so we can be smart in future, fencing around pumps to prevent animals straying, more water testing, health and safety, education of community members on the major effects of HF, air quality, fix what HF destroyed, and live more responsibly, with a participant that felt HF was sustainable already. The deduction from the code was that all participants that had knowledge of the question felt HF should be more sustainable through better road maintenance, cleaner air, and water, replacement of HF for solar energy or wind, fencing of oil well sites to prevent animal loitering, education of community members on HF, fixing of whatever was destroyed by HF, and living more responsibly.

Survey Question 3 addressed the action that should be taken to make the HF process more beneficial to Gibson community members revealed the community's feelings. Twenty participants (62.5%) were unsure /did not know how to answer the question, twelve participants (37.5%) wanted HF to be more beneficial through good/competent companies handling HF, community members visiting and seeing HF sites to see how it works, voting, HF made more available without bureaucracy, HF carried out with caution to ensure safety of community members, using resources from community, educating community members, more resources, more drinking water, good companies handling HF, demand to follow rules and regulation, use HF local workers to research the pros and cons to communicate with community. The deduction from the participants' response implied that HF companies following laid down rules and regulations, using more sustainable health and environmentally safe alternatives while involving community members in the decision-making process would be welcome.

Survey Question 4 generated codes (Figure 3.2) on barriers that may prevent Gibson community from taking actions against HF. Sixteen participants were either unsure or did not have knowledge of the question. Sixteen participants that responded to the question indicated reasons on barriers that prevented the community from taking action on HF, such as, lack of money, lack of zoning in the community, ignorance/lack of knowledge/information and understanding of HF; the effects, politics, money hungry politicians, Federal government, the amount of farmers in the area, many landowners benefited from HF, money needed to take action and the '*big boss'* involved. The codes and responses showed that 50% of participants were unsure or had no knowledge of HF. The 50% that responded to the questions felt the rich influential landowners and farmers benefiting from HF, the Federal government and politics, and lack of enough knowledge of community members were preventing the Gibson community from taking action against HF. One of the participants that responded indicated that the question was biased.

Survey Question 5 revealed codes (Figure 3.4) on sustaining any actions taken on HF. Twenty-five participants were unsure or did not have knowledge of responding to the question. Seven participants that responded indicated reasons such as, giving information to community members, a better understanding of HF, public awareness, voting, cops listening to community members and taking action which would lead to less resistance/ negative actions on HF from the community. One participant believed the community is doing well. The deduction from the participants' responses implied that sustaining actions taken on HF may be achieved by creating better public awareness, better understanding

and more information on HF, with the cops paying attention to the complaint of community members to reduce resistance and negative actions on HF.

Survey Question 6 generated codes (Figure 3.5) from any other suggestion participants may have on HF and the effects. Twenty-nine participants did not have any suggestions. Out of the three participants that responded, two indicated that the questions were not objective, and worded negatively. The third participants indicated that keeping community members involved in HF is important.

Perception and Proximity to HF Sites in Gibson County

Responses of participants on the proximity and perceptions of community members indicated that 67% of participants claiming to live 0-5 miles from HF oil and gas extraction sites had no perception of HF. Out of the participants living 5.1-10 miles from HF sites, 60% were not aware of HF, and out of the participants living 10.1-beyond, 62.5% had no awareness of HF. Contrary to existing data in the literature, the levels of perception did not increase directly with the distance from HF sites because the participants living 0-5miles from HF site in Gibson County had the least perception of HF. The second survey question on how participants found out about HF showed that 33% of participants living 0-5 miles from HF sites found out from this study, 25% did not answer, and 42% heard from the news or community members. Out of the participants living 5.1-10 miles, 20% heard from this study, 30% did not hear about HF, 50% heard from television, news, documents, HF company. 75% of the participants living 10.1 miles - beyond, heard about HF from television news, HF company, community members, newspaper, 12.5% heard from this study, 12.5% gave incorrect answers (wrote OK). The

category of participants living 10.1 - beyond from HF sites seemed to have a higher level of awareness of HF than those living 0-5miles. Awareness of HF in Gibson County increased directly with distance from HF sites, which contradicted the data in existing literature.

Gibson Community Members and Knowledge of HF

Table 21

How Distance of Community Members to HF Sites Influenced Perception of HF

	Distance	No Perception HF	Perception of HF
	0–5 miles	67%	33%
	5.1–10 miles	60%	40%
	10.1–above miles	62.5%	37.5%

Note. Summary of proximity to HF sites and perception (N = 32).

Perception of Gibson County on HF and Health Belief Model

I adapted HBM to understand why Gibson community members may or may not accept HF in their community. The six constructs of HBM were adapted in some survey questions. I adapted HBM to HFHIBM as:

- Perceived susceptibility is the belief of community members' chances of having negative health consequences from HF siting in the community

- Perceived severity is the belief in how serious the consequences of HF are in the community
- Perceived benefits are the belief in the efficacy of the action to take in reducing the risk or seriousness of HF consequences
- Perceived barriers are the beliefs preventing the community in acting or the psychological costs of taking action against HF impacts
- Cues for action are steps taken towards action against impact/ consequences of HF
- Self-efficacy is the confidence, and the step taken in maintaining action against HF impacts in the community.

The question that tested for the first construct of HBM - Perceived susceptibility, the belief of community members' chances of having negative health consequences from siting HF in the community was "What is your perception of HF in terms of the benefits or consequences". The deduction from the codes and responses was that 46.9% of the community members lacked perception of the benefits and consequences of HF in Gibson County, 18.75% believed HF had consequences, and 12.5% indicated HF was beneficial. In the responses from the question "What are the health effects of HF in Gibson community", 50% of the community members had no perception of the health effects of HF, 50% had some levels of perception of the health effects of HF but indicated that coal and power plants in Gibson County might have confounding effects. Out of the 50% that had perceptions of the health effects of HF, 70% perceived the health effect as negative.

Data collected showed that majority of Gibson community members were unaware of the susceptibility of HF, the remaining members had negative perceptions of HF effects.

The question “How severe do you think these effects of HF were on Gibson community” tested for perceived severity, the belief in the seriousness of the consequences of HF on the community. The result from responses of participants implied that 56.25% had no knowledge or answer to the question, while 12.5% implied that HF was not severe, 15.63% felt the severity was slight, and 12.5% felt HF was severe. The data showed that more than half of Gibson community members lacked knowledge of HF to know the severity, the remaining members perceived the severity to be slightly severe, severe, or not severe. The participants who indicated that HF effects were slightly severe were more than the other two groups.

Responses to the question on perceived benefits, the belief in the efficacy of the actions to be taken in reducing the risk or seriousness of the consequence HF was, “What action should be taken to make HF process more beneficial to Gibson community”. Participants indicated that HF could become more beneficial by reducing the risks, HF companies should follow laid down rules and regulations, use more sustainable health and safer environment-based alternatives while involving community members in the decision-making process.

The question to code perceived barriers, the beliefs preventing the community from acting or the psychological costs of taking action against HF impacts was, “What are the barriers that may prevent Gibson community from taking action against HF”. Participants’ responses revealed that 50% felt the rich influential landowners and farmers

benefiting from HF, the Federal government, politics, and the lack of enough knowledge of HF by community members, were preventing the Gibson community from taking action against HF.

The cues for action, steps taken towards action against impact/ consequences of HF was based on the question “What type of improvement on HF effects should be made, to live more sustainably”. Participants that had knowledge of the question felt HF should be made more sustainable through better road maintenance, cleaner air, and water, replacement of HF for solar energy or wind, fencing of oil well sites to prevent animal loitering, education of community members on HF, fixing of whatever was destroyed by HF, and living more responsibly.

The sixth construct of HBM, self-efficacy, the confidence, and the steps in maintaining action taken on the effects of HF in the community. The question to code the construct was “What suggestions should be implemented to sustain the actions taken”. The participants’ responses implied that sustaining actions taken on HF may be achieved through creating better public awareness, better understanding and more information on HF; and the cops paying attention to the complaint of community members to reduce resistance and negative actions on HF.

In conclusion, although Gibson community members had no perception of the health effects of HF, 70% of the participants felt the health effect was negative; 12.5 % mentioned the severity of HF effects, 12.5% felt HF was not severe, and 15.63% felt the severity was slight; the participants believed in the efficacy of the actions that will be taken on HF, such as, HF companies following laid down rules and regulations, using

more sustainable health and safe environmental alternatives while involving community members in the decision-making process to reduce the risk or seriousness of HF; the participants perceived barriers from the rich influential landowners and farmers who benefited from HF, the Federal government and politics, the lack of enough knowledge of HF by community members, were preventing Gibson community from taking action against HF; the suggestions based on cues for action, were, making HF more sustainable through better road maintenance, cleaner air and water, replacement of HF for solar energy or wind, fencing of oil well sites to prevent animal loitering, education of community members on HF, fixing of whatever was destroyed by HF, and living more responsibly; and self- efficacy, sustaining actions taken on HF may be achieved through creating better public awareness, better understanding, and more information on HF, the cops paying attention to the complaint of community members to reduce resistance, and negative actions on HF.

Observation Protocol

I observed separate locations in Gibson County to perceive the environmental effects of HF in Gibson County, Indiana. The first location observed on the 27th of April 2018, was in Owensville on the way to Cynthiana around County road 900. I made the first attempt to get to Wabash township for the first HF location before turning back because of the condition of the road. I was not sure also of my safety. Several pump jacks were located on farmlands along the County road, ranging from, about two to about six on a farmland. Some pump jacks were pumping oil while some were not, and some were rusty as a result of abandonment from unproductive pump jacks. The County road was

lonely with an average of two vehicles, mostly trucks, per five minutes. The road was graded for some miles after which the road only had gravel coverage. The weather condition of the area was, 7mph of wind speed,10% precipitation, moderate temperature of 69F, and mild relative humidity of 53%. The odor in the atmosphere was that of lemon, typical of this area because most were melon farmers. There was an odor from the engine oil of the pump jacks. I did not observe any HF wells, despite my closeness to the Wabash River. No vibration was observed, but the pump jacks made a continuous grinding noise as I moved closer to the site. I did not notice the prevalence of any disease or economic boom in Gibson County. The quality of the houses was typical of any farmland area in the U.S. and most households had trucks due to the quality and terrain of the roads.

The second location observed on the 28th of April 2018, was in Owensville around County Road 400. Several pump jacks were located on farmlands along the County road, ranging from about two to about six on a farmland. Some pump jacks were pumping oil while some were not, and some were rusty because of the abandonment from the lack of productivity of the pump jacks. The County road was lonely with an average of two vehicles on the road, mostly trucks, every five minutes. The County road was partially graded and partially covered with gravel. The weather condition of the area was, 7mph of wind speed, 0% precipitation, moderate temperature of 70F, and mild relative humidity of 53%. The odor in the atmosphere was that of lemon, typical of this area because most were melon farmers. No vibration was observed but the Pump jacks made a continuous grinding noise. I did not observe the prevalence of any disease or economic

boom. The quality of the houses was typical of any farmland area in the U.S and most households have trucks which may be due to the quality and terrain of the roads.

The third location observed on the 30th of April 2018, was around Route 65 in Owensville. Pump jacks were also located on farmlands along the County road, ranging from about two to about six on a farmland. Some pump jacks were pumping oil while some were not, and some were rusty because of the abandoned unproductive pump jacks. The road had an average of ten vehicles per five minutes. The weather condition of the area was 0% precipitation, moderate temperature of 68F, and low relative humidity of 25%. The odor in the area was moderately strong of engine oil from the pump jacks in the atmosphere as I moved closer to the Pump jacks. I did not observe any HF wells, but I was about 20 miles from the Wabash River. No vibration was observed but the pump jacks made a continuous grinding noise. I did not observe the prevalence of any disease and no economic boom in Gibson County. The quality of the houses was typical of any farmland area in the U.S and most households had trucks probably due to the quality and terrain of the roads.

The fourth location observed on the 1st of May 2018, was Route 68 around 650S in Owensville. Pump jacks were located on farmlands along the County road, ranging averagely from about two to about six on a farmland. Some pump jacks were pumping oil while some were not, and some were rusty because of abandonment from unproductive pump jacks. The County road was lonely, in good condition but undergoing maintenance, with an average of five vehicles, mostly trucks, per five minutes. The weather condition of the area was, 10 mph of wind speed, 0% precipitation with 45% dew point, the high

temperature of 82F with 5 out of 10 UV, and low relative humidity of 29% with 10m visibility. The odor in the atmosphere was from engine oil from the pump jacks as I moved closer to the pump jacks. I did not notice any wells, but I was about 20 miles to the Wabash River. No vibration was observed but the pump jacks made a continuous grinding noise. I did not notice the prevalence of any disease or any economic boom in Gibson County. The quality of the houses was typical of any farmland area in the U. S and most households had trucks probably due to the quality and terrain of the roads.

The fifth location observed on the 2nd of May 2018, was Route 64 around route 65 in Owensville on the way to Princeton. Pump jacks were located on farmlands along the County road, ranging averagely from about two to about six on a farmland. Some pump jacks were pumping oil while some were not, and some were rusty because of abandonment resulting from unproductive pump jacks. The County road was lonely, with an average of five vehicles, mostly trucks, per five minutes. The weather condition of the area was a high temperature of 77F with 3 out of 10 UV, and high relative humidity of 60%. The odor in the atmosphere was that of engine oil from the pump jacks. I did not observe any HF wells, but I was about 25 miles to the Wabash River. No vibration was observed but the Pump jacks made a continuous grinding noise as I approached. I did not observe the prevalence of any disease or economic boom in Gibson County. The quality of the houses was typical of any farmland area in the U.S and most households had trucks which may be due to the quality and terrain of the roads.

The sixth location observed on the 18th of June 2018, was off route 65 in Wabash township. Fewer pump jacks were located on farmlands along the County road, fewer

than previous roads observed, about two on a farmland. Some pump jacks were pumping oil while some were not, and some were rusty because of abandonment. The County road was lonely, with an average of one vehicle per five minutes with no trucks noticed once I turned off route 65. The weather condition of the area was the low temperature of 60F with 0 out of 0 UV, and high relative humidity of 60% because of the dense vegetation. There were four to five houses were observed. The odor in the atmosphere while going over the Wabash River bridge was similar to petroleum smell. I did not observe any HF wells in this neighborhood. I did not observe the prevalence of any disease or economic boom in the area except for farmlands. The quality of the houses was typical of any farmland area in the U.S and most households had trucks which may be due to the quality of the road, graded and narrow, and the terrain. I lost satellite around the Old Covered Bridge, but the green colored stagnate water beneath the bridge caught my attention. I turned back from the dense vegetation because of loss of the satellite, without sighting any HF sites. I took a screenshot of the aerial view of HF well pads and sites from Google Maps. The site was located on Latitude 38°14’58.34 N, Longitude 87°56’20.41W, Elevation 177ft.

Trustworthiness of Research

Credibility

Researchers achieve trustworthiness in qualitative research by maintaining credibility, transferability, confirmability, and dependability. The credibility of my research was achieved through triangulation of my data by administering my questionnaires to participants of diverse characteristics and townships within Gibson

County. The participants that took part in my study had the option of taking part in face-to-face interviews or completion of questionnaires. All participants opted for the completion of questionnaires. I maintained credibility by allowing the participants to complete the questionnaires without my interference.

Confirmability

I ensured my research findings were based on participants' responses and not influenced by potential bias or personal motivations by me or any other external factors. Most of the participants completed the questionnaires in their homes and returned at an agreed date. On one occasion, I was checking the completed questionnaire and explaining a question to the participant, but he felt I influenced his response, this prevented me from making further suggestions. I also avoided making any conversation with the participants while completing the questionnaires.

Transferability

The transferability of my research was maintained by thoroughly describing the research context and the assumptions made that were central to the research. The Literature review in my research explained my research context and was used to precode my data.

Dependability

The extent of replicating a study by other researchers is referred to as dependability. The detailed description of my research methodology ensured the dependability of my research for data gathering and collection. The IRB in Walden University also carried out audit inquiry to establish dependability through the review and

examination of my research process before I collected data from Gibson community members.

Summary of Research Findings

In summary, based on the themes that evolved from the codes of data collected on the factors affecting perception implied that Bi-Racial (although the only participant which may not be an accurate representation) and Caucasian participants were more aware of HF in Gibson County compared to other races in the study; that perception of HF differed by age group, age group 30-49 had more awareness compared to other age groups, perception of HF varied by level of education with better awareness among the group of participants with an associate's degree, perception of HF varied based on technology used, but using more than one technology type may not increase people's awareness of HF in Gibson County; and that awareness of HF differed based on media use but did not increase based on increased number of media used. In comparison, the result from the data analysis aligned with existing literature, that, perceptions may be influenced by age, race, gender, education, technology use, and media use.

The level of awareness or level of perception of HF in Gibson County was low, with 72% of the participants unaware of HF, and the majority of the community members lacked perceptions of the benefits and consequences of HF in Gibson County; 50% of those that had perceptions of HF learned through media, oilfields or community members. Majority of the participants had no perception of HF or justification for the continuation; 50% of the community members had no perception of the health effects of HF while the remaining 50% had some level of perception of the health effects. HF

effects may be confounded by the presence of coal and power plants located also in the community; 62.5% of Gibson County members had no idea of the economic effects of HF and the remaining 37.5% had perceptions of the economic benefits of HF which as mentioned by one of the study participants, may not be felt because the farmers who benefited did not stay or live in Gibson County; 68.75% of the participants did not have knowledge or idea of the environmental effects of HF, the remaining 32.25% had perceptions of HF, but a participant mentioned that the contamination of streams, rivers and lakes may result from the confounding effects from chemicals sprayed for treatment of farmlands, another participant mentioned coal plants/mine as having confounding effects. 40.63% of the participants lacked knowledge of the implication of living close to HF, 28.13% perceived living in close proximity to HF may result in negative effects, 9.37% felt living close to HF sites may impact their lives positively, and 12.5% did not perceive living close to HF sites will impact their lives. 62.5% of the participants felt no impact of HF in their lives, while 28.13% had no knowledge or answer to the question.

Out of the 32 participants, 29 or 90.6% were not aware of, or part of the decision-making process of locating HF in their community for national benefit in alignment with environmental justice. The data revealed that 31.25% of the participants were not sure of how to make community members take part in decision-making process of locating amenities in Gibson County, and 68.75% wanted Gibson community members to be more involved in the decision-making process through a public forum, town hall meetings, and be better informed from watching television, reading newspapers, browsing computer websites, on the effects of HF most importantly by homes close to the sites. In living

more sustainably with the effects of HF, all participants that had knowledge of the question felt HF should be made more sustainable through better road maintenance, cleaner air, and water, replacement of HF with solar energy or wind, fencing of oil well sites to prevent animal loitering, education of community members on HF, fixing of whatever was destroyed by HF, and living more responsibly.

Chapter 5: Discussion, Conclusions, and Recommendations

The purpose of this study was to explore Gibson County community members' perceptions of the economic, health, and environmental effects of living in close proximity to HF oil and gas extraction sites in Indiana. HF is a recent phenomenon globally, and the effects remain controversial. Several researchers have examined the controversial nature of HF (Boudet et al., 2014; Hoffman, 2017; Jain, 2015). These controversies mostly involve the effects of HF on neighboring communities where HF is located. The United States has been estimated to contain 622.5 trillion cubic feet of wet shale gas and 78.2 billion barrels of tight oil that are recoverable using the HF technique (McCready, 2017). HF is believed to have economic, health, and environmental effects on communities in close proximity to the extraction sites. These effects may be beneficial or detrimental.

The economic benefits of HF may be beneficial or detrimental to neighboring communities. Some economic benefits are lower fuel prices, domestic business growth, job creation, and improved employment rates (Boudet et al., 2014; Jain, 2015; Mehamy & Goggemos, 2015). Negative effects are reduced property values, drilling failures, and violation of HF regulations (McDermott et al., 2013). The perceived health effects HF has on neighboring community members are negative effects on the skin, eyes, other sensory organs, respiratory and gastrointestinal systems, immune and cardiovascular systems, kidneys, brain/nervous system, and endocrine system, cancer and mutations (Hoffman, 2017). Other negative health effects include chronic rhinosinusitis, migraine headache, and fatigue symptoms (Tustin et al., 2016). Sand used during HF may have

crystalline silica, which when inhaled by workers may cause silicosis (Hoffman, 2017). All the HF sites exceeded the occupational health criteria for respirable crystalline silica exposure, implying that wearing of proper respiratory equipment may not protect the workers (Hoffman, 2017). The pollution resulting from HF may cause nose, eye, and throat irritation; respiratory illnesses; birth defects; central nervous system damage; cancer; or premature death (Srebotnjak & Rotkin-Ellman, 2014). Children living close to HF sites are more at risk for asthma, and older people are more vulnerable to the effects of climate change (McDermott et al., 2013). The perceived environmental effects of HF are induced seismic action; release of methane and other gases; release of particles into the atmosphere; contamination of underground water (Hoffman, 2017; Jain, 2015; Rabinowitz et al., 2015); radioactivity (Jain, 2015); increased noise, water and air contamination; increased intensity of truck traffic volume; and occupational hazards, stress, and increased demands on health care and social infrastructure (McDermott et al., 2013). Methane migration in drinking water is suspected to contribute to climate change (McDermott et al., 2013). The release of HF fluids into water bodies and chemicals into the atmosphere may result in the death of domestic animals such as cows, aquatic wildlife (Bambergera & Oswald, 2014; D'Alessandro, 2014), and birds.

The main controversy involves whether the positive effects outweigh the negative effects to justify the continuation of HF. If not, it may be necessary to consider what may be done to make the process of HF oil and gas extraction more sustainable and safer for communities in close proximity to these sites. Several contradictory solutions

have been suggested by researchers. Opposing groups of researchers may need to compromise to resolve the existing controversies.

Interpretation of the Findings

The purpose of this study was to explore the perceptions of community members in Gibson County, Indiana, regarding the economic, health, and environmental effects of living in close proximity to HF. I also explored the involvement of Gibson community members in the location of HF oil and gas extraction sites within the community. I adapted the HBM to construct the HFHBM model to understand why Gibson community members may reject or accept HF. I developed a questionnaire including nine structured questions on sociodemographic data, three semi structured research questions, and 14 survey questions. I distributed the questionnaires to 32 participants who were community members residing in different townships with several oil wells and HF sites in Gibson County.

The structured interview questions were used to determine the factors that may influence participants' perceptions of HF and its effects. Participants' responses revealed diverse perceptions among age groups, races, levels of education, and media and technology use. The level of awareness of HF among participants was low with 75% having no awareness of HF. The biracial and White participants, those 30-49 years old, and those with an associate's degree were more aware of HF than the other groups in the study. Perception of HF also varied based on technology use, but using more than one technology type did not increase the perceptions of HF. Awareness of HF differed based on media use but did not increase based on the increased number of media used. These

results were consistent with those from previous studies that perception of HF may be influenced by age, race, gender, education, technology use, and media use (Boudet et al., 2014). The low awareness of HF also aligned with findings from other studies in the U.S. population (Boudet et al., 2014; De Coza, 2012; Toledo Area Human Resource Association, 2012).

The first research question and associated survey questions were designed to explore participants' perception of the awareness of HF. Findings revealed an average of 72% of participants had no level of awareness of HF. Most community members lacked perception of the benefits and consequences of HF in Gibson County. Those who had perceptions of HF did so through media, or someone else rather than being involved or being part of the decision-making process of siting HF in the community. These findings aligned with previous findings that the U.S. population has low awareness of HF (Boudet et al., 2014; De Coza, 2012; Toledo Area Human Resource Association, 2012).

Responses to the second main research question and associated survey questions revealed that more than half of the participants had no perception of HF or the justification for the continuation of HF, but more than half of the participants who had awareness of HF mentioned that the economic benefits may justify HF. Half of the participants had no perception of the health effects of HF, while one participant from the 50% with the perception of HF mentioned coal and power plants in the community which may have confounding effects. The health effects mentioned by participants may result from air pollution, gas leaks such as sulfuric acid and nitrogen oxide, explosions, illness, asthma, and cancer. These health effects aligned with existing literature that the pollution

from HF may cause nose, eye, and throat irritation; respiratory illnesses; birth defects; central nervous system damage; cancer; or premature death (Srebotnjak & Rotkin-Ellman, 2014). Children living close to HF sites are more at risk for asthma, and older people are more vulnerable to the effects of climate change (McDermott et al., 2013). Most of the participants (62.5%) in my study lacked perception of the economic effects of HF, but one participant who had perceptions of the economic benefit of HF mentioned that the economic benefit of HF may not be felt because the farmers who benefited did not stay or live in Gibson County.

The other economic effects mentioned by participants were more jobs and employment, more money from taxes, landowners making money, more oil production, and lower gas prices. The economic benefits mentioned by participants aligned with some of the economic benefits reported in previous studies, such as lower fuel prices, domestic business growth, job creation, and improved employment rates (Boudet et al., 2014; Jain, 2015; Mehamy & Goggemos, 2015). Most (68.75%) of the participants did not have knowledge of the environmental effects of HF. One participant who was knowledgeable about HF mentioned that the contamination of streams, rivers, and lakes may result from chemicals sprayed for treatment of farmlands resulting in confounding effects. Another participant suggested coal plants/mines as a confounder. The remaining knowledgeable participants on HF mentioned environmental effects such as earth tremors, water contamination, air pollution, fewer animals, and availability of utilities resulting from HF economic gains. These findings aligned with those from previous studies of HF environmental effects, such as induced seismic action, the release of

methane and other gases, release of particles into the atmosphere, contamination of underground water (Hoffman, 2017; Jain, 2015; Rabinowitz et al., 2015), increased water and air contamination (McDermott et al., 2013). The release of HF fluids into water bodies and chemicals into the atmosphere may result in the death of wildlife, domestic animals such as cows, aquatic wildlife (Bambergera & Oswald, 2014; D'Alessandro, 2014), and birds.

Some participants (40.63%) lacked knowledge of the implications of living close to HF. Of the remaining participants aware of the implications of HF, more than half perceived living in close proximity to HF may result in negative effects. The remaining half felt that living close to HF sites may impact their lives positively, or would impact their lives neither positively nor negatively. More than half of the participants (62.5%) reported no impact of HF in their lives, while the remaining participants had no knowledge of the impact of HF. Regarding the severity of HF, half of the participants had no knowledge, while the other half either felt HF was not severe, was slight, or was severe.

The third central question and related survey questions revealed that almost all the participants (90.6%) were not aware of or were not part of the decision-making process of locating HF in their community. Most participants (68.75%) wanted Gibson community members to be more involved in the decision-making process of locating HF and other services amenities through a public forum, town hall meetings, television, newspapers, and websites. The remaining participants were not sure of how to make

community members take part in the decision-making process of locating services in Gibson County.

Most of the participants (62.5%) had no idea of how to make HF more sustainable, all the other participants reported HF should be made more sustainable through better road maintenance, cleaner air and water; replacement of HF with solar energy or wind; fencing of oil well sites to prevent animal loitering; education of community members on HF; fixing of whatever was destroyed by HF, and living more responsibly. More than half of the participants (62.5%) did not know of any action that could make HF process more beneficial, the participants that had knowledge of HF, implied that HF companies following laid down rules and regulations, using more sustainable health and environmentally safe alternatives while involving community members in the decision-making process could result in a more beneficial process of HF. Half of the participants felt the barriers to taking action on HF included, lack of money to challenge HF location, the rich influential landowners big boss and large number of farmers who benefited from HF, the Federal government and politics, hungry politicians, lack of zoning in the community, and lack of enough knowledge/ ignorance or education of community members on HF. One of the participants felt the question was biased. Most of the participants (78.13%) did not know how to sustain actions taken on HF, those knowledgeable believed actions may be sustained through creating better public awareness, better understanding and information on HF by community members, and cops paying attention to the complaint of community members to reduce resistance and negative actions on HF.

Generally, most participants had no perception or awareness of HF in Gibson County, which implies that more need to be done when locating future services, to achieve environmental justice in Gibson County. This lack of perception or low awareness of HF in Gibson County from my observation may be attributed to the location of the HF sites which may be described as in a thick forest, and difficult to access without a guide. The HF sites are located in Wabash Township, sparingly populated, with dense vegetation. The proportion of the races of my research participants are representative of the Gibson County population (Tables 1 & Table 2) and should have perception or awareness based on the factors that affect perception (Tables 3 - 8). Out of my research participants, 30 (93.7%) have higher than high school education and 31 (96.9%) participants use one or more types of technology or media. The sampling scheme in the sociodemographic data (Tables 2) showed that participants are educated and have access to information from the use of technology and media, implied that the participants are expected to have higher perception or awareness of activities in their neighborhood.

Limitations of the Study

The study was a case study using Gibson County in Indiana. The use of a county may not be representative of all counties in the U.S as a result of cultural differences and behavioral changes, which implied the result may not be generalizable. The townships where the questionnaires were administered because of the location of pump jacks and HF sites, were farmers, which may influence their level of perception. The misidentification of pump jacks as HF sites on farmlands in some of the Gibson townships may influence the community members' responses to some of the questions in

the questionnaire. The inability to access HF sites may limit my observation, or perceptions of the effects of HF sites on neighboring community.

Recommendations

Coal mines, energy plants, and pump jacks in Gibson County may have confounding effects on the health of community members and there is need to conduct quantitative research to compare these effects with other counties in Indiana, to determine if some negative health effects are more prevalent in Gibson County. The need for further research is to determine the actual effects of HF from other confounding effects resulting from coal mines, energy plants, pump jacks, and chemicals used for the treatment of farmlands. Hemkems et al. (2018) stated that confounding bias posed the most pervasive threat to the validity of observational epidemiologic researches, and observational researchers do not discuss confounding bias appropriately, and even when mentioned, are confident of the irrelevance to their findings and interpretation (Hemkems et al., 2018).

The community members near HF sites need to be more involved in the location of services, to reduce the rejection of facilities and alignment with environmental justice. Environmental justice is a social movement, that emerged around the 1970s in response to the unequal distribution of risks associated with industrialization in the U.S. to overcome injustices and ensure the distribution of benefits and burdens across the population irrespective of social and economic differences (Chaudhary et al., 2018). Involvement of Gibson community is achievable through open communication between community members, community leaders, energy companies, and the government, at the

county/local levels and industry, to facilitate strategic planning on both sides. Liaison or planning will increase community participation and acceptance of HF.

The need arises to have town hall meetings, or the use of other communication media to increase the level of basic knowledge, awareness, and participation of communities where HF sites are located, to make constructive decisions which will impact community members positively, and reduce, or eliminate negative effects. Training and educating the community on what HF is, and what it does, may improve or increase community knowledge and awareness, which will lead to more community involvement. According to Honvari and Kukorelli (2018), poor communication is a key factor in the decision-making process of renewable energy investment at the local level, and lack of avenues to disseminate information, awareness and community participation in the choice of energy and issues, may lead to social attitude and negative perceptions (Honvari & Kukorelli, 2018). Increased awareness will also increase the community's perspective of the effects of HF, and what can be done collectively to mitigate the negative effects, and more evenly distribute the benefits derived from the positive effects of HF. The increased level of awareness of the positive and negative effects of HF may increase the number of farmers or community members benefiting from the gains of HF. The landowners benefiting from the leases of their farmland should be encouraged to invest part of their gains in the HF communities rather than moving out and investing outside of the communities, to increase direct local benefits.

Integrating evidence-based solution to HF is achievable by introducing more stringent regulations towards HF process through the use of effective leadership,

sustainable practice, and training. Public health interventions and solutions to health problems in Gibson County as a result of HF sites need to be introduced and crosschecked for effectiveness.

Developing, or building on the constructs of HFHIBM in future HF studies will result in having a conceptual framework specific to HF rather than using frameworks that are not completely applicable to HF or the effects. This may assist in the explanation of HF and the acceptance in neighboring communities.

Implications

The social change implication of my study is both long and short term. Reduction in diseases, a cleaner environment, such as the reduction of $PM_{2.5}$ in the atmosphere can result in a healthier population, more resilient, and less susceptible to the risk of HF related death. Healthier population implies higher life expectancy, lower morbidity and mortality rates. The increase in life expectancy is necessary because a country's health is measured based on the life expectancy. The short-term public health implications are increased awareness in the health, economic and environmental effects of HF in the U.S, and Gibson County. Increased awareness will have multiplier effects resulting in the development of preventive actions, better community health, and better practice of HF.

The long-term public health implications of my research findings are better education and awareness of HF, a more sustainable environmentally friendly solution to HF practice that will result in better health outcomes, reduced morbidity and mortality rates, and increased life expectancy of Gibson community members and other communities in the U.S. where HF is located. Better environmentally friendly and

sustainable practice of HF will also reduce the greenhouse gas effects of HF, the reduction of methane, and other ozone-depleting gases suspected to be released during the HF process.

Community involvement in HF and other activities may increase oil production. My research outcome may result in better acceptance of HF among community members through the use of a collaborative approach between community members and HF organizations when siting HF in communities. Increased oil production means increased revenue for neighboring communities, and as mentioned by one of the participants, lower taxes for communities.

Conclusion

HF is a recent phenomenon in the U.S., as a result of the effects on community members living in close proximity to the oil and gas extraction sites. HF has both beneficial and consequential effects on the health, economy, and environment of neighboring communities (Gorman, 2009; Howarth, Ingraffea, & Engelder, 2011; Jackson et al., 2014; McDermott-Levy et al., 2013), and the entire global population. Researchers need to reach a compromise on HF in the U.S. and globally, on whether the beneficial effects outweigh the consequences for the continued practice of HF.

My research will contribute to the body of knowledge, to some controversies surrounding HF, and the effects on neighboring communities as perceived by community members. Understanding the perceptions of community members will help in attaining necessary compromises towards better practice and acceptance of HF. This acceptance will be beneficial to U.S. economy in terms of higher oil and gas production.

The result of my study revealed low awareness of Gibson community members on HF. The majority of Gibson community members also lacked awareness of the effects, benefits, severity, actions to take on HF, and how to sustain any action that may be taken. Most community members also felt HF had not improved their way of life or impacted them. My study revealed potential problems with environmental justice in the siting of HF facilities in Gibson community because community members were not part of the decision-making process when locating HF sites. According to Elnokaly (2014), involving communities in the approval, planning, and management of activities carried out within, or in close proximity to their communities is necessary, because the community members are mostly impacted by the consequences of such actions, and may contribute to the success of such decisions. My study also revealed that despite the economic benefits that may justify the continuation of HF in Gibson County, the few participants that had some level of perception of HF, believed HF has more negative effects on their community than benefits.

The need arises to develop ways to increase community members' awareness of HF, and as the participants suggested, adopting town hall meetings, advertising in public places, voting, and other methods, to disseminate information is important to improve community members' perceptions.

Sustenance of all the actions that will be taken on HF is important. Gibson community members need to develop ways to sustain all the actions that will be taken, for continuity. Funding is one of the ways to sustain these actions, by the monetary gains

from HF. The money may be from special taxes or levies from HF organizations, or from the farmers who leased their farmland to HF companies.

Government and administrative officers in communities where HF oil and gas extraction sites are located need to involve community members in the decision-making process. According to Norris, Michalski, and Gibbs (2018), governance which is described as the motivation of stakeholders to follow set-out rules for successful management, is not always sufficient, and there is increasing evidence that self-regulating community-based management can be equally or more effective than external enforcement in the prevention of the over-exploitation of natural resources (Norris, Michalski, & Gibbs, 2018).

Finally, the involvement of community members in activities taking place in the communities will create positive social change to both the community members and the government, through the benefits that will result from community involvement. The benefits may range from better health outcomes, higher oil and gas production, a cleaner environment, a higher agricultural production that may result from better income of farmers, better infrastructure and several other benefits. These benefits will also contribute to the successful implementation of such activities.

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Appendix A: Research Questionnaire

Research Questionnaire to determine

the

"Perceptions of Community Members in Gibson, Indiana, on the Economic, Health, and Environmental Effects of Living in Close Proximity to Fracking"

by

Juliana O. Bayowa

from

Walden University, Minnesota

CASE NUMBER……

Hydraulic fracturing (HF) is the unconventional oil and gas extraction through fracturing of shale rock using sand, gallons of water, and chemicals. The purpose of this study is to research into the several controversies surrounding the economic, health and environmental effects of HF on neighboring communities. Controversies such as lack of transparency in the oil and gas extraction process; and, no consensus reached in whether the merits outweigh the demerits and vice versa, resulting in a gap and the need for further research to reach a consensus.

SOCIO-DEMOGRAPHIC DATA

Age: What is your age?

☐ s 18-29 years old

☐ 30-49 years old

☐ 50-64 years old

☐ 65 and above

What is your gender?

☐ Male

☐ Female

Ethnicity origin (or Race): Please specify your ethnicity.

☐ White

☐ Hispanic or Latino

☐ Black or African American

☐ Native American or American Indian

☐ Asian / Pacific Islander

☐ Other

Education: What is the highest degree or level of school you have completed? If currently enrolled, highest degree received.

☐ No schooling completed

☐ Nursery school to 8th grade

☐ Some high school, no diploma

☐ High school graduate, diploma or the equivalent (for example: GED)

☐ Some college credit, no degree

☐ Trade/technical/vocational training

☐ Associate degree

☐ Bachelor's degree

☐ Master's degree

☐ Professional degree

☐ Doctorate degree

Employment Status: Are you currently…?

☐ Employed in HF-based company

☐ Others

What is your level of technological exposure?

☐ Computer use

☐ Smartphone use

☐ No computer/ smartphone use

What is your level of media use?

☐ Watches or listens to daily news at least once a day

☐ Reads daily newspaper

☐ Reads daily news on computer/ social media

Geographic location from HF sites

☐ Within 5 miles

☐ Within 5.1 to 10 miles

☐ 10.1 miles–beyond

Do you smoke?

☐ I smoke

☐ I do not smoke

☐ I do not wish to answer

Semi structured Interview questions

RQ1. How do the Gibson community and its members perceive HF in the neighborhood, in terms of economic, environmental and health effects?

How did you get to find out about Hydraulic fracturing (HF)?

What is your perception of HF in terms of the benefits or consequences?

RQ2. Considering the diverse perceptions of the positive and negative effects of HF on the Gibson community, which effects (if any) justify the continuation of HF in the community?

What are the health effects of HF in the Gibson community?

What are the economic effects of HF in the Gibson community?

What are the environmental effects of HF in the Gibson community?

How do you think living within 5 to 10 miles from HF oil and gas extraction sites impacted your way of life?

How has HF changed the way you live in Gibson community?

How severe do you think these effects of HF are on Gibson community?

RQ3. Based on the approach used in the location of HF oil and gas extraction sites for national benefit, how was the Gibson community considered in alignment with environmental justice?

What ways do you feel Gibson community members should be made to be more involved in the location of HF sites or all other facilities in the future?

What type of improvement as a result of HF effects would you like to be made, to live more sustainably?

What action should be taken to make HF process more beneficial to Gibson community?

What are the barriers that may prevent the Gibson community from taking action against HF?

What suggestions should be implemented to sustain the actions taken?

Do you have any other questions or suggestions?

Appendix B: Research Observation Protocol

Research Observation Protocol to determine

The

Perceptions of Community Members in Gibson, Indiana, on the Economic, Health, and Environmental Effects of Living in Close Proximity to Fracking

by

Juliana O. Bayowa

from

Walden University, Minnesota

CASE NUMBER……

OBSERVATION PROTOCOL

Road Observation 4/28/2018

Name of Infrastructure: _____

Does the road provide access to Hydraulic fracturing site? _____

Average number of vehicles per 5 minutes:

_____

How often do heavy traffic move on road compared to other roads per 5 mins?: _____

State of the infrastructure: _____

Observation of the Environment

Weather condition at the site:

- Wind speed / direction

Wind Speed (*MPH*)_____

- Precipitation_____
- Temperature (0F) _____

Relative Humidity_____

Noticeable odor in the atmosphere? _____

Odor description _____

Are there wells or water body close to HF site

_____?

Any vibration or movement noticed on the ground: _____

Health Observation:

Any prevalent disease noticed in community: _____

Economic Observation

Any economic boom noticed in community_____

Quality of the houses_____

Quality of the vehicles _____

State of employment: _____

Appendix C: Figures

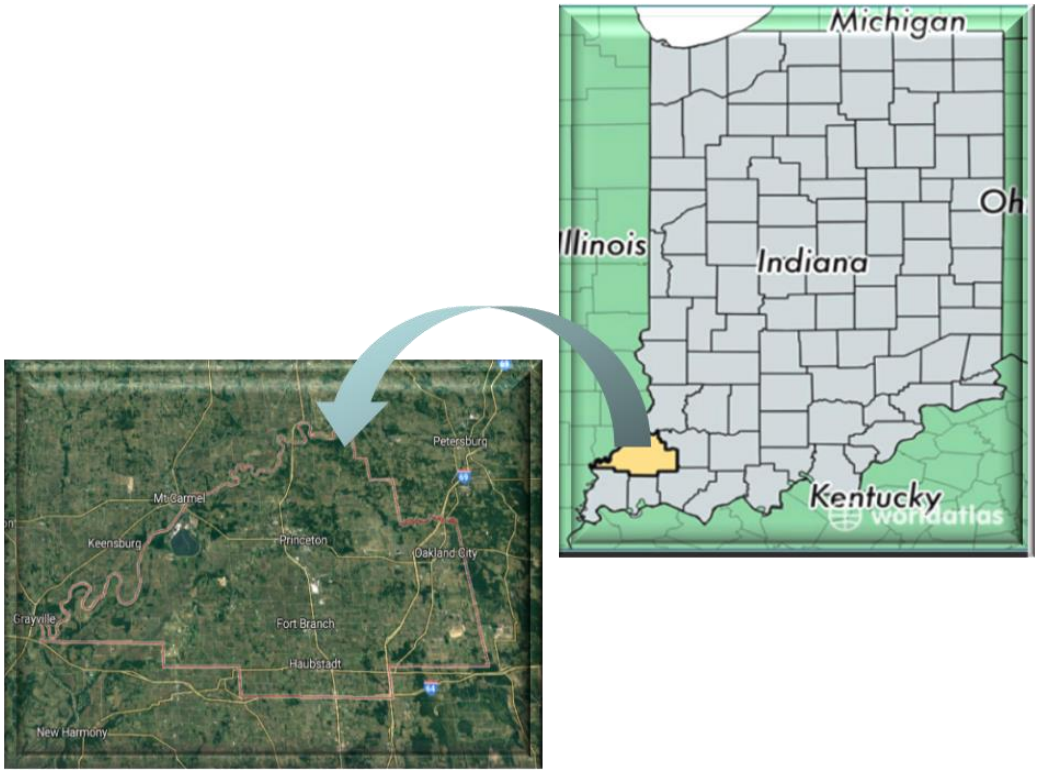

Figure 4.0. Google Map of Aerial view of the Boundary of Indiana, State showing Gibson County.

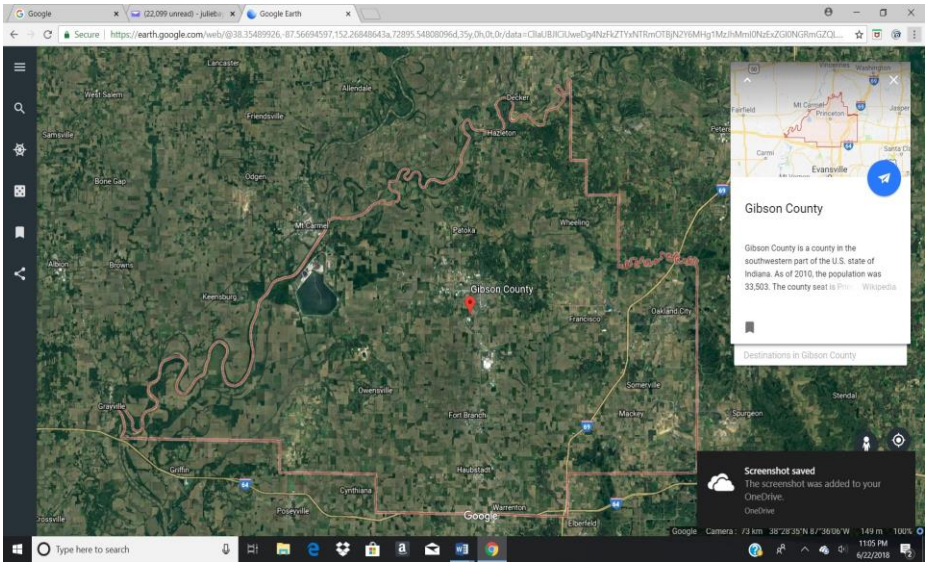

Figure 5.0. Google Map of Aerial view of the Boundary of Gibson County, Indiana

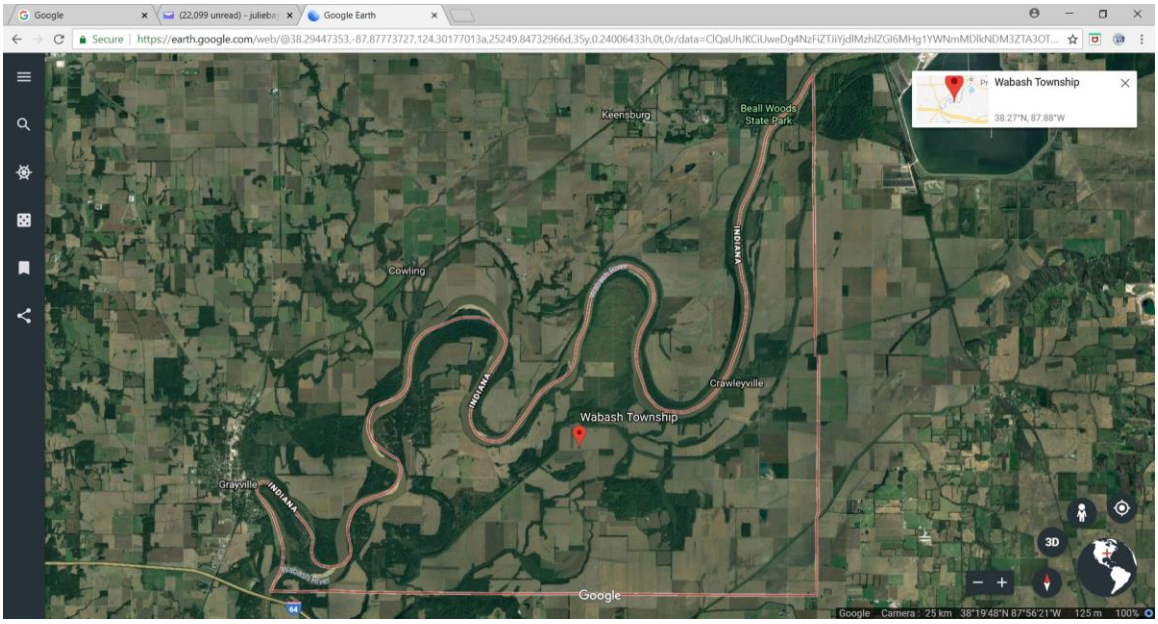

Figure 6.0. Google Map Showing Boundary of Wabash Township (Tail of Gibson County), Gibson County

Figure 7.0. Google Map Showing truck movement in Wabash Township

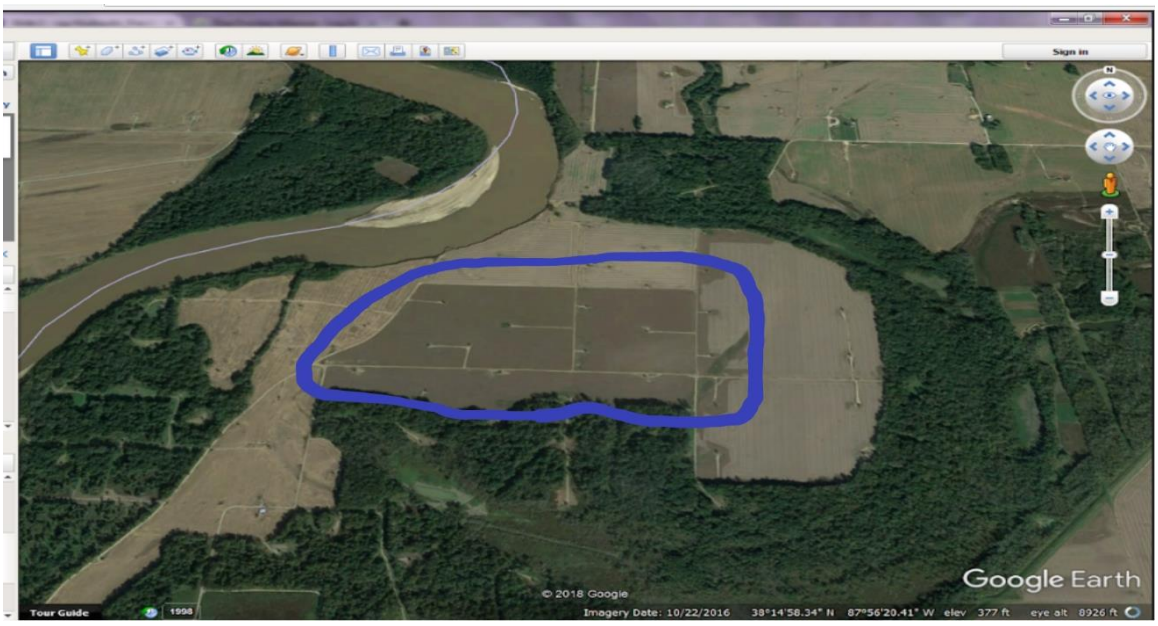

Figure 8.0. Google Map of HF Well Pads in Wabash Township, Gibson County.

Figure 9.0. Showing Old Red Covered Bridge in Gibson County

Figure 10.0. Showing Old Red Covered Bridge, Gibson County

Figure 11.0. Showing Greenish Stagnant water underneath the Red Covered Bridge.

Figure 12.0. Underneath the Red Covered Bridge

Figure 13.0. Pump Jacks near some major routes in Gibson County

Figure 14.0. Showing Pump Jacks near a Rail line

Figure 15.0. Picture showing typical Grain Storages in Gibson County

Figure 16.0. Water and Oil storage tanks located in Pump Jack field.

Figure 17.0. Typical farmland leased for Oil Pumping with about Six Pump Jacks (some abandoned due to lack of production).

Figure 18.0. Coal Mine flaring gas in Gibson County.

Figure 19.0. Typical Storage tanks for Pump Jack