A Study of Sustainability-Oriented Innovative Solutions for Carbon Emissions in Aker Solutions Value Chain.

Master Thesis by

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ABSTRACT

The rapid and forecasted warming of the global average temperature to 1.5 ºC poses a challenge for the ability of the current and future generations to meet their own needs. This is largely due to industrialization that has impacted a global environmental footprint. The environmental footprint is driven by the synergies of high energy intensity, high energy consumption and high econometrics for gross domestic product (GDP). Therefore, the aim and purpose of the thesis is to corroborate the sustainability-oriented innovation (SOI) model through a case study for innovative solutions to reduce carbon emissions in the Aker Solutions value chain. The thesis explores the theoretically the concept of sustainability, innovation and sustainability- oriented innovation (SOI). Furthermore, the thesis abductively adopts the sustainability-oriented innovation (SOI) model through a qualitative thematic analysis of the innovative activities of the SOI model for strategy, innovation process, learning, linkages and organizational design with a focus on reducing carbon emissions in the Aker Solutions value chain. The main scope of the study is based on the concept of sustainability as a driver for innovation through the sustainability-oriented innovation framework by Adams et al (2016). The overall objective of the thesis is to map the Aker Solutions innovative activities in the sustainability-oriented innovation model's pillars that are operational optimization, systems building and organizational transformation for building a low carbon business portfolio in the value chain. The findings for the mapping of the SOI model in Aker Solutions shows a strong focus on operational optimization and organizational transformation through carbon capture and storage, and offshore floating wind. Furthermore, the findings did not show any innovative activities on systems building of the SOI model in the firm.

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'All that I am, or hope to be, I owe to my angel mother.'-Abraham Lincoln

To my mum, for her love, inspiration and hope for my bright future made it possible for me to complete this unimaginable journey to excel high and finish this master's degree. I wholeheartedly thank my dad and mum their souls rest in eternal peace for the man I am today - a graduate!

I candidly would like to extend my deepest heartfelt thank you to my family and friends for the love and support during the time I have been away to pursue my dreams. The missing feeling was mutual however, the support was overwhelming, and now I hope to be more accessible in sharing the good times and bad times together again.

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ABBREVIATIONS

CCS – CARBON CAPTURE AND STORAGE

CO2 – CARBON DIOXIDE

DUI – DOING-UISING-INTERATING

FKR – KEY FUNCTIONAL RESPONDENT

GDP – GROSS DOMESTIC PRODUCT

GHG – GREENHOUSE GAS

IEA – INTERNATIONAL ENERGY AGENCY

IPCC – INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

IRENA – INTERNATIONAL RENENEWABLE ENERGY AGENCY

KEPIs – KEY ENVIRONMENTAL PERFORMANCE INDICATORS

LCA – LIFE-CYCLE ASSESSMENT

MDG – MILLENIUM DEVELOPMENT GOALS

NOAA – NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NSD – NORSK SENTER FOR FORSKNINGSDATA

R & D – RESEARCH AND DEVELOPMENT

SDG – SUSTAINABLE DEVELOPMENT GOALS

SOI – SUSTAINABILITY-ORIENTED INNOVATION

STI – SCIENCE TECHNOLOGY AND INNOVATION

UNFCCC – UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

VAVE – VALUE ANALYSIS AND VALUE ENGINEER

WEO – WORLD ENERGY OUTLOOK

1. CHAPTER: INTRODUCTION

1.1 INTRODUCTION

The growing debate on the current climate crisis is transforming new business paradigms focusing on sustainability as a social license to operate (Prno, 2013, Prno & Slocombe, 2012, Nelsen, 2006, Wilburn & Wilburn, 2016, Shiva, 2008, Archer & Rahmstorf, 2010, Gunningham, 2003/2004). The growing debate on the climate change and the impact of businesses on the environment has raised consumer awareness, which has led to preference for products, goods and services that are sustainable. In other words, consumers are becoming more greener and hence the demand for green products and services that are sustainable (Chen & Chai, 2010, Abdul-Muhmin, 2007, Roberts, 1996). One of the key drivers for consumer awareness on the impact of firms on the environment and climate crisis is focused on rising level of carbon emissions in the atmosphere (Pinksen & Kolk, 2012, Kolk & Pinksen, 2015). Therefore, to mitigate the modern challenges of the climate crisis and overconsumption of natural resources to promote growth and development, firm's business models, values and practices are transforming to meeting the needs of consumers through the implementation of sustainability and innovation as new business frontiers (Nidumolu & Rangaswami, 2009, Chen , 2017, Chen et al, 2006).

The most prominent approach for firms to mitigate the impact and account for the environmental footprint and address social causes has been through embedding corporate social responsibility (CSR) (Laudal, 2011, Beschorner & Hajduk, 2017). Therefore, the overall framework for the thesis addresses sustainability-oriented innovation (SOI) as a new paradigm for firms to address the climate crisis by embedding environmental, social and economic sustainability as a core strategic management approach (Adams et al, 2012, 2016 , Hansen& Grosse-Dunker, 2013, Klewitz & Hansen, 2014, Tidd & Bessant, 2014, Nidumolu & Rangaswami, 2009). Sustainability-oriented innovation is defined as "making intentional changes to an organization's philosophy and values, as well as to its products, processes or practices to serve the specific purpose of creating and realizing social and environmental value in addition to economic returns" (Adams et al, 2016, p. 180). The recent literature review shows a growing focus on academic scholarship to address environmental, social, environmental and economic

sustainability within firms. The studies are associated to green innovation, responsible innovation, eco-innovation, environmental innovation, and sustainable innovation (Chen, 2006, Schomberg , 2013, Gema-Albort-Morant, 2017, Tim Schiederig et al , 2012, Adams et al 2016, BJ Koops, 2015, Blok & Lemmens 2015). This thesis contributes to the theory development by thematically analyzing the innovative activities of the SOI model through an empirical test in a single-case study. The thesis aims to address the key research question: *What drives sustainability-oriented innovative solutions for carbon emissions in Aker Solution?* The background to the study in sub-section 1.1.1 will be the precursor of to the problem statement and an outline of the thesis will be presented.

1.1.1 THE BACKGROUND OF STUDY

The section addresses the background of study which is the precursor for the problem statement of the master thesis research. The research problem identification and statement are extrapolated from this background of study for the thesis. The conclusive scientific evidence on climate change or global warming is consistently focusing on carbon dioxide emissions from fossil fuels as the chief cause of the climate crisis (National Research Council, 2001, Oreskes 2004, IPCC, 2014). Therefore, in order to situate the problem of carbon emissions, the section will analyse the key conclusive literature concerning carbon dioxide emissions reviewing reports from academic journals, scientific articles, IPCC special reports, Kyoto protocol, Paris Agreement 2015, the Norwegian Petroleum and the Global Carbon budget 2018 as key primary sources in analyzing carbon emissions impact on the environment. Furthermore, the analysis will be extrapolated to the unit of analysis: Aker Solutions carbon emission forecast using the energy scenarios of the international energy agency (IEA).

As compared to pre-industrial era, the current rise in the global average temperature to 1. 0 degrees Celsius is scientifically associated with the increased anthropogenic activities due to the increased level of greenhouse gases in the atmosphere , that is in fact warming the earth surface responsible for climate change (IPCC SR, 2018, Stern et al, 2007, National Research Council, 2001, Paris Agreement 2015, Kyoto Protocol). The increased level of greenhouse gases (GHG) which exist as natural and man-made gases and naturally functions as absorbing energy medium by creating a cooling effect in the earth's atmosphere is making the earth surface temperature much warmer (Houghton et al, 1990, McCormick ,

2018). The focus for the detailed background of study is the increased greenhouse gas concerning fossil fuels, with the level of carbon dioxide emissions in the atmosphere exacerbating the warming effect that is causing climate change. Therefore, the following sub-sections will address drivers of carbon emissions *figure 1.1* specifically energy related drivers, the impact of carbon emissions on climate change, carbon budget, carbon emissions mitigation and Aker Solutions carbon emissions in energy scenarios. This approach is a prerequisite to the discussion on the problem statement and research issues related to this thesis.

1.1.2 Drivers of carbon emissions

There is a multitude of drivers of greenhouse gas emissions especially for carbon dioxide. Therefore, this thesis mainly focuses on drivers related to energy intensity and gross domestic product (GDP) intensity that drives economic growth (*see figure 1.1*). According to the IPCC, "drivers are the elements that directly or indirectly contribute to GHG emissions" (IPCC, 2014, p. 364). The main driver of carbon dioxide emissions is associated with the global energy security which is driven by the rising global energy consumption or demand (Bhattacharyya, 2011, IEA 2018, IPCC, 2014, Cherp & Jewell, 2014). Recent studies show that , half of the total emissions released in the atmosphere are largely fossil fuel carbon emissions emanating from the 1980's fossil fuel consumption and resulting overall since circa 1751 to date 411parts per million (ppm) which is equivalent to 400 billion metric tons of carbon has been released in the atmosphere (Boden et al 2017, NOAA, 2019, Houghton et al 1990). Furthermore, a study from Boden et al, shows that, "combustion of gas fuels (e.g., natural gas) accounted for 18.5% (1823 million metric tons of carbon) of the total emissions from fossil fuels in 2014 and reflects a gradually increasing global utilization of natural gas. Emissions from cement production (568 million metric tons of carbon in 2014) have more than doubled in the last decade and now represent 5.8% of global CO2 releases from fossil-fuel burning and cement production. Gas flaring, which accounted for roughly 2% of global emissions during the 1970s, now accounts for less than 1% of global fossil-fuel releases" (Boden et al 2017). And Boden et al further notes that, 2014 emissions compared to 2013 emissions resulted in 9855 million metric tons of carbon an all-time high and this metric had a spillover effect to 2015 global average temperature recording the warmest year (Boden et al 2017, global climate

report, 2015).

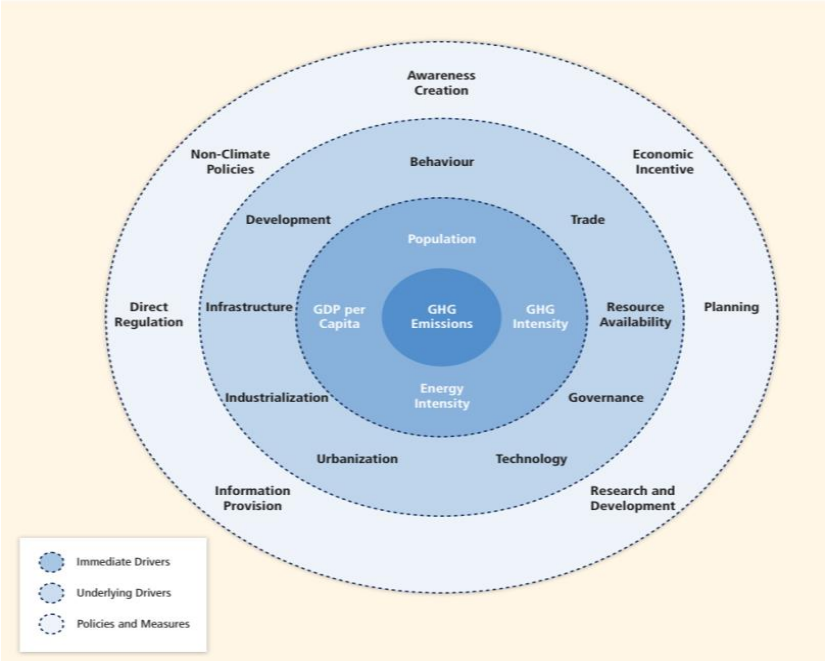

Figure 1.1. Drivers of Carbon dioxide illustration (IPCC, 2014, p. 356).

The rapid concentration of carbon emissions see *figure 1.2* in the atmosphere is mainly produced through the burning of hydrocarbons from fossil fuels that includes, oil, coal and gas. Each of the fossil fuels contains different hydrocarbon composition properties with coal having the highest and gas the lowest hydrocarbon properties (Bhattacharyya, 2011, Houghton 1990). The burning process of hydrocarbons produces carbon dioxide a colorless, odorless gaseous molecule involving a chemistry of two oxygen atoms and a carbon atom (Joshi, 2014). The International Panel on Climate Change (IPCC) reported that, carbon dioxide is mainly released during the combustion of fossil fuels that is, coal, oil, and gas as well as the production of cement and the report continues to note that, carbon dioxide remains the largest component of human activity greenhouse gas emissions (Houghton, 2007, IPPC 2014). And Wang & Zeng noted that, of all greenhouse gas emissions produced during the conversion process, carbon dioxide is the most significant and accounts for three quarters of the total greenhouse gas emissions (Wang & Zeng, 2019).

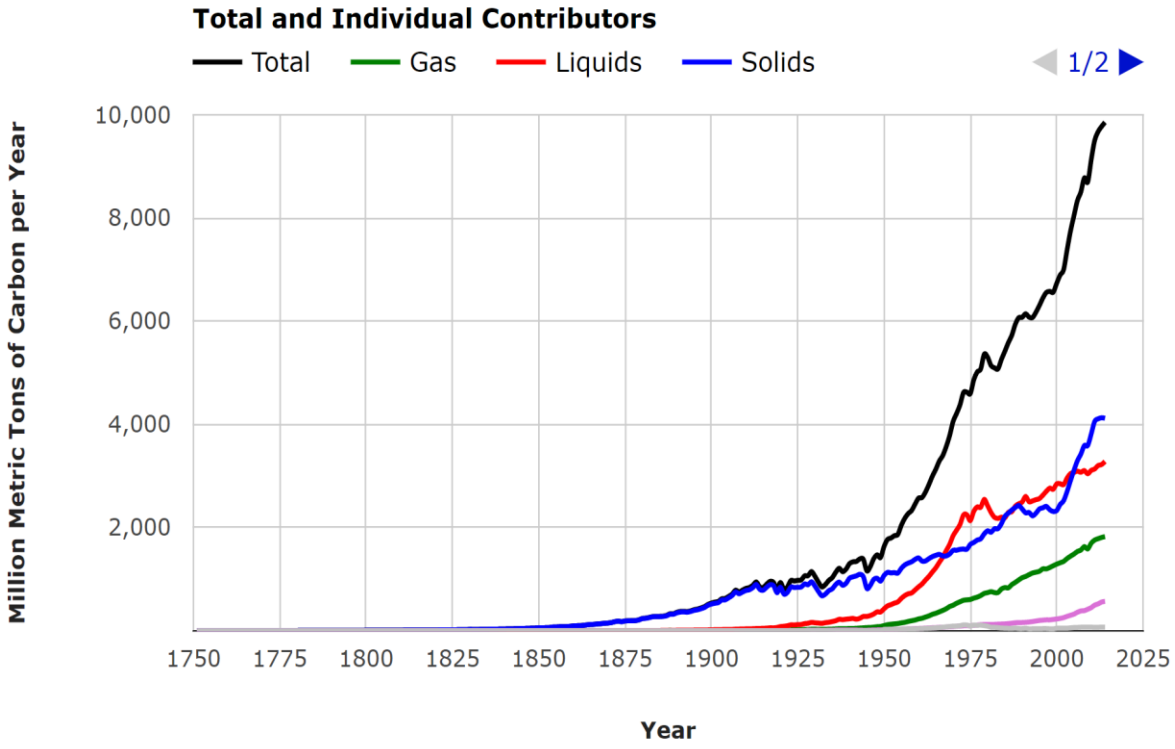

Figure 1.2. Data presenting concentration of carbon emissions since 1700s (Boden et al, 2017).

The major driver of the rising concentration of the anthropogenic carbon dioxide emissions in the atmosphere is directly associated to an energy system that is currently highly dependent on the use of fossil fuels as primary energy source, with oil, coal and gas in the global energy mix representing for about 80% of the global primary energy demand (Bhattacharyya, 2011). The current energy mix data for electricity consumption still indicates fossil fuels as lead energy sources in *figure 1.2* (IEA, 2018). Joshi observed that, "fossil fuels are relied to produce at least 80% of global energy demands and 61% of greenhouse gas (GHG) emissions are linked to energy production, delivery and use" (Joshi, 2014, p. 1208). The global energy demand or consumption (Bhattacharyya, 2011) is directly associated to energy security, which is defined as a "low vulnerability of vital energy systems" (Cherp and Jewell, 2014, p. 415).

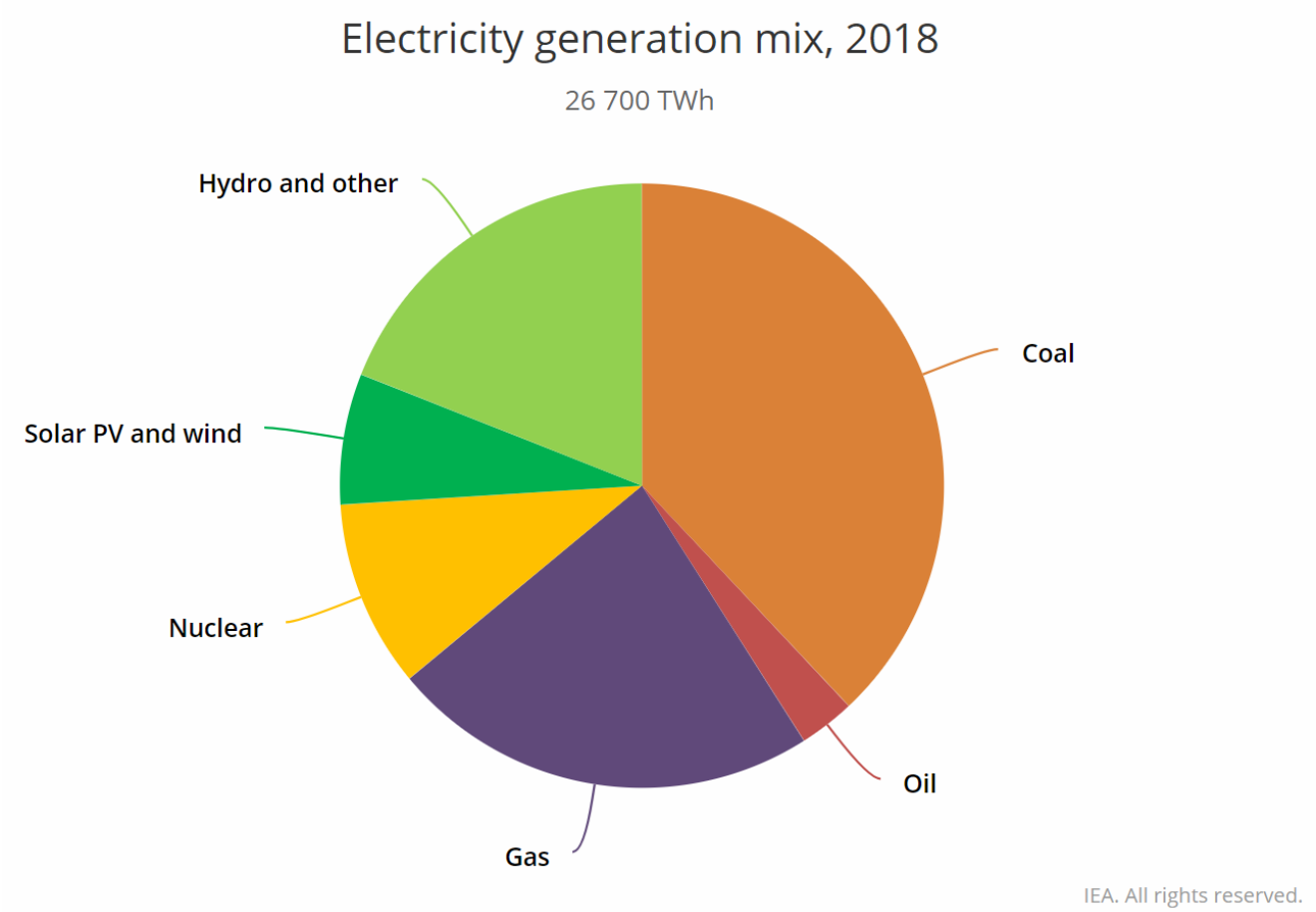

Figure 1.3. Current Sources of electricity mix from the IEA, 2018.

Therefore, the relationship between the global energy demand and greenhouse gas emissions is manifest in the energy intensity for the use of fossil fuels to enhance economic activities or sectors of the economy. According to Bhattacharyya, energy intensity is the ratio of energy consumption to gross domestic product (Bhattacharrya, 2011). Raupach et al noted that, "the strong global fossil-fuel emissions growth since 2000 was driven not only by long-term increases in population and per-capita global GDP , but also by a cessation or reversal of earlier declining trends in the energy intensity of GDP and the carbon intensity of energy" (Raupach et al, 2007, p. 9).

According to the BP statistical report, which closely resonates with the report findings from the IPCC and the IEA, concludes that, "carbon emissions from energy consumption are estimated to have increased by 1.6% in 2017" (BP, 2018, p. 6, IPCC, 2018). The overdependence on fossil fuels drives

economic growth and has exacerbated the level of carbon dioxide emissions globally with fossil fuels emissions from developing countries skyrocketing compared to fossil fuels emissions from developed countries which are in a carbon lock-in (Bhattacharyya, 2011, Kuzemko et al., 2016). Houghton et al observed that, historically the global rising input of carbon emissions in the atmosphere from burning fossil fuel and in industrial processes in cement production for instance has exponentially risen the rate of emissions in the atmosphere by 4% per year since the beginning of the industrialization (Houghton, 1990). And Bhattacharyya concluded that, "the energy demand for passenger and freight transportation tends to increase rapidly, often at a rate higher than the growth rate of GDP, due to economic growth" (Bhattacharrya, 2011, p. 97).

1.1.3 Carbon emissions and climate change

The rising concentration of greenhouse gases such as carbon dioxide in the atmosphere is scientifically responsible for causing global warming and climate change. Houghton et al noted that, "increasing greenhouse gas concentrations alter the Earth's climate, changing climate and environmental conditions in their turn act back on the carbon cycle atmospheric CO2" (Houghton et al, 1990, p. 17) *see figure 1.4*. Therefore, this subsection will explore the dichotomous relationship between the carbon dioxide emissions and its impact on climate change caused by and large by the energy intensity and GDP intensity.

Although there are a many definition by different scholars, climate change in this thesis is defined as changes in weather or metrological statistics over a long period of time, spanning generations (National Research Council, 2001). Bhattacharyya notes that, climate change and global warming are interchangeably used sometimes (Bhattacharyya, 2011, National Research Council, 2008, Ahmad et al 2014). Bhattacharyya further notes that, there is a scientific consensus that sources of pollution affect climate change. The IPCC conclusions that the global temperature has been rising since the beginning of industrialization in an exponential manner (Bhattacharyya, 2011, IPCC 2007, Bauer et al 2015, Corinne Le Quéré et al 2017, Oreskes , 2004).

According to Ploeg & Rezai, they note that, “the warning from climate scientists to limit global warning to less than 2 degrees °Celsius above the average global temperature of pre-industrial times , the cumulative carbon emissions in the atmosphere between 2011 and 2050 need to be limited to 1100 Gigatons of carbon dioxide or 300 Gigatons of carbon” (Ploeg & Rezai 2016, p. 216). This carbon dioxide emissions footprint due to human activities is calculated and analyzed through the global carbon budget.

According to Le Quéré et al 2018, global carbon budget is defined as “the mean, variations, and trends in the perturbation of CO2 in the environment, referenced to the beginning of the industrial era. It quantifies the input of CO2 to the atmosphere by emissions from human activities, the growth rate of atmospheric CO2 concentration, and the resulting changes in the storage of carbon in the land and ocean reservoirs in response to increasing atmospheric CO2 levels, climate change and variability, and other anthropogenic and natural changes” (Le Quéré et al 2017, p. 407)

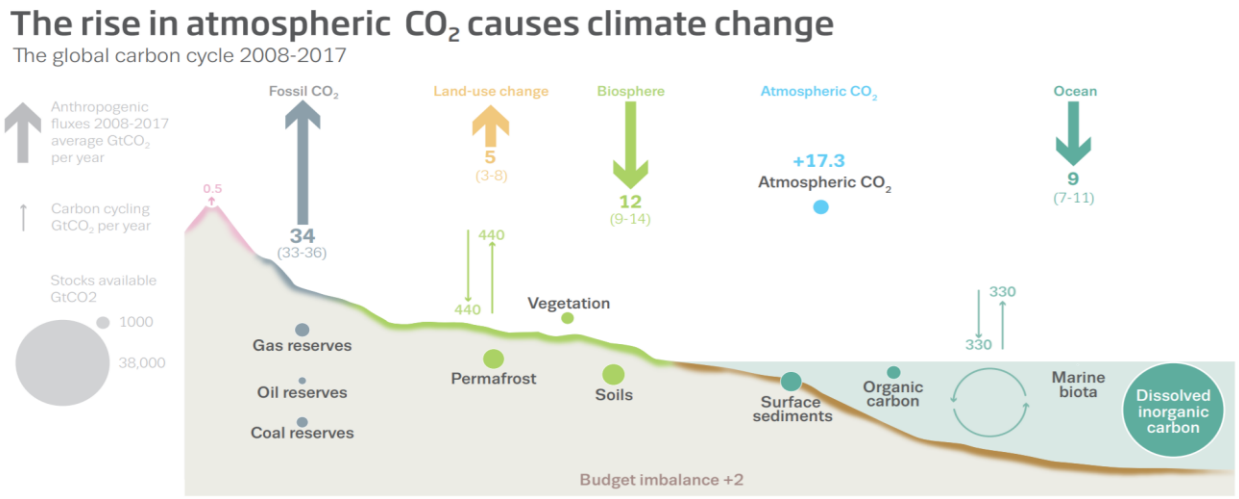

Figure 1.4.Global carbon cycle and carbon emissions ratio (Global Carbon Project 2017).

According to Raupach et al noted that, “CO2 emissions need to be considered in the context of the whole carbon cycle of the total cumulative anthropogenic CO2 emission from both fossil fuels and land use change, less than half remains in the atmosphere, the rest having been taken up by land and ocean sinks” (Raupach et al, 2007, p. 9) as presented in *figure 1.4*. above indicates. The rise in the global carbon emissions in the atmosphere is mainly the combustion of fossil fuels that warms the earth surface and

climate change. However, the current climate change impacts caused by the increased global temperature are alarming to the welfare of the planet and survival of humankind. The analysis of the increased global temperature due to the increased levels of greenhouse gases that causes climate change is assessed by the International Panel on Climate Change (IPCC) under the auspices of the United Nations Framework Convention on Climate Change (UNFCCC) since the first assessment reports in the 1990's.

A study by Minx et al observes, the IPCC assessment reports provide a general scientific consensus on the discourse of climate change, climate policy negotiations under the UNFCCC and has been impacted science and policy (Minx et al 2017). One of the objectives and recommendations set by the World Meteorological Organization (WMO) during the formation of the IPCC were to scientifically and environmentally assess all aspects of the greenhouse gases and communicate the assessments to key climate governance actors such as governments (Jarraud & Kopfer, 2004). The mandate of the International Panel on Climate Change cited in Minx et l (2017) is "to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation" (Minx et al 2017. P. 252).

The general scientific conclusion in the IPCC assessment reports on climate change anchors human activities as chief perpetrators of climate change through the rising concentration of emissions from greenhouse gases such as carbon dioxide in the atmosphere (IPCC, 2018, Oreskes, 2004, Boden et al, 2017). However, efforts to limit the concentration of the rising carbon emissions have received global attention see *figure 1.5*. In the recent assessment report, the IPCC noted that, "limiting global warming to 1.5ºC would require rapid, far-reaching and unprecedented changes in all aspects of society, the IPCC said in a new assessment. With clear benefits to people and natural ecosystems, limiting global warming to 1.5ºC compared to 2ºC could go hand in hand with ensuring a more sustainable and equitable society (IPCC 2018, p. 1).

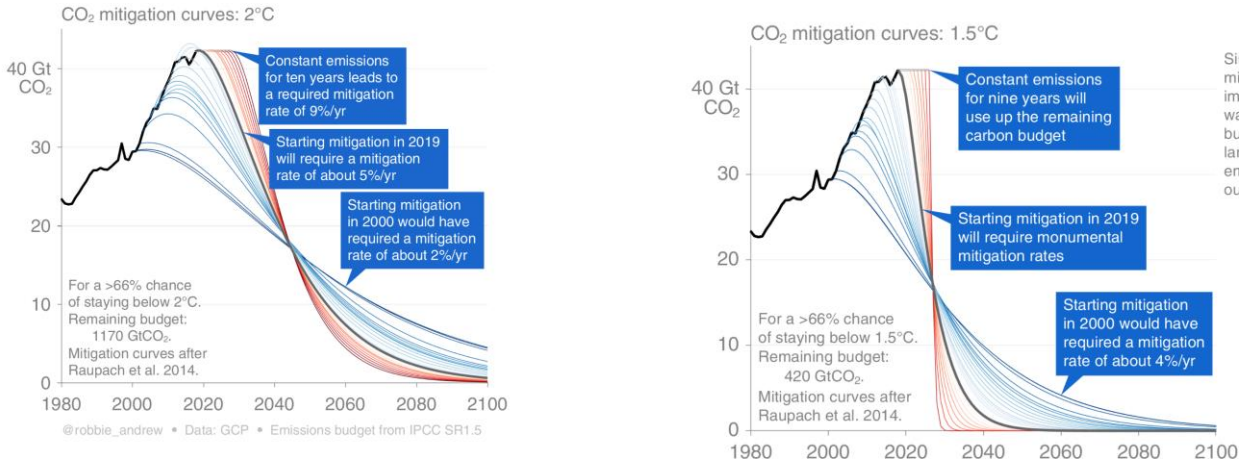

Figure 1.5.Illustration of climate mitigation pathways for 2°C and 1 °C (Andre Robbie, 2018).

The IPCC and other international agreements to "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change" (Paris Agreement 2015 , p. 2). That Kyoto Protocol main focus was to mitigate six main greenhouse gases that is, carbon dioxide, methane and Nitrous oxide and including hydrofluorocarbons, perfluorocarbons and Sulphur hexafluoride (Bhattacharyya, 2011). Therefore, this thesis reflects the scientific consensus from the International Panel on Climate Change, and its subsequent Conference of Parties (COP) to address greenhouse gases such as carbon dioxide emissions in the atmosphere and mitigate the rising temperature to well below 2°C above pre-industrial levels.

1.1.4 Synthesis of the IEA scenarios in Aker Solutions

Berkman et al hypothesis posits that state and international actors' commitment to climate change will impact the firm's costs relating to climate risks (Berkman et al, 2019). According to Huisingh, "climate change physical risks are likely to have a strong effect on the economic performance of firms since they can increase their costs significantly...Industrial firms are central to the efforts to seek to achieve carbon emissions reductions due to the large materials flows they process. Building an effective management system for carbon reduction has become an important issue for a firm's survival in today's competitive environment…Most firms are willing to allocate resources and set a target for carbon emissions reduction projects" (Huisingh, D., et al., 2015, p.6). It is imperative for this thesis to analyse the meaning

of world energy outlook scenarios for fossil fuels carbon emissions in Aker Solution.

According to Bhattacharyya, "scenarios are used to analyse a range of plausible outcomes" (Bhattacharyya, 2011, p. 113). The World Energy Outlook report from the International Energy Agency outlines three mainstream global energy demand scenarios to year 2040 that is, the current policies scenario, the new policies scenario and the sustainable development scenario that directly corresponds to the carbon dioxide emissions intensity (WEO, 2018, IEA, 2018, Mohn, 2017). The current policies scenario in *figure 1.6* is premised on the 'business-as-usual' positing with the status quo in energy policies and practices that do not prioritize addressing global carbon emissions, energy efficiency, energy consumption and global warming at large (Mohn 2017, WEO, 2018). The carbon emissions trajectory under the current policy scenario is a dead road and will result in adverse impacts on climate change to people, planet and profits (businesses). The new policies scenario in *figure 1.7* on that other hand is oriented on energy-related carbon dioxide emissions on a slow upward pathway to year 2040, a trajectory that does not resonate with the scientific consensus on carbon dioxide mitigation and climate change target (IEA, 2018, Paris Agreement , 2015). With regards to the sustainable development scenario in *figure 1.8* is notes Mohn that "this scenario sets out requirements and implications of Paris ambitions for global warming, as well as UN sustainability goals for universal energy access, and improved air quality" (Mohn, 2017, p. 5). The scenario is premised on low-carbon future that confluences climate goals, air quality, universal access to clean energy supported by low-carbon technology for people and planet (WEO IEA, 2018, Mohn, 2017). The scenarios from the International Energy Agency standpoint creates a pathway for the current and future energy demand and trajectories for carbon emissions globally. It is the imperative of this thesis to extrapolate the scenarios from the International Energy Agency in Aker Solutions carbon emissions trajectory.

The scenarios from the IEA forecast carbon dioxide emissions trajectories, which could impact Aker Solutions emissions trajectories. Aker Solutions value chain is driven by customer demands and activities, which overall have fluctuated according to the market energy demand and supply economics. However, in the recent Corporate Responsibility Report, they posit on reducing carbon emissions, reducing energy consumption and forging a sustainable future for the industry by creating low carbon innovative technologies and solutions in the value chain (Aker Solutions CSR, 2018). Therefore, it is

the aim and significance of this thesis to analyse carbon emissions through the lens of Aker Solutions carbon dioxide emissions footprint in tandem with IEA scenarios.

Current Policies Scenario

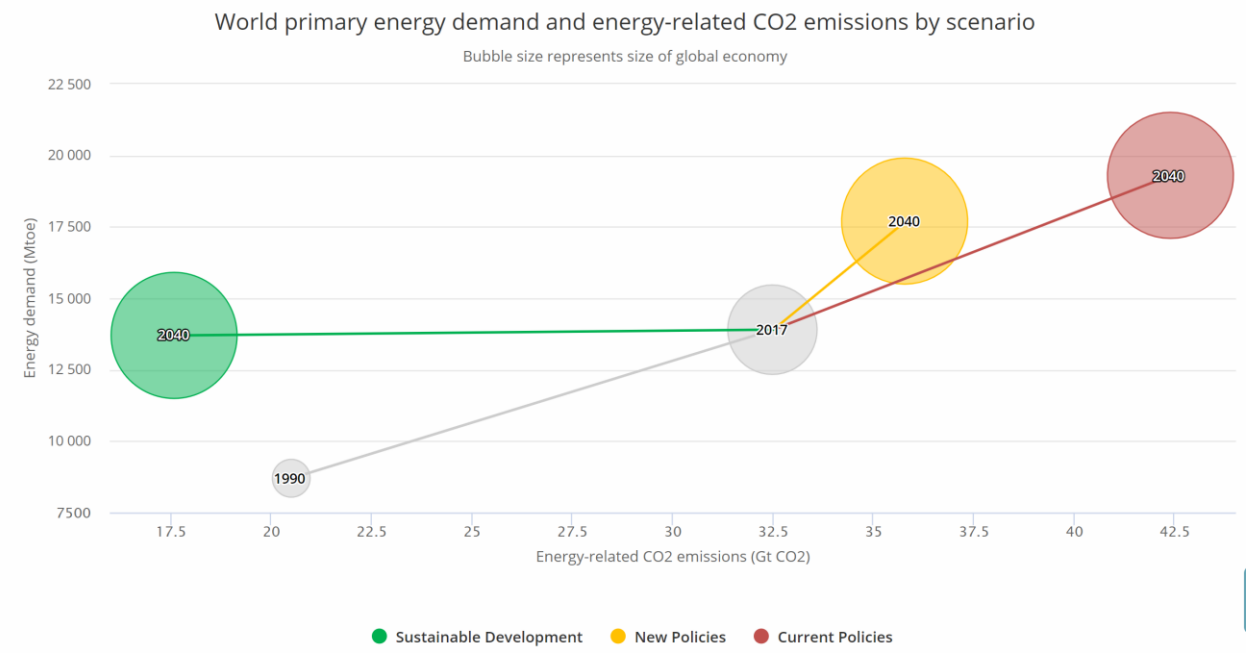

Figure 1.6.Energy scenarios for 2017 – 2040 (IEA, 2016).

According to a study by Hepburn & Stern the current policy scenario also known as the business-as-usual, the underlying assumption in this scenario correlates energy demand and energy-related carbon emissions to that of combustion of fossil fuel which also affect the GDP positively (Hepburn & Stern, 2007, Mohn 2017). It is further noted by Mohn that the "scenario would be associated with higher economic growth over the first 10-30 years, which would then fall significantly beyond this horizon due to long-term costs of global warming" (Mohn 2017, p. 8). The IEA projects an increase in the average cost of oil and gas extraction in the future, by contrast the costs of new renewable technologies which are projected to fall (Mohn, 2017). The current policies scenario in Aker Solutions entails a rise in emissions trajectory which will impact the numbers of carbon emissions intensity compared to 2008 and 2009 level of carbon dioxide emissions, which were driven by strong global energy demand and energy-related carbon dioxide emissions.

New policies scenario

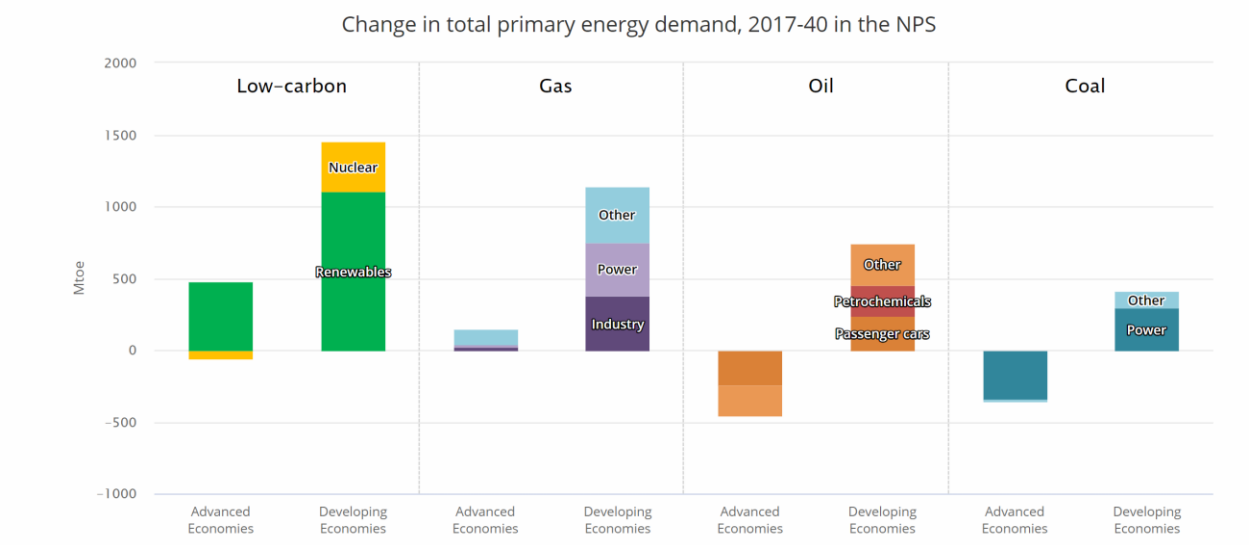

Figure 1.7.New policies scenario for a low -carbon, gas, oil and coal 2017 -2040 (IEA, 2016).

New policies scenario mirrors the current policies scenario; however, for the new policies the carbon emission trajectory is on a slow pathway. The new policies scenario incorporates climate policies, which have a dampening impact on carbon dioxide emissions intensity through incremental gains in energy efficiency and renewable energy integration in the energy mix (IEA, 2018, Mohn, 2017). The premise for the new policies scenario is building capacity for renewable energy in the global energy mix to meet the rising energy demand (Mohn, 2017). However, as the IEA notes, the share for fossil fuel will still dominate as shown in the above *figure 1.7* 2040 (IEA, 2018). In Aker Solutions under this scenario , the status of the increase in carbon dioxide emissions will correspond to the current policies scenario but on a slow upward trend, however the net carbon dioxide emissions will plus or minus equal to the net emissions in the business-as-usual scenario. This is due to the dampening effect of the climate policies, energy efficiency gains and renewable energy in the energy mix (Mohn, 2017).

Sustainable development scenario

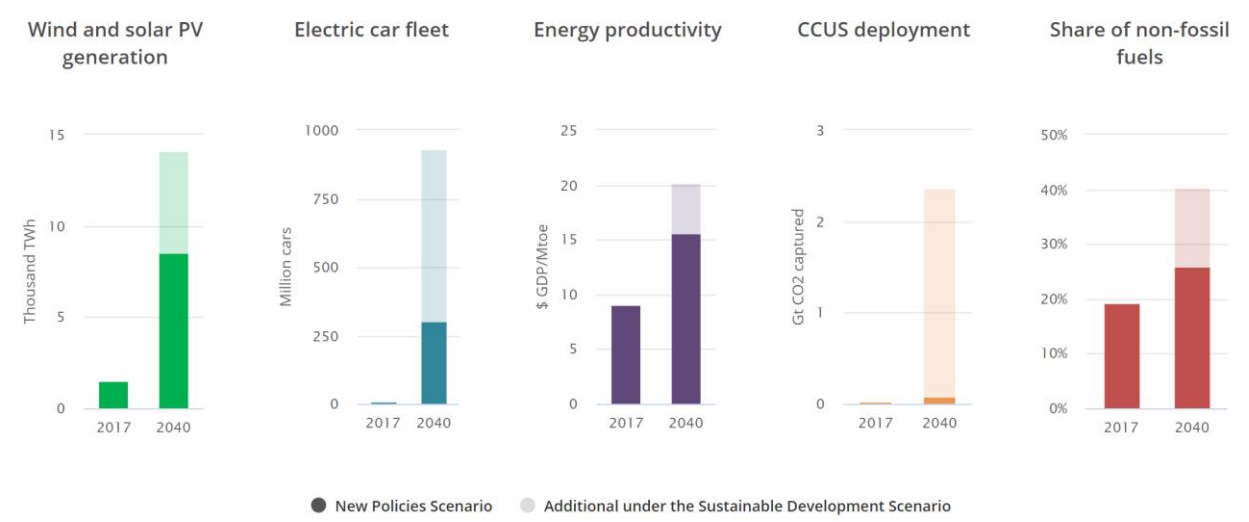

Figure 1.8.Sustainable development scenario 2017- 2040 (IEA, 2016).

The sustainable development scenario in the above *figure 1.8* is premised on drastic climate plans and policies oriented towards a low carbon society abetted by a massive deployment of technological development, energy efficiency decoupled from economic growth and energy intensity (Mohn, 2017). However, with no net emissions fossil fuels consumption will still have presence with technological deployment of carbon capture and storage (IEA, WEO, 2018, Mohn 2017). Bhattacharrya observed that, the threat of a rapid rise in carbon emissions that cause climate change has enveloped new business opportunities in the fossil fuels industry (Bhattacharyya, 2011). The sustainable development scenario in Aker Solutions posits a net zero negative emissions and opportunities for business growth due to technological development, and energy efficiency.

In conclusion, the background of study of the thesis is a precursor for the problem statement in the following section 1.2. Therefore, the conclusive scientific evidence presented in this section acknowledges human activities associated to coupling of energy intensity and economic growth measured by GDP as key drivers for causing the rise in the GHG; carbon dioxide. The background of study noted that the impact of climate change will affect business. Furthermore, the scenario analysis of the future trajectories; current policies scenario; new policies scenario and; sustainable development

scenario are presented in tandem with Aker Solutions emissions trajectory. The thesis standpoint for sustainability-oriented innovative solutions for carbon emissions in Aker Solutions value chain posits with the sustainable development scenario for net zero emissions for Aker Solutions.

1.2 PROBLEM STATEMENT

The problem statement for this thesis case analysis study is formulated based on the background study presented in section 1.1.1. However, after a literature review of academic scholarship, there is dearth of literature for applying the sustainability-oriented innovation (SOI) framework. Therefore, the thesis approach for sustainability-oriented innovation framework premises on applying the SOI model to address the literature gaps and recommendations to empirically test the model (Adams et al, 2016, Adams et al, 2012, Ghassim , 2018). Therefore, based on the background of study, the thesis will address the following key research question and sub-research questions using the SOI model in Aker Solutions as unit of analysis:

- *What drives sustainability-oriented innovative solutions for carbon emissions in Aker Solution?*
    - *How does Aker Solutions build collaboration with external stakeholders to reduce carbon emissions or reduce waste and usage of resources?*
    - *How does Aker Solutions organizational culture drive sustainability-oriented innovation for carbon emissions solutions in the oil and gas industry?*

1.3 OVERVIEW AND THESIS OUTLINE

The thesis outline, for a study of sustainability-oriented innovative (SOI) solutions for carbon emission in Aker Solutions value chain is be presented in this order:

Chapter one: Introduction of the thesis, the presentation for the introduction is largely based background of study. The introduction also addresses the problem statement for the thesis and presents the research question. The overall aim for the introduction advancing the literature and knowledge largely focusing on issues for the problem statement and presenting the research questions.

Chapter two: The thesis chapter presents the theoretical framework for sustainability-oriented innovation (SOI) adopted from (Adams et al, 2016). The point of departure for this chapter is the concept sustainable development or sustainability as a frontier of innovation which is the main theoretical background Nidumolu & Rangaswami, 2009). This chapter also explores the concept of innovation particularly it addresses, organizational innovation, which is a proxy of the unit of analysis, the firm. Furthermore, the theoretical framework of sustainability oriented (SOI) is explored by analyzing the innovative activities of the SOI model: strategy, process, learning, linkages and organizational design.

Chapter three: This chapter addresses the methodological and research design approach. The chapter addresses the philosophical assumption that is interpretivist and qualitative approach for the research design. Data collection is qualitative through interviews with key respondents, data is analysis and reduction is processed using Nvivo qualitative software. The issues relating to validity, reliability, generalizability and limitations are also addressed in this chapter.

Chapter four: The chapter presents the data and results collected and analyzed in chapter three. The presentation of data and results is done using word cloud frequency query results and the thematic analysis for each of the five innovative activities of the SOI model using data structures.

Chapter: The chapter will discuss the main research questions based on the results and data presented in chapter three and four. The discussion for the research question also identifies and maps the SOI innovative activities findings into the SOI model.

Chapter 6: The chapter presents the conclusion and managerial implications for next practice of the SOI model in the firm. The main findings of the thesis, limitations and future research studies are will be presented in this chapter.

2 CHAPTER 2: THEORETICAL FRAMEWORK

2.1 INTRODUCTION

The concept of sustainability is a modern-day buzzword, idealized by many and practiced by a few. Etymologically it comes from a Latin word 'sus-tenere' (Tidd & Bessant, 2014). Therefore, the point of departure for the theoretical framework will explore the concept of sustainability as a driver of innovation, the combination that conceptualizes sustainability-oriented innovation. The concept sustainability has been widely quoted since time immemorial in social, political, economic, and environmental spheres, however the definition for sustainability is defined differently in different situations. The concept is clearly analyzed through the tragedy of the commons conceptualized by Hardin. Hardin described the tragedy of the commons as a manifest overuse and depletion of natural resources causing a greater ecological footprint in the quest to boost economic growth, which has an adverse impact on climate change on the human and natural environment (Hardin, 1968, McCormick, 2018).

In modern times, sustainability and climate change have deservedly gained a global attention, however the former as the antidote and the latter as a problem. Climate change as many scholars, governments, international governmental organizations and climate scientists have acknowledged is the greatest threat of the century, caused by and large by the rising greenhouse gases emissions in the atmosphere, principally carbon dioxide emissions. The impacts of climate change is manifest and the Inter-governmental Panel on Climate Change (IPCC) since their first assessment report to the most recent assessment report have clearly stated through a scientific consensus that human activities are in fact causing the rise in the average temperature and which causes climate change (Oreskes, 2004, IPCC, Kuzemko et al 2016). The IPCC quoted in their recent assessment report noted that "limiting global warming to 1.5ºC would require rapid, far- reaching and unprecedented changes in all aspects of society,…with clear benefits to people and natural ecosystems, limiting global warming to 1.5ºC compared to 2ºC could go hand in hand with ensuring a more sustainable and equitable society," (IPCC, 2018, p1). Since the industrial revolution, the quest for energy to drive growth and economic development is the enabler climate change and has resulted in emissions rise from fossil fuel.

Therefore, with that backdrop, the theoretical framework of sustainability will define and explore the *what question* of sustainability with a historical backdrop. Furthermore, the thesis theoretical framework will discuss the weak sustainability and strong sustainability as two economic paradigms associated to sustainability, and the *why question* for sustainability. Thereafter, the theoretical framework will address the concept of innovation, particularly organizational innovation. The main theoretical framework for the thesis: sustainability-oriented innovation (SOI) where sustainability is the key driver for innovation will be discussed in tandem to the sustainability-oriented innovation model (Adams et al, 2016).

2.2 Sustainability defined by the Brundtland Commission

The United Nations General Assembly through the adoption of the resolution was behind the creation of the Brundtland Commission that coined the concept of sustainable development (Kates et al 2005). However, Langhelle argues that, the usage of the term 'sustainable development' existed prior to the Brundtland Commissions in 1987 (Langhelle, 2000, Schiederig et al 2011). The report by the World Conservation Strategy defined Sustainable development as relating to "the conservation of living resources" (IUCN, 1980, p. 7). Therefore, the conceptualization of sustainable development in the WCS report was impetus to the mainstream and widely adopted definition of sustainable development by the Brundtland Commission, however both conceptualization's objective was focused conservation and development (IUCN, 1980, Brundtland, 1987, Langhelle, 2000). Therefore, with that brief backdrop, the thesis will address the what and why question for sustainable development as conceptualized by the Brundtland Commission.

According to the Brundtland commission in the World Commission on Environment and Development Report, sustainable development was defined as, "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (Brundtland, 1987, p 43). The conceptual definition of sustainable development is complimented by two key components to address:

> "the concept of "needs", in particular the essential needs of the world's poor to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs" (Brundtland, 1987, p. 43)

Perhaps the most holistic interpretation of the definition of sustainable development which captures the main context and the two-key components of the sustainable development that is addressing global inequality and ecological footprint limitation is noted by Meadowcroft (2007). Meadowcroft noted that "promoting human well-being, meeting the basic needs of the poor and protecting the welfare of the future generations, preserving resources and global life systems, integrating economics and environment in the decision-making, and encouraging popular participation in development processes" (Meadowcroft, 2000, p, 73). Meadowcroft definition meets some of the objectives stipulated in UN Sustainable Development Goals (SDGs). Langhelle however, observed a dearth of sustainable development definitions in practice that captures the two key concepts in addendum to the definition of sustainable development (Langhelle, 1999, Verburg & Wiegel, 1997, Jacob, 1997).

It is imperative to analyze the conceptual definition of sustainable development by highlighting the key words. Sustainable Development is the development…. development in this sense is defined as progressive transformation of the economy and society with an objective of satisfying human needs and aspirations through a social and political setting (Brundtland, 1987). Development is a measure of economic outcome of a state or country to attain growth. However, the concept of sustainable development captures economic, social and political development. Through the economic, social and political development human needs and aspirations are attained. The second key word to sustainable development definition is 'meet the 'needs' which in this sense human needs especially the needs of the poor in developing countries as priority (Brundtland, 1987). In this sense, addressing human needs in a rigid economic, social and political setting, has an overriding effect on the second key concept of sustainable development. And the criticism sustainable development has encountered is for been overtly bias towards economic development and growth (Langhelle, 1999, 2000, Brundtland, 1987). However, the WCED report in our common future noted that "sustainable development requires meeting the basic needs of all" (Brundtland, 1987, p, 44). The third and fourth key words is 'present and future'

generations in the sustainable development definition.

There is a strong critique with the 'present and future' generation variable evaluation of sustainable development from Neumayer, who notes that "present and future generations is a fictitious simplification…everyday people are born while others die so there is a permanent flow of people into and out of the present generation ,while future are not given but are contingent on the present generation's actions" (Neumayer, 2013, p12). Therefore, the needs and interest of the present and future generations could be different, a development path that is physically sustainable could guarantee a path that has less compromise between generations in pursuit of their own needs (Langhelle, 2000). However, Neumayer further noted optimistically that, 'present and future generation' variables evaluation of sustainable development is abstractive but with great importance in conceptualizing and analyzing the problems and mitigations (Neumayer, 2013). Malnes (1990) conceptualized this as the proviso of sustainability (Malnes, 1990, Langhelle, 2000). The critique for sustainable development is that it is anchored more towards meeting economic development as reviewed through the economic paradigms for weak and strong sustainability.

2.2.1 Economic paradigms: weak and strong sustainability

Sustainable development identifies with different dimensions of sustainability. Physical sustainability which is a sustainable biophysical environment is vividly highlighted in the WCED report. The Brundtland report notes regarding physical sustainability that, "at a minimum, sustainable development must not endanger the natural systems that support life on Earth: the atmosphere, the waters, the soils, and the living beings" (Brundtland 1987, p, 45). However, they are two mainstream economic paradigms of sustainability emerged that is, weak sustainability and strong sustainability (Neumayer, 2013, Dietz & Neumayer, 2007). The economic paradigms for sustainability are anthropocentric in terms of utility for natural capital for non-renewable and renewable resources (Dietz and Neumayer, 2007). The weak sustainability and strong sustainability argue for the capitalization of the intrinsic value of the natural environment to advance intergenerational economic growth. In a sense, this argument is ideologically compared to the argument for shallow ecology and deep ecology, however the focus the economic paradigms is economic and environmental tradeoffs to measure growth and development

(Dietz and Neumayer, 2007).

The notion of weak Sustainability is theorized by Harts-Solow under the auspice of neo-classical theory on economic growth (Gutes, 1996, Dietz and Neumayer, 2007, Ayres et all 1998, Neumayer, 2013). The basic assumption of this economic approach to sustainability is that, "natural capital is either abundant or substitutable both as an input into the production of consumption of goods and as a provider of direct utility" (Neumayer, 2013, p.23). In a nutshell, Neumayer notes that weak sustainability is premised on substitutability of natural capital and thus its moniker substitutability paradigm (Neumayer, 2013). According to Gutes, weak sustainability is measured in terms of non-decreasing total capital stocks, that is manmade and human capital from the natural capital (Gutes, 1996).

The argument for weak sustainability has exacerbated the impacts of climate change and the environmental degradation of the natural environment in its pursuit for natural capital for manufactured capital. This is noted by Robert Ares et al in the viewpoint article that "weak sustainability may be consistent with a situation of near complete environmental devastation" (Ayres et al 1998, p.3). And Beckerman noted that proponents of weak sustainability are not environmentally conscious (Beckerman, 1995). Therefore, weak sustainability argument is misplaced in the echelon of sustainable development as it does not meet the key conceptual framework of sustainable development, that is the idea of limitations imposed by the state of technology and social organizations on the environment's ability to meet present and future needs (Brundtland, 1987). Furthermore, weak sustainability is the antithesis of sustainability and this is noted by Gutes that, "by assuming a high degree of substitutability between natural and manmade capital, and applying it to the analysis of sustainability, we are in fact diminishing the concern by which it was originally created-namely, the potential conflicts between viable economic development and preservation of the environment" (Gutes, 1996, p.151).

The other opposing economic paradigm for sustainability is strong sustainability, which is a direct antithesis of weak sustainability. Strong sustainability according to Gutes is based on the simple assumption that, "natural capital as providing some functions that are not substitutable by manmade capital" (Gutes 1996, p.147). Unlike weak sustainability, with strong sustainability natural capital is a non-substitutability paradigm (Neumayer, 2013). Neumayer explores further the two economic

paradigms in his book weak vs strong sustainability. He notes further regarding strong sustainability as having two interpretations, one that is premised on preserving natural capital in value terms and the other interpretation is that, it advocates for the constraining substitution of natural capital needs, a thesis weak sustainability is fundamentally premised on (Neumayer 2013).

The argument for strong sustainability and weak sustainability have an anthropocentric approach to the value of natural capital, to serve human welfare, thus a shallow ecological approach. Therefore, the approach rules out the deep ecological approach, that premises on intrinsic value of life of living beings or non-human entities have value independent of human valuation (Neumayer, 2013, Ayres et al 1998, Sessions, 1995). The thesis posits with the argument for strong sustainability as the right economic paradigm that resonates to the key issues for this research. A further analysis of the importance of addressing sustainable development is outlined in sub-section 2.3.

2.3 Addressing the 'Why' for sustainable development

The nexus of sustainable development is focused on the three pillars: economic, social and environmental and these interdependent elements in the fabric of society form the triple bottom line of sustainable development. The triple bottom line is impetus to analyzing the concept sustainable development, however, the economic pillar of sustainable development overrides the social and ecological approach of sustainable development. Therefore, the argument for economic paradigms of weak and strong sustainability open the paradox of sustainability which is too anthropocentric and largely based on econometrics.

Sustainable development despite its fair share of contestation and overtly bias on economic growth heralded a new paradigm to meeting the needs of the global poor and a focus on the physical environment at large. However, Jacobs notes that, "the term sustainable development has helped to create an unprecedented level of at least rhetorical political commitment to the environment…its very universality has generated a debate about environmental economic policy which shows no signs of abating" (Jacobs, 1995, p. 65). However, since the inception of sustainable development as a policy and

political tool, economic development and growth has thrived at the expense of the physical environment. Therefore, the why of sustainable development examine key issues and the proxy of sustainable development that is, climate change, this thesis framework identifies with. Climate change has been used as a proxy in measuring the impacts and economic outcomes of strong sustainability and weak sustainability economic paradigms (Neumayer, 2013). Neumayer in his article weak sustainability and strong sustainability takes climate change as a proxy for sustainability because it transcends on all economic, social and environmental spectrums in the fabric of society. He further notes that, "the benefits of abating greenhouse gas emissions will be mainly enjoyed by the future generations, while the cost of abating greenhouse gas emissions will have to be borne already by the current generation" (Neumayer, 2013, p.30).

The rising greenhouse gases in the atmosphere through the production and consumption methodologies in the global supply chain is a major concern for sustainability. The rising greenhouse gas emissions principally the extraction of fossils fuels through the burning of hydrocarbons which is responsible for the production of carbon emissions in the atmosphere has far and unprecedented impact on the global economy and society. Although these unprecedented impacts of climate change may not be severe for the present generation, the future generations are prone to experience the severe impacts of climate change if the present business as usual neo-classical economic, social and ecological approach persist.

At the conceptualization of sustainable development, climate change as an environmental problem did not receive too much attention. However, resource depletion (ecological footprint) and social injustice especially for developing countries was the major focus of sustainable development. Langhelle noted that, climate change, however, was highlighted in the Brundtland report but not explicitly (Langhelle, 1999). Therefore, attention to mitigate the impacts of climate change was led international efforts through a number of international platforms (Schreurs, 2012).

Critical to the discourse of sustainable development is the objective of meeting the sustainable development goals (SDGs). The impetus for the MDGs was the UN Millennium Declaration, which was signed by 189 countries, reflecting eight Millennium Development Goals (MDGs) for human development, eradication of poverty, hunger and disease (Travis et al 2004, Sachs, 2012). Sustainable

development goals an addendum of the millennium although with increased number of goals 17 accompanied by the 169 targets for the goals (UN A/RES/70/1, 2015). However, the theoretical interest in this thesis resonates with goal number nine which states that "build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation" (UN SDGs, 2015). The sustainable development goal number nine addresses the overall scope for this thesis on sustainability-oriented innovation for economic industrialization. Therefore, the thesis standpoint is that, meeting the goal number nine will have a trickle-down effect on the attainment of the other sustainable development goals, and more specifically the locus for this thesis approach on mitigating emissions footprint to well below 2 ºC (Paris Agreement, 2015). The following theoretical section will focus on the innovation as part of the theoretical framework of sustainability-oriented innovation.

2.4 Innovation

In the recent report, the IPCC quotes climate-driven innovation as a panacea to mitigate greenhouse gas emissions and limiting global warming to 1.5°C (IPCC, 2018). The IPCC notes that, "adapting to and limiting global warming to 1.5°C include the widespread adoption of new and possibly disruptive technologies and practices and enhanced climate-driven innovation" (IPCC 2018, p.24). In the same vein, the WCED notes in their requirements for sustainable development in advancements in technologically innovative solutions (Brundtland, 1987). Innovation is also reflected in the United Nations sustainable development goals, specifically goal number nine, which states that, "build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation." (United Nations SDGs, 2012) as earlier alluded to. With this backdrop, the section will address the overall 'what' question on innovation and the how of innovation through an analysis of organizational innovation as a up build to addressing sustainability-oriented innovation as the main theoretical framework for the thesis.

The word Innovation in academia and theoretical foundation was the brainchild of Joseph Schumpeter, developed through intellectual innovation – that was triggered by the beleaguered structure of classical

and neoclassical economic theories of development, institutional structure, social change and rising technological change (Elliot, 2017, Schumpeter 1934, Fagerberg et al 2005). Innovation a nomenclature that is interchangeably confused with invention, however, the latter is the entrée of innovation (Fagerberg 2005, Bortolotti 2008). Innovation as a concept is an ambiguous term and resonates to many other definitions, perspectives and interpretation to different scholars both in academia and industry and yet it is widely quoted in most spheres of ideologies and daily practices. The etymology of the word innovation is from a latin word innovates or innovare, connoting to renew or to change (Tidd & Bessant, 2014, Godin 2015). The word innovation also traces its origin in the echelons of ancient Greek political school of thought as καινοτομία; kainotomia denoting political or constitutional change (Godin, 2012, Godin, 2015). According to Godin, "word kainotomia is a combination of kainos (new) and the radical tom (cut; cutting)" (Godin 2015, p.75). Godin continued to note that the historical etymology of the term innovation was pejoratively used in the ancient Greek political thought and to a positive perspective in latin school of thought though with a pinch of salt (Godin, 2015). Godin in his working paper on; the conceptual history of innovation notes the evolving timeline since time immemorial of the word and concept of innovation and its associated synonyms. He noted four distinct associations and analogies of existing concepts of innovation historically that is, change, heresy, revolution and combinations (Godin 2015).

Schumpeter defined innovation as a, "commercial or industrial application of something new – a new product, process, or method of production; a new market or source of supply; a new form of commercial, business or financial organization" (Schumpeter 1934, p. 65). Schumpeter's definition for innovation was a breakthrough conceptual definition, widely quoted in the innovation scholarship. Furthermore, the definition of innovation was more inclined to the new or improved means of production, making it more process oriented and outcome (Crossan & Apaydin, 2010). Since the conceptualization of innovation, a plethora of definitions have emerged in the innovation scholarship and for the purpose of this thesis, a holistic definition is provided by the Oslo Manual definition of innovation. According to the Oslo Manual "innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (Oslo Manual, 2005, p.46). The definition of the innovation from the Oslo Manual encapsulates the broader framework of the concept of innovation,

involving the four types of innovation that is, product innovation, process innovation, market innovation and organizational innovation including a stakeholder (external relations) through an open approach to innovation. The definition of innovation by the Oslo manual has relative proximity to the Schumpeter's definition, however the Oslo manual definition of innovation is more explicit in highlighting the types of innovation. A holistic conclusion for a plethora of all definitions of innovation, Dosi noted that, the most definitions of innovation are focused primarily on solving problems (Dosi, 1998).

Prior to addressing the various types of innovation, it' is the aim of this thesis theoretical framework to highlight in brief the degree of novelty of innovations which has two outcomes that are manifest in the most forms of innovation that is , incremental or radical (Fagerberg .,et al 2005, Henderson & Clark 1990, Tidd & Bessant 2014). Henderson & Clark notes that, "radical innovations establishes new dominant designs and, hence a new of core design concepts embodied in components that are linked together in a new architecture" (Henderson & Clark 1990, p.3). And this is echoed by Fagerberg et al radical innovations have considerably reduced the costs of key economic inputs and have therefore been widely adopted and become the catalysts for major economic inputs (Fagerberg 2005, p.104). Henderson & Clark further notes that, "incremental innovations refine and extends an established design" (Henderson & Clark 1990, p.3) noting continuous improvements. Therefore, the novelty of innovation is imperative to the overall innovation concept as it transcends in all spheres of innovations that is, in product or process, market or organizational, and addresses the challenges in terms of capabilities (Henderson & Clark, 1990). Michael Porter argues that, "much innovation is mundane and incremental, depending more on the accumulation of small insights and advances, than on a single major technological breakthrough" (Porter, 1990, p.57). Innovation scholars have argued for and against the novelty of innovation approaches that is radical and incremental to the notion of sustainability in addressing climate change and other social and environmental challenges (Ghassim 2018). Therefore, the novelty of innovation is imperative and is a common denominator in the overall forms of innovations. Furthermore, the following sub-section 2.4.1 addresses organizational innovation as key form of innovation for the unit of analysis.

2.4.1 Organizational innovation

According to Fagerberg et al, organizational innovation refers to "the creation or adoption of an idea or behavior new to the organization" (Fagerberg et al 2005, 115). The various types of innovation are captured in the both Schumpeter's definition of innovation implicitly and by the thesis adopted definition of innovation from the Oslo manual that is product innovation, process innovation, market innovation and organizational innovation (Oslo Manual, 2005, Schumpeter, 1934). As Porter noted that, "innovation can be manifested in the new product design, a new production process, a new marketing approach, or a new way of conducting training" (Porter, 1990, p.75). The thesis explicitly focuses on organizational innovation as it resonates with the theme of sustainability-oriented innovation for the unit of analysis.

Organizational innovation is imperative for explicit analysis for the theoretical framework of this thesis. Organizational innovation embodies the innovation process including product innovation and process innovation, and all innovations are formulated and have a direct impact on organizational innovation. The analysis of organization innovation will be examined in tandem with organization theory pillars that is cognitive, regulative and normative (Scott 2014). In theories of organizational innovation, Amabile theorized the various stages of the organizational innovation process in stage models through which organizational innovation proceeds that includes: departmental-stage models; activity stage models; decision-stage models; conversion-process model and; response models (Amabile, 1988). However, the thesis examines the theoretical framework for organizational innovations that encompasses three main pillars that is, organization structure and innovation, focusing how organizational structure can foster innovation process; Organizational cognition, learning and innovation that is the niche ideas organizations formulate for problem solving, and; Organizational change and innovation, how organizations can overcome inertia and adapt in the face of radical environmental shifts and technological changes (Fagerberg et al 2005). These three pillars of organizational innovation are of paramount to the theoretical buildup of this thesis as well as for the analytical framework. The Oslo manual also notes that, much of the literature on organizational innovation is tailored on the role of organizational structures, learning processes and adaptation to changes in technology and the environment (Oslo manual 2005). The thesis will highlight the main theoretical foundations of organizational innovation that is, organizational structure and innovation,

organizational cognition and innovation, and organizational change and innovation as they correlate to the unit of the analysis for the thesis.

With that backdrop, it is imperative to examine the three elements under the auspice of organizational innovation that is, organizational structure and innovation, learning and knowledge creation, and change and adaptation respectively. The elements of organizational innovation are critical to the unit of analysis as regards the nexus of sustainability, innovation and emissions in the thesis.

Organizational structure and innovation. Organizational structure reflects the overall business model or innovation process, as Amabile noted it's hard for organizations to get way from innovation (Amabile 1988). Therefore, organization structure is critical for the innovation process in organizations and the two concepts are integral to the overall organizational innovation. Organizational structures enables the creation of new products and processes in fast changing environment as several studies have shown, the assertion observed by Fagerberg et al (2005). Much of theoretical contribution to organizational structure was theorized by Mintzberg (1979), who formulated architypes that provide the basic structural configurations of organizations operating in different environments (Fagerberg et al 2005) and Mintzberg argued that, successful organizations design its structure to its business model (ibid). Organization structure encompasses paradigm innovation that is defined as "changes in the underlying mental models which frame what the organization does" (Tidd & Bessant et al 2009, p10). In terms of organizational theory, organization structure and innovation fall under the auspice of normative and more or less on regulative pillars of institutions (Scott 2001). Scott in institutions and organizations notes that the normative pillar involves strategy on how things ought to be done and the means of achieving the defined goals and objectives (Scott, 2001). The normative pillar of institutions consolidates the organization structure and innovation and the overall organizational innovation process through formulating deliberate strategy to innovate within the organization. Kanter notes that, "the organizations producing more innovation have more complex structures that link people in multiple ways and encourage them to "do what needs to be done" within strategically guided limits, rather than confining themselves to the letter of their job. Such organizations are also better connected with key external resources and operate in a favorable institutional environment" (Kanter 1996, p.95).

Organization learning and knowledge creation. This conceptual pillar of organizational innovation is under the auspice of organizational cognition, learning and innovation (Fagerberg et al 2005). Organization learning and knowledge creation is vital for theoretical analysis of the unit analysis of the thesis, as learning and knowledge creation is the chief factor in the innovation process both at strategy and processes level. The scholarship of organizational learning and knowledge creation is consistent on the synergies of organizational structures, learning processes and adaptation to changes in technology and the environment as key themes of organizational innovation and specifically literature on organizational learning focuses on the social interaction, context, and shared cognitive schemes for learning and knowledge creation (Oslo Manual 2005, Fagerberg et al 2005). Organizational innovation sets the precedence for learning which involves organization as well as individual skills and the capability to learn effectively and create knowledge which is definitive of an innovative organization (Teece et al 1997, Fagerberg et al 2005). This assertion is captured by Kanter who notes that, by default the innovation process creates intensive knowledge which is dependent on individual human intelligence and creativity that involves interactive learning (Kanter, 1996, Quinn, 1985, Amabile 1988). In the same vein, the Oslo manual notes that, "Organizational learning depends on practices and routines, patterns of interaction both within and outside the firm, and the ability to mobilize individual tacit knowledge and promote interaction. Such learning can be encouraged through careful design of practices, routines and relationships, or through a more flexible, fluid organization in which individuals are encouraged to develop new ideas and ways of doing things" (Oslo Manual, 2005, p.31). And the second process involves knowledge creation within the organizational foundation is vital to the overall organizational innovation. According to Fagerberg, "knowledge creation is rooted in the idea that shared cognition and collective learning constitute the foundation of organizational knowledge creation" (Fagerberg et al 2005, p.125). And this view is reflective in the meaning of organizational knowledge that refers to "shared cognitive schemes and distributed common understanding within the firm that facilitate knowledge sharing and transfer" (Fagerberg et al 2005, p.126).

In terms of institutional and organization theory, organization learning, and knowledge creation is under the auspice of organizational cognition, learning and innovation resonates with the cultural-cognitive pillar. Through interaction, meanings to objectives and activities are synthesized to produce knowledge

to explain the phenomenon occurring (Scott, 2001). Therefore, learning and knowledge creation is integral and complimentary to cultural-cognitive pillar of organizational and institution theory. Furthermore, Scott continues to note the influence of cultural-cognitive pillar of the institutions and organizational learning and knowledge creation that, "at the organization field level, researchers have employed discourse analysis and other types of content-analytic techniques to assess meaning system" (Scott, 2001 p.58). Cultural-cognitive is an important pillar to organizational learning and knowledge creation that recognizes, assimilate and exploit knowledge internally and externally.

Organizational change and innovation. The versatility of organizations to change and adapt to rapid spontaneous environmental and technological change that addresses sustainability, energy, environment and society synergies including climate change and innovation is paramount to survival of the organization. Theoretically, Fagerberg notes that "organizational ecology and institution theories, as well as evolutionary theories of the firm, emphasize the powerful forces of organizational inertia and argue that organizations respond only slowly and incrementally to environmental changes" (Fagerberg et al 2005, p.133).

The analysis for sustainable development and innovation is the precursor for the main thesis theoretical framework for sustainability-oriented innovation (SOI).

2.5 Sustainability-oriented innovation (SOI)

The main theoretical framework for the is formulated on the backdrop of the afore-mentioned theoretical framework of sustainable development (sustainability) and the discourse of innovation coupled with organizational theory. The theoretical framework on sustainability-oriented innovation will be key to the overall analysis of the thesis for the unit of analysis (Aker Solutions) approaches and strategies to a sustainable-oriented innovation that is aimed in meeting innovative solutions for carbon emissions in the value chain. The framework in this section will address the what question for sustainability-oriented innovation, involving the model innovative activities and the three main pillars of the SOI model.

The concept of sustainability-oriented innovation is defined differently by different scholars; however, the key words are associated to the triple bottom line approach of sustainable development and the synergies of innovation and organizational theory. Sustainability-oriented innovation according to Adams et al is explicitly defined as, "making intentional changes to an organization's philosophy and values, as well as to its products, processes or practices to serve the specific purpose of creating and realizing social and environmental value in addition to economic returns" (Adams et al.,2016, p.180).

For the point of departure, the theoretical framework for sustainability-oriented innovation will adopt Adams et al (2016) framework analysis of the sustainable-oriented innovation (SOI) see *figure 2.1* below. The theoretical framework will examine the key blocks for innovative activities towards a sustainable business practice by examining the strategy, process, structure, learning, linkages and organizational design used in lieu of innovative organization in the thesis. The innovative activities are theorized in correlation to sustainability-oriented innovation (SOI) model main pillars: operational optimization, which reflects an internally originated perspective on sustainability, referring to "'doing the same things but better' approach directed towards reducing harm through reactive, incremental improvements driven by compliance or proactively pursuing ecological efficiencies" (Adams et al 2016, p. 188); organizational transformation, involves a fundamental shift in mindset and purpose for 'doing less harm' to creating shared value and delivering wider benefits for society: doing good by doing new things" (Adams 2016, p.189), and ; systems building,, requires another shift in philosophy to thinking beyond the firm and reframing the purpose of business in the society: "doing good by doing new things with others" (Adams, 2016, p. 190). The following sub-sections will examine the innovative activities associated to the final SOI model in tandem with the three main pillars of the final SOI model.

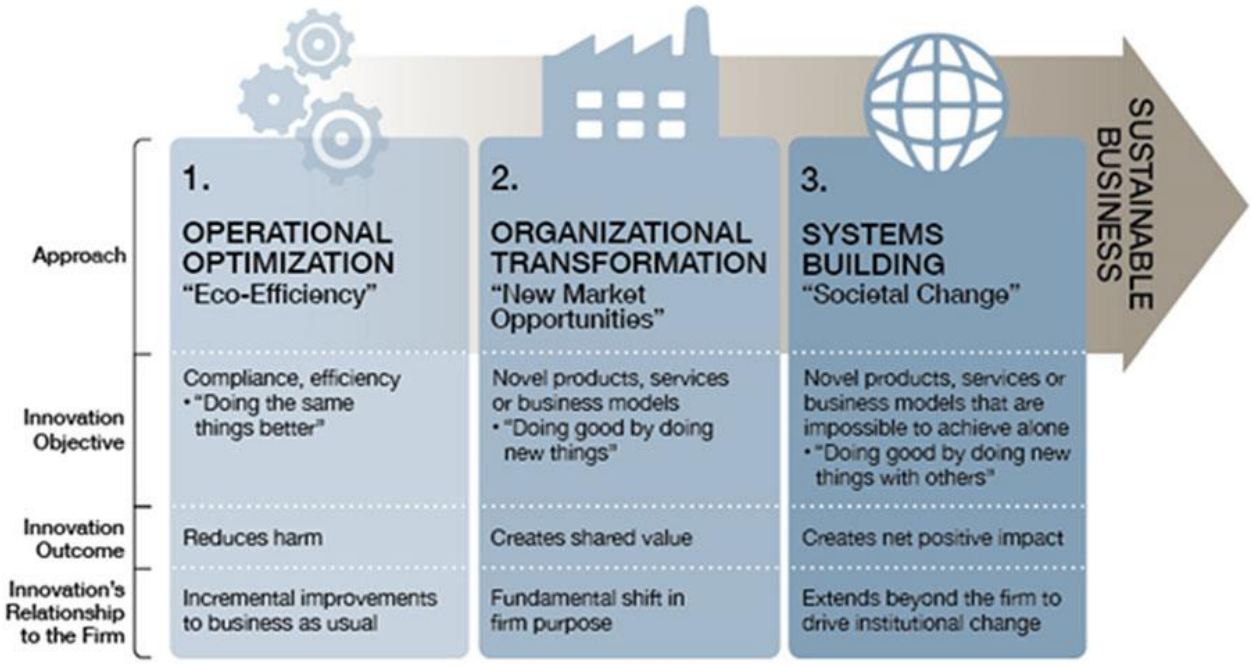

Figure 2.1.Final SOI model by Adams et al (2016, p 185).

2.5.1 Innovative activities of the SOI model

2.5.1.1 Strategy

According to Tidd and Bessant, "strategy is also about making clear a vision for the future and sharing this with others who can help shape the direction and support the journey" (Tidd & Bessant, 2014, 22). There are two distinctive competitive advantage approaches to a firm strategic management that is, resource-based perspective and dynamic capabilities approach (Teece et al 1997, Tidd and Bessant, 2014). According to Tidd & Bessant, capabilities involves the firm's potential for executing specific activities or set of activities (Tidd & Bessant, 2014). And dynamic according to Teece et al refers to "the capacity to renew key new competences in order to attain leverage with the changing business environment" (Teece et al 1997, p. 515).

Therefore, dynamic capabilities are defined as "the firm's ability to integrate, build and reconfigure internal and external competences to address rapidly changing environment" (Teece et al, 1997, p. 516). And dynamic capabilities are also defined in a nutshell by Iakovleva et al as "the capacity of an organization to create, extend and modify its resource base" (Iakovleva et al, 2012, p. 223). Furthermore,

the resource-based view or perspective premises on the firm's configuration that is systems and structures focus on profitability based on product efficiency, quality and performance (Teece et al 1997). Tidd and Bessant noted that, "resource-based view of strategy proposes that competitive advantage is primarily driven by the firm's valuable, rare, inimitable and non-substitutable resources" (Tidd and Bessant, 2014, p. 42). However, Teece et al concluded that, dynamic capabilities approach is more promising in achieving the firm's competitive advantage in increasing changing business environment (Teece et al 1997).

Strategic approaches exist in many organizations and institutions approaches to achieving a certain desired objective. However, innovation strategy in this realm is key for examination of the final SOI model. Innovation alone because of its uncertainty nature and does not happen in a vacuum needs a strategy (Tidd & Bessant, 2014). Tidd and Bessant further noted that, "it needs a clear strategic leadership and direction, plus the commitment of resources to make this happen" (Tidd & Bessant, 2014, p. 285). With that view the strategic activity will be examined in tandem with the three pillars of sustainability-oriented innovation model that is;

Operational Optimization. According to Adams et al notes that, adopting sustainable social and environmental policies and regulations results in competitive advantage to firms (Adams et al, 2016). According to Sarkis, research findings in greening practice indicated a focus on liability reduction and compliance to regulations than environmental partnering with the suppliers (Sarkis, 1999). And Adams et al, further notes that, "strategically focus of innovation activity in operational optimization lies within the firm's boundaries: the targets for change are internal. Principal drivers include responding to regulatory requirements (compliance) and the pursuit of efficiency gains through new practice adoption" (Adams et al 2016, p. 189).

Organizational transformation. According to Adams et al, envisaging strategy at the organizational transformations, innovation and sustainability are deliberately triggered within the firm, where sustainability-oriented innovation culture is embedded not as an addendum but coalesced in the cultural and strategic processes (Adams et al 2016). The radical shift from the strategic goodwill (doing good) creates opportunities for innovation in business concepts and practices, that exceeds the operational

optimization for greening to engagement with external stakeholders and a more strategic focus on sustainability (Adams et al 2016).

Systems building. The premise for systems building for strategy involves a logic of wide collaborations and investing in systems solutions to derive new, shared value propositions from the entire sociotechnical and ecosystem network to make a positive shared impact and value (Adams et al, 2016).

2.5.1.2 Process

The innovation process is key to the discourse of sustainability-oriented innovation and involves key sub-activities envisaged in the innovation process model for searching, selecting, implementing and capturing value aspects in the innovation process (Tidd & Bessant 2014). However, the search, select, implement and capture of the innovation process is faced with many challenges as Seebode et al noted that, "the innovation challenge is essentially around processes of search (for innovation trigger signals), selection (resource allocation) and implementation" (Seebode et al 2012, p197). Therefore, it's imperative to analyzing sustainability-oriented innovation with the innovation process by examining the various phases involved through searching for ideas phase, selecting ideas phase, implementing ideas phase and capturing the value phase in tandem to sustainability that will be critical in the analytical framework for the unit of analysis.

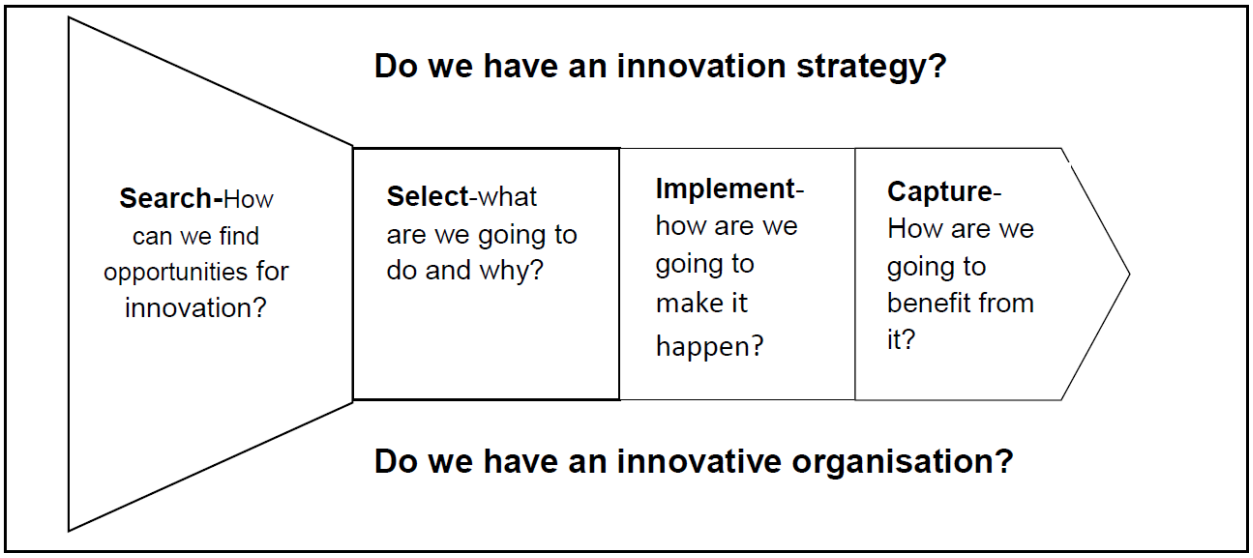

Figure 2.2. Tidd & Bessant Innovation Process Model (2009, p. 44).

Search phase. This phase involves "detecting signals in the environment about potential for change" (Tidd et al 2005, p 89). The search for opportunities for innovation are aplenty and there is a spectrum of sources for innovation, however, the scarcity of resources to utilize the abundant sources for opportunities poses a major challenge for innovation management (Tidd & Bessant, 2014). Despite the challenges, the search phase for innovation opportunities is a key element in the innovation process overall, as it triggers the funnel for innovation process that involves a chain of potential ideas from both the internal and external environment for an organization to maximize innovation. Kanter noted that, "to generate ideas in the first place, a great deal of diverse outreach is involved" (Kanter 1996, p.106, Tidd & Bessant 2014). The search phase in innovation management involves the deployment and application of strategies, however it all depends on the novelty of innovation which manifests in radical or incremental and much of the search for innovation triggers is focused on the incremental improvement innovation (Tidd & Bessant, 2014, John Bessant et al 2014). However, Johnson notes "the practical work when generating ideas is highly abstract and involves many uncertainties, and the abstract work continues throughout the selection phases of what ideas to prototype and test for market reactions" (Johnson, 2018:16).

Selection phase. This phase encompasses a strategic vetting and selection process of products ideas before the decision -making to more forward for product development (Tidd &Bessant, 2014). The

selection process of innovation management is also shrouded in uncertainty and risk due to the nature of the innovation process, linearity, novelty and its outcome (Tidd & Bessant, 2014, Tidd et al 2005). Therefore to minimize the risks and uncertainties associated to the selection process , Tidd et al observed that, "it is thus essential that some selection is made of the various market and technological opportunities, and that the choices made fit with the overall business strategy of the firm and build upon established areas of technical and marketing competence" (Tidd et al, 2005, p. 90). Just like the search process, the selection process also involves the application and deployment of strategies that are commensurate to the organizational business model (Eveleens 2010, Tidd & Bessant 2014, Tidd et al 2005). One of the key approaches in dealing with risks and uncertainties in this process is the capacity of the organization strategy to spread the risks across existing business platforms through portfolio management and using the stage gate model that manages risk over time (Eveleens 2010, Tidd & Bessant 2014).

Implementation phase. The implementation of an idea is the operational framework for the concept of innovation (Eveleens 2010). Aubrey noted that, "Successful innovation is the creation and implementation of new processes, products, services and methods of delivery which result in significant improvements in outcomes, efficiency, effectiveness or quality" (Albury 2005, p. 2). Uncertainty is less in the implementation phase due to the acquisition of knowledge through various routes and at an increasing cost, unlike search and select phase where uncertainty is high (Tidd et al 2005). With that alluded, Tidd et al observed three core elements at the implementation phase which includes, knowledge acquisition, project execution, and launching and sustaining the innovation (Tidd et al 2005).

Capturing value phase. According to Tidd & Bessant, value is simply "defined in terms of creating a product or service which others find useful and which they value" (Tidd & Bessant, 2014 p. 5). Creating, delivering and employing strategies to capture value is the essence of innovation and business model innovation at large (Tidd & Bessant 2014, Yang et al 2017). The prerequisite of capturing value is manifested in the value created and this is in consonance with the conceptual definition of innovation by Tidd & Bessant viewed as a process of "creating value from ideas" (Tidd and Bessant, 2014, p. 3). The process of creating value resonates or falls under the auspice of the search and select phase of the innovation process. Chesbrough however, noted that, business model creates a rapport to access both

internal and external ideas and deploy strategies to capture that value (Chesbrough, 2012). A business model according to Amit & Zott is defined a as "a system of interconnected and interdependent activities that determines the way the company "does business" with its customers, partners and vendors" (Amit & Zott 2012, p. 37).

Innovation scholars has earmarked business model innovation as an approach for creating and capturing of value from innovations (Amit & Zott 2012, Yang et al, 2017, Chesbrough 2012). According to Yang et al, "Business model innovation envisages a holistic approach for the creation and capturing of value through the analysis of each phase of the product's journey all through to the market (Yang et al, 2017). In relation to sustainability, scholars have noted that, "focusing business model innovation on sustainability requires a framework for understanding how sustainability may generate opportunities for value creation" (Yang et al 2017, p. 31). The innovation process can be analyzed with the interaction with the three building blocks of the sustainability-oriented innovation framework proposed by Adams et al (2016) that is;

Operational Optimization. According to Adams et al operational optimization, innovation process focuses on incremental improvements to reduce environmental impacts while doing the same business (Adams et al 2016). One industrial example from is the application of topology optimization through additive manufacturing, which results and impacts on resource and energy saving (Junk et al, 2017). In terms of the impact of operational optimization significant incremental improvement can have an overall impact on process innovation defined by the Oslo manual as "the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software" (Oslo Manual 2005, p. 49). In the Oslo manual it is noted that, process innovation can maximize value creation within the innovation process by decreasing unit costs of production, increasing quality of products, and a production of significantly improved products (Oslo Manual 2005). Significant improvements as regards to sustainability is further noted by Adams et al that, executing the same business but in a more efficient (Adams et al, 2016). Lean thinking is essential in improving product quality in the process innovation and results in productivity, cost reductions, and efficiency (Tidd & Bessant, 2014, Gomes et al, 2017).

Product innovation is a key proxy under the process innovative activities of the SOI model. This is reflected by Nidumolu et al who noted that" to design sustainable products, companies have to understand consumer concerns and carefully examine product life cycles" (Nidumolu & Rangaswami, 2009, p.9). Lifecycle approach is a useful tool for the examining the triple bottom line of sustainability that' is economic, social and environmental, impacts and footprint of a product across its entire life, taking accountability of manufacturing, transportation, including materials sourcing and disposal or recycling (Kate et al 2005). Adams et al noted that, "the application of tools , of which there are many and which range in purpose, complexity and ease of use, enables users to evaluate sustainable materials and sustainable design alternatives and relate them to financial incentives, environmental regulations or the demands of clients" (Adams et al 2016, p.189). Life cycle assessments can enhance the firm's sustainability-focused value opportunities in the entire product life cycle and identify opportunities to maximize value and minimize social and environmental impacts (Kate et al 2005).

Organizational Transformation. Organizational transformation can be enhanced through adopting paradigm innovation in pursuing new innovative activities or radical shift in developing new things that is product, services and process (Tidd & Bessant, 2014). Paradigm innovation takes a radical novelty of innovation that involves changes in the organization business mental model to venture in new products and services (Tidd & Bessant 2014). Organizational transformation involves the adoption and implementation of knowledge sources that is absorptive capacity of a firms to utilize external knowledge to maximize innovation (Cohen & Levinthall, 1990, Teece et al 1997). Tidd & Bessant further observed that, paradigm innovation which is a key ingredient of organizational transformation is been cited in the discourse of sustainability symposium on climate change and resource depletion concerning energy and materials (Tidd & Bessant 2014). Organizational transformation through adoption and implementation of new business models is associated to systems changes (Tidd & Bessant, 2014) discussed in the following paragraph.

Systems Building. System building is under the auspice of systems innovation scholarship, which premises on an approach that drives on interdependence and non-linearity of the innovation process and with the standpoint that, firms innovate not in isolation but in collaborations with other organizations with the industry or external to the industry through various mechanisms characterized by vivid

industrial symbiosis or ecosystem (Fagerberg et al 2005). This is echoed by Adams et al that, collaborations enhance the "firm's search activities and knowledge base, particularly in relation to picking up weak signals, to deliver innovations and also enhance social legitimacy" (Adams et al 2016, p. 193). Adams et al further notes, "system building requires another radical shift in philosophy to thinking beyond the firm and reframing the purpose of business in society: 'doing good by doing new things with others' (Adams et al, 2016, p. 192). Adams et al further notes that, in building system or collaborations anchored towards environmental sustainability, there is a consolidated societal approach to problem identification, definition and search for opportunities (Adams et al 2016). In that sense, it is imperative to function with the open innovation framework, that encourages systemic collaboration across all stakeholders in the fabric of society to maximize the firm's innovation. Therefore, open innovation defined by Chesbrough as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation" (Chesbrough 2012, p. 20).

2.5.1.3 Learning

Learning involves the acquisition of knowledge as a final outcome and knowledge plays a key role in innovation (Arrows, 2015, Tidd & Bessant, 2014, Jensen et al 2007). The scientific knowledge is a brainchild of Polanyi who noted that, "we can know more than we can tell" (Polanyi, 1966, p.4). Therefore, learning or acquisition of knowledge exists in two forms that is codified knowledge and tacit knowledge (Polanyi, 1958, 1967, Cowan et al 1999, Johnson et al 2002, Gertler 2003).

Cowan et al defined tacit knowledge as tacit knowledge is personal knowledge that is not untransferable (Cowan et al 1999). Gertler notes that tacit knowledge is the untapped knowledge with potential to solve specific tasks and problems (Gertler 2003). Some scholars have argued the significance of tacit knowledge as a key element that maximizes innovation and value creation in the learning economy (Gertler 2003, Cowan et al 1999). Gertler further notes that "The idea is that, in a competitive era in which success depends increasingly upon the ability to produce new or improved products and processes, tacit knowledge constitutes the most important basis for innovation-based value creation" (Gertler 2003, p. 79). Cowan et al further notes, tacit knowledge exists in value chains between different stakeholders (Cowan et al 1999). The other form of knowledge is codified knowledge (Cowan et al

1999, Johnson et al 2002). Codified knowledge is knowledge that exists in a conventional way and is shareable (Jensen et al 2007).

Tacit knowledge and codified knowledge are complimented by modes of innovations, that is Science, Technology and Innovation (STI) mode which premises on the production and use of scientific and technical knowledge, and another mode is Doing, Using and Interacting (DUI) mode which premises on the experienced -based mode of learning (Jensen et al 2007, Fitjar et al 2011).

According to Jensen et al, the STI-mode innovation refers to the manner in which firms acquire, assimilate and exploit the scientific based knowledge or understanding in the context of their innovative activities (Jensen et al 2007). This view is echoed by Isaksen et al who observed that, the STI mode is more premised on scientific learning, research and development (R&D) activities where much of the innovation activities takes place through collaborations with research intensive firms, and universities and research institutes, with an objective for producing radical innovations. (Isaksen et al 2013). The STI mode is associated to codified knowledge that is, know-why and know-what form of knowledge (Fitjar et 2011, Johnson et al 2002).

On the other hand, DUI-mode is crucial for innovation and the learning in this mode is premised from experiences and competences acquired during job execution by the workforce, tailored for problem solving and meeting new challenges (Jensen et al, 2007, Isaksen et al 2013). Jensen further notes that, DUI mode knowledge, regardless of the extent for codification, the mode is acquired during task execution as the workforce are faced by on-going changes that confronts them with new evolving problems (Jensen et al, 2007). On the contrary to the STI-mode, DUI-mode of learning resonates to tacit knowledge that is, know-how and know-who (Jensen et al, 2007, Fitjar et al 2011). And Fitjar et al, noted that, "the DUI-mode of innovation, by contrast, tends to rely on 'know-how' and 'know who' types of knowledge. These are types of knowledge which are obtained through repeated, mainly informal, interaction. Imitation and learning by doing are the main sources of 'know-how' "(Fitjar et al, 2011, p. 130). Therefore, learning is the crucial element both in practice and value for acquiring knowledge that can foster sustainability-oriented innovation. At this juncture, the learning will be cross examined with the three pillars of the sustainability-oriented innovation model, in the following sub-

paragraphs.

Operational Optimization. Learning or producing and sharing knowledge at the operational optimization involves the firm's absorptive capability to recognize, assimilate and exploit the knowledge in order to maximize innovation (Cohen & Levinthal, 1990). According to Cohen & Levinthal, absorptive capacity is defined as "knowledge confers an ability to recognize the value of new information, assimilate it, and apply it to commercial ends collectively"(Cohen & Levinthal, 1990, p. 128). Absorptive capacity is based on the incremental premise that the organization need prior related knowledge to assimilate and use new knowledge (Cohen & Levinthal, 1990). Fagerberg et al notes synthetic knowledge base for enhancing innovation at the industrial setting through the application or novel combination of existing knowledge to address specific problems emanating from client and supplier's interaction (Fagerberg et al 2005). According to Adams et al, external employment of sustainability tools and external knowledge are critical operational optimization since a dearth of knowledge within the firm (Adams et al, 2016).

Organizational transformation. An explicit cross examination of learning at organizational transformer can be envisaged by examining the firm's dynamic capabilities. Teece et al defined dynamic capability as "the firm's ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments" (Teece et al, 1997, p. 516). And Iakovleva et al observes that, "these dynamic capabilities is to strengthen the firm's extant resource base and transform it in such a way that a new configuration of resources is created so the firm can sustain or enhance its competitive advantage" (Iakovleva et al, 2015, p. 225). According to Adams et al, under the auspice of organizational, leadership and of the external knowledge on the internal and external is imperative for a making the SOI model successful (Adams et al, 2016).

Systems Building. Learning innovative activities at systems change involves wider strategic collaborations and partnerships that can enhance organizational learning by maximizing external knowledge within the firm" (Teece et al 1997). Novel Collaborations within the nexus of industry, academia and society will enhance national systems of innovation, which will cascade into local regional innovation systems in addressing sustainability through knowledge acquisition (Adams et al, 2016).

2.5.1.4 Linkages

Linkages activities of the SOI model involves a critical analysis of the firm's value chain towards building a sustainable innovative organization. This view is echoed by Nidumolu et al that, "companies develop sustainable operations by analyzing each link in the value chain…first they make changes in obvious areas, such as supply chains, and then they move to less obvious suspects, such as returned products" (Nidumolu & Rangaswami 2009, p. 4). And Tidd & Bessant observed that, building cross-function linkages across boundaries internal to the organization and external with other players plays involving suppliers, sources of investment, customers, skilled resources and of knowledge plays a key role in maximizing the firm's innovation process (Tidd & Bessant, 2014).

Therefore, the creation of value within the firm's capabilities and the external linkages with other players creates a value chain and the value chain captures the value through economic, social and environment measures. While value is captured in many forms, economic value is quoted with a high frequency as the most prominent form of captured value, which overrides at the firm' social value and environmental value (Brown, 1984). Philosophically, Brown defined value as "an enduring conception of the preferable which influences choice and action" (Brown, 1984, p. 232). And in that line of thought, Tidd & Bessant defined value as, product or service that is useful and valuable (Tidd & Bessant, 2014). Therefore, creating and capturing value is manifest through the establishment of value chains or linkages internal and external through business model innovation (Yang et al, 2017). Yang et al further noted that, "building business models focused on sustainability requires companies to link resources and outcomes across multiple stakeholders" (Yang et al, 2017, p. 32). With that entrée to linkages activities for the final SOI model, a cross examination of linkages in tandem to the three building blocks of the final SOI will be presented below.

Operational Optimization. Linkages activities at the operational optimization is premised on the transfer of knowledge through the application of analytical knowledge base within the firm. Analytical knowledge base is premised on the importance of scientific knowledge and where formal models, codified science and rational processes creates a rapport for knowledge creation (Fagerberg et al, 2005). And Fagerberg further notes that with analytical knowledge base, "university-industry links and

networks are thus important, and this type of interaction is more frequent than in synthetic type of knowledge base" (Fagerberg et al 2005, p. 29). According to Adams et al , operational optimization linkages in this context is cross-functional knowledge build up that can influence the changes prerequisite for compliance for regulation and legislation and this knowledge is non-existence in the firm as regards to the application of tools for sustainability and therefore, external knowledge expertise is required to navigate and implement these sustainability tools within the firm (Adams et al 2016).

Organizational Transformation. In the similar view of addressing sustainability at the organizational transformation, Fagerberg et al notes that, "the innovation process for industries with synthetic knowledge base tends to be oriented towards the efficiency and reliability of new solutions, or the practical utility and user-friendliness of products from the perspective of customers" (Fagerberg et al, 2005, p. 295-296). According to Adams et al linkages at the organizational transformation pillar involves establishing new networks into their wider value chains and stakeholder networks focusing on supply chains, to establish collaborations with external partners that are long-term (Adams et al 2016). Adams et al further notes that, establishing networks invokes a paradigm shift from internal activities to engaging the firm's immediate stakeholders, exploring new opportunities through strategic alliances with stakeholders and developing sustainable supply chains (Adams et al, 2016).

The precursor for a firm to establish concrete networks with multiple players in the value chain especially a focus on the supply chain involves an open innovation approach that culminates into creative relationships (Tidd & Bessant). Chesbrough credited for coining the term open innovation noted that, open innovation will enhance more extensive, more collaborative pool of stakeholders involving suppliers, partners, customers, third parties and the general community at large (Chesbrough, 2012). And Nidumolu et al observed that the application of tools such as enterprise carbon management, carbon and energy footprint analysis, and life-cycle assessment help companies identify the sources of waste in supply chain (Nidumolu & Rangaswami 2009, p. 4-5). Nidumolu et al particularly identified life-cycle assessment tools as integral as it captures the environment related inputs and output of the entire value chain, from raw materials supply through product use and return (Nidumolu & Rangaswami 2009, p. 4-5).

Systems Building. Systems building can be envisaged at a multi-level perspective through the formulation of systems of innovation that is, global, regional and national systems of innovations (Fagerberg et al 2005). They not only focus internally, but also look to lead and inspire change in the wider societal, economic, technical and environmental management systems through strong and visionary leadership and the mobilization of dynamic capabilities. And Adams et al notes that, systems building is a precursor for creating an industrial ecosystem involving collaboration and interactions of multiple stakeholders working on shared net positive value for solutions (Adams et al, 2016). This view of the firm collaborative capacity is noted by Nidumolu et al that , "unless companies form alliances with other businesses, nongovernmental organizations, and governments ..success often depends on executives' ability to create new mechanisms for developing products, distributing them, and sharing revenues" (Nidumolu & Rangaswami 2009, p. 10).

2.5.1.5 Organizational Design

Organizational design is used in place innovative organization as theorized by Adams et al 2016. Organizational design involves activities can be analyzed through the lens of several factors involving; appropriate structure, creative climate, external focus, effective team working, shared vision, leadership, and, change and adaptation (Hersey et al, 2013, Tidd & Bessant, 2014). Another key outlook of organizational design is the analysis of its dynamic capabilities which involves the firm's recognition, assimilation and exploitation of its absorptive capability, adaptive capability and innovation capability (Teece et al, 1997, Cohen & Levinthal,1990, Iakovleva et al 2012). While absorptive and adaptive capabilities are important to the organization of innovation external to the firm, the firms innovative capability, defined as "the ability to continuously transform knowledge and ideas into new products, processes and systems for the benefit of the firm and its stakeholders" (Iakovleva et al 2012, p. 224) is crucial to the survival of the organization.

Operational Optimization. Mobilizing and exploiting existing innovation capabilities is a panacea for operational optimization for an innovative organization (Adams et al 2016). This view is also claimed by Iakovleva et al that "companies must develop absorptive capabilities in the process of familiarizing potential customers with the product idea, preparing the market by building firms' legitimacy, increasing the visibility of the business, and building relationships with potential customers and suppliers"

(Iakovleva et al 2012, p. 227). Adams et al notes that, innovation activities built on the firm's absorptive capabilities enhances increased sustainability at the firm level (Adams et al, 2016). Furthermore, Adams et al noted that firms' approach of environmental management practices compensates in terms of operational optimization but there is dearth vivid application of sustainability mindset that requires a radical shift from business as usual to sustainable innovation (Adams et al, 2016). Iakovleva et al further noted that, noted "higher absorptive capacity can promote innovation within a firm in addition to recognizing the commercial potential of innovations (Iakovleva et al 2012, p. 227). Organizational design innovative activities at the organizational transformation involves strategy, leadership and communication key proxies an innovative organization (Adams et al, 2016, Hersey et al 2013). Furthermore, Organizational design at the systems change pillar of the SOI involves new business philosophies with a shared positive value (Adams et al 2016).

3 Chapter 3: METHODOLOGY AND RESEARCH DESIGN

3.1 Introduction

The methodological approach in scientific research has been contested since time immemorial in the scientific community especially during the scientific revolution. The scientific rebuttals during the scientific revolution is evidenced in from the system of planetary motion by Copernican, thought experiment by Galileo Galileo through to Newton´s laws of physics, at this apex of the scientific revolution, methodological innovations in new scientific reasoning was highly questioned (Bortolotti, 2008).

The aim and purpose of the thesis to corroborate the philosophical assumptions of the thesis research process by analyzing the ontological and epistemological assumptions of the phenomena. "Ontological tradition according to Blaikie is concerned with establishing a set of concepts that identifies the basic features of the social world, and that are essential for understanding societies, major social institutions or small-scale social institutions" (Blaikie, 2010, p. 113). Blaikie further noted that, ontological assumptions study the nature of social reality (Blaikie, 2010). The premise on the ontological assumptions is connecting the dots in the social phenomenon and establishment of a relative group in the fabric of society (Blaikie 2010). Epistemology on the other hand is an addendum to the ontological assumptions on the premise of knowledge foundation on the ontological assumption. They are various types of ontological assumptions: idealist, depth realist and conceptual realist to mention a few. The scope aim and purpose of this thesis resonates with the ontological assumptions which includes; critical theory, social realism, ethnomethodology, structuration theory, and feminism (Blaikie 2010). Therefore, the thesis resonates with the interpretivist ontology, where social reality is a proxy and product in the social setting, that an interpretation of a social phenomenon is produced and reproduced by participants as part of the fabric of the everyday activities together (Blaikie, 2010).

With that background, this chapter of the thesis will explore the methodological and philosophical approach of the research process. Firstly, analyzing in sub-section 3.1.1 the philosophical assumptions of epistemological and ontological for this research thesis. And secondly, by unveiling of the

methodological approaches used for the selection of the research approach in sub-section 3.1.1, research design and strategy 3.1.2, qualitative approach in sub-section 3.1.3, data collection techniques in sub-section 3.1.4, presentation of data analysis in sub-section 3.1.5, sub-section 3.1.6 limitation of the methodological approaches and a brief summary will be presented in sub-section 3.1.7.

3.1.1 PHILOSOPHICAL ASSUMPTIONS

The two mainstream philosophical paradigms in research studies are manifest in positivist and interpretivist approaches, under the auspice of epistemological and ontological assumptions respectively. According to Willis et al, "the fundamental assumptions of positivism is that the use of scientific method is the primary or only way of discovering truths about the world" (Willis et al 2007, p. 33). While it is noted that "interpretivist is the term given to research in the hermeneutic tradition which seeks to uncover meaning and understand the deeper implications revealed in data about people. Interpretivist is a broad category which encompasses a wide range of research approaches including ethnography and case study" (Somekh & Lewin, 2005, p, 346). On the other hand, interpretivist encompasses several more specific and focused movement such as critical theory, ethnomethodology, social realism as a rebuttal to the positivist and empiricism paradigms (Willis et al, 2007, Blaikie 2008). Willis et al further noted that, interpretivism is premised on the ideology that is against an iterative approach to the applicability of research methods and paradigms in social sciences for natural sciences (Willis et al, 2007). Blaikie notes that, "in interpretivism, social reality is regarded as a product of its inhabitants; it is a world that is interpreted by the meanings participants produce and reproduce as a necessary part of their everyday activities together "(Blaikie, 2010, p. 99). Therefore, the philosophical assumptive paradigm of this thesis adopts the interpretivist paradigm as a cornerstone philosophy of science in the research process.

The aim and purpose of this thesis is to map Aker Solutions innovative activities in the SOI model by analyzing the innovative activities of the operational optimization, organization transformation and systems building. This forms the basis for the theoretical framework of the study and therefore it is imperative to identify with the research design, which includes deductive research design, inductive

research design, retroductive research design and abductive research design (Brotherton, 2008, Kovacs 2014). The thesis aligns with the interpretivist assumptions which is exclusively qualitative and the application of abductive research design, as a result of the interaction on the concept of sustainability and innovation in tandem sustainability-oriented innovation as a grounded theoretical framework and the empirical data. According to Kovacs et al, "abductive reasoning emphasizes the search for suitable theories to an empirical observation, call "theory matching", or "systematic combining" (Kovacs et al 2014, p. 138). This is what the thesis seeks to achieve by mapping and matching of the theoretical framework of the sustainability-oriented innovation (SOI) and the real empirical data through observation, document review, semi-structured and unstructured interviews in Aker Solutions innovative activities.

The research process through the application of abductive research design will add to the theory development, as Kovacs et al observed a scarcity of application of the research design in supply chain research studies. However, the research process approach in Kovacs 'abductive reasoning in logistics research' article reflects the value chain research focus approach for this thesis (Kovacs et al 2007). Logistics is part and parcel of the supply chain in Aker Solutions value chain. Another example of the application of abductive research design that resonates to this thesis theoretical framework is applied by Ghassim thesis on 'embracing stakeholders in sustainability-oriented innovation', where he noted that "cross-referencing between theory and empirical data is abductively designed to address the research issues (Ghassim, 2018). In conclusion , the framework for the adoption of this research design approach is principally its philosophical standpoint that is interpretivist and its aim to develop an understanding of a "new" social phenomenon and theory development that is , from the empirical observation of the sustainability-oriented innovation theoretical framework through to the in-depth inquiry or discourse analysis of the activities in Aker Solutions value chain with the objective of gaining an understanding of the social phenomenon (Adams et al, 2016). And echoing Kovacs et al abductive approach is drawn "abductively suggesting hypothesis/prepositions i.e. at developing new theory" (Kovács et al ,2014:140). In the following sub-section 3.2, will address the research design and strategy for the thesis.

3.1.2 RESEARCH DESIGN AND STRATEGY

The interpretivist philosophical assumption point of departure for the thesis, is a precursor for the research design and strategy that identifies with this thesis techniques for data collection and analysis, validity and liability in the research process to address the research questions for this thesis (Creswell, 2014). Quantitative and Qualitative are the two mainstream research approaches and the precursor for data collection and analysis, reduction, ethical considerations and final findings in the research process (Silverman, 2000, Punch, 1998, Blaikie 2010, Creswell, 2014).

According to Creswell, qualitative approach is "one in which the inquirer often makes knowledge claims based primarily on constructivist perspectives (i.e., the multiple meanings of individual experiences, meanings socially and historically constructed. with an intent of developing a theory or pattern) or advocacy/participatory perspectives (i.e., political, issue-oriented, collaborative. or change oriented) or both" (Creswell, 2014, p. 18). Blaikie notes the contrast between the two approaches that is, quantitative is premised on quantification of statistical aspect of social life, while qualitative is premised on empirical aspects of social life, where social actors meaning and interpretation is key and both of the approaches have shortfalls (Blaikie, 2010).

Therefore, this thesis research process identifies with the qualitative approach, which is based on the ontological interpretative or phenomenological metaphysical assumption which asserts on the belief that, " the real world , and the phenomena and events that occur in this world , are created by the subjective thoughts, actions and interactions of people who inhabit it" (Brotherton, 2008, p. 36). The argument therefore to apply the qualitative approach is strong for addressing the research questions for this thesis based on the afore-mentioned philosophical assumptions and methodology of collecting data and analyzing data through theory matching of Aker Solutions innovative activities in the SOI theoretical framework (Adams et al, 2016). The detailed description of the qualitative approach is explored further in the following sub-sub-section 3.1.3 as an entrée to the thesis research process of data collection and analysis.

3.1.3 Qualitative Research Approach

The thesis research approach identifies with qualitative exploratory single case study, Aker Solutions as a unit of analysis (Silverman, 2010, Brotherton 2008, Punch 1998). According to Neuman, exploratory research is "premised on the purpose to examine a little understood issue or phenomena and to develop preliminary ideas about it and move towards refined questions" (Neuman 2014, p. 38). The concept of sustainability-oriented innovation (SOI) as the theme for this thesis is less explored or is explored implicitly in Adams et al framework-synthetic approach and methodological contribution is the precursor to the theory development of this concept (Adams et al 2018, Tidd & Bessant, 2014, Ghassim 2018). Exploratory studies address the 'what' research questions (Neuman, 2014, Yin, 2003) and this thesis framing of the 'what' research question is '*what drives sustainability-oriented innovative solutions for carbon emissions in Aker Solutions*? The generic definition of a case study from Yin is twofold, that, "an empirical inquiry that investigates a contemporary phenomenon (the "case") in depth and within its real-world context, especially when the between phenomenon and context may not be clearly evident" (Yin, 2014, p. 16). This research identifies with a case study research, where Aker Solutions is the unit of analysis. However, the research thesis identifies Aker Solutions as a single-unit analysis which resonates a single-case study, in which Yin asserts that, single-case study is premised on the optimum test of a significant theory (Yin, 2014, Brotherton, 2008).

Qualitative research approach is the rival research approach to quantitative approach and as such, it premises on the approach in collecting and analyzing data is distinct from quantitative approach, however, both approaches are subject to criticism (Silverman, 2010). According to Blaikie, the basic premise in qualitative study is technical language of the researcher, where data is produced and reproduced by both the researcher and social actors (Blaikie, 2010). Blaikie further notes that, "languages are used to describe behaviors, social relationships, social processes, social situations, and in particular the meanings people give to their activities, the activities of others, and to objects and social contexts" (Blaikie 2010, p. 204).

Furthermore, Silverman notes that, we should not assume the techniques used for quantitative research which is largely based on the use of numbers which cumulatively results in statistical data, however, the basic premise for qualitative research is expressed in form of words techniques as a key technique for

collecting data and analyzing data (Silverman , 2010, Neuman , 2014, Yin 2003). Therefore , the qualitative approach is pertinent to the data collection technique for this thesis , in that, it offers in-depth empirical data on the sustainability-oriented innovation model in Aker Solutions which will culminate into high corroboration of the theory contrary to quantitative high logical probability , and qualitative guarantees a high credibility , validity and liability of the social phenomenon (Lincoln & Guba, 1985, Neuman , 2014). The adoption of this research approach in this thesis is validated by the argument by Shaw in his study on 'guide to the qualitative research process: evidence from a small firm study', small firms as a unit of analysis, which resonates with the thesis unit of analysis Aker Solutions which is a large firm (Shaw 1999). Bygrave (1989) cited in Shaw 1999 observed that "emphasis in an emerging paradigm should be on empirical observations with exploratory, or preferably grounded research, rather than testing hypotheses deduced from flimsy terms" (Shaw, 1999, p. 60). This view by Bygrave resonates with this thesis research approach on the emergent paradigm on sustainability-oriented innovation (SOI) and the following section will explore the data collection techniques in sub-section 3.3 by first analyzing the selection techniques of the respondents, and the subsequent selection criterion of respondents. A detailed discuss will envelope further on data collection.

3.1.4 Data Collection

The methodological background and the adoption of qualitative research approach in this research process provides background to the form of data collection and analysis, which posits this thesis qualitative data based on empirical evidence. Therefore, a thorough process of analyzing the instruments and tools for collecting empirical data through interviews, document review, observation and internal online platforms (intranet) searches on the phenomenon were utilized. The technique for collecting data through interview was the key to this thesis, which presented the major primary source of data collection for this thesis. Therefore, based on the interview questions guide, a semi-structured interview was constructed presented in *annexure x*, which involved a cross-sectional structure of the five building blocks of the sustainability-oriented innovation (SOI) model innovative activities, that is, strategy, process, learning, linkages and organizational design, in tandem with the interview question as a point of departure . The innovative activities of the SOI model were cross-examined to the three pillars of

the sustainability-oriented innovation (SOI) model, including operational optimization, organizational transformation and systems building, the procedure for collecting empirical data through interviews commenced.

The respondents for the interview represented functional key respondents anonymized and acronymized as (FKR). The overall sample size in *table 1* for the respondents was seven in total, which included Vice President Carbon Capture and Storage, Vice-President Strategy, three Senior Managers from Supply Chain, Research & Innovation, Global Projects and two seniors Engineer Products and Design. In total 4 semi-structured interviews and three unstructured interviews was conducted. The checked box in *table 1* represents the addressed interview questions and the blank space representing no response was given. Data collection for the interview was collected via the transcription of the audio recorded interviews and all respondents were selected purposefully (Creswell et al 2013) where their functional duties resonated or was in close proximity to the SOI innovative activities under study for this thesis. The data collection via face to face interviews lasted between 45 minutes to 1 hour with all functional key respondents and produced 32 pages of interview transcripts.

TITLE	STRATEGY	PROCESS	LEARNING	LINKAGES	ORG DESIGN
Vice-President, CCUS	✓		✓		
Vice-President, Strategy	✓	✓	✓	✓	✓
Senior Manager, R& I	✓	✓	✓	✓	✓
Senior Manager, Supply Chain	✓	✓	✓	✓	✓
Project Manager,		✓		✓	
Senior Engineer,	✓	✓	✓	✓	
Senior Engineer,	✓	✓			

Table 1.Presentation of Functional Key Respondents for the Interview.

While other data sources such as internal document review such annual corporate social responsibility reports, PowerPoints, procedures, observation, open source online data platforms both internal and external qualified as secondary data for this qualitative thesis research. The following subsections highlights the data collection techniques through interview process prior to the data analysis.

3.1.4.1 Interview Precondition

According to Robson, "collecting data is about using the selected methods of investigation. Doing it properly means using these methods in a systematic, professional manner" (Robson, 2003, p. 385). In the buildup prior to the interview, a checklist was systematized containing preconditions for carrying out an interview. The pre-interview checklist included the following; ensuring compliance to the legal requirement for conducting scientific research through the Norwegian Center for Research Data acronymized as NSD, this process provides legal guidance for researcher in Norway throughout the research process to research ethics.

The second precondition involved creating an interview guide protocol in tandem to the interview questions, that helped to record time, data, place, function of the respondents. The third interview precondition, interview requests were sent via email to functional key respondents (FKR) for each building block innovative activities of the SOI model. In this request, information letter highlighting the legal rights and privileges of the respondents and consent form, acknowledging participation in this research process were attached. Fourth interview precondition involved inviting respondents via email meeting invites on Microsoft 365 office application, with date, time and place indicated. These interview preconditions guidelines are reflected in McNamara (2009) cited in Turner (2010, Josselson, 2013) on the eight to the preparation stage of conducting an interviewing (Turner, 2010). Confirmation and consent of participation from respondents was in principle by accepting the meeting invite for the interview.

3.1.4.2 The Interview

According to Punch, "the interview is one of the main data collection tools in qualitative research. It is a good way of accessing people's perceptions, meanings, definitions of situations and construction of

reality" (Punch, 1998, p. 174). The interview for this thesis, was guided by the NSD legal requirements with supporting documents, information letter, consent form and interview protocol guide. Interviews manifest in many forms, that is structured interviews, group interviews, focus group and unstructured interviews mainly via face to face and technological tools via telephone and videoconferencing (Punch, 1998, Brotherton, 2008). This thesis identifies with the structured interview form which is highly standardized and focused in addressing the research questions and the thesis scope, aims and purpose. The question format for a structured interview is based on open-ended questions, which allowed respondents to give a narrative account of the research issues, this approach avoided affirmative answers from respondents.

The interview protocol that followed during the interview involved the following formalities between the researcher and the respondent: Giving a vote of thanks to the respondent for taking the time and efforts to participate in the interview process. Secondly, a brief introduction via visual presentation of the time frame, theme, problem, research issues, scope, aims, purpose of study was presented to the respondent. Thirdly, the researcher presented the legal framework of the respondents that included confidentiality, anonymity and protection of any personal data and the manner of how the results would be reported. Fourthly, the researcher asked for permission to audio-record the interview for notetaking ensuring quality and clarity of the responses and assured the participant that all information collected will be deleted after the research delivery. The interviewer concluded by thanking the respondents.

The following *section 3.2* will describe the data analysis procedure during this thesis research process. Data analysis builds on the backdrop of the methodological framework & ontological assumptions , research approaches, data collection techniques through analyzing the thematic framework as a major data analysis tool , indexing through keyword concept framing, charting of Aker Solutions innovative activities with sustainability-oriented innovative activities , mapping and interpretation of Aker Solutions innovative activities that is strategy, process, learning , linkages, organizational design and sustainability (Ritchie & Spencer, 1994).

3.2 DATA ANALYSIS

According to Blaikie & Priest, generated data from different data collection methodologies requires reduction (Blaikie & Priest, 2019). The preamble for data analysis for this thesis was based on data reduction from the collected empirical data from the interview process. Punch noted that, data reduction occurs in tandem and is intertwined in the analysis process from the start to the end of the research process and at this stage of the thesis data reduction will involve coding and memoing, and findings themes, clusters and patterns that resonates or addresses the research questions, (Punch, 1998, Blaikie, 2010). According to Blaikie, the data reduction transforms qualitative data into quantitative data by coding, or re-coding mechanism to quantify into numerical data for different categories (Blaikie, 2010). To attain that goal for this thesis, framework analysis conceptualized by Ritchie and Spencer's (1994) was applied as a tool for analyzing data (Rich & Spencer, 1994, Srivastava & Thomson, 2009). Srivastava & Thomson noted that, "framework analysis is flexible during the analysis process in that it allows the user to either collect all the data and then analyze it or do data analysis during the collection process" (Srivastava & Thomson, 2009, p. 75).

Therefore, the thesis data analysis identified with framework analysis concept by Ritchie & Spencer (1994) guidelines in sifting, charting, and sorting data to correspond to key issues and themes of qualitative data (Ritchie & Spencer, 1994, Srivastava & Thomson, 2009). Ritchie & Spencer (1994) cited in Srivastava & Thomson framework analysis involves 5 key steps; (1) familiarization; (2) identifying a thematic framework; (3) indexing; (4) charting and; (5) mapping and interpretation (Srivastava & Thomson, 2009, p. 75, Ritchie & Spencer, 1994, Bryman & Burgess, 1994) which will be described further in sub-sections below.

3.2.1 Familiarization

According to Srivastava & Thomson, "familiarization refers to the process during which the researcher becomes familiarized with the transcripts of the data collected (i.e. interview or focus group transcripts, observation or field notes) and gains an overview of the collected data" (Srivastava & Thomson, 2009, p. 75, Ritchie & Spencer, 1994). Therefore, the thesis reviewed data through listening to the recorded interviews in tandem with reading from the transcribed interviews. The process was an iterative process

to maintain quality and reliability of the transcribed interviews. Thereafter, a process of data reduction was initiated through identifying and capturing key themes and ideas that corresponded to the research issues by using a qualitative research tool that is Nvivo for analyzing qualitative data. Then data was sifted and sorted through a process of noding of key themes and concepts in Nvivo for each of the innovative activities that is strategy, process, learning, linkages, organizational design and including a node on sustainability. The noding process in Nvivo was directly linked to the research questions (interview questions) for the thesis. The nodes for the unstructured interviews was also created that included three of the seven functional key respondents.

3.2.2 Identifying the Thematic Framework

According to Ritchie et al, "the thematic framework is used to classify and organize data according to key themes, concepts and emergent categories" (Ritchie et al, 2003, p. 220). The theoretical background in *Chapter 2* provided a background for capturing the key themes and concepts to analyze the data thematically. The thesis extrapolated the key themes and concepts from the theoretical framework paired them to the data from the transcribed interviews through the Nvivo qualitative data analysis tool.

The thesis approach to analyse qualitative data through using Nvivo, a thematic network analysis was adopted to organize the thematic data for analysis (Corley& Gioia, 2004, Attride-Sterling, 2001). According to Attride-Sterling they observe that, "thematic analyses seek to unearth the themes salient in a text at different levels, and the thematic networks aim to facilitate the structuring and depictions of these themes" (Attride-Sterling, 2011, p. 387). The thematic networks was applied for this thesis and systematized the build up to the data immersion from the transcribed interviews through the noding process in Nvivo (Corley & Gioai, Attride-Sterling, 2001).

3.2.3 Indexing

Indexing or coding refers to "the process whereby the thematic framework or index is systematically applied to the data in its textual form" (Bryman & Burgess, 1994, P.180). The thesis extrapolated the key themes and concepts from the theoretical framework infused them to the transcribed interview to formulate indexes through the creation of nodes in Nvivo qualitative analysis tool that resonates to the

research issues of the thesis.

The data extraction from the noding process from the transcripts developed the lowest order corresponding to the key interview questions from the respondents, the first order codes (Essamri et al 2019, Attride-Sterling, 2001,); the first order concepts from final four key respondents on sustainability, strategy , process, learning, linkages and organization design nodes was extrapolated and reduced to the second order themes, which is a summarized abstract principle from the first order codes (Attride-Sterling , 2001, Corley & Gioai, 2004). Key themes emerged from the reduced first order codes to develop the second order themes that resonated with the respondent's views on the key nodes in tandem with the key semi-structured interview questions. Axial coding was enveloped to create the second order themes, which was an iterative process in pursuit of locating or placing the right reduction of the respondent's answers into an organized theme (Attride-Sterling 2001, Essamri et al 2019, Corley & Gioai, 2004). And finally, the second order themes were aggregated into a super-ordinate theme that coalesces a holistic discourse or global theme (Attride-Sterling, 2001,). The second order theme was finally reduced to final theme or aggregate dimension that captures a global theme (Attride-Sterling, 2001, Gioai & Corley, 2004). For each particular node which involved 5 nodes in total for the final four respondents for sustainability, strategy, process, learning, linkages and organization a thematic network analysis was developed to visualize the thematic process see visualization in the below figure.

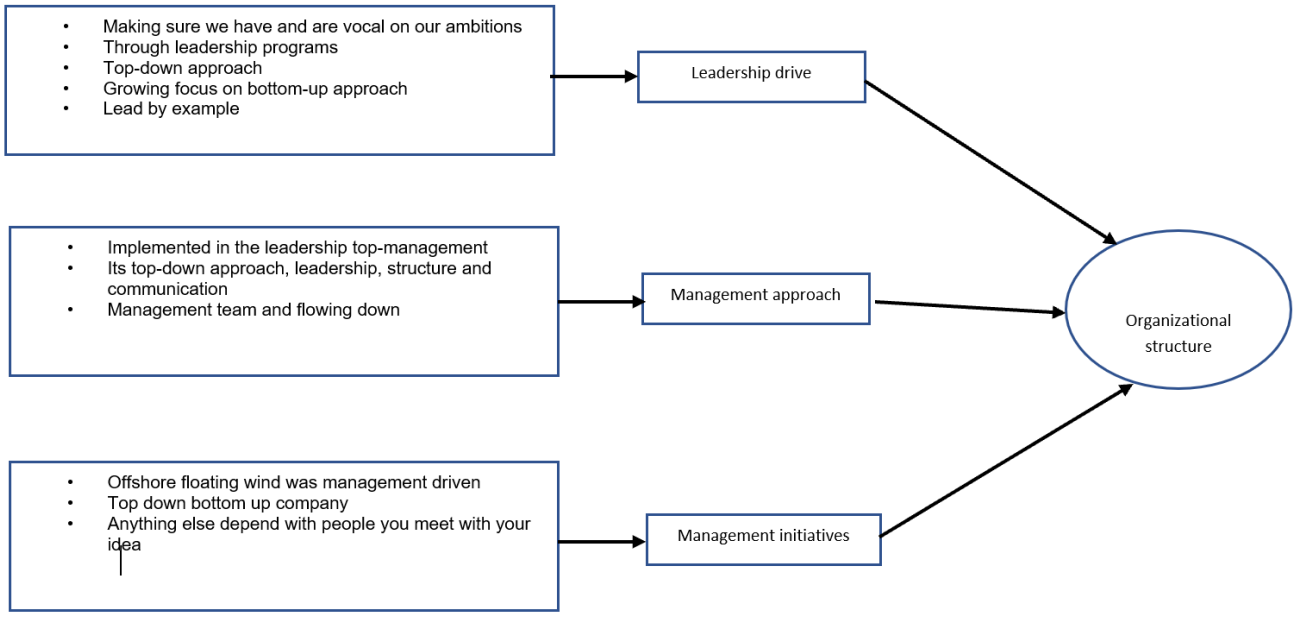

Figure 3.1. Thematic qualitative data analysis visualization (self-constructed)

Data analysis presentation and visualization of the coding or indexing process is presented in presented in Chapter four for each of the innovative activities that is strategy, process, learning, linkages and organization design in tandem with sustainability as a precursor for the overall theoretical framework.

3.2.4 Charting

According to Ritchie et al, charting refers to, "the process of synthesizing the original data and locating it within the thematic framework or matrix that has been developed" (Ritchie et al, 2003, p. 262). Charting was extensively used in analyzing data on each of the five innovative activities on the vertical column that is, strategy, process , learning , linkages and organizational design transcribed responses in the SOI three key pillars on the horizontal row, that is operational optimization, organizational transformation and systems building (Adams et al, 2016).

The data analysis using charts or tables were formatted in the following order; the vertical column presented the assigned respondent code, respondent functional domain and the building blocks of the SOI innovative activities that is strategy, process, learning, linkages and organizational design. And the horizontal row presented the corresponding three main pillars of the SOI model that is, operational

optimization, organizational transformation and systems building. The introduction of the activities theme was followed by the cherrypicked responses from the transcribed interviews and an overview of the results. Secondly, the data from the nodes in Nvivo was presented in a chart by marking x or checking the box on specific responses from the transcribed interviews from respondents in the vertical column on the three pillars of the SOI framework.

3.2.5 Mapping and interpretation

Mapping and interpretation is the final stage in the framework analysis conceptualized by Ritchie and Spencer (1994). This stage encapsulates the afore-mentioned stages where data is mobilized, sifted and sorted reflecting the key themes, and is mapped and interpreted in its entirely (Bryman & Burgess). According to Ritchie and Spencer, this stage involves "defining concepts, mapping range and nature of phenomena, creating typologies, finding associations, providing explanations, and developing strategies" (Ritchie and Spencer, 1994:186).

During the mapping process, the responses from the respondent were mapped into the SOI framework, describing the key defining concepts, mapping range and nature of phenomena, creating typologies, finding associations, providing explanations, developing strategies of building a sustainable business case with a focus on emissions reduction in Aker Solutions value chain. Each innovative activity in tandem with the key respondent data from the transcribed interviews in the SOI model was interpreted to provide a conclusive case.

The mapping and interpretation stage of the framework provided a template for addressing the research questions of the thesis and the key research findings. Addressing the research questions using this framework allowed the researcher to corroborate the theoretical and literature key concepts and themes into the SOI model for Aker Solutions.

3.2.6 VALIDITY AND RELIABILITY OF THE RESEARCH PROCESS

Validation of the research process is key for accrediting the quality, credibility, reliability, generalizability and confirmability of the thesis (Creswell, 2014, Silverman, 2010, Lincoln & Guba

1985, Neuman, 2014). Creswell noted that qualitative validity means "means that the researcher checks for the accuracy of the findings by employing certain procedures, while qualitative reliability indicates that the researcher's approach is consistent across different researchers and different projects" (Creswell, 2014, p. 251). Therefore, to maintain the quality of this research process for the thesis, an iterative research process was employed in figure 3.2 for analyzing data from its original form to application of thematic analysis and finally to interpreting the meaning of the second order themes against the aggregated dimensions.

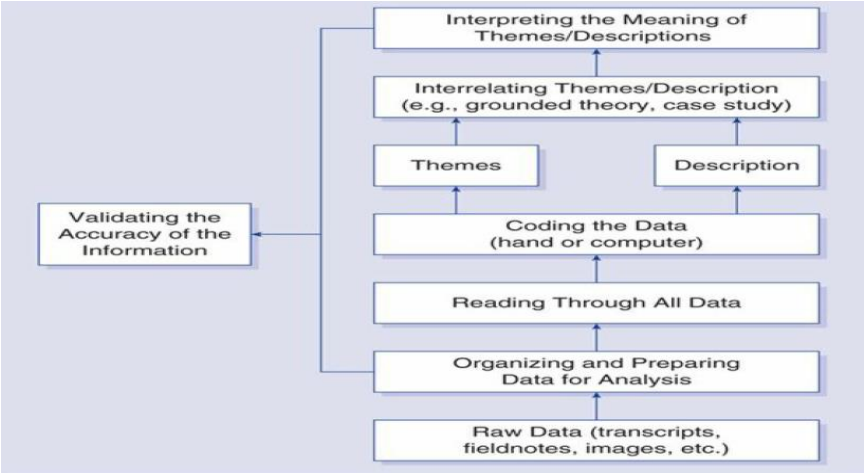

Figure 3.2. Overview of the data analysis process (Creswell, (2013, p. 246.

3.2.7 LIMITATIONS OF STUDY

The key limitations surrounding qualitative analysis involves the validity of the research approach through qualitative interviews. Silverman notes that, validity which also means truth can be compromised and can create biasness of the researcher forsaking to incorporate opposing views to the study (Silverman, 2000). Specifically, Silverman noted that qualitative analysis has two major problems that is, problem of reliability (Silverman 2000). Hammersley defined the problem of reliability as "the degree of consistency with which instances are assigned to the same category by different observers or by the same observer on different occasions" (Hammersley 1992, p. 67). And according to Silverman, the other problem of qualitative analysis in regard to validity involves anecdotalism which posits the research reports only appealing to a few due to lack of inclusion of other rebutting statement than the researchers in the report (Silverman, 2000).

The thesis limitation does not involve the two pitfalls prescribed by Silverman 2000, however due to a limited sample size, generalizability of the quality of the research will not be extrapolated for this study (Yin, 2003). Another pitfall involving this research was the data from the unstructured interviews did not yield due diligence because of the 'hawthorne effect' where participants did not follow the interview protocol due to limited time (Creswell, 2014). This resulted in three of the interviews into unstructured interviews and the data was scarcely utilized. Another pitfall to the study, there was no representation of key functional personnel from the learning domain of the innovative activities of the SOI. This limited the scope and in-depth knowledge from the learning domain point of view of the SOI model. The cost and time factor of face to face interview posed a challenge, that involved travel to conduct face to face interviews with the key functional respondents for the thesis. Lastly, the selection of the respondents through purposive selection questions rises biasness of the research process, that could alter the findings validity of the research process (Creswell, 2014, Silverman, 2010).

4 CHAPTER 4: DATA PRESENTATION AND RESULTS

4.1 Introduction

The previous chapter highlighted the research strategies and methodologies that included the philosophical assumptions of the research , data collection techniques and data analysis to address and corroborate the SOI framework and the key research issues central to this thesis that is; '*what drives sustainability-oriented innovative solutions for carbon emissions in Aker Solutions*? The methodological framework provides a structure for this chapter in enabling the research to present and interpret the data through visualization using word cloud frequency results in Nvivo and thematic analysis. Therefore, the Chapter unveils the analysis, interpret and presents data through thematic analysis for the key theoretical framework in the SOI model innovative activities that is strategy, process, learning, linkages and organization design. The presentation of data is based on the semi-structured interviews respondents and unstructured interview.

4.1.1 PROFILE OVERVIEW OF PARTICIPANTS

The thesis purposively selected 7 participants for the interview, which was conducted face to face. The aim and purpose for the selection was to collect data for each building block of the innovative activities of the sustainability-oriented innovation model that is; strategy, process, learning, linkages and organizational design. The participants functional domain in the unit of analysis for the thesis resonated to the innovative activities of the SOI model see *table 2* below and were coded as Functional Key Respondents FKR1 – FKR7.

FUNCTIONAL AREA	CODE	STRATEG	PROCESS	LEARNING	LINKAGES	ORG DESIGN
Senior Engineer, Products	FKR1		X			
Vice-President, Strategy	FKR2	X	X	X	X	X
Senior Manager, Supply Chain	FKR3				X	
Senior Manager, Research & Innovation	FKR4		X			
Vice-President, CCUS	FKR5				X	
Senior Manager, Global Projects	FKR6		X			
Senior Engineer, Design	FKR7		X			

Table 2. Functional Key Respondents cross-tabulation with the SOI innovative activities

Table 2 above indicates that, the functional key domain of the respondent's cross tabulation with the final SOI model innovative activities. The FKR2 and FKR5 in the *table 2* represented senior management and had the overall know-how, know-why, know-when and know-who of the firm and hence the presence in all five of the SOI innovative activities, as shown in *table 2.* The aim and purpose of this methodology in the selection of the participants is mainly for addressing the key research questions and corroborating the SOI model into the unit of analysis through confirmation of the theoretical framework.

4.2 PRESENTATION OF RESULTS

The presentation of the results in this section represents responses from 5 of the 13 key interview questions in tandem to the SOI innovative activities based on the theoretical framework for this thesis. Therefore, the presentation of the results reflects on the following key interview questions;

- *Please describe Aker Solutions strategy in addressing carbon emissions and usage of resources for reducing waste. This question represents the strategic activity of the SOI model*.

- *Please can you provide some examples of innovative solutions for aims to reduce carbon emissions or reduce waste. This question represents the process activity of the innovative of the SOI model.*
- *Please describe how you learn. This question represents the learning activity of the SOI model.*
- *Does Aker Solutions build collaboration with external stakeholders to mitigate emissions or reduce waste and usage of resources? This question represents the linkages activity of the SOI model, focusing on the overall supply chain and value chain.*
- *How does the Organization structure enhance innovative solutions for mitigating carbon emissions in the value chain? This question represents the organizational innovation activity of the SOI model.*

The structure of the presentation of the results corresponded with the five final interview question order using the thematic analysis. Each of the five innovative activities of the SOI model was visualized in Nvivo qualitative analysis software using word cloud frequency query results as a point of departure for the presentation of the data.

4.2.1 Strategy

The strategic pillar of the innovative activities of the SOI model represented the overall scope of the unit of analysis, as it transcended on all other innovative activities of the SOI model in the research process. The key question that was addressed under the strategy pillar of the SOI model was; *Please describe Aker Solutions strategy in addressing carbon emissions and usage of resources for reducing waste.* And the *figure 4.1* below using Nvivo illustrates the word frequency query results of key themes from the respondents on describing the strategic approach in addressing carbon emissions and usage of resources for reducing waste.

Figure 4.1. Functional Key Respondents word frequency query results for strategy

The word cloud frequency query results on strategy in the above *figure 4.1* indicates that a high word frequency key themes from the respondents are extrapolated from Nvivo corresponding to the interview question under strategy. The aim and purpose of using the word cloud frequency query was to attest the second-order themes results. For example, themes on carbon solutions as illustrated in the above *figure 4.1* are reflected by the functional key respondent in the following verbatim;

> *"We focus on low carbon solutions, system solutions that shall take out carbon dioxide out of the energy production, so we get as low footprint per produced barrel." FKR2*

The thesis thematic data analysis using a thematic framework produced a data structure which also addressed the strategy research questions for corroboration in the SOI framework strategy activities. The results by thematic analysis identified key themes and concepts using the first order concepts, second order themes and the aggregated dimensions (Corley & Gioia, 2004, Essamri et al 2019) and

this is illustrated in the following results in *figure 4.2*.

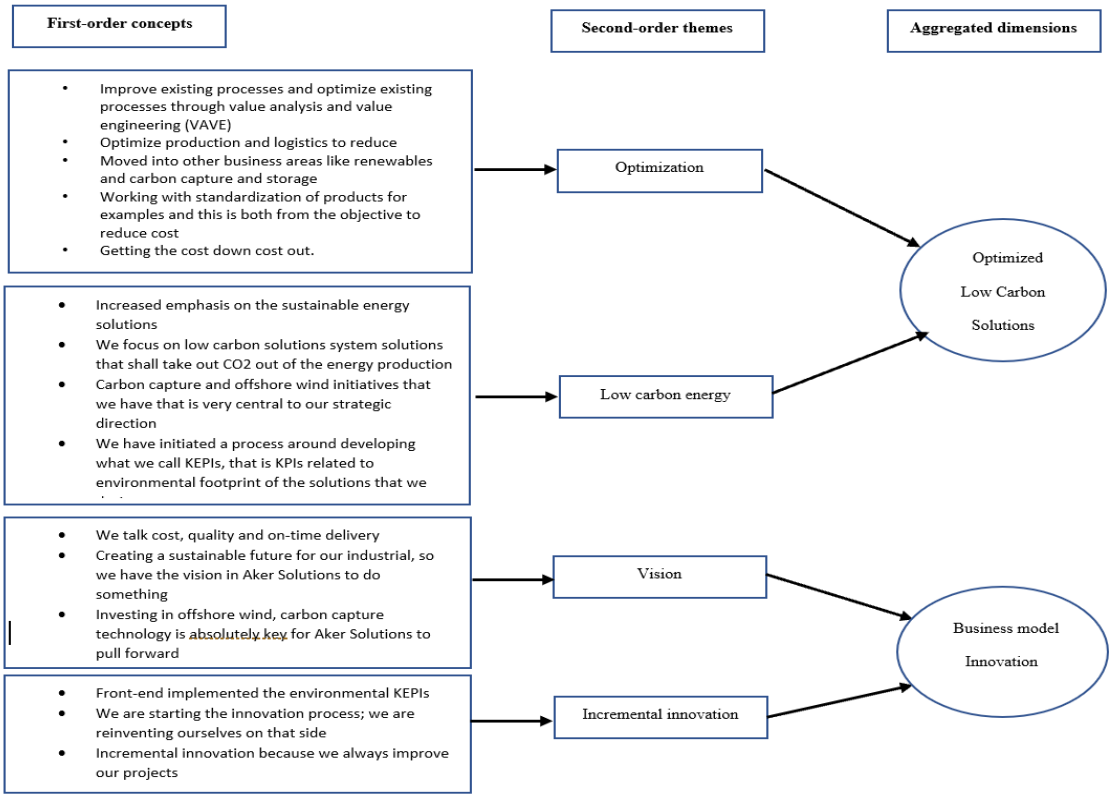

Figure 4.2. Thematic analysis for strategy in Aker Solutions (self-constructed).

4.2.1.1 Optimized Low Carbon Solutions

The results for the thematic analysis in *figure 4.2* on strategy in addressing carbon emissions and usage of resources identified optimized low carbon solutions as a major aggregated dimension. The key sub-themes under the optimized low carbon solutions is optimization and low carbon energy as the sub-themes.

Optimization

Optimizing systems and low carbon energy solutions is the foci in addressing carbon emissions and usage of resources in the firm noted in this thesis. It is a key strategic approach through incremental improvements and standardization of process and products in the firm's operational activities. As noted by the functional key respondents and document review;

"We are trying to look at existing processes and see how we can improve existing processes and optimize existing processes through value analysis and value engineering (VAVE) and we are looking into in a way optimize production and logistics to reduce emissions." FKR1

"Because we are working at taking out waste from the value chain. That we look at our products and solutions to do to optimize them for how we produce. And that we optimize your platform with regards to the steel footprint and cost." FKR2

"*Aker Solutions continued its focus on waste reduction and material optimization. Several locations replaced single use plastic cutlery, cups and food trays and wrapping with biodegradable alternatives. Measures to reuse wood packaging for product transportation and scrap metal for minor repairs further decreased the environmental impact.*" (Aker Solutions SR Report, 2018, p. 28)

Low carbon energy

The firm as a major player in the energy industry, low carbon energy solutions is key to the strategic direction in addressing carbon emissions in the energy supply chain. Focusing on low carbon energy solutions in the energy supply chain, the unit of analysis has ventured into carbon capture and storage in the niche market to capture carbon emissions from the energy production systems and the unit of analysis also has invested in renewable energy through offshore floating wind to address low carbon solutions in the value chain. Some of the key respondents observed that;

"This is very much related to our daily business, that we should develop solutions and technologies that meets the future requirements. And that environmental footprint is very important it's not only carbon but use of materials for example and chemicals is also important , energy but CCS is an important part of this and if you look at Aker Solutions today, there are few green activities that is floating wind and the other one is CCS" FKR5

"*sustainable energy solutions is the alignment of renewables but it's also making the industries that we are in sustainable. So, that's decarbonization and low carbon solutions, helping our clients to realize their energy production in a more sustainable way*" FKR2

4.2.1.2 Business model innovation

The thematic analysis under strategy in *figure 4.2* above also indicates a shift towards new low carbon business innovation. This is reflected through the incremental shift into low carbon business opportunities that is strategic investments in renewable energy solutions and carbon capture and storage to address carbon emissions in the value chain. The sub-themes under the auspice of business innovation is the trigger in unit of analysis vision and through incremental innovation.

Vision

The unit of analysis vision has been calibrated after a document review of its previous social responsibility report from period 2009 to 2018. The new vision captures sustainable energy in the energy supply chain and at large serving the needs of the world (Aker Solutions *SR Report, 2018*). This is also noted by the key respondents that:

> "*I would definitely see what Aker Solutions is doing right with the offshore wind technology, what do you call it -creating a sustainable future for our industrial, so we have the vision in Aker Solutions to do something. I think that, what we are doing investing in offshore wind, carbon capture technology is absolutely key for Aker Solutions to pull forward.*" FKR3

> "*And what we are working on now is that, we are shifting our portfolio towards renewables. That we invest in renewables, invest into digital solutions to improve our efficiencies and that we enable carbon solutions that we can*" FKR2

The unit of analysis vision is the key strategic objective in addressing carbon emissions in the energy value chain , as noted in the social responsibility report, "Aker Solutions has a vision to be a leader in forging a sustainable future for our industry and the world it serves" (Aker Solutions SR report**,** *2018, p. 28*).

Incremental innovation

Incremental improvement within internal and external processes and products under the auspice of business model innovation is gaining importance in the firm. Therefore, the thesis process indicates that

incremental innovation has a direct impact on addressing carbon emissions and usage of resources in the unit of analysis. The incremental innovations in the unit of analysis is manifest through the lens of standardization and optimization of process and products internal to the value chain. Some of the key incremental innovations are noted by the key respondents;

> "*We have been able to reduce on the most standardized components, the most common components that we have and where we have skilled suppliers, we have been able to reduce inspections during procurement activities and take away costs.*" FKR1

> "*For instance, if you don't need to produce anything in Italy, you can actually do it backdoor through a printer of course it will have an impact.*" FKR3

In summing up the analysis and presentation of the strategy activity of the SOI model, the results show that a number of strategic initiatives within the firm is key to addressing carbon emissions and usage of resources. The thematic analysis identified two major global themes that is optimized low carbon solutions and business model innovation. The thematic analysis also showed the sub-themes under the auspice of the optimized low carbon solutions that is optimization as sub-theme and under business innovation, incremental innovation as the sub-theme. Therefore, the strategy activity of the SOI model is the main driver of addressing carbon emissions and usage of resources in the value chain of the unit of analysis.

4.2.2 Process

The analysis of the process activity pillar of the SOI model is based on theoretical framework on the overall internal process of the unit of analysis. The analysis of presentation of results looked into the internal systems in tandem to addressing the key research questions. To facilitate the process of addressing the research questions, the key question that was addressed to functional key respondents under the process pillar of the SOI activity was: *Please can provide some innovative solutions for aims to reduce carbon emissions or reduce waste*. This process allowed the researcher to gain insight in the

various processes within the unit of analysis through a show of examples from the functional key respondents.

Therefore, in order to capture the key themes from the functional key respondents, Nvivo software for qualitative research was applied. The criterion to capture the key themes was through the word frequency query results as illustrated in *figure 4.3.*

Figure 4.3. Functional Key Respondents word frequency query results for process

The word cloud frequency query results in *figure 4.3* indicates the overall key themes from functional key respondents are associated to digital, environmental, footprint from which the key themes for analysis and results were captured. The word cloud frequency results in *figure 4.3* also addresses the key questions regarding the process in the unit of analysis that is innovative solutions for addressing carbon emissions and usage of resources in the value chain.

Based on the above *figure 4.3*, a thematic analysis for process activity of the SOI model was applied to capture the first order concepts, sub-themes and aggregated dimensions (Corley & Gioia, 2004, Essamri et al 2019). The results for the thematic analysis was illustrated in the following data structure below.

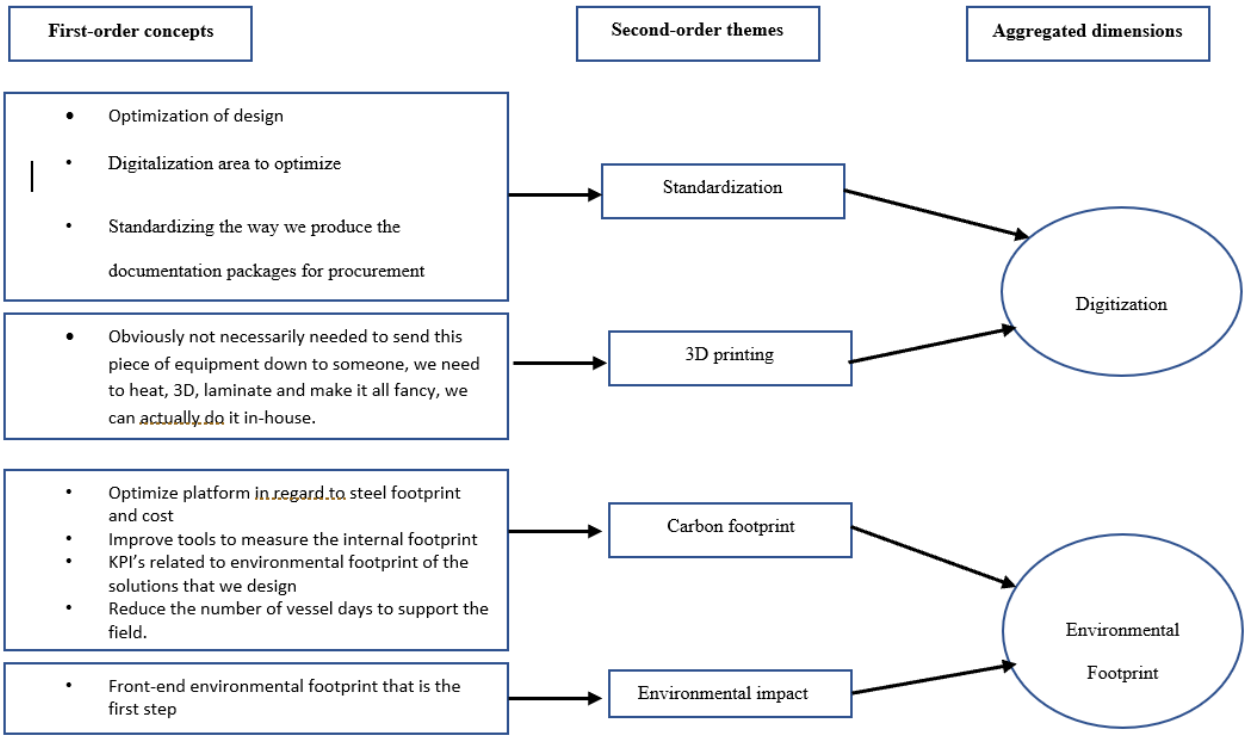

Figure 4.4. Thematic analysis for process in Aker Solutions (self-constructed)

The results in *figure 4.4* for the thematic analysis for process activity in the SOI model for the unit of analysis captures two aggregated themes and two second order themes. The process activity aggregated dimensions for innovative solutions for aims to reduce carbon emissions or reduce waste includes digitization and measuring the environmental footprint in the value chain. This result is based on the theoretical backdrop of the process activity in the SOI model in tandem with the key respondents' assumptions on the internal process within the firm's value chain.

4.2.2.1 ***Digitization***

The aggregated dimension of the process activity of the SOI model under the auspice of digitization captured two key second order themes that is standardization and 3D printing in the internal process of the firm. Digitization theme is operative in the firm and according to the functional key respondent that;

> "*I believe we have some ongoing initiatives to within digitalization area to optimize to make activities that we do or the chain of activities more efficient and be able to identify were we can do cost savings also by collecting digital data instead old fashioned PDFs where we basically have to look through all data manually and decide based on that which is not very reliable, instead we collect data digitally and easily make statistical models on different activities.*" FKR1

> "*Where we are developing and implementing tools rapidly to take out waste to be able to use more for less. So, we use the information that we have spend less hours on solutions we have configurations tools and weight optimization tools that's part of the design tool box to make sure that we take out as much waste as possible from the designs and solutions that we have*." FKR2

Standardization

Standardization in the unit of analysis process or product is the sub-theme under digitalization in the unit of analysis value chain to address aims to reduce carbon emissions and reduce waste as per functional key respondents. The result in the analysis in *figure 4.4* shows that, functional key respondents are working on standardizing processes mainly with a cost reduction objective, however, standardization has also resulted in reducing waste and impacts the processes carbon emissions reduction positively. This view is recollected in the functional key respondent

> "*We are standardizing the portfolio and we are standardizing the way we produce the documentation packages for procurement. So, instead of making project specific documentation packages for every project, we are standardizing the common features and properties and we are only adapting the actual identified features that are special for that project and the rest we copy, by that we are taking away unnecessary work and we are reusing the properties that we already have in the system.*" FKR1

"*But then you also see that, more so that we also do with regards to addressing cost also addresses sustainability to some degree. Because we are working at taking out waste from the value chain. That we look at our products and solutions to do to optimize them for how we produce.*" FKR2

3D printing

3D printing under the auspice of digitalization as a sub-theme is crucial to the unit of analysis process or products in aims to reduce carbon emissions and reduce waste in the value chain. The use of digital tools like the 3D printer has an impact on multiple benefits chiefly on cost, however, 3D printers have extended benefits in realizing reducing waste which has a spillover effect on carbon emissions in the value chain. Some key respondents noted that;

"*So, whenever we order for forging from our suppliers, environmental and sustainability is not necessary on the agenda but that been said 3D printing might of course bring aspect of these of course. For instance, if you don't need to produce anything in Italy, you can actually do it backdoor through a printer of course it will have an impact.*" FKR3

4.2.2.2 Environmental footprint

The thematic analysis in *figure 4.4* captured environmental footprint as a key theme within the firm's process and product in aims to address carbon emissions and reduce waste in the value chain. Based on the responses from key respondents, two key sub-themes emerged under the auspice of environment footprint that is carbon footprint and environmental impact. The unit of analysis operating as a key player in the oil and gas industry supply chain is involved in the number of activities that have a negative impact on the environment including oil spills and carbon emissions (Aker Solutions SR report, 2018). Therefore, the thesis observed that monitoring the environmental footprint within and outside the value chain for process and products is clearly reflected in the social responsibility reports for the unit of analysis. The firm's social responsibility report notes:

> "*our target is to be a recognized leader, creating value through green engineering, the development of low carbon offerings and solutions, and improved environmental performance for all stakeholders*." (Aker Solutions SR report, 2018, p. 28).

With that backdrop, the thematic analysis results under environmental footprint theme indicates managing carbon footprint and environmental impact as key themes aimed to address carbon emissions and reducing waste in the firm processes and products. This is also reflected by the functional key respondents during the interview process.

Carbon footprint

The firm's position in the oil and gas supply chain is global. Therefore, aims to address carbon emissions and reducing waste under environmental management is reflected in the firm's target to manage internal environmental footprint including carbon emissions. This is noted by the key respondent that;

> "*Then we are also looking into removing CO2 from process fluids as well and also then its solutions. An example of low carbon solutions will be all sky project, the subsea compression. Rather than, having a big top side unit with people traveling back and forth, you install everything subsea then you get a much efficient energy production and gas production from that field compared to our top side solution. So, it's more efficient and less CO2 footprint."* **FKR2**

The document review for carbon footprint sub-theme in the unit of analysis is reflected in social responsibility report. The social responsibility report notes under 'managing our carbon footprint' that,

> "*we shall design products and services to have no undue environmental impact, to be safe and to be efficient in consuming energy and natural resources.*" (Aker Solutions SR report, 2018, p. 28).

Environmental impacts

The thematic analysis results in *figure 4.4* also shows environmental impacts as a second-order theme to environmental footprint. The environmental impacts relating to the oil and gas industry supply chain

has an impact and externalities on aims to reduce carbon emissions and waste in the unit of analysis. The thesis study observed that, the firm's robust implementation of the Key Environmental Performance Indicators (KEPIs) is new to the oil and gas supply chain in safeguarding the environmental footprint. According to the document review, the key objective for the KEPIs is a holistic approach on the firm's value chain in co-creating sustainable solutions and minimizing the environmental footprint in product, processes, and systems lifecycle accounting metrics of energy consumption, carbon footprint, resources use and water use from the beginning of life to the end of life (Aker Solutions KEPIs Procedure , 2019).

The functional key respondents noted regarding the KEPIs approach aims to address carbon emissions and usage of resources indicated that;

> "*KEPIs are a kind of total environmental approach. So, we will look at all aspects having an impact on the environment, not only CO2 but energy in general consumption, material consumption, use of chemicals, use of cooling water, look at CO2 regarding transport installation, fabrication. It's a big task, but then we use the tool for screening and selecting the most favorably projects based on the environmental conditions."* FKR5

> "*As part of the KEPI measurement and the ambition within that is to be able to trend and measure what kind of CO2 footprint per produced barrel. So, you can compare concepts and compare it versus benchmark, so this is a typical way of designing and then you have this tons per produced barrel versus alternative concepts. It's a challenging process to measure that from the cradle to the grave through the full value chain and supply chain*." FKR2

> *"front-end implemented the environmental KPI to go along side with more financial KPIs. So, those are the two ones that I know that are at least very visible." FKR4*

In conclusion, the process activity of the SOI model has a direct impact on innovative aims to address carbon emissions and reduce waste in the unit of analysis value chain. The results from the thematic analysis identified environmental footprint as the aggregated dimension in tandem to two sub-themes that is carbon footprint and environmental footprint. The unit of analysis as part of the key player in the

oil and gas supply and value chain, carbon footprint management and impact are addressed in the internal document review and by the key respondent

4.2.3 Learning

The analysis of the learning activity pillar of the SOI model is based on theoretical framework on the overall internal systems of the firm. The analysis of the presentation of results examined the internal systems in tandem to addressing the key research questions for the firm. The overall aim was addressing the research questions, the key question that was addressed to functional key respondents under the learning innovative activity of the SOI: *Please describe how you learn*. This process allowed the researcher to gain in-depth knowledge within processes and system of the firm.

Furthermore, in order to capture the key themes from the functional key respondents, Nvivo software for qualitative research was applied using the word cloud. The criterion to capture the key themes was through the word frequency query results based on the respondents reviews as illustrated in *figure 4.5*.

Figure 4.5. Functional Key Respondents word frequency query results for learning

The above learning word cloud frequency results in figure *4.5* was a proxy to applying a thematic analysis for learning activity of the SOI model to capture the first order concepts, second-order themes and aggregated dimensions (Corley & Gioia, 2004, Essamri et al 2019). The results for the learning thematic analysis was illustrated in the following data structure in figure *4.6*.

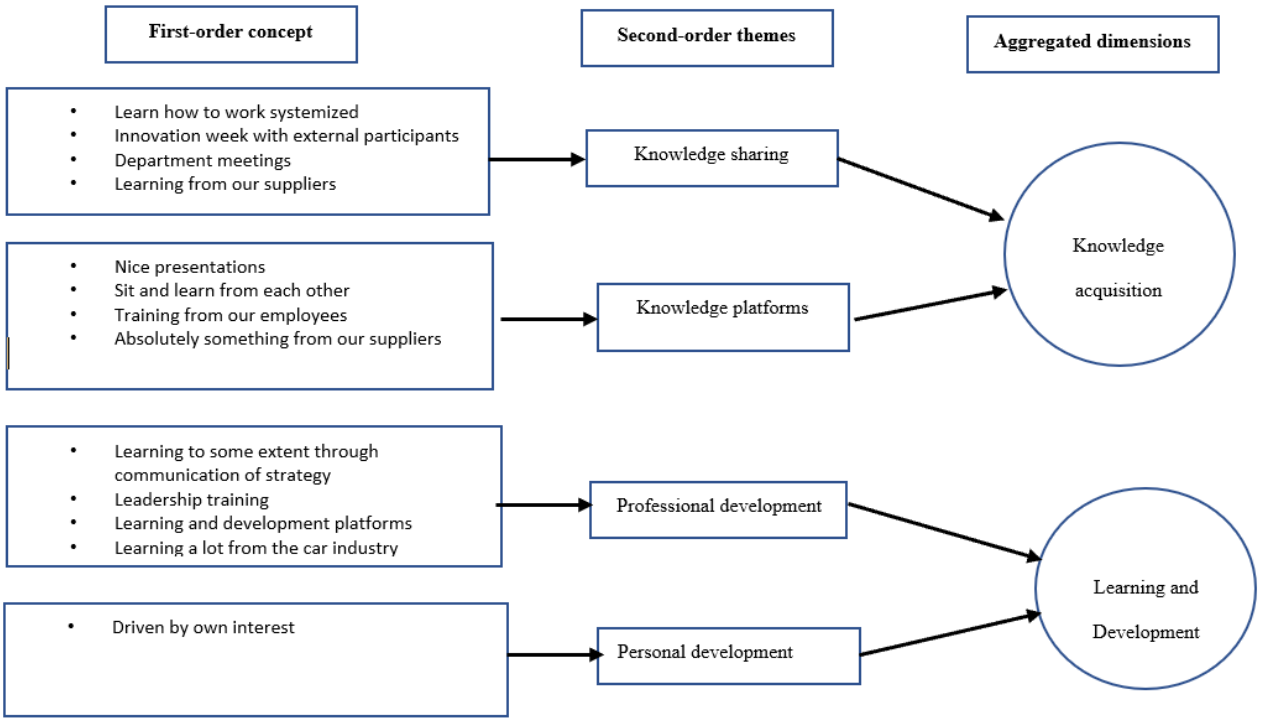

Figure 4.6. Thematic analysis for learning in Aker Solutions (self-constructed)

The results in the above *figure 4.6* for the thematic analysis for learning activity of the SOI model for the firm shows knowledge acquisition and, learning and development as the two major themes. The analysis from the functional key respondents first order concepts identifies two second-order themes that is, knowledge sharing, knowledge platforms, professional development and personal development supplementary to the two major themes. The analysis is based on the theoretical backdrop of the learning activity of the SOI model in tandem with the key respondents' assumptions on the internal learning process within the firm.

4.2.3.1 Knowledge acquisition

The results from the thematic analysis in *figure 4.6* shows knowledge acquisition as the aggregated dimension for two second-order themes that is knowledge sharing and knowledge platforms. This result shows that, the two second order themes addresses the question on the unit analysis learning processes.

Knowledge sharing

Knowledge sharing as one of the second-order themes captured under the auspice of knowledge acquisition envisions learning processes in the firm through different knowledge arenas. The knowledge sharing from the thematic analysis *figure 4.6* indicates that, the functional key respondents are learning from the internal learning systems within the firm and externally through collaborations stakeholders in the value chain. This is noted by the key respondents' perceptions on the learning process within the firm;

> "*Okay, sometimes we had what was it called innovation week with external participants where knowledge was shared during that week. And they were meetings with different topics, I think that is going to be once a year or twice a year. We have department meetings of course, where we get information about what is going on.*" FKR1

> "*Definitely from outside and from my perspectives at least on strategy we see that it's much more on the agenda with regards to what we speak and hear about on different venues or arrangements (meetings) that we are at in dialogue with investors*." FKR2

Knowledge platforms

Knowledge acquisition from the thematic analysis in *figure 4.6* is also captured through different knowledge platforms, which is the second-order theme for this result. The analysis captured from the first order concepts indicates the functional key respondents through in-house training and engagement with stakeholders creates a rapport for learning within the firm. As noted by the key respondents;

> "*The Lean and Kaizen isn't invented internally. These are the industry by processes so we definitely learning a lot from the car industry, in terms of removing waste and design, optimization our value chain with regards to manufacturing processes.*" FKR2

> "*We have department meetings of course, where we get information about what is going on. Also, I feel that there is a common mindset to share information about sustainability within different disciplines and work-packs*." FKR1

4.2.3.2 Learning and development

The results in the thematic analysis in *figure 4.6* result shows learning and development as the aggregated dimension for the learning processes within the firm. The main theme on professional development also captures two second-order themes that is, professional development and personal development based on the assertions from the functional key respondents from the first order concepts. Therefore, the results show that, professional development and personal development under the auspice of learning development is a proxy for the learning innovative activity of the SOI model within the firm.

Professional development

The results in the thematic analysis *figure 4.6* indicates professional development under the auspice of learning and development is incorporated in the learning process for the firm. This addresses the research question how the functional key respondents learn within the unit of analysis. As some of the key respondents have noted that;

> "*We have to learn about the systems, we learn how to work systemized, because we are all the time delivering to clients what we have, and we need to deliver in a systemized way. This is a learning process, learning how the systems are set up and how we can define the systems the best way and the product hierarchy.*" **FKR1**

> *"Learning and training programs we have, been different leadership training, communicate that the strategy, ambitions and focus. And we are working on addressing lean in pocket to have it as normal way of operating fully embedded."* ***FKR2***

Personal development

The thematic analysis results in *figure 4.6* shows professional development and personal development as a proxy for learning in the firm. The analysis showed that, personal development to learning within the firm is the driver for personal development. Therefore, the study finds that, learning is motivated by personal development under the theme analysis of learning development within the firm.

> "*Learning and Development platform and Kaizen is internal driven*." FKR2

In conclusion, the thematic analysis results in *figure 4.6* for the learning activity of the firm unveiled two aggregated dimension that is knowledge acquisition and learning and development in the learning process. The results also showed four sub-themes under the auspice of knowledge acquisition and learning development and these are; knowledge sharing, knowledge platforms, professional development and personal development. The analysis of the learning process in the unit of analysis also indicates externally knowledge sharing with stakeholders inside the value chain. Therefore, the learning process based on the theoretical framework of the SOI model in tandem with the thematic analysis shows that knowledge acquisition and learning development are key major drivers of the learning activity in the firm.

4.2.4 Linkages

The analysis of the linkage's activity pillar of the SOI model is based on theoretical framework and the value chain of the unit of analysis. The approach for the presentation of analysis and results was examining the linkages or collaborations existing within the unit of analysis value chain to reduce carbon emissions or reduce waste and usage of resources. The overall aim was addressing the research questions and the key question that was addressed to functional key respondents under study on the learning pillar of the SOI activity was: *How does Aker Solutions build collaborations with stakeholders to reduce carbon emissions, reduce waste and usage of resources?* The approach allowed the researcher to gain in-depth knowledge within existing linkages in the value chain of the firm.

Therefore, in order to capture the key themes from the functional key respondents, Nvivo software for qualitative research was applied using the word cloud. The criterion to capture the key themes was through the word frequency query results based on the respondents reviews as illustrated in *figure 4.7*.

Figure 4.7. Functional Key Respondents word frequency query results for linkages

The word cloud frequency query results in *figure 4.7* captured the spectrum of themes that are associated to the linkage innovative activity of the SOI model based on the first order concepts from functional key respondents. The word cloud as a point of departure to the presentation of results, enabled the researcher to analyse the key themes associated with linkages innovative activity based on the first-order concepts, second-order themes and the aggregated dimension (Corley & Gioia, 2004, Essamri et al 2019) from the functional key respondents . Based on the above word cloud, the results for the linkages thematic analysis was illustrated in the following data structure in *figure 4.8*

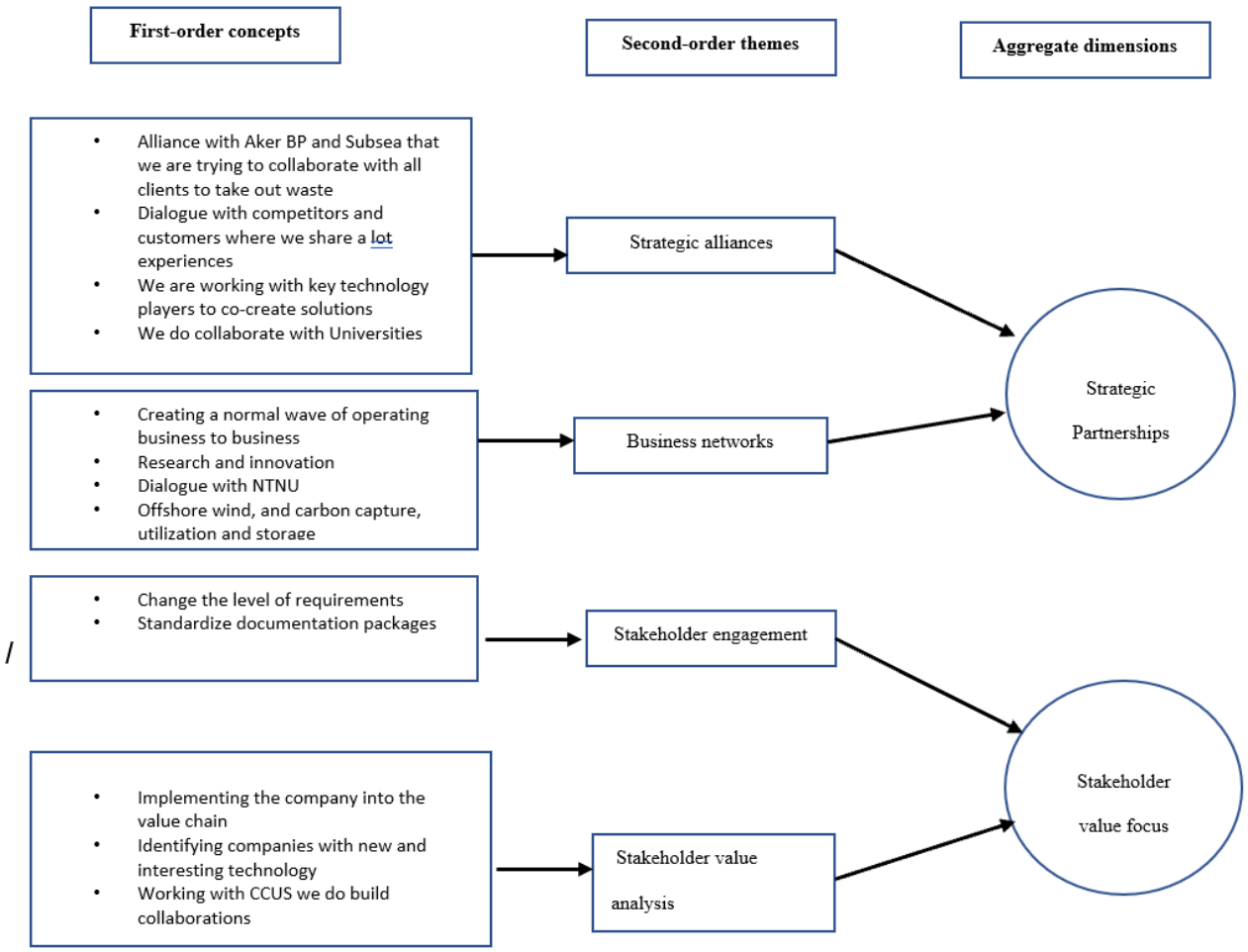

Figure 4.8. Thematic analysis for linkages in Aker Solutions (self-constructed)

The results in the above *figure 4.8* for the thematic analysis for linkages activity of the SOI model for the firm indicates strategic partnerships and stakeholder value focus as the two aggregated dimensions for themes on linkages innovative activity. The analysis from the functional key respondents using the first order concepts identifies second-order themes that is, strategic alliances, business networks, stakeholder engagement and stakeholder value analysis under the auspice of the two major themes. The analysis is based on the theoretical backdrop of the linkage's activity of the SOI model in tandem with the key respondents' assumptions on the value chains internal or external to the firm.

4.2.4.1 Strategic partnerships

The thematic analysis in *figure 4.8* shows co-creation as the major theme under the linkage's activity of the SOI model in the firm. Based on the data from the first order concepts, the results show that strategic alliances and business network themes are collaborations with stakeholders within the firm to reduce carbon emissions and usage of resources. The results were extrapolated based on the following analysis of the themes under the auspice of strategic partnerships that is: strategic alliances and business networks.

Strategic Alliances

The study finds that, the firm collaborations with other stakeholders within the value chain to take out waste has a positive impact on the carbon emissions and usage of resources. The drive to take out waste in the supply chain has resulted in different strategic alliances, engaging competitors and working with non-economic players like universities to co-create. A document review for the unit of analysis in the social responsibility report notes a commitment to engage players in the unit of analysis value chain to meet their expectations (Aker Solutions SR Report, 2018). An example for the unit of analysis collaborations with stakeholders to mitigate carbon emissions in the oil and gas supply chain is in the unit of analysis technological deployment of carbon capture, utilizations and storage (CCUS) in the energy industry. According to the functional key respondent efforts to collaborate with stakeholders to mitigate carbon emissions in the oil and gas supply chain are developing rapidly to create a circular economy around technology. This is noted by the functional key respondent that;

> "*We work very closely with customers to apply Carbon Capture and Technology and one of the issues as discussed, the cost is high today but that you can see from all other industries, when you start a new product or a new technology the cost is always high*." FKR5

According to the document review, creating strategic alliances with players inside and outside the value chain is a strategic business approach for the firm. However, the key objective to strategic alliances with stakeholders is focused on taking waste out of the supply chain. As one of the key respondents on creating strategic alliances to take-out waste solutions;

"*Where you see the alliance with Aker Bp, and Subsea 7 that we are trying to collaborate with all clients to take out waste and see if we can improve the solutions that we bring. And before the downturn, we had a lot of suppliers, so that's not very efficient and we can't work close with a lot of suppliers. So, we reduced the number of key suppliers substantially and then work much closer with less suppliers to co-create solutions*." FKR2

Business Networks

The thematic results in *figure 4.8* under the auspice of strategic partnerships shows that business networks a as the second-order theme. The first -order concepts which involved the firm creating business to business solutions, research and innovation and dialogue with non-economic actors such as academia and universities were proxies for creating innovative solutions to take out waste. The document review for the firm shows a global supply chain involving over 7,500 direct and indirect suppliers across the globe (Aker Solutions SR report, 2018). The results for business networks under strategic partnerships indicates the firm engagement with key stakeholders in the oil and gas industry to collaborate on solutions to mitigate emission and usage of resources;

"*We do collaborate with Universities and my colleagues will be able to share more regards to what we are doing on the research side with universities and institutions , especially on within the carbon capture domain we are in frequent dialogue with companies like Bellona so forth as well*." FKR2

"*Yes, it is a new domain. But within our domain, since we are working with CCUS we do collaboration on the topic of Carbon Capture Utilization and Storage. We have people we need to get rid of the Carbon dioxide*." FKR4

"*It's a shared benefits , from our customers , what they see is that okay if we manage to make it competitive then we get a better system at the same cost but also the follow on effects by reducing environmental footprint, reducing pressure systems on site , more flexibility in relation to connecting up dual systems, it will be easier to connect electrical systems, cheaper components in the structure*." FKR6

4.2.4.2 Stakeholder Value Focus

The linkages thematic analysis in *figure 4.8* indicates stakeholder value focus based on the analysis for the first order concepts and second-order themes. The thematic analysis under the auspice of value position identified inclusive decision making and value analysis as second-order themes.

Stakeholder engagement

The analysis based on the first-order concepts indicates engaging players in the value chain in decision making on standardization of documentation packages and changing the level of requirement.

> "*We have been able to standardize documentation packages and get acceptance from that from our clients, so we can deliver more or less the same documentation packages every time unless there is a change to fit for main function. So, we need to ensure that fit for main function is taken care of, but as long there is still other properties we can copy*." FKR1

Stakeholder Value analysis

Stakeholder Value analysis was captured from the first-order concepts from the key functional respondents in the thematic analysis in *figure 4.8*. Stakeholder Value analysis under the auspice of stakeholder value focus is noted by some of the respondents in the following verbatim;

> "*Hope we can be more in open innovation; I hope we can work more with actors that are not oil and gas. I think we can learn about from related industries such as the maritime industry , like shipping industry , I think we can learn a lot from the renewable industry, I think we can learn a lot more from companies working data driving solutions and digital solutions*." FKR4

Some of the first-order concepts that were captured in the thematic analysis for linkages under the auspice of stakeholder value analysis includes working with collaborations with carbon capture and storage, identifying companies with interesting technology and implementing the companies into the value chain.

In conclusion, the thematic analysis for linkages activity in the firm resulted in two aggregated dimension or major themes associated to linkages. The major themes identified in the thematic analysis in *figure 4.8* includes, strategic partnerships and stakeholder value focus. Under the auspice of the two major themes, the results show four sub-themes based on the functional key respondents first order themes that is, strategic alliances, business networks, stakeholder engagement and stakeholder value analysis.

The document review shows that, firm as a key player in the oil and gas industry has a global supply chain. Therefore, the firm is engaged in a number of collaborations with a number of economic stakeholders in the value chain. The study also shows that, the firm based on the results for the sub-themes is engaged with collaborations with non-economic actors in academia and universities. However, the linkages innovative activity through the established collaborations within the firm, the study finds is focused on reducing waste or usage of resources which in turn has a positive impact on carbon emissions reduction. Therefore, in line to the research questions, the mapping of the firm stakeholders' collaborations does not directly address mitigating carbon emissions, however it does address the usage of resources by taking waste out in the value chain.

4.2.5 Organizational Design

The analysis of the organizational design activity pillar of the SOI model is based on theoretical framework by examining the leadership, and organizational structure of the unit of analysis. The analysis and presentation of results examined leadership and organizational structure to address the key research questions for the unit of analysis for the thesis. The overall aim was addressing the research questions, the key question that was addressed to functional key respondents under the organizational design pillar of the SOI activity was: *How does the organization structure enhance innovative solutions for mitigating carbon emissions in the value chain?* This process allowed the researcher to gain in-depth knowledge within processes and system of the firm.

Therefore, in order to capture the key themes from the functional key respondents, Nvivo software for qualitative research was applied using the word cloud. The criterion to capture the key themes was

through the word frequency query results based on the respondents interviews as illustrated in *figure 4.9.*

Figure 4.9. Functional Key Respondents word frequency query results for organizational design

The word cloud frequency query results in *figure 4.9* was the point of departure capturing key themes from functional key respondents in tandem to organizational design activity pillar of the SOI model based on the theoretical framework. As seen from the *figure 4.9* leadership top approach are the themes captured for the organizational design in the firm. The word cloud as a point of departure to the presentation of results, enabled the researcher to analyse the key themes associated with organizational design based on the first-order concepts, second-order themes and the aggregated dimension (Corley & Gioia, 2004, Essamri et al 2019) from the functional key respondents . Based on the above word cloud frequency results illustration, the results for the organizational design thematic analysis was illustrated in the following data structure in *figure 4.10*

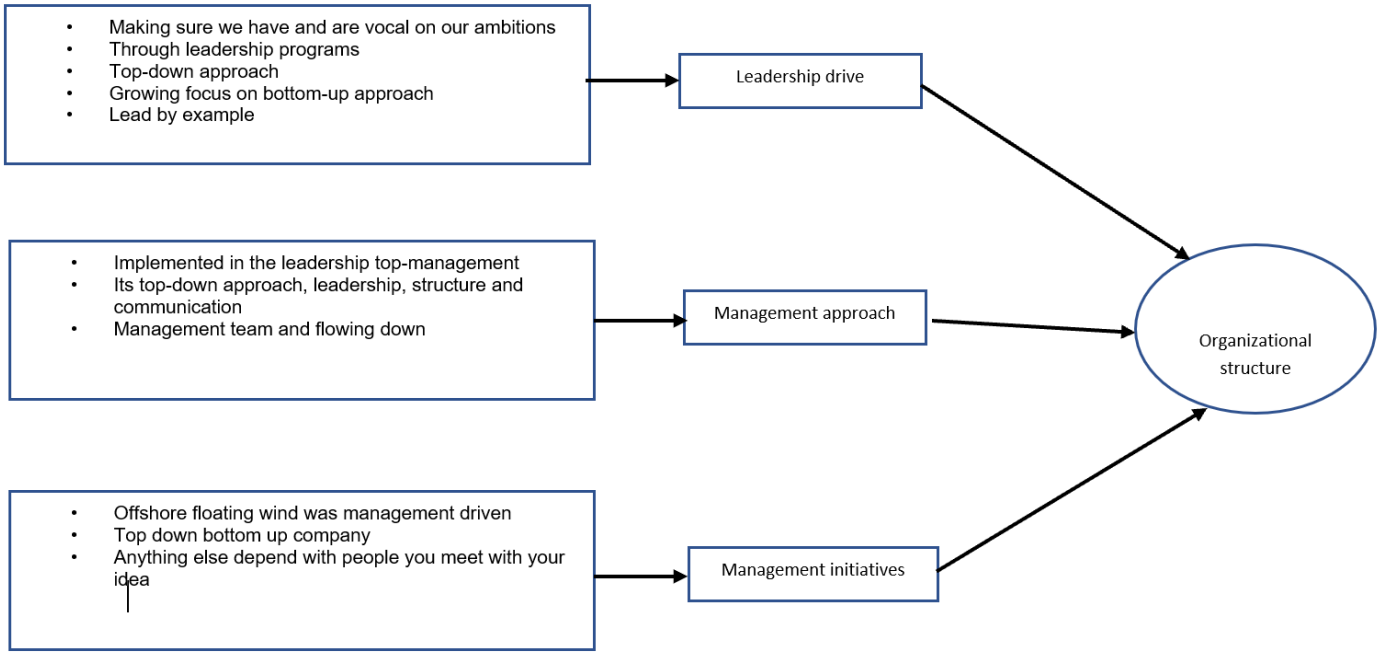

Figure 4.10. Thematic analysis for organizational design in Aker Solutions (self-constructed)

The thematic analysis for organizational design in *figure 4.10* indicates first order concepts, second-order themes and the aggregated dimensions extrapolated from three of the seven functional key respondents. The results in *figure 4.10* indicates organizational structure as the aggregated dimension of the three second-order themes that is, leadership drive, management approach and management initiatives to address the research question on organizational structure influence to address carbon emissions in the value chain. The proxy for the thematic analysis for organizational structure based on the theoretical background is management structure analysis in tandem to communication in the firm.

*4.2.5.1 **Leadership drive***

The results from the first-order concepts showed leadership drive as the second-order theme under the auspice of organizational structure for addressing innovative solutions for carbon emissions in the value chain. This result shows that, leadership drive through leadership programs, goals and ambitions is the main driver for addressing carbon emissions reduction in the value chain. This result is reflected in the document review vision statement that,

"Aker Solutions' leadership will forge a sustainable future for our industry and the world we serve." (Aker Solutions SR report, 2018, p.29).

Some of the key assertions captured from the functional key respondent's interview process regarding leadership and innovative solutions to address carbon emissions;

"*I think it implemented in leadership top management. I think that people are proud of the vision that we have but I don't necessarily see it flowing through the whole organization. But it depends on how we see it as well; we need to have the bread and butter that keeps the company alive and that allows the company to invest in offshore wind and invest in carbon capture.*" FKR 3

"*We are in the process where we are establishing CCUS network within Aker Solutions, so will have business development function and technical functional in each location. And then will have kind of information system in the network will be updated what is going on. And then and will use these two people in each hub as a kind market intelligence and also selling our products globally*." FKR5

*4.2.5.2 **Management approach***

The thematic analysis in *figure 4.10* identified management approach as a sub-theme under the organization structure aggregated dimension. Based on the first-order concepts extrapolated from Nvivo interview transcripts, functional key respondents noted that management approach in the firm is associated to top-down management approach. This result also indicates that, based on organization structure, decision and information for enhancing solutions to address carbon emissions in the value chain is through a top-down approach. As reflected by some of the functional key respondents in verbatim that;

"*It's definitely not so many examples on bottom up approach for sustainability but look at all the kids marching for climate change, demonstrating that's actually bottom up. But what will actually change from this that is yet to be seen. I do believe Aker Solutions and other companies*

if they want to attract young talents coming forward as well, I'm looking at young population these days they are super eager and super curious into sustainability and environmental." FKR3

The functional key respondent from the interview process observed a growing bottom-up management approach;

"*One of the nice things about Aker Solutions is a top-down bottom up company. A lot of initiatives come from the bottom then upwards and some come from the top-down*." FKR4

"*But of course, we see that growing focus from a bottom up approach from that right and as part of the you have to have it and source it. It comes with of course the growing awareness of the younger generations*." FKR2

*4.2.5.3 **Management initiatives***

The sub-theme identified under the auspice of organization structure in the thematic analysis in *figure 4.10* is management initiatives. The assumption in the thematic analysis based on the first-order concept is that, the innovative measures to address carbon emissions in the value chain such as the implementation of offshore floating wind technology is a management initiative in transitioning towards a low carbon society. However, this result is enhanced by the organization structure, the aggregated theme and reflected by the functional key respondents in verbatim;

"*Yes, you can say offshore floating wind was management driven*." FKR4

"*I think of course you lead by example. So it's about making sure that we have and are vocal on our ambitions for instance sustainability. And that we act in accordance with those ambitions and goals.*" FKR2

"*I think we are perceived as a company that are working towards forging a sustainable future. As internally they are trying to build that framework to enable us to more easily communicate what we are doing I think that is the issue as well. It's a lot of work down in the near levels which may not have the mindset to understand what is happening*." FKR4

In conclusion for the thematic analysis of the organizational design for the firm, the overall results captured organizational structure as major theme. The results also captured under the auspice organizational structure three second-order themes that is, leadership drive, management approach and management initiatives in addressing innovative solutions for carbon emissions in the value chain. The result also corresponds to the word cloud frequency query results run in Nvivo to find the key themes for analysis. Therefore, the assumption for the firm based on the theoretical background of the study, leadership, management drive and management initiatives under the auspice of organizational structure are key drivers to enhancing solutions for carbon emissions in the firm's value chain.

5 Chapter 5: DISCUSSION OF RESULTS

5.1 Introduction

The point of departure for this chapter is based on the future study recommendations by Adams et al study of sustainability-oriented innovation; a systematic review. Adams et al noted that, "future research efforts should be directed towards both empirically testing the framework and operationalizing it in the form of a maturity model" (Adams et al 2016, p. 198). Therefore, based on that recommendation for future study, it is the aim and purpose of this thesis to empirically test the sustainability-oriented innovation model in Aker Solutions as a case study.

The theoretical framework discussed in chapter two, the research methodology approach and design discussed in chapter three and the data presentation and results in chapter four provides a strong and reliable structural research approach for the discussions in this chapter. However, this chapter discuss the main results extrapolated from chapter four and corroborate the findings of the firm in the sustainability-oriented innovation framework. The discussion is presented through an overview of innovative activities mapping into the sustainability-oriented innovation model as illustrated in *table 3*.

The illustration in *table 3* shows a cross-tabulation and mapping of the of the innovative activities of the SOI model; strategy, process, learning, linkages and organizational design results in tandem to the three pillars of the SOI model; operational optimization, organizational transformation and systems building based on the empirical results.

The opening for the main discussion for the thesis in sub-section 5.1.1 addresses the key main research question for the thesis research process; *What drives sustainability-oriented innovative solutions for carbon emissions in Aker Solutions?* The discussion also addresses in sub-section 5.1.2 and 5.1.3 the sub-research questions: *How does Aker Solutions build collaboration with external stakeholders to reduce carbon emissions or reduce waste and usage of resources? How does Aker Solutions organizational culture drives sustainability-oriented innovation for carbon emissions solutions in the oil and gas industry*

It is imperative for this research to note the overall scope of the adopting and adapting the SOI model in the firm prior to the main discussions and findings. And based on the conclusion from the main theoretical framework of the SOI model, applying the recommendations for testing of the framework by scholars was put forth. In Adams et al conclusions, they noted that, "we argue that , by understanding how organizations can become sustainable, pragmatically oriented SOI-related research has the potential positively to influence organizational behaviour: our model provides a strong basis for such influence" (Adams et al , 2016, p. 1999). Therefore, this research approach overall attest the theoretical framework of the model in the firm based on the innovative activities discussions of results and findings.

	Operational Optimization: doing more with less	Organizational Transformation: doing good by doing new things	Systems building doing good by doing new things with others
Strategy	Optimized low carbon solutions	Business model innovation (e.g. offshore floating wind &CCS)	
Process	Digitization Environmental footprint		
Learning	Knowledge acquisition Learning and development		
Linkages	Strategic partnerships Stakeholder value focus		
Organizational Design	Organizational structure		

Table 3. Cross-tabulation and mapping of the of the innovative activities and pillars in Aker Solutions

The *table 3* shows the mapping of the innovative activities into the SOI model pillars; operational optimization, organizational transformation, and systems building. The mapping of the innovative activities is based on the theoretical framework and the results presented for the firm. Therefore, the discussion and findings of the thesis is based on the results from the data presentation in chapter four.

The thesis discussion addresses simultaneously the three main key research question based on the results from the thematic analysis, the research questions will be addressed in tandem to the mapping of the three main pillars of the SOI model; operational optimization, organizational transformation and systems building. The following subsection will address key research in sub-section 5.1.1 and the sub-research questions will in addressed in sub-section 5.1.2 and 5.1.3.

5.1.1 Addressing the thesis key research question

The results for the study show that, strategy and process innovative activities of the SOI model addresses the key research question; *What drives sustainability-oriented innovative solutions for carbon emissions in Aker Solutions?* The strategy and process innovative activities are mapped under operational optimization and organizational transformation pillar of the SOI model. According to Adams et al, "operational optimization is 'doing the same things but better' directed towards reducing harm through reactive, incremental improvements driven by compliance or proactively pursuing efficiencies" (Adams et al, 2016, p. 189, Tidd & Bessant, 2014). Whereas, Organization transformation is an oversight beyond the incumbent organization in responding to external environment changes that triggers changes in the organization vision, strategy, structure, and systems for recreating organizational behavioral and cultural processes (Hersey et al, 2013). According to Adams et al, organization transformation is 'doing good by doing new things' and the innovative outcome is shared value (Adams et al, 2016, p. 190, Tidd & Bessant, 2014). Therefore, results for the study show that, strategy and process innovative activities of the SOI model under operational optimization and organizational transformation are responsible for addressing innovative solutions for carbon emissions in the firm. Additionally, the result of the study indicates the strategy innovative pillar of the SOI model as an overarching activity to other innovative activities of the SOI model; process, organizational design, learning and linkages.

The results for strategy innovative activity at the firm captured two major themes in aims to address innovative solutions for carbon emission; optimized low carbon solutions and business model innovation. These results also show through a thematic analysis that, strategy is associated to four different sub-themes; the firm's vision, optimizing the existing processes and products, low carbon energy in the supply chain for oil and gas, and incremental innovation as illustrated in the above figure.

Optimized low carbon solutions from the results indicates that, the firm's energy related business portfolio in the oil and gas supply chain transition in investing in low carbon energy solutions that is technology in renewable energy and carbon capture and storage (CCS). A study by Li et al, notes that, "due to efforts to optimize the energy mix and curb GHG emissions, low carbon energy, also known as non-fossil energy, has enjoyed rapid growth since 2005" (Li et al 2012, p. 393). The firm's gradual transition towards optimized low carbon solutions indicates a shift from the mainstream business portfolio that is oil and gas related projects to low carbon solutions; offshore wind and carbon capture and storage the study shows. Therefore, the study notes, the deployment of renewable energy and decarbonization through implementing low-carbon energy technological solutions such as carbon capture and storage are key measures to mitigate climate change (Parthan et al, 2010).

Business model innovation is another key theme captured in the analysis in *table 2.4*. According to a study by Lyytinen notes new technology and/or developing new business models for products and services are key indicators and opportunities for firm's to be greener (Lyytinen, 2017). This thesis study show business model innovation as a key strategic driver for innovative solutions for carbon emissions in the firm. Business model innovation in the study overlaps into the operational optimization and manifests more under organization transformation pillar of the SOI model for the firm. The key proxy for organizational transformation theoretically is a radical shift from reducing harm, increasing operational efficiencies to creating shared value (Adams et al,2016, Porter & Kramer 2011 Nidumolu & Rangaswami, 2009). Shared value is clearly defined as, "policies and practices that can enhance the competitiveness of a company while simultaneously advancing the economic and social conditions in communities it operates" (Porter & Kramer, 2011, p. 6). Business model innovation focused on 'doing good by doing new things creates a shared value as the innovative outcome (Adams et al, 2016). According to Nidumolu, "developing a new business model requires exploring alternatives to current ways of doing business as well as understanding how companies can meet customers' needs differently" (Nidumolu & Rangaswami, 2009, p. 7). A firm's business models can be defined as an internal ecosystem within the firm's business portfolio that ushers the firm's new business frontier on 'what we do' with stakeholders in the value chain (Amit & Zott, 2010).

The study observes that key driver under the business model innovation is the firm's vision to provide low carbon solutions and transition to a low carbon future beyond a single market and this driver is stated explicitly in the firm's vision statement. The vision statement notes that the firm's position in the oil and gas supply chain to be a, "leader in forging a sustainable future for our industry and the world it serves" (ASR report, 2018). The observation is noticeable in the firm's business model innovation in deploying the carbon capture technology (CCS) and investments in renewable resources; offshore floating wind that is beyond the oil and gas market and ultimately creates shared outcome in the energy supply chain.

The aerodynamics of wind turbine is having a fair share of deployment in harnessing offshore wind power in the global energy mix and since 2017, the cumulative global installed capacity for offshore wind increased to 20 gigawatts (IRENA, 2018). Furthermore, the firm's strategic implementation of low carbon energy solutions in offshore floating wind is a new business model innovation frontier and resonates with the 'going good by doing new things' and creates shared value for solutions in the oil and gas, and the energy industry at large (Adams et al, 2016, Porter & Kramer, 2011). This strategic approach addresses the research question under the organizational transformation pillar of the SOI model on innovative activities to reduce carbon emissions not only for the oil and gas industry but transitioning as an energy company. A study by Esteban et al notes , "the push of offshore wind power is clear, and wind technology should take the opportunity of the advantages achieved onshore to move forward in the sea as soon as possible, it would be necessary to push the rest of the technologies" (Esteban et al 2011, p.447). The strategic approach, the study shows is also reflected in the Paris Agreement that, "parties share a long-term vision on the importance of fully realizing technology development and transfer in order to improve resilience to climate change and to reduce greenhouse gas emissions." (Paris Agreement, 2015, p. 14, Esteban et al, 2011).

Another proxy for organizational transformation pillar of the SOI model empirical assessment under the firm's business model innovation is the technological development of carbon capture and storage (CCS) in addressing the impact of carbon emissions in the oil and gas supply chain as well as the emissions from non-fossil fuels industry. Carbon capture and storage is a technological key to the decarbonization of the fossil-fuel energy and is imperative for non-fossil fuel industries to curb emissive gases to the

atmosphere that impacts climate change. However, the climate change mitigation targets to limit the average global temperature to well below 2°C presents a rapid opportunities for the deployment of CCS in the energy mix to mitigate the impacts on greenhouse gases effects on climate change (IEA, 2016, Mohn, 2017, IPCC, 2018).

The study found the firm's investments in expanding and developing the technology for the post-combustion capturing carbon resonates with 'doing good by doing new things', creates shared value by mitigating climate change and addresses the key research question under the organizational transformation pillar of SOI model. And according to the IEA, "The deployment of all low-emissions technologies, including CCS, will be essential to limit energy sector emissions to levels consistent with limiting global temperature increases to below 2°C" (IEA, 2016, p. 51).

Furthermore, strategy innovative activity of the SOI model is key to organizational transformation for the firm. The study notes that, the firms optimized low carbon solutions and business model innovation show within the firm floating wind and carbon capture technology outreaches the firm's single market that creates shared value.

The study also notes that process innovative activity of the SOI model also addresses the key research question under the auspice of operational optimization pillar of the SOI model. Operational optimization as earlier discussed is premised on 'doing the same things better' and in the innovative outcome is reducing harm (Adams et al, 2016, Tidd and Bessant, 2014). The results for process innovative activity at the firm, indicates two major themes; digitization and monitoring of the environmental footprint.

Operational optimization pillar of the SOI model through optimizing operations in the firm is manifest in various incremental improvements such as standardization and application of 3D printing in the firm's daily business operations. The study empirical example involving digitalization is observed through the lens of the firm's process application of value analysis and value engineering (VAVE) as a driver to operational optimization pillar of the SOI model (Mills, 1951, Mandelbaum, 2006). Value analysis and value engineering (VAVE) approach is based under the auspice of value engineering which is a

systematic analysis of functions processes and systems considering cost, process standardization, quality, digital technology, safety and key performance indicators in the value chain (Mandelbaum, 2006). Value analysis and value engineering is internally applied by the firm for optimizing processes and systems. The study notes that, while the focus within the firm is oriented towards cost reduction, quality and performance, the practice of value analysis has also impacted the carbon emissions positively. Therefore, the study observes that, while value analysis and value engineering is imperative for reducing harm not only financially for the firm, but methodologically also cuts across reducing environmental harm by reducing the use of resources and carbon emissions ultimately (Ubusuki et al, 2007, Junk et al, 2007). This assertion is noted by Ubusuki et al 2007 that, "the methods used to diminish the direct material cost include reducing the number of parts, designing smaller and lighter parts, using cheaper parts and designing parts that do not require special high-precision or very expensive production processes" (Ubusuki et al, 2007, p. 463). Therefore, value analysis and value engineering is closely linked to digitization, standardization, cost, and value analysis as discussed is operative inside the firm's innovation process to optimize systems and processes. Furthermore, the application of value analysis and engineering in the firm the study shows is consistent with the 'doing the same but better' theoretical conceptualization of the operational optimization pillar of the SOI model (Adams et al, 2016, Ubusuki et al 2007).

Operational optimization from the process innovative activity also addresses eco-efficiency through carbon footprint management, as noted by some key respondents in the analysis and the firm's document review. This is explicit in the firm's social responsibility report, that states "our target is to be recognized leader, creating value through green engineering, the development of low carbo offerings and solutions, and improved environmental performance for all stakeholders" (Aker Solutions SR Report, 2018). The study notes, eco-efficiency for operational optimization is examined by the firm's approach to implement lifecycle-thinking by adopting and implementing key environmental performance indicators (KEPI's) in processes and services for the firm (Yang et al, 2017). Yang et al noted that "lifecycle thinking can help companies to discover sustainability-focused value opportunities across the entire product life cycle, and perhaps identify new ways to both maximize value and minimize environmental and social impacts" (Yang et al, 2017, p. 31). The lifecycle thinking under the operational optimization by minimizing environmental and social impacts, ultimately reduces harm. Silvestre & Tirca study

notes, “to address these environmental challenges, scholars, industry, and civil society have been discussing and proposing approaches and mechanisms that could mitigate or remove the impact of the activities of organizations, supply chains, and communities on the natural environment” (Silvestre & Tirca, 2018, p. 2). This study notes with reviews from the functional key respondents, document review consistent with the premise for operational optimization pillar of the SOI model on eco-efficiency and reducing harm on the environment through accounting the environmental footprint of the firm with the KEPI’s approach.

In summation, strategy and process innovative activities of the SOI model under the pillars of operational optimization and organizational transformation are key drivers for addressing the key research question: *What drives sustainability-oriented innovative solutions for carbon emissions in Aker Solutions?* The study notes, the key results for the firms aims to address carbon emissions and resonates with the SOI model theoretical framework on business as usual but better with less harm and employing good will by doing new things with shared value (Adams et al, 2016). The study results show that, the firm’s strategic approach to optimized low carbon energy and business model innovation are key themes in addressing innovative solutions for carbon emissions for the firm. This is reflected by the firm’s investment in offshore floating wind and development of carbon capture and storage as innovative solutions for carbon emissions.

5.1.2 Addressing the first sub-research question

The point of departure for addressing the sub-research question is by examining the synergy between learning and linkages innovative activity of the SOI model, into the three pillars of the SOI model. The linkages and learning innovative activity of the sustainability-oriented innovation model based on the theoretical background exist at all three pillars of the sustainability-oriented model: operational transformation, organizational transformation and systems building (Adams et al, 2016). However, the results in the analysis for this thesis show learning and linkages as key innovative activity of the sustainability-oriented innovation to address this sub-research question. Furthermore, the innovative activities are fundamental in addressing the second research question for the thesis based on the case

study analysis results in chapter four of the thesis. The discussion in this section involves addressing the research question based on the results for the analysis of the SOI model in the firm: *How does Aker Solutions build collaboration with external stakeholders to reduce carbon emissions or reduce waste and usage of resources?* The thesis discussion in addressing this research issue identifies learning and linkages as the innovative activity of the SOI model that is a key driver for addressing this research question. The study based on the theoretical framework of the thesis is that, learning and linkages of the SOI model complement each other positively. Based on the theoretical framework, learning through absorptive and dynamic capabilities of the firm involves creation of linkages both internal and external for knowledge acquisition. And this is noted in the same vein with linkages activity of the SOI model which involves learning internal and external with key stakeholders in the value chain of the firm.

The results in the thematic analysis in *figure 4.6* for learning and *figure 4.8* for linkages captured key theme that are crucial in addressing the sub-research question. The key themes for discussion of results in this section involves knowledge acquisition, learning development, strategic partnerships and stakeholder value focus under the auspice of learning and linkages as innovative drivers of the firm to limit carbon emissions in the value chain.

The study notes that, learning through knowledge acquisition is a key driver for the innovative activities of the SOI model and this is a proxy for having competitive advantage through maximizing dynamic capabilities of the firm (Iakovleva et al, 2015, Teece et al, 1997, Arrow, 1962). According to Teece et al this, "reflect an organization's ability to achieve new and innovative forms of competitive advantage given path dependencies and market positions" (Teece et al, 1997, p. 516).

The analysis and results of learning activity of the sustainability-oriented innovation model assessment in *figure 4.6* shows two key results: knowledge acquisition and learning development. Therefore, the foci for addressing the sub-research question is on knowledge acquisition theorized under learning activity of the SOI model. The study notes that, the acquisition of knowledge is imperative towards building dynamic capacity for creating an innovative, informed value chain involving the firm and the stakeholders to addresses carbon emissions. Teece et al noted that, "if control over scarce resources is a source of economic profit, then it follows that such issues as skill acquisition, the management of

knowledge and know-how and learning become fundamental strategic issues" (Teece et al, 1997, p. 514).

The study noted from the respondent responses on how people learn inside the firm. The internal and external knowledge transfer was fundamental to the learning process in the firm. The learning processes included learning to work systematized, peer to peer learning, self-interest and working through internal learning platforms. Working systemized is a theorized under the learning modes and involves experienced based mode of learning: doing, using and interacting (DUI) (Jensen et al, 2007, Fitjar et al 2011, Arrows 1962). In particular, the study noted that, especially concerning working systemized has a positive impact on resource use and consequentially on solutions to address the carbon emissions inside and outside the firm's value chain. Arrows strongly noted that regarding experience based that, learning "can only take place through the attempt to solve a problem and therefore only takes place during activity" (Arrows, 1962, p. 155). This view resonates with the firm's process of learning which is systemized and based on experience to solve problems and provide innovative solutions.

Another key proxy for discussion on knowledge acquisition based on the theoretical framework of the thesis is regarding how stakeholders in the value chain are involved in the learning process of the firm to address carbon emissions and usage of resources. Knowledge transfer within the firm's value chain is a key proxy for discussion. And based on the results, knowledge sharing, and knowledge platforms are indicators noted by respondents on how knowledge is shared and transferred inside the firm. Knowledge that is transferable exists in two forms: codified knowledge which is explicit and tacit knowledge which implicit, held only by the person sharing the knowledge (Jensen et al, 2007). The results from the analysis show, the knowledge within the firm is transferred departmentally, peer to peer, through learning platforms, leadership programs and self-drive to learn new things. The results in assessing the transferability of knowledge within the firm to maximize external shared knowledge entails the firm's absorptive capacity (Teece et al, 1997, Iakovleva et al, 2015,). Cohen & Levinthal defined absorptive capacity as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends . . . the ability to evaluate and utilize outside knowledge is largely a function of the level of prior knowledge" (Cohen and Levinthal (1990: 128).

A case study by Iakovleva et al in the oil and gas industry formulated three sub-dimensions of absorptive capacity: industry absorptive capacity , supplier absorptive capacity and customer absorptive capacity, all simply aggregated results in analyzing value chain absorptive capacity that resonates with this thesis (Iakovleva et al , 2015). The thesis results correlate with knowledge transfer within the firm's value chain, the extent of how that transferred knowledge is maximized is not reflected in the analysis. The analysis on the absorptive capacity within the firm's value chain can be extrapolated within the firm's to address usage of resources and carbon emissions with the firm's key stakeholders through the application of the value chain absorptive capacity on emissions and usage of resources. Therefore, the discussion surrounding knowledge acquisition and absorptive capacity is imperative to addressing the key research question under the theorized learning activity of the SOI model. In that, the learning innovative activity of the SOI model is a pathway for creating linkages in value chain with key stakeholders through the firm's dynamic capability that includes absorptive capacity and adaptive capacity (Iakovleva et al, 2015, Teece et al, 1997, Arrows, 1962).

As discussed, learning is a precursor for the linkage's innovative activity of the SOI model and it is of vital importance to address the research question on innovative value chain with key stakeholders in emissions reduction. The results in the analysis for the linkages innovative activity of SOI model shows two key aggregated dimensions: strategic partnerships through the firm's strategic alliances as a second-order theme and business networks with industry and non-industry stakeholders. And another key aggregated dimension under linkages involves a stakeholder value focus based on the key respondent interview responses on collaboration on document standardization packages and requirements for processes.

The linkages innovative activity of the SOI model is a driver of the firm's operational optimization, and organization transformation driven by the firm's strategic ambitions (Adams et al, 2016). Therefore, the study based on the first order concepts, captured strategic alliances and creating business networks as fundamental to the aggregated dimension of strategic partnerships. The key proxy for addressing the research question under the linkage's innovative activity of the SOI model, is by examining the firm's value chain internally and externally.

The point of departure for examining the firm's value chain internal and external to the firm involves examining the firm's search, select, implement and capture shown in *figure 2.2* as discussed in the theoretical background under process innovative activity of SOI model(Adams et al, 2016, Tidd & Besant, 2014). The search, select, implement and capture provides a strong theoretical background in examining the overall overview of the firm's value chain. However, the key focus based on the analysis and results of the linkages activity of the SOI model is on two major themes: strategic partnerships and stakeholder value focus.

The results from the study noted a number of initiatives based on observations from respondents such as the firm's strategic alliance with other key stakeholders to take out waste which has an overall impact on carbon emission and usage of resources. Also, the results show engagement stakeholders through sharing of experiences, advancing research and innovation and dialogue with academia/universities as part of efforts to address usage of resources. The keynote for the firm's strategic alliance is that, the overall goal is to take-out waste on a specific timetable with other stakeholders (Tidd & Bessant, 2014). This view is noted by Ghassim that, "recognition and assimilation capabilities could also be enhanced by linkages between competitors or firms from different sectors within an industry…in this regard, both informal interactions via employee networks and formal collaborations in the form of strategic alliances have proved to be useful" (Ghassim & Foss 2018, p. 60). Nidumolu et al notes that, building collaborative capacity in the firm's value chain is imperative for enhancing alliances both economic actors and non-economic actors (Nidumolu & Rangaswami, 2009). Therefore, the analysis from the firm and its subsequent results based the firm's strategic alliances with other stakeholder to take out waste addresses the second research question.

Another proxy under the results for linkages pillar of the SOI model is concerning stakeholder value focus to mitigate carbon emissions and usage of resources. Stakeholder value focus is another theme identified in the analysis based on two sub-themes, stakeholder engagement and stakeholder value analysis. The focus regarding the discussion on the results for stakeholder value focus is through the lens of the firm's supply chain. This assertion is noted by Nidumolu et al that, "companies develop sustainable operations by analyzing each link in the value chain… first they make changes in obvious areas, such as supply chains, and then they move to less obvious suspects, such as returned products"

(Nidumolu & Rangaswami 2009, p. 4). Supply chain though has multiple connotations and definitions from a number of scholars, however the thesis defines supply chain as a complex chain of activities that generates the firm's value from the point of source of materials to the delivery of the final product to the key customers (Dhull & Narwal, 2016). According to documents review, the overall impact of the firm's supply chain is reflected in the firm's corporate social report as building a responsible supply chain (ASR report, 2018). However, the respondents for this study noted that, a continuous improvement of the supply chain especially addressing carbon emissions and usage of resources. The firm's approach to the supply chain is solely on cost, time and quality as noted by the respondents from this study.

Therefore, supply chain analysis is important in addressing the second research question on the firm's approach to build collaboration with external stakeholders to mitigate emissions or reduce waste and usage of resources. In the study, a respondent noted regarding standardization of documentation packages as beneficial for the firm in cutting down cost and also has a spillover effect on reducing carbon emissions. The firm also implemented the key environmental performance indicators in the supply chain to measure environmental footprint from front-end. This is the first step for the firm to implementing decarbonization within the firm.

5.1.3 Addressing the second sub-research question

According to Fagerberg et al 2005, "successful organization designs its structure to match its situation (Fagerberg et a, 2005, p. 119). Based on the results from the organizational design innovative activity of the SOI model and the theoretical framework, the discussion addresses the third sub-research question: *How does Aker Solutions organizational culture drive sustainability-oriented innovation for carbon emissions solutions in the oil and gas industry?* The discussion focuses on the organization structure as a driver for sustainability-oriented innovation for carbon emissions in the oil and gas industry. Lam in Fagerberg et al notes that, "continuous change and product innovations are supported by organizational structures that can be described as "semi-structures," a combination of mechanistic and organic features , that balance orders and chaos" (Lam , 2005, Fagerberg et al, 2005, p. 137).

The results from the thematic analysis in *figure 4.10* shows leadership drive, management approach and

management initiatives as second-order themes to the aggregated dimension of organizational structure. And based on the theoretical framework this discussion is under the auspice of organizational innovation. Organizational design has a directly influence on organizational transformation pillar of the SOI model through the firm's new opportunities that creates a shared value (Fagerberg et al, 2005, Adams et al, 2016).

The results in the study shows three second-order themes: leadership drive, management approach and management for the aggregated dimension organizational structure. Leadership drive and strategies influence the organizational transformation pillar of the SOI model (Adam et al, 2016, Hersey et al 2013). The study from the respondents observes that, leadership drive in the firm as a driver towards organizational transformation through strategies to forge a sustainable future for the oil and gas industry (Aker Solutions SR report, 2018). The leadership drive towards organizational transformation is transparent in the firm's vision based on the firm's values and inspirational communication (Tidd & Bessant, 2014). Leadership drive according to Hersey et al, who notes that, "studies of successful and unsuccessful organizational transformations have emphasized the decisive role of leadership in these situations and have given rise to the concept of transformational leadership, which is also termed visionary leadership , strategic leadership, or charismatic leadership" (Hersey et al, 2013, p. 300).

The study notes this strategic key leadership drive is behind the firm's strategic investment in offshore floating wind and the technological advancement of carbon capture and storage (CCS) to capture carbon emissions from the oil and gas, as well as to capture non-fossil industry emissions. As noted by Rip & Kemp, "technology is implicated in global climate change in various ways–as a source of the problem, a possible solution, and an instrument of measurement and analysis" (Rip &Kemp, 1997, p. 328). The strategic leadership drive in line with its values and vision is key to the threat of rising carbon emissions under the business as usual scenario in the oil and gas supply chain.

The assumption from scholars that, firms respond slowly and incrementally to environmental changes such as technological change, the firms still hold the power to influence and shape the technological changes (Lam, 2005, Fagerberg et al, 2015). Therefore, the firm's technological development of carbon capture and storage (CCS) is of great importance for present and future mitigation the impacts of climate

change caused by and large by greenhouse gases especially carbon dioxide in the atmosphere. Therefore, the leadership drive for sustainability-oriented innovations such as carbon, capture and storage and offshore floating wind is key to addressing the sub-research question. And this is noted by Nidumolu et al that, "leadership and talent are critical for developing a low-carbon economy" (Nidumolu & Rangaswami, 2009, p.12).

The study based on the results for the analysis captured management approach under the auspice of organizational structure important to addressing the sub-research question. According to Hersey et al, management is defined as, "the process of working with and through individuals and groups and allocating other resources (such as equipment, capital, and technology) to accomplish organizational goals" (Hersey et al 2013, p.3). The study notes that, an inclusive management approach that consolidates the top-down management approach is critical for the firm to address sustainability-oriented innovative solutions for carbon emissions and usage of resources. Some respondents noted a growing-base of the bottom-up approach that compliments top-down management commitments in the firm. This assertion is noted by Tidd & Bessant, "there is potential for employees to contribute to incremental innovation, especially around the processes on which they work…research regularly shows that this effect can have a huge cumulative impact" (Tidd & Bessant, 2014, p. 33).

Management initiatives on decarbonization in the oil and gas industry is crucial for the firm's value chain. As already discussed, solutions for addressing carbon emissions takes a radical organizational transformation approach. The study noted according to the respondents that; management initiatives are visible as shown by management commitment towards decarbonization by advancing the CCS technology through Just Catch initiatives. Nidumolu et al noted regarding management initiatives that, "two enterprise wide initiatives help companies become sustainable…when a company's top management team decides to focus on the problem, change happens quickly" (Nidumolu & Rangaswami, 2009, p. 12).

In summing up the chapter, it is imperative to note that the key research questions are addressed through the synthesis of the sustainability-oriented innovation model activities in tandem to the pillars of the

SOI model. The innovative activity of strategy of the SOI within the firm in addressing innovative solutions for carbon emissions and usage of resources. The discussion addressed the key research question based on the results and the theoretical background involved two innovative activities of the SOI model: strategy and process that reflected the operational optimization and organization transformation pillar of the SOI model. The key themes discussed for strategy and process involved optimized low carbon solutions, business model innovation, digitization as key to addressing the key research question. The keynote on strategy innovative activity was the firm's vision.

The study in addressing the second research, showed learning innovative activity as a precursor to the linkage's innovative activity of the SOI model. The discussion on learning and linkages complimented each other and involved these key themes: knowledge acquisition, learning and development, strategic partnerships and stakeholder value focus. The study addressed under the learning and linkages innovative activities reflected the operational optimization and organization transformation. The keynote was the supply chain as the driver for the value chain and key to addressing carbon emissions and usage of resources.

The study discussed organizational design innovative activity of the SOI model which captured key themes: leadership drive, management approach and management initiatives as key drivers to organization transformation to address the third research question.

6 Chapter 6: CONCLUSIONS AND MANAGERIAL IMPLICATIONS

The aim and purpose of the thesis was corroborating the sustainability-oriented innovation (SOI) through theory confirmation using a single case study. According to Adams et al, single-case studies have the ability for providing insight with novel or under-explored phenomena(Adams et al, 2012). Sustainability-oriented innovation is an under-explored study, however, the theoretical framework of sustainability-oriented innovation defined sustainability-oriented a deliberate change in the firm's business methodology by adopting a triple-bottom line approach to its daily operations. The unit of analysis for the thesis is Aker Solutions, an oil and gas service company. Therefore, the thesis objective was corroborating the sustainability-oriented innovation through theory confirmation for carbon solutions in Aker Solutions value chain.

The point of departure for thesis was a discussion on the background of study a precursor for the problem statement of the thesis. The background study involved a pragmatic approach to the current discourse on the rising carbon dioxide emissions to the atmosphere due to humans induced activities and climate change. A generic discussion on the drivers of the carbon emission was posited by analyzing energy intensity, through energy demand and consumption to foster economic growth as key drivers. The thesis corroborated the energy scenario that is current scenario, new policy scenario and sustainable development scenario with Aker Solutions future emissions under the scenarios by the IEA. The pragmatic background of study was key to analyzing the problem statement.

Therefore, the formulation of the problem statement is noted from the background of study on global carbon emissions intensity. The literature that connotes directly to the framework of sustainability-oriented model thus far has focused on building a sustainable business case using the framework by analyzing the main pillars of the SOI model: operational optimization, organizational transformation and systems building (Adams et al, 2012, Adams et al 2016, Tura, 2018). However, the thesis approach was corroborating the sustainability-oriented innovation model by analyzing the innovative activities of the sustainability-oriented model that is, strategy, process, learning, linkages and organizational design with a focus on reducing carbon emissions in the unit of analysis value chain. This research approach in regard to the literature is novel by in analyzing the innovative activities of the SOI model.

Furthermore, the approach unveils the gaps in literature and also addresses recommendations for future studies by providing indicative activities for each pillar of the SOI and empirically attesting the framework as a developed model (Adams et al, 2012, Adams et al 2016).

Based on the empirical background of study and the problem statement, research questions for the thesis were unveiled. The key research questions included addressing following research questions:

1. What drives sustainability-oriented innovative solutions for carbon emissions in Aker Solutions? The aim and objective of the research question was a cross-examination of the drivers of sustainability-oriented innovative solutions for addressing carbon dioxide in Aker Solutions.
2. How does Aker Solutions build collaboration with external stakeholders to reduce carbon emissions or reduce waste and usage of resources? The aim and objective for the research question was the analysis of the value chain involving stakeholders to co-create innovative solutions for carbon emissions reducing waste and usage of resources.
3. How does Aker Solutions organizational culture drives sustainability-oriented innovation for carbon emissions solutions in the oil and gas industry? The aim and objective of the research question was to examine the organizational culture through organizational structure and leadership as key proxies for driving the sustainability-oriented innovation for carbon solutions from the oil and gas industry perspective.

Therefore, the thesis addressed the research questions by examining theoretically the overall framework of sustainability-oriented innovation. As the point of departure, the thesis addressed the overall conceptual scope of sustainability defined by the Brundtland as “the development that meets the needs of the present, without compromising the ability of future generations to meet their own needs” (Brundtland 1987, p. 43). The thesis also addressed the two economic paradigms of strong and weak sustainability (Neumayer, 2013, Diet & Neumayer 2015). The thesis posited on the strong economic paradigm of sustainability that resonated to the thesis framework.

Innovation was theorized and particularly organizational innovation which was a precursor to the main theoretical framework for the unit of analysis the firm. The synergies of sustainability and innovation makes sustainability as the new driver of innovation (Nidumolu & Rangaswami, 2009, Adams et al 2012). Therefore, sustainability-oriented innovation theorized by Adams et al was the main theoretical framework for the thesis. Sustainability-oriented innovation defined as deliberate strategic changes to the firm's business model philosophy and organizational values that captures people, planet and profit in the firm's value chain regarding its product, processes or practice.

The thesis contributed to the theory development by thematically analyzing the innovative activities of the SOI framework. Furthermore, the theoretical framework of sustainability-oriented innovation, the thesis abductively applied the sustainability-oriented innovation model which encompasses three main pillars: operational optimization, organizational transformation and systems building. The sustainability-oriented innovation model also encompasses five innovative activities: strategy, process, learning, linkages and organizational design. The choice for applying the sustainability-oriented framework is based on future study recommendation and argument that, "we argue that, by understanding how organizations can become sustainable, pragmatically oriented SOI-related research has the potential positively to influence organizational behaviour: our model provides a strong basis for such influence" (Adams et 2016, p.199). The thesis aims and purpose was empirical corroboration of the sustainability-oriented innovation model through theory confirmation by applying it in a single case-study analysis. However, the focus for the thesis was sustainability-oriented innovative solutions for carbon emissions in Aker Solutions value chain.

Single-case study is premised on the optimum test of a significant theory (Yin, 2014, Brotherton, 2008). Therefore, based on the epistemological and ontological philosophical assumption, qualitative research approach was applied as a key methodological framework for addressing the research questions. The techniques for data collection for the thesis was through a semi-structured and unstructured face to face interview process. The thesis purposive sample selection and population resonated the innovative activities of the sustainability-oriented innovation model: strategy, process, learning, linkages and organizational design of functional key respondents in the unit of analysis.

The thesis data analysis and reduction were conducted using Nvivo qualitative analysis software. The data collected through interview transcript was then exported to Nvivo qualitative analysis software. Thereafter, nodes on the innovative activities of sustainability-oriented innovation model were created to capture the key themes from the transcribed interview in Nvivo. The nodes on strategy, process, learning, linkages and organizational design reflecting the innovative activities of the SOI model were created.

The thesis data analysis was based on the thematic analysis which encompassed the first-order concepts, second-order themes and aggregated dimensions (Corley & Gioia, 2004, Essamri et 2019, Attride-Sterling, 2001). The thesis analyzed data on each node created using Nvivo qualitative analysis software. The point of departure for the analysis in involved capturing themes in Nvivo using word cloud frequency results query and an illustration of the themes in a word cloud was presented for each of the five innovative activities of the SOI model. This allowed the researcher to gain the key concepts from the functional key respondents. A thematic analysis followed using a data structure map constructs involving the analysis of the first-order themes, second-order themes and aggregated dimensions for each of the innovative activity of the SOI model. An interpretation of the key concepts in the thematic analysis to describe the constructed was presented for each thematic analysis of the five innovative activities of the SOI model.

The thesis discussed the results based on the theoretical framework of sustainability-oriented innovation, and data presentation in tandem to addressing the research questions. The results discussion addressed the research question by identifying the innovative activities in tandem to the pillars of the SOI model. The results strategy and process addressed the first research question on drivers for innovative solutions for carbon emissions in Aker Solutions. The results reflected the operational optimization and organizational transformation as the main pillars. Whereas, learning and linkages were complimentary in addressing the second research question for building collaborations with stakeholders to reduce carbon emissions and usage of resources. This similarly reflected operational optimization and organizational transformation as the main pillars of the SOI model. The thesis discussed the third

research issue by organizational design innovative activities as the key proxy analyzing through the lens of organizational transformation pillar of the SOI model. Furthermore, the results showed that, systems building pillar of the SOI model was note represented and there was no empirical evidence for systems building. This conclusion is consistent with both the lack of literature focus and lack of evidence of systems building practice (Adams et al, 2012). Therefore, the discussion conclusion noted the existence of innovative activities in the unit of analysis operating on the operational optimization and organizational transformation pillar of the SOI model.

6.1 Findings

The main finding for this thesis shows that, innovative activities for operational optimization, organizational transformation exist to some extent within the firm, however, the innovative activities for the third pillar of the SOI model systems building does not exist in Aker Solutions. Therefore, the conclusion in this thesis is that, there is no evidence in the internal practice of systems building of the SOI model in *figure 2.1* based on the empirical data. The finding in the firm corresponds with the study on SOI theoretical framework conclusions findings which showed 0% focus on the systems building pillar of the SOI model, 28% is focused on organizational transformation, 70% is focused on operational optimization and 2% a mix of organizational transformation and operational optimization (Adams et al, 2012). Adams et al further noted that, a fully-fledged sustainable company does not exist unless innovative activities for systems building pillar of the SOI model are implemented (Adams et al, 2012).

The thesis also finds at the strategic innovative activity of the SOI model, cost reduction approach within the firm as a key driver for innovative solutions to reduce carbon emissions and usage of resources implicitly. The cost approach dominates the firm's operational optimization through the application of value analysis and value engineering (VAVE). As discussed on operational optimization, value analysis and value engineering by definition and function carters for a spectrum of the process innovative activities but chiefly it mainly serves the firms cost reduction approach in tandem to operational

improvements to processes and systems (Nick & Holweg, 2000, Mandelbaum, 2006). Furthermore on value analysis and value engineering and cost reduction, Mandelbaum noted that, "because "costs" are measurable, "cost reduction" is often thought of as the sole criterion for a VE application, and indeed, cost reduction …it is, however, important to recognize that value improvement is the real objective of VE, and that may not result in an immediate cost reduction" (Mandelbaum, 2006, p. 2). It is imperative to note that the thesis did not delve into analyzing the results of value analysis and value engineering (VAVE) in terms of its environmental impact. However, the application of VAVE is the driver of operational optimization representing the process and strategy innovative pillar of the SOI model.

The thesis findings regarding the process innovative activity to measures the environmental footprint is that, while the process to monitor environmental impacts is reflected in the social report and implemented through the KEPI's, there is lack of tools to measure the products lifecycle. Nidumolu et al notes that the application of life-cycle assessment tools helps to captures the firms value chain operation activities inputs and outs from beginning of life , through to the middle of life and end of life of products (Nidumolu & Rangaswami et al, 2009, Schiederig et al, 2011, Mashayekhi et al, 2012, Yang et al, 2017). However, the internal engineering design tools such as solidworks has the provision to measure the life-cycle assessments metrics on environmental footprint (LCA).

The findings of the thesis under the organizational design innovative activity posits the firm's organizational structure exists under the auspice of professional bureaucracy that is flat functional and market-based organization structure in the oil and gas industry (Mintzberg, 1979). According to Child, organizational structure is defined as "the formal allocation of work roles and administrative mechanism to control and integrate work activities including those which cross formal organizational boundaries" (Child, 1972, p. 2). The thesis finding indicates that the firms organizational design innovative activity is a key custodian of the firm's strategy, process, learning and linkages innovative activities of sustainability-oriented innovation model. This implies that, the firms functional and market-based organizational structure is imperative to drivers for innovative solutions for carbon emissions and usage of resources in its value chain. Famously put, "structure and strategy are managerial choices" (Richter & Anna, 2014, p. 800) This view is evidenced by the leadership strategic decision-making on low carbon energy and decarbonization through the strategic approach to invest in offshore floating wind and

advancing carbon, capture and storage technology. This strategic approach is driven by the firm's leadership in tandem to the firm's organizational values and inspirational communication to "to be a leader in forging sustainable solutions to the industry and the world it serves" (Aker Solutions SR Report, 2018).

6.2 Managerial Implications.

The thesis managerial implications for practice should focus on the strategic adoption of the sustainability-oriented innovation as a key strategic approach towards building a sustainable business portfolio. The study shows evidence of the firm's presence two of the three main pillars of the sustainability-oriented innovation (SOI) model. The three main pillars as discussed are: operational optimization, organizational transformation and systems building. While the thesis focus framework was analyzing activities under the three pillars of the SOI model, the managerial implication should focus on building dynamic capabilities for the SOI model pillars especially on organizational transformation and systems building that creates a pathway for a circular economy with net positive shared value. Therefore, adoption and application of the SOI model as strategic approach should build a strong case for creating a sustainability business portfolio in Aker Solutions.

The managerial implications for practice to the firm must focus on operational optimization pillar of the SOI model for innovative solutions carbon emissions internal to the firm. Operational optimization can be more enhanced by the firm by implementing sustainability value chain life-cycle assessment tools (LCA) that can complement the internal front-end environmental key performance indicators (KEPIs) to measure carbon footprint. Based on recent empirical studies in academia , the following life cycle assessment tools are recommended for implementation at the concept phase and design: GaBi LCA software , user friendly for all professionals to manage data, SimaPro LCA software, Solidworks sustainability tool and Packaging Impact Quick Evaluation Tool (PIQET) software for packaging environmental impact (Ma & Moultrie, 2017, Nidumolu & Rangaswami, 2009, Leong & Cheung, 2017, Ingarao et al 2017).

Another managerial implication involves the decoupling of cost reduction approach and emissions

reduction approach in the firm's value chain. There is strong evidence of cost reduction in the firm implicitly reducing the usage of resources which overall impacts the environmental footprint and carbon emission. However, the measurement of carbon emissions relating to the reduced usage of resources through cost reduction approach is not captured. Therefore, metrics for reduced resource use should be captured in tandem with measure of carbon dioxide reduced through the cost reduction approach.

Furthermore, implementation of a low carbon business approach internal to Aker Solutions. This could be done through establishing a bottom-up low-carbon culture across the Aker Solutions business units. Building an internal low-carbon culture will require a mindset change through communication and leadership. Therefore, a platform for eco-business within the journey plan management where possible should be implemented. Another approach on building an internal low-carbon culture is by reducing the manhours for office travel, a rotational plan for telecommuting and teleworking could be devised (Nidumolu & Rangaswami, 2009). The recommendation for Managers is to develop and customize a carbon footprint calculator within the internal systems.

Another implication for Managers is infographics for carbon emissions and energy consumption should be visualized per capita for employees on Aker Solutions intranet. This implication should be completed by knowledge acquisition on learning and development platforms on low-carbon mindset training. The transition to a low-carbon future for the firm, it is imperative for employees to be have the knowledge both internal and external to the firm.

6.3 Limitations

The thesis limitation is varied in the research process. One of the limitations was concerning data collection from suppliers inside the firm's value chain. The insight was to get an overview on collaborations on aims to reduce carbon emissions between the firm and its suppliers. No supplier was available for the data collection phase. Therefore, the dearth of participation of suppliers inside the value chain impacted the thesis research analysis phase to capture suppliers' perspectives on building innovative collaborations to reduce carbon emissions and usage of resources in the firm value chain.

The limitations concerning tools for qualitative analysis posed a big challenge for the thesis. This was mainly due lack of detailed training in the know-how on the options for analyzing data qualitatively. Furthermore, the sources for locating the right framework for qualitatively analysis was not the easy to locate in the echelons of academic data analysis literature.

The third limitation of the thesis is regarding the generalizability of the study due to a limited sample size of only 7 employees were purposively selected as part of data collection techniques. The company has over 14,000 employees across the globe and the study therefore does not generalize the findings on all the 14,000 (Aker Solutions SR report, 2018). However, the objective for the thesis was achieved to corroborate the SOI model framework through theory confirmation using a single case-study.

6.4 Suggestions for Future Study

The thesis suggestion for future study is applying a quantitative cross-sectional multiple case- study focusing on the innovative activities of the SOI model. This future research should aim to capture the metrics on each innovative activity of the SOI model and mapping the activities with pillars of the SOI model. Although the SOI model provides an overview, we need to obtain more data on how firms can transfer their strategy, process, learning, linkages and organization design to achieve systems building pillar of the SOI model. This transition requires tools and collect real numbers with a quantitative study.

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Annexures 1: Interview Protocol Guide

No.	QUESTIONS	STRATEGY	PROCESS	LEARNING	LINKAGES	ORG DES
1	How does Aker Solutions define sustainability, what does the sustainability concept actually means for you?	✓	✓	✓	✓	✓
2	Please describe Aker Solutions strategy in addressing carbon emissions and usage of resources for reducing waste.	✓				
3	Does Aker Solutions have product and process sustainability strategy to mitigate carbon emissions?	✓				
4	Please can you provide some examples of innovative solutions for aims to reduce carbon emissions or reduce waste?		✓			
5	Do you use some application of smart technologies to reduce carbon emissions or reduce resource usage and what other instruments do you use?		✓			
6	How is Aker Solutions developing a sustainable product portfolio that builds on competitive advantage and capture value that is economic, social and environmental?		✓			
7	Is Aker Solutions engaged in new business platforms that promotes sustainability?		✓			
8	How do you learn ?			✓		
9	How is the knowledge about sustainability processes transferred inside the organization?					
10	Does Aker Solutions build collaboration with external stakeholders to mitigate emissions or reduce waste and usage of resources?				✓	
11	To what extent external stakeholders impact the culture of organization in terms of sustainable development?				✓	
12	How is Aker Solutions supply chain involved with working with stakeholders to mitigate carbon emissions in the value chain?				✓	
13	How does the Organization structure enhance innovative solutions for mitigating carbon emissions in the value chain?					✓