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## Abstract

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Ghana as a developing country has some challenges for the future. These challenges include an energy crisis, a high dependence on firewood and high levels of poverty. Biogas technology has the potential to make a contribution in solving these challenges, but is not yet widely implemented in Ghana. For this reason, the aim of this thesis was to find ways to increase the use of biogas technology in Ghana. To do this, a business model for community based biogas enterprises was created which was based on Ghanaian cultural values and by that included the most appropriate complexity and scale of biogas technology. To arrive at a representation of Ghanaian culture, a field study was done in which thirteen SMEs were visited. Data were collected by in-depth interviews and participatory observation. For the cultural analysis, a model was made based on cultural dimensions by Hofstede and Trompenaars. The model consisted of six dimensions which were given a score between one to five. Based on these scores, the degree in which a civil society and innovative entrepreneurship are present in Ghana were determined. A multi criteria analysis was done to find the most appropriate form of biogas technology in a Ghanaian business setting. The feedstock availability of an average Ghanaian community was assessed to find the most feasible alternative and determine the size of the digester. Various value propositions were compared on their economic viability by calculating their NPV, IRR and DPB. The major findings of this research were that the garage-type digester was the most appropriate digester design, fed with only crop residues available from the community. For an average community size of 491 people, a digester size of 67 m<sup>3</sup> would be needed. The best value proposition was concluded to be collecting all the available crop residues from within the community with a cargo tricycle, digesting the crop residues in a garage-type digester, using the produced biogas to generate electricity, selling it to the grid, and drying the digestate and selling it as organic fertilizer. The cultural analysis and discussion showed that additional training for the workforce would be required in cooperation, dialogue, proper work ethic, due planning and precision in labor.



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## List of figures

FIGURE 1. SCHEME OF A FIXED-DOME PLANT .....	19
FIGURE 2. SCHEME OF A FLOATING-DRUM PLANT .....	19
FIGURE 3. SCHEME OF A BALLOON DIGESTER .....	20
FIGURE 4. SCHEME OF A GARAGE-TYPE DRY DIGESTION PLANT.....	21
FIGURE 5. TEMPORAL GAS PRODUCTION IN PARALLEL OPERATION OF DIFFERENT BATCH DIGESTERS.....	21
FIGURE 6. THE CONCEPTUAL FRAMEWORK AS USED FOR THIS THESIS RESEARCH .....	30
FIGURE 7. SQUARE COMMUNITY AREA ABCD WITH N FEEDSTOCK SOURCES.....	33
FIGURE 8. RESULTS OF THE CULTURAL ANALYSIS FOR THE DIMENSION HIERARCHY VS EGALITARIANISM.....	40
FIGURE 9. RESULTS OF THE CULTURAL ANALYSIS FOR THE DIMENSION COMMUNITARIANISM VS INDIVIDUALISM.....	41
FIGURE 10. RESULTS OF THE CULTURAL ANALYSIS FOR THE DIMENSION PARTICULARISM VS UNIVERSALISM. ....	43
FIGURE 11. RESULTS OF THE CULTURAL ANALYSIS FOR THE DIMENSION TRADITIONALISM VS VOLUNTARISM. ....	44
FIGURE 12. RESULTS OF THE CULTURAL ANALYSIS FOR THE DIMENSION SYNCHRONIC VS SEQUENTIAL TIME ORIENTATION .....	46
FIGURE 13. RESULTS OF THE CULTURAL ANALYSIS FOR THE DIMENSION ASCRIBED VS ACHIEVED STATUS. ....	48
FIGURE 14. THE DEGREE OF A CIVIL SOCIETY AND INNOVATIVE ENTREPRENEURSHIP IN GHANAIAN BUSINESS CULTURE .....	48
FIGURE 15. RANKING OF THE SELECTED DIGESTER DESIGNS ON RELATIVE COMPLEXITY.....	53
FIGURE 16. THE ESTIMATED CORRESPONDING AREAS FOR DIFFERENT COMMUNITY SIZES.....	55
FIGURE 17. THE RELATION BETWEEN THE COLLECTION AREA AND THE DISTANCE OF THE FEEDSTOCK COLLECTION TRIP .....	55
FIGURE 18. THE ESTIMATED CORRESPONDING DIGESTER SIZES FOR DIFFERENT COMMUNITY SIZES .....	57
FIGURE 19. OPTIONS FOR REVENUE CREATION: A) SELLING BIOGAS IN BACKPACKS; B) SELLING ELECTRICITY TO THE GRID.....	62
FIGURE 20. POSSIBLE VEHICLES FOR TRANSPORT: A) TRUCK; B) VAN; C) CARGO TRICYCLE.....	63
FIGURE 21. THE RELATION BETWEEN THE NUMBER OF SOURCES AND THE DISTANCE OF THE FEEDSTOCK COLLECTION TRIP. ....	75
FIGURE 22. FISHPONDS FOR CATFISH AND TILAPIA .....	83
FIGURE 23. BREEDING TANKS FOR CAT FISH FINGERLINGS.....	84
FIGURE 24. OSTRICHES AT KUMAH FARMS.....	85
FIGURE 25. THE COURTYARD OF NUAMAH ENTERPRISE WHERE THE PAINT IS STORED AND ALL OPERATIONS TAKE PLACE. ....	87
FIGURE 26. OPERATIONS INVOLVE MOVING PAINT FROM THE LARGE CONTAINERS IN THE BACKGROUND INTO SMALLER ONES.....	88
FIGURE 27. THE MIXING EQUIPMENT AT NUAMAH ENTERPRISE.....	89
FIGURE 28. A SCENE FROM ONE OF FAMILY STAR'S LATEST MOVIES: AN ACTION FILLED ZOMBIE SHOOTER .....	91
FIGURE 29. DURING THE SHOOTING OF ROAD ATTACKERS. ROSALINDA AND THE DIRECTOR BEHIND THE CAMERA .....	92
FIGURE 30. THE CHEMICALS ARE MIXED AND POURED IN A CONTAINER TO PRODUCE LATEX FOAM.....	95
FIGURE 31. THE CHEMICALS ARE MEASURED BY USING A BUCKET. ISSAH (LEFT) IS WATCHING HIS EMPLOYEES. ....	95
FIGURE 32. EQUIPMENT AT MANCO .....	96
FIGURE 33. KOBY FROM THE SALES TEAM VISITING A FURNITURE MAKER.....	97
FIGURE 34. STUDENTS AT KITA PLANTING CARROT SEEDS AND WATERING THE GROUND .....	100
FIGURE 35. STUDENTS ADDING WORMS TO THE COMPOST AS PART OF A PERMACULTURE CLASS ON VERMICOMPOSTING .....	101
FIGURE 36. SAMUEL OWUSU-TAKYI, KITA'S ACTING DIRECTOR .....	102
FIGURE 37. GEORGE ANSAH, THE FORMER PROJECTS MANAGER AT KITA .....	103
FIGURE 38. PRINCE, A STUDENT AT KITA, COOKING HIS LUNCH ON A BIOGAS FIRED COOKING STOVE. ....	104
FIGURE 39. A TYPICAL WAY OF SERVING A GHANAIAN DISH. ....	106
FIGURE 40. THE INTERIOR OF ROYAL CHEF.....	107
FIGURE 41. THE COOKS DISHING UP FOOD. ....	108
FIGURE 42. A YOUNGER NANA DURING A TRADITIONAL RITUAL CONCERNING HIS DUTIES AS CHIEF. ....	108
FIGURE 43. THE ENTRANCE OF THE PIONEER AT ADUM, KUMASI.....	112
FIGURE 44. THE FRONT AND BACK PAGE OF THE PIONEER .....	113
FIGURE 45. THE MIDDLE PAGES OF THE NEWSPAPER WITH A FUNERAL ADVERTISEMENT OF HALF A PAGE. ....	114
FIGURE 46. A VENDOR SELLING NEWSPAPERS WHILE WALKING BETWEEN CARS.....	115
FIGURE 47. TERRACOTTA'S LOCATION LOOKING OUT OVER CENTRAL MARKET .....	117
FIGURE 48. APPRENTICES WORKING IN THE WORKSHOP OF TERRACOTTA. ....	118
FIGURE 49. TYPICAL GHANAIAN SLIPPERS .....	119
FIGURE 50. END OF THE LINE AT THE ABATTOIR .....	122

FIGURE 51. LINE WORKERS PREPARING THE CARCASS. ....	123
FIGURE 52. LANDLORDS AT THE CATTLE MARKET NEXT TO THE ABATTOIR. ....	125
FIGURE 53. THE BIOGAS PLANT UNDER CONSTRUCTION IN DECEMBER 2015 ....	125
FIGURE 54. A WATON KYINI, ALREADY DECORATED WITH A TEXT ON THE BACK. ....	128
FIGURE 55. A MATE CALLING FOR PASSENGERS ....	129
FIGURE 56. TAXIS AT A STATION IN KUMASI IN 1995 ....	130
FIGURE 57. A TROTRO STATION IN KUMASI. ....	130
FIGURE 58. NANA BOAMEH TOGETHER WITH THE AUTHOR. ....	131
FIGURE 59. THE BIOGAS DIGESTER AT TIP TOP FARMS. ....	134
FIGURE 60. RENEWABLE ENERGIES AT TIP TOP FARMS. ....	135
FIGURE 61. EDWARD KOFI AHIABOR. ....	136
FIGURE 62. SENA NEXT TO THE TOMATO PULPER. ....	139
FIGURE 63. THE WASTE AND EXCESS TOMATOES ....	140
FIGURE 64. SENA IN THE STORAGE ROOM WITH THE FINISHED PRODUCT ....	141
FIGURE 65. ETHNIC GROUPS FISHING ALONG THE COAST OF GHANA. ....	143
FIGURE 66. A BEACH-SEINE NET, AS USED BY HORTOR FISHING COMPANY. ....	144
FIGURE 67. FISHERMEN PULLING THE NET OF HORTOR FISHING COMPANY. ....	145
FIGURE 68. THE RESULT OF A COUPLE OF HOURS REELING IN THE NET. ....	146
FIGURE 69. DISTRIBUTING THE FISH OVER MULTIPLE STACKS. ....	146

## List of tables

TABLE 1. NUMBER OF BIOGAS PLANTS IN GHANA, TANZANIA, KENIA, INDIA AND CHINA. ....	3
TABLE 2. COMPOSITION OF BIOGAS .....	14
TABLE 3. THERMAL STAGE AND TYPICAL RETENTION TIMES .....	15
TABLE 4. METHANE YIELDS FOR COMMON GHANAIAIN FEEDSTOCKS .....	16
TABLE 5. THE BUSINESS MODEL CANVAS .....	24
TABLE 6. BIOGAS POTENTIAL OF SELECTED RESIDUES IN GHANA.....	27
TABLE 7. PRICES OF PRODUCTS FOR WHICH A CBBE COULD SUBSTITUTE FOR .....	29
TABLE 8. DATA-INPUT TABLE OF THE MCA FOR RANKING THE FOUR SELECTED DIGESTER DESIGNS FROM SIMPLE TO COMPLEX .....	32
TABLE 9. THE SMEs VISITED DURING THE FIELD RESEARCH .....	36
TABLE 10. RANKING OF THE FOUR SELECTED DIGESTER DESIGNS .....	52
TABLE 11. MINIMUM NUMBER OF LIVESTOCK AND DAILY YIELD OF CROP RESIDUE NEEDED PER FEEDSTOCK SOURCE .....	56
TABLE 12. FEEDSTOCK AVAILABILITY PER CAPITA AND FOR AN AVERAGE COMMUNITY OF 491 PEOPLE IN GHANA. ....	57
TABLE 13. EXPLANATION ON THE DIFFERENT ALTERNATIVES FOR FEEDSTOCK AVAILABILITY. ....	59
TABLE 14. DIGESTER SIZES AND THE RELATED IN- AND OUTPUTS FOR DIFFERENT ALTERNATIVES.....	59
TABLE 15. ECONOMIC COMPARISON OF THE TWO SELECTED OPTIONS TO CREATE REVENUE FROM BIOGAS. ....	62
TABLE 16. FINANCIAL COMPARISON OF THREE COMMON GHANAIAIN VEHICLES, TO POTENTIALLY BE USED FOR FEEDSTOCK COLLECTION. ...	63
TABLE 17. COMPARISON OF THE NPV, IRR AND DPB FOR THE DIFFERENT FEEDSTOCK ALTERNATIVES. ....	64
TABLE 18. INITIAL INVESTMENT AND ANNUAL CASHFLOW OF A CBBE IN GHANA. ....	68
TABLE 19. CALCULATIONS OF THE NPV, IRR OVER A PERIOD OF 20 YEARS AND THE DPB FOR A CBBE IN GHANA, ....	69
TABLE 20. RESULTS ON RELATIVE COMPLEXITY OF DIGESTER DESIGN ASSUMING ALTERNATIVE WEIGHING FACTORS. ....	73
TABLE 21. EFFECT OF USING OTHER ASSUMPTIONS ON THE FEASIBILITY OF THE BUSINESS MODEL .....	76
TABLE 22. SCORES OF KUMAH FARMS ON THE CULTURAL DIMENSIONS. ....	85
TABLE 23. SCORES OF NUAMAH ENTERPRISE ON THE CULTURAL DIMENSIONS .....	89
TABLE 24. SCORES OF FAMILY STAR ENTERTAINMENT ON THE CULTURAL DIMENSIONS .....	93
TABLE 25. SCORES OF MANCO INDUSTRIES ON THE CULTURAL DIMENSIONS .....	98
TABLE 26. SCORES OF KITA ON THE CULTURAL DIMENSIONS .....	104
TABLE 27. SCORES OF ROYAL CHEF ON THE CULTURAL DIMENSIONS.....	109
TABLE 28. SCORES OF THE PIONEER ON THE CULTURAL DIMENSIONS.....	115
TABLE 29. SCORES OF TERRACOTTA ON THE CULTURAL DIMENSIONS .....	119
TABLE 30. SCORES OF THE KUMASI ABATTOIR COMPANY LTD ON THE CULTURAL DIMENSIONS.....	126
TABLE 31. SCORES OF STAR COMPANY ON THE CULTURAL DIMENSIONS .....	131
TABLE 32. SCORES OF TIPTOP FARMS ON THE CULTURAL DIMENSIONS .....	136
TABLE 33. SCORES OF TIPTOP FOODS ON THE CULTURAL DIMENSIONS.....	141
TABLE 34. SCORES OF HORTOR FISHING COMPANY ON THE CULTURAL DIMENSIONS.....	146
TABLE 35. DATA ON MANURE AVAILABILITY IN GHANA. ....	152
TABLE 36. DATA ON THE BIOGAS POTENTIAL OF MANURE IN GHANA .....	152
TABLE 37. DATA ON CROP RESIDUE AVAILABILITY IN GHANA.....	153
TABLE 38. DATA ON THE BIOGAS POTENTIAL OF MANURE IN GHANA .....	154
TABLE 39. DATA ON MUNICIPAL WASTE AVAILABILITY AND THE ASSOCIATED BIOGAS POTENTIAL. ....	154



## List of abbreviations

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AD	Anaerobic Digestion
BMC	Business Model Canvas
CBBE	Community Based Biogas Enterprise
CSTR	Continuously Stirred Tank Reactor
DPB	Discounted Payback period
ECG	Electricity Company Ghana
IRR	Internal Rate of Return
KITA	Kumasi Institute of Tropical Agriculture
MCA	Multi Criteria Analysis
MFP	Multi-Functional Platform
MLW	Municipal Liquid Waste
MSW	Municipal Solid Waste
MW	Mega Watt
MoE	Ministry of Energy
MoFA	Ministry of Food and Agriculture
NPV	Net Present Value
SME	Small and Medium Enterprise
SSD	Solid State Digestion
TS	Total Solids
UASB	Upflow Anaerobic Sludge Blanket digester
VFA	Volatile Fatty Acids
VS	Volatile Solids

# Contents

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Abstract .....	iii
Acknowledgements .....	iv
List of figures .....	vi
List of tables .....	viii
List of abbreviations .....	ix
Contents .....	x
1. Introduction .....	1
1.1. Background .....	1
1.1.1. Ghana .....	2
1.1.2. Biogas technology .....	2
1.1.3. Biogas in Ghana .....	3
1.2. Research problem .....	3
1.3. Goal and scope .....	4
1.4. Research questions .....	5
1.5. Thesis outline .....	5
2. Theoretical Framework.....	6
2.1. The role of cultural values in development.....	6
2.1.1. The development debate and technology transfer .....	6
2.1.2. The role of entrepreneurship linked with innovation .....	7
2.1.3. Capacity building for innovative entrepreneurship.....	7
2.1.4. Cultural differences and value dimensions .....	8
2.1.5. Civil society.....	10
2.2. The cultural model .....	10
2.2.1. Hierarchy versus Egalitarianism .....	11
2.2.2. Communitarianism versus Individualism.....	11
2.2.3. Particularism versus Universalism .....	12
2.2.4. Traditionalism versus Voluntarism .....	12
2.2.5. Synchronic versus Sequential time orientation .....	12
2.2.6. Ascribed versus Achieved status .....	13
2.2.7. The degree of a civil society and innovative entrepreneurship.....	13
2.3. Design and complexity of biogas technology .....	13
2.3.1. The anaerobic digestion process .....	13
2.3.2. Process parameters .....	14
2.3.3. Selected digester designs and their strong and weak points .....	17
2.3.4. Complexity of biogas technology .....	21
2.4. Community based biogas enterprises .....	22
2.4.1. Definitions and examples of biogas enterprises.....	22
2.4.2. Components of a community based biogas enterprise .....	23
2.5. Conceptual framework .....	30

3.	Methodology .....	31
3.1.	Setup of the study.....	31
3.1.1.	Performing the cultural analysis.....	31
3.1.2.	Ranking the digester designs on relative complexity .....	32
3.1.3.	Calculations for the technical analysis.....	32
3.1.4.	Calculations for financial assessment of the value propositions .....	35
3.2.	Selection of case studies for the cultural analysis.....	35
3.3.	Data collection .....	37
3.3.1.	Literature study .....	37
3.3.2.	In-depth interviews .....	37
3.3.3.	Participatory observation .....	37
4.	Cultural analysis.....	38
4.1.	Ghana's cultural profile.....	38
4.1.1.	Hierarchy versus egalitarianism .....	38
4.1.2.	Communitarianism versus individualism.....	40
4.1.3.	Particularism versus universalism .....	41
4.1.4.	Traditionalism versus voluntarism .....	43
4.1.5.	Synchronic versus sequential time orientation .....	44
4.1.6.	Ascribed versus achieved status.....	46
4.1.7.	The degree of a civil society and innovative entrepreneurship.....	48
4.2.	Cultural implications for a CBBE in Ghana .....	49
5.	Technical analysis .....	51
5.1.	Comparison of possible digester designs on their relative complexity .....	51
5.2.	Infrastructure in Ghana.....	53
5.3.	Community size and transport of feedstock .....	54
5.4.	Digester size .....	56
5.5.	Digester in- and output for different alternatives.....	58
6.	Design of a business model for a CBBE .....	61
6.1.	Financial assessment of possible value propositions and feedstock alternatives.....	61
6.1.1.	Selling biogas in backpacks or selling electricity to the grid .....	62
6.1.2.	Vehicle for transport .....	63
6.1.3.	NPV, IRR and DPB of the different feedstock alternatives .....	63
6.2.	Business model proposal for a CBBE.....	65
6.2.1.	Customer segments.....	65
6.2.2.	Channels.....	65
6.2.3.	Customer relationships .....	65
6.2.4.	Key resources .....	65
6.2.5.	Key activities.....	67
6.2.6.	Key partners .....	68
6.2.7.	Financial analysis of a CBBE.....	68
7.	Discussion .....	70

7.1.	Limitations of the cultural analysis .....	70
7.1.1.	Weaknesses and uncertainties in the data.....	70
7.1.2.	Discussion on the used method .....	71
7.1.3.	Comparison to similar research.....	72
7.2.	Limitations of the technical analysis .....	72
7.2.1.	Discussion on the MCA method .....	72
7.2.2.	Discussion on the estimations for feedstock availability, digester size and transport .....	73
7.3.	Limitations of the proposed business model .....	75
8.	Conclusions.....	78
9.	Recommendations.....	80
	Appendix A – Case studies in Ghana .....	82
	Appendix A.1 - Kumah farms .....	83
	Appendix A.2 - Nuamah enterprise .....	87
	Appendix A.3 - Family star entertainment.....	91
	Appendix A.4 - Manco Industries Ltd.....	95
	Appendix A.5 - Kumasi institute of tropical agriculture (KITA) .....	100
	Appendix A.6 - Royal chef.....	106
	Appendix A.7 - The pioneer .....	112
	Appendix A.8 - Terracotta .....	117
	Appendix A.9 - Kumasi Abattoir Company Limited.....	122
	Appendix A.10 - Star company Ltd. ....	128
	Appendix A.11 - Tiptop farms.....	134
	Appendix A.12 - Tip top foods Ltd. ....	139
	Appendix A.13 - Hortor fishing company.....	143
	Appendix B – Questionnaire .....	148
	Appendix C – Data used for technical analysis .....	152
	Appendix C.1 – Livestock .....	152
	Appendix C.2 – Crop residues.....	153
	Appendix C.3 – Municipal waste .....	154
	Appendix D – Workshop “Biogas as a social enterprise” .....	155
	Appendix D.1 – Main outcomes of the workshop .....	155
	Appendix D.2 – List of participants.....	156
10.	References .....	157





## 1. Introduction

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Globally, more and more people realize that climate change is a genuine threat to the lifestyles our generation has grown accustomed to. In the course of history, the seemingly everlasting race for money, power and growth has made people set up systems that are fundamentally unsustainable for future generations (United Nations, 1987). These systems are mostly aimed at short-term gains and hinder future generations to live in harmony with the earth's ecosystems and its resources. The growing global need for energy and the ways it is provided for are major drivers for climate change. Many studies have projected that our heavy dependence on fossil fuels will lead to them being depleted within this century (Höök & Tang, 2012; Shafiee & Topal, 2008; Hoel & Kverndokk, 1996; United Nations, 1987). From this it becomes clear that a transition to renewable energy technologies is urgently needed within the coming decades.

Biogas technology is a form of renewable energy that could be part of the strategy to combat climate change. It is based on microbial processes that digest organic material in the absence of oxygen (anaerobically) and convert it into biogas and a nutrient-rich digestate that can be used as a liquid or solid fertilizer. When burnt as substitute for fossil fuels, the CO<sub>2</sub> emissions associated with biogas are part of the short carbon cycle and thus have no extra impact on the environment.

This research looks at the opportunities for biogas technology in Ghana and the following chapter is written as introduction into this topic. First the background of this thesis is laid out in paragraph 1.1 and the reasons for doing this research are made clear. This is followed by the problem definition in paragraph 1.2. In paragraph 1.3 the goal and scope are stated. From this the main research question is defined in paragraph 1.4, accompanied by several sub-questions to help answering the main question. Finally in paragraph 1.5, the structure of the whole report is explained in the project outline.

### 1.1. Background

This paragraph explains why this thesis focuses on biogas and why in Ghana. The first sub-paragraph 1.1.1 gives some background information on Ghana and the issues it faces as a developing country. The second

sub-paragraph 1.1.2 gives a short overview on biogas technology: the basics and its potential advantages. In 1.1.3, the final sub-paragraph, the two subjects come together and there is elaborated on the status and potential of biogas technology in Ghana.

#### 1.1.1. Ghana

Ghana is a developing country in West-Africa facing many issues related to an inadequate power supply, a high dependence on firewood and high levels of poverty. Because of these issues, Ghana could benefit from biogas technology as is explained in section 1.1.3. Even though Ghana had one of the fastest growing economies of Sub-Saharan Africa in the last decade, the country has been going through an energy crisis in recent years<sup>1</sup> (World bank, 2017; Clerici, et al., 2016; Opare, 2016). Next to some unforeseen natural and geopolitical events, Ghana was not able to keep up with the energy demand related to the economic growth, forcing the government to ration the available energy (RVO, 2016). In practice, this means that Ghanaians are without electricity for twelve hours every two days. This is a huge barrier for economic growth and becoming a middle-income country (Opare, 2016), especially since it is often unknown when the power will be shut off or turned on. This fluctuating access to electricity is reflected in the GDP, which has been dropping in recent years. Next to the energy crisis, Ghana is also heavily reliant on firewood as an energy source as it makes up 60% of the total energy use (Bensah & Brew-Hammond, 2010). This brings with it issues of deforestation, indoor air pollution and lower quality of life for women (Van Nes et al., 2009). Also, despite the growing economy, there are still many people living on just a dollar per day, keeping them in a poverty trap. Improving their socio-economic situation just slightly could already be enough to lift them from this trap and is something to strive for (Sachs, 2005; United Nations, 2015).

#### 1.1.2. Biogas technology

Biogas technology is based on the decomposition of biomass into mostly CH<sub>4</sub> and CO<sub>2</sub> by anaerobic digestion (AD). AD means digestion in the absence of oxygen. It happens inside an anaerobic digester and in four successive stages by various groups of microbial communities. These stages are: hydrolysis, acidogenesis, acetogenesis and methanogenesis. The microorganisms of the different stages work together in a delicate interdependent syntrophic harmony (Van Lier et al., 2008).

There are many different types of biogas systems and reactor designs possible, dependent on the feedstock availability, location of the plant and the socioeconomic context. These different system designs and the way they need to be operated will be further discussed in paragraph 2.3.

Biogas technology is based on the decomposition of biomass from many different sources. The most common biomass categories used in biogas production are: animal manure and slurry, agricultural residues and by-products, digestible organic wastes from food and agro industries (vegetable and animal origin), organic fraction of municipal solid waste and from catering (vegetable and animal origin), sewage sludge and dedicated energy crops (e.g. maize, sorghum, clover) (Duku, 2011). Lignocellulose-containing feedstocks (woody material) have high energy content but must be treated (thermally, mechanically or chemically) before they can be fermented.

When biogas systems are operated successfully, the technology can have a multitude of benefits. First and foremost, the produced biogas can be burned as substitute for fossil fuels for cooking, lighting or electricity generation. Also, the digestate can be used instead of fossil fuel-based fertilizers. This substitution will help decrease pressure on the environment (Boerboom, 2015b). When the biogas is used to substitute for firewood, which is still the most popular energy source in most Sub-Saharan countries (Karekezi & Kithyoma, 2002; Jones, et al., 2016), related benefits are a decrease in deforestation (Aklaku, 2007), a reduction in indoor air pollution and associated respiratory health issues (Duflo, 2008; Gemert, 2015) and an improvement in the quality of life for women as they will spend less time collecting firewood

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<sup>1</sup> Ghana is not alone in this. According to the World bank (2013), some 25 countries in Sub-Saharan Africa are facing an energy crisis.

(Van Nes et al., 2009). When organic waste is used as feedstock, biogas technology can also improve the socio-economic situation in developing countries as it will give material previously considered a waste an economic value.

### 1.1.3. Biogas in Ghana

Biogas is in the initial stage of market development in Ghana. There is great potential for biogas technology: the German development organization GIZ has calculated a biogas potential for Ghana of 845 MW installed capacity/year, or 42% of Ghana's total energy mix, with agricultural industries having the biggest potential (Daniel et al., 2014). But currently, there are not yet many biogas projects to be found in Ghana, or the whole of Africa for that matter. In Table 1 the number of biogas plants in Ghana, Tanzania, Kenya, India and China is indicated.

**Table 1. Number of biogas plants in Ghana, Tanzania, Kenya, India and China. The ratio people per plant is indicated per country**

Country	Population* (in millions)	Number of plants**	People/plant	Reference
Ghana	28,6	200	143.000	(Bensah & Brew-Hammond, 2010)
Tanzania	53,4	3.334	16.017	(SNV, 2012)
Kenia	46,1	4.917	9.376	(SNV, 2012)
India	1311	4.000.000	328	(Heegde & Sonder, 2007)
China	1371	20.000.000	69	(Heegde & Sonder, 2007)

\*based on figures from 2015 (World bank, 2017)

\*\*mainly household plants, most numbers are based on rough estimations

It shows that Africa, and especially Ghana, is running behind on biogas dissemination compared to Asian countries like India and China. Compared to Ghana, Tanzania and Kenya are currently doing better because they have national biogas programs (Edward D. Antwi 2015, personal communication, 17 April). Multiple studies (Ghimire, 2013; Arthur, 2011; Duku, 2011; Amigun & Blottnitz, 2007; Akinbami, 2001) have attributed the slow-moving growth to high investment costs and limited access to credit facilities. Most of the digesters in Ghana are institutional, built at hospitals and schools, with sanitation being the main driver for the projects (Bensah & Brew-Hammond, 2010). Bensah conducted a technical review of biogas plants in Ghana and found that only 44% of all plants were functioning properly. The rest of the plants were functioning partially, not functioning or abandoned. The reasons for non-functioning of biogas plants were non-availability of manure, breakdown of balloon gasholders, absence of maintenance services, lack of operational knowledge, gas leakages, and bad odor in toilet chambers of bio latrines. Bensah proposes to develop a state-organized national program on biogas technology that focuses on three areas: sanitation, energy and fertilizer production.

It seems that there are chances for biogas technology on a political level. Bringing down the use of wood fuel in Ghana from 60% to 40% by 2020 has been a target in the Strategic National Energy Plan (SNEP) for over a decade (Essandoh-Yeddu, 2006). And in recent years, the Ghanaian government has been working to create a favorable environment for business in the renewable energy sector by doubling the feed-in tariff for electricity from bioenergy (RVO, 2016; Daniel et al., 2014). Comparing Ghana's biogas potential and favorable political climate with the low number of biogas projects indicates that there is a need for initiatives to help disseminate biogas technology throughout Ghana.

## 1.2. Research problem

When implementing a technology in a developing country, resource availability and political backing are not the only factors for successful projects. Cultural and institutional frameworks are important underlying factors for successful technology transfer but often overlooked in literature (Nguyen & Aoyama, 2015; Janssen, 2010; Lina & Berg, 2001). To disseminate a technology and innovate responsibly,

a country needs to have sufficient capacities. These capacities are intimately related to the inherited cultural values and institutions of a country (Kroesen & Ndegwah, 2015).

Africa, including Ghana, is caught up between a set of traditional values which are over-represented and by that, hamper the implementation of complex technologies. Common traditional African values are communitarianism, respect for elders and a belief in the supernatural (Gutterman, 2017). It seems an additional set of values is needed for technology to be adopted. It is essential first to examine what indigenous people know before telling them what to do since development does not just simply implementing modernity. Instead, development implies improving existing ways of doing things to make the processes more efficient and productive than before (Appiah-Opoku & Mulamoottil, 1997).

Technology is inherently value laden as it is invented by supporters of particular values. Technology in developed countries can be more complex and advanced because the presence of a modern set of cultural values that are well suited for complex technologies. For adopting more advanced technology in Ghana, an increased entrepreneurial spirit is needed. Values that are important for this include: disciplined labor, time management, universalistic rules, individual judgement and an appetite for novelty (Kroesen & Ndegwah, 2012). The reasons for non-functioning biogas plants as mentioned by Bensah (2009) could possibly be traced back to a lack of these values. Research is needed to find out how the proven technology of biogas can be moved forward. A model that utilizes Ghana's traditional values and compensates for the lack of the above mentioned cultural values could help the implementation of biogas technology. The priorities of Ghanaians must be assessed for the creation of a technological base for anaerobic digestion that blends both traditional or indigenous and modern approaches (United Nations, 1987).

### 1.3.Goal and scope

The type of system installed and the way it is managed directly affect the efficiency of the plant (Serna, 2013). Thus, it is important to realize how the different options for setting up biogas systems will fit the culture they are implemented in. Considering the implications of country-specific cultural values on how a technology will be managed and taking them into account when choosing the best technological option will increase the chances for success of that technology. By doing so, the implemented technology can have the intended impact on the development of that country. For this reason, Ghana's culture and institutions and their implications for successful biogas dissemination are the main focus of this thesis.

There are various project scales and organizational forms that can be focused on. The scope of this study is limited to a community based biogas enterprise (from now on referred to as CBBE). The 'community based' component in this concept was chosen to build on the existing traditional value of communitarianism in Ghana and because it implies the recovery of energy and nutrients from multiple sources and thus moves towards circular thinking, an important part of the study program of the author: industrial ecology. Practically, it refers to a medium scale project that operates on feedstocks from a typical Ghanaian community. This scale was also chosen because small and large scale projects both have their drawbacks in a Ghanaian setting. Drawbacks of small scale (usually domestic) projects are that no constant flow of biogas can be reached and that they are owned and operated by people without the necessary operational knowledge. Therefore, these systems have a history of less than optimal gas production due to gas leakages and inadequate feeding of the system (J. van Lier 2016, personal communication, 21 June) (Amigun & Blottnitz, 2007). No large-scale projects (projects in the MW range (Cameron, et al., 2014)) are currently present in Ghana because the country lacks the proper infrastructure. For large-scale projects to be feasible a country needs to have the right infrastructures and operational knowledge present (Thomsen, et al., 2014; Jeon, et al., 2006). The "enterprise" component was chosen because there are indications that community projects in Ghana that are also owned by the community do not work due to ownership issues and lack of trust (J. Lam 2014, personal communication, 24 July; M. Commeh 2015, personal communication, 22 January) (Njoroge, 2002; Bensah & Brew-



Hammond, 2010). Therefore, this study focusses on an enterprise approach with a single owner. It is expected that a community scale enterprise will have the size of a small to medium enterprise (SME) so in the cultural analysis will be focused on SMEs in Ghana.

Summarizing the goal of this thesis is to help the dissemination of biogas technology throughout Ghana by shaping a medium to long term strategy for a biogas enterprise that operates on feedstocks from an average Ghanaian community. A sub-goal within this goal is to determine the most appropriate type of technology and business structure for the biogas system, based on a cultural and technical analysis that reveal the professional and technological capacity of SMEs in Ghana. The level of complexity and scale of the different possible biogas systems are the main parameters for this analysis.

#### 1.4. Research questions

The following research questions are derived from the problem definition, goal and scope of this thesis:

**What would be a realistic business model for a CBBE in Ghana, given the technological options and cultural institutional constraints?**

- What are the characteristics of business models of SMEs in Ghana and within what cultural and institutional framework are they managed?
- Which technological complexity and scale are appropriate for a CBBE in Ghana?
- What effect does the collection of different types of feedstock have on the operation of the plant?
- What would be the most viable value proposition for a CBBE in Ghana?

#### 1.5. Thesis outline

In this first chapter the background, research problem, goal & scope and research questions have been introduced. In the second chapter the theoretical framework is presented. This chapter contains an overview of the different definitions of key concepts in this research and the models derived from the definitions used. Chapter three sets apart the methodology for this research. This is followed by two analysis chapters: a cultural and a technical analysis. In the cultural analysis, the first sub-question is answered. A cultural profile of Ghana is presented and this profile is analyzed on the implications it has for setting up a CBBE. In the technical analysis, the next two sub-questions are answered. Here is focused on what is technologically possible for a CBBE considering complexity, scale and feedstock availability. In chapter six, the analysis chapters are combined and by answering the final sub-question, a possible business model for a CBBE is proposed. Chapter seven contains the discussion where the uncertainties of the research will be discussed. The conclusions of the research are presented in chapter eight, where the answers to all the sub-questions are combined to answer the main research question. Recommendations for follow-up research are given in chapter nine. The report is concluded with an appendix and the literature list.



## 2. Theoretical Framework

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This chapter contains the results of the literature study and will set forth the different key concepts and theories that are used within this thesis and how they relate to each other. First is elaborated on the role of cultural values in the development debate in paragraph 2.1. This is followed by the cultural model that has been used in this thesis in paragraph 2.2. Then paragraph 2.3 brings forth the different types of biogas technology and how the various possible technologies for a CBBE in Ghana need to be managed for a successful and sustainable operation. Paragraph 2.4 presents a literature review of the definitions for community based enterprises and the components of such an enterprise. The chapter ends with paragraph 2.5 summarizing the chapter in the conceptual framework.

### 2.1. The role of cultural values in development

This paragraph will elaborate on the concept of cultural values and what role they play within the development debate. This debate shifted from economical and technical factors to human actors in the last 50 years because it became clear that just transferring money and technology was not enough for development to take off. The need for building capacity of these human actors to deal with technology became apparent as the failure of many projects in Africa often have their root in attitude and values, which are a layer of the concept of capacity (Kroesen & Ndegwah, 2015). There is a need to revisit the African core values and enable a civil society to emerge from it (Ndegwah & Kroesen, 2012; Kroesen & Ravesteijn, 2014; Jackson, et al., 2008). With a civil society present, entrepreneurial activities are able to flourish and bring about innovation and successful technology transfer. In the following sub-paragraphs, these various concepts will be explained.

#### 2.1.1. The development debate and technology transfer

In the field of development studies there are many approaches to be found to reduce the lack of wealth in some parts of the world. There are so many because it is a field of science known to have an ever-widening repertoire (knowledge tends to accumulate and revolutions are a rare phenomenon) and thus

gaining in depth and richness but also in complexity (Knutsson, 2009). With Adam Smith came the birth of economics as a discipline on its own, from which development economics later emerged as separate branch. The focus was then, as well as later on in the early works of Marx and Schumpeter, mainly on economic growth, and technology was seen to be at the center of it. By many different scientific disciplines the central role of technology in economic growth was confirmed (Reddy & Zhao, 1990). The contemporary development debate shifted away from economic growth and towards human development but technology still is generally accepted as a major driving force behind development (Kroesen & Ndegwah, 2015). The Keynesian economics that dominated the post WWII period advocated for large government and foreign aid but it is now widely agreed that the entrepreneur is the prime driver of economic progress or at least an important factor within development (Bwisa & Ndolo, 2011; Naudé, 2013).

### 2.1.2. The role of entrepreneurship linked with innovation

Entrepreneurship is understood as the creation of a new organization, arising as a result of combinations of familiar or new elements, in pursuit of opportunity (Gartner, 1988; Kirzner, 1973; Schumpeter, 1983; Sharma & Chrisman, 1999). The entrepreneur is an important driver of economic progress and can be seen as acting in a grass root movement towards that goal. But not just any form of entrepreneurship will do. It seems that entrepreneurship only contributes to development when it is related to the introduction of new technologies to an area, the exploitation of new markets and the development of new ways to organize business, i.e. innovation. This type of innovative entrepreneurship is sometimes lacking in developing countries where entrepreneurship mostly takes place in the informal economy<sup>2</sup> and is associated with marginal activity and survival strategies. Entrepreneurs like this do not innovate but just copy others out of economic necessity (Jackson, 2012; Naudé, 2011). To have innovative entrepreneurs within a country that can introduce new technologies, exploit new markets and develop new ways to organize business, the capacity needs to be present to adopt these technologies (Kroesen & Ndegwah, 2015).

### 2.1.3. Capacity building for innovative entrepreneurship

As mentioned in the previous sub-paragraph, capacity is needed for innovative entrepreneurship. In first instance, capacity can be understood as the ability to get things done (Balassanian, 2006). Furthermore, there are multiple context dependent meanings of the concept of capacity in literature to be found. These are summarized by Kroesen & Ndegwah into three layers that together make up the concept of capacity. They propose the following formula:

$$Capacity = IESA + VAB + SI$$

The first layer IESA consists of the terms information, experience, skills and algorithm (in the sense of expedience), which in an innovative entrepreneurial context involves business knowledge and organizational skills. The second layer VAB consists of the terms values, attitudes and believes. Values, such as taking responsibility, internal discipline, openness or loyalty, are based on beliefs and expressed in attitudes. Values that are important for innovative entrepreneurial activities that are geared towards bringing about change are: personal initiative, planning and valuing labor. The third layer SI consists of the terms social environment and institutions. This is the enabling environment for enterprises that consists of adequate regulations and policy arrangements that are needed for individual entrepreneurs to bring about lasting change with their innovative initiatives (Kroesen & Ndegwah, 2015).

For this research, the second two layers are of interest. The third layer, institutional capacity, needs to be present for a market to work and creating favorable conditions for introducing new technologies and developing new ways to organize business. This means that there should be institutions in a country that fulfill functions like a legal framework, equal rule of law, public services, accountable administrations and

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<sup>2</sup> The informal economy in Ghana constitutes of 80% of the total workforce (Osei-Boateng, 2011)

free press. In developing countries, issues like patronage systems, corruption and a lack of trust often cause problems that inhibit innovative entrepreneurship. Innovation also implies the adoption of new values. Knowledge on how to use technology is important but also the values, attitude and beliefs towards it are, as they will integrate it into the social environment (Engelen, 2016). Values, attitude and beliefs are comprised within the national culture of a country. The concepts of culture and institutions are interdependent and blend together and as such will be used as one concept where possible (J. O. Kroesen 2016, personal communication, 16 November).

#### 2.1.4. Cultural differences and value dimensions

From all the different models that have been developed to determine which values are present in a society, the models of Hofstede (2010) and Trompenaars (1997) are the most important and most often used (Gutterman, 2017; Kroesen & Ravesteijn, 2014; Bwisa & Ndolo, 2011; Jackson & Aycan, 2006). For this reason, their models will be the basis of the cultural model as used in this thesis which is presented in paragraph 2.4.

Over time, many different definitions of culture have been conceived. Definitions of culture include: a complex whole which includes knowledge, beliefs, art, morals, laws, customs and any other capabilities and habits acquired by man as a member of society (Tylor, 1871); the man-made part of the human environment (Herskovits, 1948); transmitted patterns of values, ideas and other symbolic systems that shape behavior (Kroeber & Kluckhohn, 1952); values, beliefs and expectations that members come to share (Van Maanen & Schein, 1978); the collective programming of the mind which distinguishes the members of one human group from another (Hofstede, 1980). The last definition from Geert Hofstede is probably the most widely known because of his pioneering research that attempted to compare national cultures in terms of broad value differences.

The way cultural differences manifest themselves is plentiful but Hofstede captures them in the following four terms: symbols, heroes, rituals, and values. These can be described as an onion with symbols being the outer, most superficial layer and values the deepest layer or core, with heroes and rituals in between. Symbols are easily developed, replaced or copied by other cultures and thus make up the outer layer. These can be words, gestures, objects, fashion, brands, etc. Heroes are persons, alive or dead, real or imaginary, who serve as models for behavior because of the characteristics they possess and are highly prized in a culture. Rituals are collective activities which are considered as socially essential without having any other real purpose. The core of the onion is made up by values, which are broad tendencies to prefer certain states of affairs over others (Hofstede, 1991).

Between 1967 and 1973 Hofstede analyzed a large database of employee value scores collected within IBM that covered more than 70 countries. He initially identified four dimensions of value differences which can be used to describe cultures relative to each other. Later, two more dimensions were added. The six dimensions were described by him as follows:

Power distance (from small to large)

Social inequality, including the relationship with authority. This dimension expresses the degree to which the less powerful members of a society accept and expect that power is distributed unequally. People in societies with a large degree of power distance accept a hierarchical order in which everybody has a place and which needs no further justification. Societies with a small degree of power distance strive for equal opportunities and equalization of the distribution of power.

Collectivism versus individualism

The relationship between the individual and the group. If people's self-images in a certain society are defined in terms of "I" or "we".



### Femininity versus masculinity

Also referred to as tender vs tough cultures. Feminine cultures have a preference for cooperation, modesty and caring for the weak and quality of life. Masculine cultures are more competitive and aim for achievements.

### Uncertainty avoidance (from weak to strong)

Ways of dealing with uncertainty, relating to the control of aggression and the expression of emotions. It expresses the degree to which members of a society feel comfortable with uncertainty and ambiguity: trying to control the future or just letting it happen.

### Long-term versus short-term orientation in life

"Long Term Orientation stands for the fostering of virtues oriented towards future rewards, in particular perseverance and thrift. It's opposite pole, Short Term Orientation, stands for the fostering of virtues related to the past and present, in particular, respect for tradition, preservation of 'face' and fulfilling social obligations." This dimension was added later on by Bond (1991). The fact that it was overlooked by researchers shows their programming according to their own particular cultural framework. One should always keep in mind their own cultural point of reference when studying another culture.

### Indulgence vs restraint

A society that allows for having fun against a society that suppresses the gratification of needs and regulates it, having strict social norms in place. This is the newest dimension by Hofstede, added in the 2010 edition of *Cultures and Organizations* (Hofstede & Minkov, 2010).

Another author that is often referred regarding culture and cultural dimensions together with Hofstede is Trompenaars (Trompenaars, 1997). With his book *Riding the waves of culture* he tries to give the new generation of international managers -who are educated according to the most modern management philosophies which are all based on Western type of thinking- the tools to conduct themselves in the ever-globalizing world and all the different cultures that exist in it. His work was similar to that of Hofstede with some slight differences. This is due to the fact that Hofstede and Trompenaars initially developed their model together but eventually parted ways. Trompenaars also indicates there are layers to culture and describes it with the use of dimensions. He states one should be aware of the differences in cultures to be able to effectively use these management techniques in other cultures than one's own. Unlike Hofstede, Trompenaars indicates three levels of culture: the outer layer which are explicit products, a middle layer which consists of norms and values and the core that is made up from assumptions about existence. To describe these layers, he defined seven dimensions which are presented below.

### Universalism versus particularism

This dimension can be understood as societal versus personal obligations. In a universalistic culture, it is believed the rules are the same for everybody while in a particularistic culture this depends on relationships and maintaining them.

### Individualism versus communitarianism

This dimension describes whether personal goals or group goals are more important in a culture.

### Neutral versus emotional

This dimension describes the emotional orientation in relationships: do people hide or express their emotions?

### Specific versus diffuse

Degree of personal involvement in business relationships. Specific cultures like to get to the point when doing business without getting familiar with the other party while diffuse cultures allot more value to building relationships before doing business.

Achievement versus ascription for status

Legitimation of power and status. Ascribed status is acquired by birth, gender, age or personnel contacts, whereas achieved status is acquired by your accomplishments.

Synchronic versus sequential perception of time

Whether time is perceived in a circular or linear way. In cultures where time is perceived as cyclic or synchronic, past, present and future are mixed and the order in which things are done is of less importance. When a culture perceives time in a linear or sequential way, people will be more inclined to set future goals and make a planning to reach those goals. An exact order of activities will become more important.

Internalism versus externalism

Whether a society feels the external environment can be controlled or not. In an internalistic culture, people feel more disconnected to nature and see it as something that can or even needs to be controlled while people in an externalistic culture feel more in harmony with nature and will let it take its course.

There has been some criticism from literature on the theories from Hofstede and Trompenaars. Hofstede himself already indicates that using questionnaires is a difficult method to research values because people might not always act like they say they do (or want to do: desirable vs. desired). But they can show the difference between groups or categories of respondents. He also indicates that culture applies more to societies than nations, and the two should not be equated to each other (Hofstede, 1991).

#### 2.1.5. Civil society

Wiarda indicates that the concept is deeply rooted in Western culture and wonders to what extent it fits in a Sub-Saharan context. The first versions of the concept were theorized by the ancient Greeks such as Plato and Aristotle. It was then further culturized by the Romans, but in these early days the state had still an important role to play by a system of corporatism (state-sponsored, state-licensed, state-organized, and state-controlled interest associations). During the ages, more nuances were added by for example catholic and protestant influences or by thinkers like John Lock or Adam Smith. Through ideas of individual property rights and equal rule of law the modern conception of a civil society began to take shape (Wiarda, 2003).

A civil society is a concept that has been described by Kroesen (2014) as a society where open associations between people are possible without interference from tribe, clan, family or state; a society that enables anonymous trust among people so equal opportunities on an open market can be created; and a society that has the right balance between state and society, where there is trust in the state to apply an universal rule of law (Kroesen, 2014).

Important cultural values for a civil society are egalitarianism, individualism and universalism. Important cultural values for entrepreneurship are voluntarism, sequential planning and status by achievement (initiative, planning and labor are needed to instigate change) (Kroesen & Ndegwah, 2015).

The technological complexity that is possible for a project/enterprise is related to the degree in which a civil society is present in that country (Kroesen & Ndegwah, 2015). The Ubuntu Company in South Africa is a good example of a company that successfully combined traditional and modern values in its management model (Kroesen & Rozendaal, 2010).

## 2.2. The cultural model

Based on the cultural dimensions mentioned in paragraph 2.1, a cultural model was formulated which is presented below. The specific dimensions of this model were taken from Kroesen (2014), who in turn based them on the work of Hofstede (1991) and Trompenaars (1997). As will be further explained in chapter 3, this model was used to set up a questionnaire. For practical purposes during data gathering, the questionnaire had to be concise. Because of this, some of the dimensions from Hofstede (1991) and

Trompenaars (1997) were combined because of a strong overlap and some were left out because they were less relevant for the purposes of this thesis.

The dimensions power distance and collectivism versus individualism by Hofstede are not included in the model since they are almost, if not completely, the same as the dimensions hierarchy versus egalitarianism and communitarianism versus individualism by Trompenaars. The dimensions uncertainty avoidance by Hofstede and internalism versus externalism by Trompenaars are combined in the dimension traditionalism (called fatalism by Kroesen) versus voluntarism because of their strong overlap.

The dimensions long-term versus short-term orientation in life and indulgence versus restraint by Hofstede are also left out. Because what makes them interesting for this model is their focus on planning which is already covered by the dimensions traditionalism versus voluntarism and synchronic versus sequential time orientation.

The dimensions neutral versus emotional, specific versus diffuse and femininity versus masculinity are not incorporated in the model because they do not have a significant influence on capacity, entrepreneurship or innovation.

Below, the six dimensions of the model will be explained together with the motivation for choosing these specific dimensions. Also is for every dimension mentioned how it relates to the level of complexity of technologies that are to be introduced. The model also includes the degree of a civil society that is present, which is based on the scores of the cultural dimensions.

#### 2.2.1. Hierarchy versus Egalitarianism

This dimension by Trompenaars is also called power distance by Hofstede and measures if people within a society expect and accept inequality of power and a hierarchical order. A hierarchical order can be desirable at times because it creates functional relationships between people who, without having to know each other, can come to great results. The pyramids are a well-known man-made marvel that could not have been built without the use of a strict hierarchical order. Of course the use of slaves, like the Egyptians did for building the pyramids, is an extreme form of hierarchical order and is not accepted anymore in these modern times, but it serves well as an example of the potential of hierarchy. So hierarchy can be useful when work needs to be done, but too much hierarchy in a company should be avoided as it can get in the way of innovation. Moreover, hierarchical control stimulates merely functional responsibility and will stand in the way of individual judgement. In high hierarchic companies, bosses will not feel comfortable consulting with their employees and vice versa. In this way, a lot of knowledge gets ignored and the company's development will stagnate. This dimension becomes more important as projects get bigger and more sophisticated and more specialists are needed to keep it running. It then becomes a matter of people with power against people with knowledge: will the boss listen to the employee with more knowledge on the topic? Simple technologies have for this reason more chances to succeed than more complex technologies in hierarchical cultures. Also for a biogas project to be bigger in scale, people need to be treated equally in order to cooperate better. []

#### 2.2.2. Communitarianism versus Individualism

This dimension appears in the work of Trompenaars as well as Hofstede -who calls it collectivism- and is also handled as such in the work by Kroesen. It describes whether people in a culture value taking care of either themselves or their communities and extended families. In individualistic cultures, individual freedom is encouraged while in communitarianistic cultures individuals are encouraged to work for the group interest. It is a question of whether people think in terms of "we" or "I". Thinking too much in terms of "we" can hinder people to feel responsible as an individual because their responsibility is just a small part of the group. If a certain action needs to be taken, people will first look at each other and only act after a mutual consensus has been reached.

This focus on others rather than yourself of communitarian cultures also translates how they behave in business, which from an individualistic perspective often seems better than it is. It might seem as a pleasant way of living together and caring about your community, but it can also lead to discrimination/paternalism of in-group against out-group (Jackson, et al., 2008). This in-group against out-group thinking can in practice be recognized by companies taking care of their in-group first and focusing solely on their family and own tribe. Communitarian companies will give family members positions in the company for which they might not be most qualified for. Also, the main language will be the own tribal language to which others should adapt to and business is preferably done with members of the own tribe. The question is how a business should counteract this phenomenon as out-group employees will grow a lack of commitment. Following this logic, communitarianism can lead to many business opportunities being squandered because of in-group against out-group thinking. For this reason, large scale projects are difficult in communitarianistic cultures.

#### 2.2.3. Particularism versus Universalism

This dimension by Trompenaars describes whether within a culture people feel that everyone should be treated according to the same universal rules or that a preferential treatment is desired in particular cases, when for example personal relationships come into play. Particularism is often based on patronage systems, where relationships within groups cause certain obligations that can last lifetimes and hinder freedom of choice in business. Patronage systems can create hierarchical dependencies and it is difficult to get involved as a non-member (Kroesen & Ndegwah, 2014). Also corruption is a result of particularism. Family businesses are more likely to be particularistic because of strong family bonds. This can become problematic and hinder business when the one with knowledge is not treated with the same amount of respect as family members. In these cases, particularism differentiates between people which makes some people feel second-rate. This leads to less motivation overall and hinders an enterprise to grow. For this reason, there is a limit to the scale of technological projects in particularistic cultures. In line with this argument, a culture needs to have universalistic value characteristics to make entrepreneurship thrive.

#### 2.2.4. Traditionalism versus Voluntarism

This dimension is taken from Kroesen who calls it fatalism over voluntarism (Kroesen, 2014) and is similar to the dimensions of uncertainty avoidance by Hofstede and internalism versus externalism by Trompenaars. It describes whether people in a culture prefer to either stick to tradition and their shared history or if they feel comfortable taking initiative to change their environment and bridge the gap between past and future. This latter value means people have to get out of their comfort zone and see themselves as a pivotal point for change. To have this value present in at least some degree is crucial for innovative entrepreneurship to exist within a society. Otherwise people will not invest their time and money in new things because they are likely to be inclined to do things the way they are used to (Engelen, 2016; Kroesen, 2014). When technologies are introduced in traditional cultures, they have to be low in complexity and in close resemblance with existing technologies.

#### 2.2.5. Synchronic versus Sequential time orientation

This dimension by Trompenaars covers how different cultures perceive time, which for synchronic cultures is cyclic and for sequential cultures is more linear. People in synchronic societies follow the rhythm of life and its seasons while sequential cultures make a well-defined planning divided up in smaller steps towards a future goal. Both types of time orientation have their strengths and weaknesses. Sequential cultures can be very rigid and do not like to depart from their planning towards a future goal. Too much planning also causes people to not actively live in the present. In synchronic cultures on the other hand, people live in the present and are used to doing multiple activities in parallel. Because of this they can easily adapt to unexpected events. Nevertheless, a clear planning is needed to effectuate change. Also, when technologies become more complex, a more strict planning is needed. Technologies low in complexity are thus better suited in synchronic cultures.

### 2.2.6. Ascribed versus Achieved status

How status is accorded to people in a culture is addressed in this dimension by Trompenaars. This can be done by solely someone's position in society (e.g. age, gender, family, title, class, social connections, education, profession) or by their own achievements and the labor they have put in. In cultures where status is ascribed to people based on for example seniority or to which family he or she belongs, labor is often less valued because getting to important positions is dependent on other factors. Because of this lack of incentive, employees will feel less motivated to work hard and work might even be halted when the manager is away. Since managers are already in a position of power, they will also be less involved in the work that needs to be done and will mainly just give orders to their subordinates. When change is desired, hard work is needed and an involved boss will ensure a better attitude towards labor. Complex technologies need more attention and work put in during operation and maintenance and thus will thrive better in a culture where status is accorded by someone's achievements.

### 2.2.7. The degree of a civil society and innovative entrepreneurship

For this simplified model, the degree of civil society will be indicated by whether society consists more of patrimonial systems/vertical networks and closed in groups, or of a transparent and universalistic state, anonymous trust and open associations between people without interference from tribe or state. As was mentioned in paragraph 2.1.5, important cultural values for a civil society are egalitarianism, individualism and universalism. The score of the values, together with factors mentioned above will indicate the degree of a civil society in Ghana. From this, expectations arise about the level of cooperation between different groups of people and thus the possible scale of a CBBE in Ghana.

For innovative entrepreneurship and the right kind of professionalism, the most important values are voluntarism, sequential planning and status by achievement. For this model, the degree of innovative entrepreneurship will be indicated by the average score of these three values. The more professional an organization is the more independent and egalitarian it will be. A higher degree will mean that more professional capacity is present in Ghana and that CBBE can be of a higher complexity.

## 2.3. Design and complexity of biogas technology

This paragraph will go into the design and complexity of biogas technology and in particular of different types of biogas technology. First, the basics of the AD process will be explained. Then, the next sub-paragraph will go into the important process parameters and the different ways the process can be designed. After that, a selection of possible digester designs is presented and the paragraph is concluded with an elaboration on the complexity of biogas technologies.

### 2.3.1. The anaerobic digestion process

As mentioned in paragraph 1.1.2, biogas technology is based on the anaerobic digestion of biomass in four successive stages: hydrolyses, acidogenesis, acetogenesis and methanogenesis. These stages are explained in more detail below.

In the hydrolysis stage, enzymes produced by the acidogenic bacteria degrade large biopolymers (proteins, carbohydrates, lipids, etc.) into monomeric and dimeric compounds (amino acids, simple sugars, long chain fatty acids (LCFAs), etc.) that can go through the cell barrier of these fermentative bacteria (Vavilin, et al., 2007). Hydrolysis is in most cases the rate limiting step of the overall process (Marchaim, 1992).

In the acidogenesis, the second stage of AD, these smaller compounds are taken up by the acidogenic bacteria into the cell and broken down further into mainly volatile fatty acids (VFAs), alcohols, lactic acid, CO<sub>2</sub>, H<sub>2</sub>, NH<sub>3</sub> and H<sub>2</sub>S, as well as new cell material. These VFAs are acetate, which is the main substrate for the methanogenic bacteria, but also higher carboxylic acids like propionate and butyrate. This conversion from neutral biopolymers into VFAs and amino acids makes that this step is the acidogenic step. Because the acidogenic bacteria have higher growth rates and bacterial yields compared to the methanogens, it is

important not to overfeed the digester to prevent a shutdown of the digester by acidifying. If the alkalinity of the digester is consumed (when the VFA-consuming methanogens cannot keep up with the VFA production) the pH will drop which leads to an inhibition of the methanogens which again adds to the pH drop (Van Lier et al., 2008).

During the acetogenesis, the third stage of AD, acetate,  $H_2$  and  $CO_2$  are produced by conversion of carboxylic acids (mostly propionate and butyrate). Acetate is also formed from  $H_2$  and  $CO_2$ . Overall in this step, more  $H_2$  is produced than consumed. The acetogenic bacteria are interdependent on the methanogenic archaea (syntrophic association) for the uptake of  $H_2$  because the acetogenic reaction can only occur when the  $H_2$ -pressure is below  $10^{-4}$  atm. (Van Lier et al., 2008).

During the methanogenesis, the fourth and final stage of AD, there are two groups of methanogenic archaea that produce  $CH_4$ . The acetolactic methanogens decarboxylate acetate and the hydrogenotrophic methanogens reduce  $CO_2$  using  $H_2$  as electron donor. About 70% of the produced  $CH_4$  comes from acetate as precursor, the rest comes mostly from  $H_2$  and  $CO_2$ . Since decarboxylating means taking off a  $CO_2$  molecule, and 70% of the produced  $CH_4$  comes from acetate, the final biogas mixture also has a significant  $CO_2$  concentration. The composition of biogas is given in Table 2.

**Table 2. Composition of biogas (Seadi, et al., 2008)**

Compound	Chemical formula	Percentage (vol-%)
<b>Methane</b>	$CH_4$	50-75
<b>Carbon dioxide</b>	$CO_2$	25-45
<b>Water vapor</b>	$H_2O$	2 (20°C) – 7 (40°C)
<b>Oxygen</b>	$O_2$	<2
<b>Nitrogen</b>	$N_2$	<2
<b>Ammonia</b>	$NH_3$	<1
<b>Hydrogen</b>	$H_2$	<1
<b>Hydrogen sulphide</b>	$H_2S$	<1

Because the acetoclastic methanogens have very low growth rates, anaerobic digesters need a long time to start up. This is typically two to four weeks, but start-up times can be less when seed sludge from another digester or cow manure is used during start-up.

The material that remains after the feedstock is anaerobically digested is called the digestate and can be used as an organic fertilizer, provided it is not polluted with heavy metals, plastics, etc. It is rich in nutrients and has also high moisture retention properties. There are different estimations to be found regarding the digestate that is produced as a percentage of the feedstock fed to the digester. These range from roughly 70% (European Biogas Association, 2015) to 90-95% (NNFCC, 2017). Boerboom (2015b) also calculated this percentage, using a mass balance and arrived at 73,4%. Based on these percentages, an estimated percentage of 80% will be used in this thesis.

### 2.3.2. Process parameters

There are several operational parameters to describe a digester system (retention time, temperature, solids content, number of stages, etc.). There is no clear consensus among practitioners on what the optimal design is in different contexts, but experience in design is vital (Cameron, et al., 2014). To give a basic overview of these parameters, they are each briefly discussed in the following paragraph.

Organic loading rate, retention time and digester size

Digester sizes are determined based on the amount and type of available feedstock. The amount of feedstock available determines the loading rate in  $m^3/day$  (or  $t/day$ ). The retention time in days depends on the type of available feedstock and its specific decomposition rate. The loading rate and retention together determine the size of the digester (in  $m^3$ ). Overloading the digester or adding large batches of

acidic substrates should be avoided as this leads to an acidification and potential break down of the process. The loading rate should be adjusted to the growth rate of the methanogens. For a CSTR reactor, the normal load is 1-6 kg COD/m<sup>3</sup> reactor volume/day. When changing substrates, this has to be done gradually so that the bacteria can adapt to the new conditions (Jørgensen, 2009).

#### Temperature

The AD process can take place in three different temperature ranges: psychrophilic (below 25°C), mesophilic (25°C - 45°C), and thermophilic (45°C - 70°C). At higher temperatures, biomass is more effectively converted and thus shorter retention times are needed, as is shown in Table 3. When feedstocks are digested with high levels of pathogens, like night soil, longer retention times or higher temperatures are needed (Koottatep, et al., 2003; Avery, et al., 2014).

**Table 3. Thermal stage and typical retention times (Seadi, et al., 2008)**

Thermal stage	Typical process temperatures	Minimum retention time
<b>psychrophilic</b>	< 20°C	70 to 80 days
<b>mesophilic</b>	20 to 42°C	30 to 40 days
<b>thermophilic</b>	43 to 55°C	12 to 20 days

At psychrophilic temperatures, reaction rates are very slow and thus not the preferred range for AD. The thermophilic process some important advantages over the mesophilic process like faster gas production and more effective pathogen destruction. When looking at thermophilic options and its advantages for biogas plants in Ghana, the additional energy that is needed and the added operational complexity should be taken into consideration. An advantage of Ghana's warm climate is that it is easier to operate digesters under mesophilic temperatures without little or any additional heating.

#### AD process inhibitors

In the AD process, there are a couple critical parameters that can be monitored to prevent process inhibition (digester conditions that a negative effect on the microorganisms without directly killing them) and maximize methane yields: the pH value, VFA and ammonia concentration. A combination of parameters should be monitored because as stand-alone process monitoring parameters they fall short.

Just like every other biological process, the bacteria in the AD process have a pH-optimum and straying from this value inhibits them. Methanogenic archaea are active within a relatively narrow pH interval of around 5,5 to 8,5 and have their pH-optimum between 7,0-8,0. The pH-optimum for acidogenic bacteria is usually a bit lower so it is important for optimal operation to keep track of the pH in a digester. A constant pH is important for a healthy AD process. The alkalinity of a digester is mainly controlled by the bicarbonate buffer system. This system causes the digester to only experience minor changes in pH value and thus imbalances are difficult to spot with a monitoring system. For systems with a weak buffer capacity, like AD of various wastewater types, monitoring the alkalinity of a digester can be a cheap way of identifying a system imbalance.

The concentration of VFA also reflects the stability of the digester, as process instability will lead to an accumulation of VFAs and an associated pH-drop. However, when dealing with feedstocks like manure that have a surplus of alkalinity the pH will not drop until the VFA concentration reaches a certain value. When the pH does finally drop, the process can already be severely inhibited by the high concentrations of VFAs. Whether a digester will be inhibited by high concentrations of VFAs depends on the digester, as the composition of bacterial populations is different for each digester. Just monitoring the VFA concentration is thus not recommended.

Ammonia should be kept below 80 mg/l to prevent inhibition, especially the unionized form. This means that high pH levels increase the risk of ammonia inhibition. But when a process is inhibited by ammonia the [VFA] will increase and in turn decrease the pH. The amount of ammonia is indicated with the C/N

ratio and is a function of feedstock characteristics and other operational parameters. Although too much or too little nitrogen can have an impact on the health of the digester, ratios can vary significantly between 10:1 and 90:1 and still lead to efficient digestion, depending on the composition of the microbial communities. It is mostly the formation of CH<sub>4</sub> from H<sub>2</sub> and CO<sub>2</sub> that is inhibited by free ammonia (Marchaim, 1992). At thermophilic temperatures, there is a higher risk of ammonia inhibition than at mesophilic temperatures because [NH<sub>3</sub>] is directly proportional to temperature.

#### Feedstock consistency and feed method

Feedstock consistency is expressed in the percentage of total solids (TS). This percentage determines the preferred feed method of the feedstocks: can they flow around or do they have to be stacked. When the TS of the used feedstocks are less than 15%, it is called wet digestion. The high liquid content allows for a continuous process as it will be a slurry that is easily pumpable. Most biogas plants in developing countries are traditionally operated as a semi-continuous process, where new feedstock is added at regular intervals while an equivalent amount of digested material leaves the digester. The wet conditions also allow for a better contact between the bacteria and the organic matter and thus a higher gas production. Common feedstocks are animal manure or wastewater.

When the TS is higher than 15% it is called dry digestion. Above this percentage the feedstocks will not flow through the digester but have to be stacked. Solid state digestion (SSD) is another name for dry digestion and more correct, since the bacteria will still require water. SSD is usually performed as a batch process in a garage-type digester, but can also be done as a continuous process in a plug-flow digester. These digester types will be further explained in the next sub-paragraph.

#### Biogas yields of various Ghanaian feedstocks

The part of the TS in a feedstock that can be digested are called the volatile solids (VS). The percentage of VS is an indicator for the biogas potential of a feedstock (in m<sup>3</sup>/kg VS), or biomethane potential (also in m<sup>3</sup>/kg VS) when only at the methane-fraction is of interest. The amount of VS differs per feedstock and is also dependent on the timing of collection. For example, biogas yields decline for crops when they approach full ripeness (Amon, et al., 2006) and the yields for manure goes down with water content so drying out of the manure should be avoided (Köttner, 2013). Some common feedstock for the Ghanaian situation with their typical biomethane yields are given in Table 4.

**Table 4. Methane yields for common Ghanaian feedstocks (Thomsen, et al., 2014)**

<b>Feedstock</b>	<b>methane yield [m<sup>3</sup> CH<sub>4</sub>/kg TS]</b>
Cassava peelings	0,323
Cassava stalk	0,192
Cattle manure	0,22
Cocoa pods	0,8
Coconut shells	0,289
Cocoyam straw	0,167
Groundnut shells	0,227
Municipal waste	0,094
Oil palm kernel shells	0,28
Pig manure	0,22
Plantain trunks and leaves	0,213
Poultry manure	0,22
Sheep manure	0,22
Sorghum straw	0,285
Yam straw	0,167



The terminology for the digestible part of the feedstocks is inconsistent in literature. Next to VS, also the terms oTS (organic total solids), VSS (volatile suspended solids) or oDM (organic dry matter content) are used, where SS (suspended solids) and DM (dry matter content) mean the same as TS. Also the chemical oxygen demand, which stands for the theoretical amount of dissolved oxygen needed to break down the organic fracture, is similarly used sometimes. For this research, only the terms TS and VS are used.

#### Co-digestion

The AD process is often operated with a single type and source of feedstock. It is however, also possible to operate a digester using feedstock of multiple types and sources. Using multiple types of feedstock for the digestion process is called co-digestion. This is usually a combination of manure, which is high in inoculants and water content but low in biogas potential, together with (mostly undigested) plant material which therefore has a high biogas potential. Summing up the biogas yields from all the different types of feedstock times their fraction gives a good estimate of a plant's total biogas yield. However, biogas yields are not completely linear with composition, so if precise values are needed, predictions on the plant-specific biogas yields always must be done by lab-testing the available mixture of feedstocks. Because there is a degree of uncertainty in the consistency of the supplied feedstock, the operator on duty should always be aware of this fact.

The way the supply scheme is organized is different for a situation with a single supplier compared to a situation with multiple suppliers working together. So when feedstock is supplied by multiple parties, extra organizational capacity is necessary. It is always important to secure constant and long term supply of the necessary feedstocks.

#### Possible process steps for AD

There are multiple options when designing the AD process for a biogas plant. Several process steps can be added to the AD process depending on the intended purpose of the plant, like pre-treatment, mixing, storage or post-treatment steps. The AD process can also be separated into multiple steps.

Pre-treatment steps can be taken to make the digestible feedstock slurry more uniform in size (and smaller) and composition. Also sand or other unwanted particles can be taken out. Mixing the digester is a valuable step towards an optimal biogas production as it leads to a more uniform distribution and it will break up any scum formation. For smaller plants, agitation can be done by simply poking with a stick through the inlet or outlet. When digester volumes exceed 50 m<sup>3</sup>, stirring or agitation facilities are required. Larger digester systems also require storage facilities as feedstocks and slurry often have to be stored for several weeks (Sasse, 1988). Post-treatment steps include scrubbing the biogas of unwanted gasses like H<sub>2</sub>S or H<sub>2</sub>O that could corrode generators when the biogas is used for electricity production. When the biogas is fed to the gas-grid, it should be upgraded to pure methane by also separating the CO<sub>2</sub> from the mixture.

Next to additional process steps, the AD process itself can be operated as a single stage process or a multi-stage process. In a multi-stage process the different stages are based on the stages of the AD process. The acidogenesis and methanogenesis will be separated into different tanks. Feedstock will first be converted into VFAs in the first tank after which it will pass to the second tank where most of the biogas is produced by the methanogens. A multi-staged process is more complex and usually has higher retention times, but is more stable as the pH can be controlled for the methanogens separately (Vögeli, et al., 2014).

#### 2.3.3. Selected digester designs and their strong and weak points

There are many known digester designs that have been constructed throughout the years, all with their own characteristics and (dis)advantages. Choosing the right design for a biogas project depends on a couple of factors like feedstock type and availability, operational capacity, availability of maintenance services,

spare parts and capital. In this sub-paragraph the most common digester designs for developing countries (Vögeli, et al., 2014) are explained based on their general design, advantages and disadvantages and management requirements.

Three simple designs, the fixed-dome, floating-barrel and plug-flow digester will be mentioned as they make most sense in the context of a developing country. This is because already have been implemented in developing countries and thus proven technologies. To have a proven technology and be beyond experimenting and piloting is the first step towards the successful implementation of sustainable rural entrepreneurship (Kroesen & Darson, 2013). Kossman et al. also mention that the selection of an appropriate design is largely determined by the prevailing design in the region (Kossman, et al., 2012). These three designs are all based on semi-continuous wet digestion under mesophilic conditions. They can also be used for SSD, but this will require high labor input and their gas-output will not be steady (Kossman, et al., 2012). The designs are inexpensive, easy to handle, can be built with locally available material, do not have many moving parts and are thus less likely to fail.

Another design, the garage-type which is designed as a batch operated SSD system, is also included as it is considered a technology suitable for developing countries (Vögeli, et al., 2014). There were however tests done in Ghana by converting an old shipping container into a SSD digester that showed the technology was promising but not yet ready for the commercial market (Lohri, et al., 2013; Vögeli, et al., 2014).

There are other possible types like the earth-pit or ferro-cement pit that stand out for their low cost and easy of construction. But these designs are mostly suitable for small scale implementation and thus are not included in this section. Also, designs that are used for large scale digesters as implemented in Western countries like the UASB (upflow anaerobic sludge blanket), EGSB (expanded granular sludge bed), FB (fluidized bed reactor) or the CSTR (continuous stirred tank reactor) are not included as they are more focused on AD for wastewater treatment and are deemed too complex for implementation in developing countries.

#### Fixed-dome digesters

A fixed-dome digester consists of a non-moveable dome shape digester with possibly an in-built gas holder. Fresh feedstock is introduced through the inlet and is mixed to some extent with the slurry. Fresh feedstock and the increasing gas pressure will push out the digested slurry into the compensating tank. A disadvantage of fixed-dome digesters is a fluctuating gas pressure as it is dependent on the volume of stored gas. In Figure 1 a possible design of a fixed-dome plant is given with all its different components.

Advantages of fixed-dome digesters are their low construction costs and lack of moving or rusting parts which gives them long lifetimes of 20 years or more. Underground construction is possible, which offers protection from the elements and day/night temperature fluctuations are minimized. The soil on top of the digester also counteracts the internal pressure within the digester. When increasing the size of a fixed-dome digester, the pressure increases proportionally. For that reason, larger fixed-dome plants need a separate gasholder (Sasse, 1988). Local materials can be used and local masons can be hired for the construction. It is recommended the construction is supervised by experienced biogas technicians, as there is a risk of cracks and porosity in the digester walls (Sasse, 1988; Vögeli, et al., 2014).

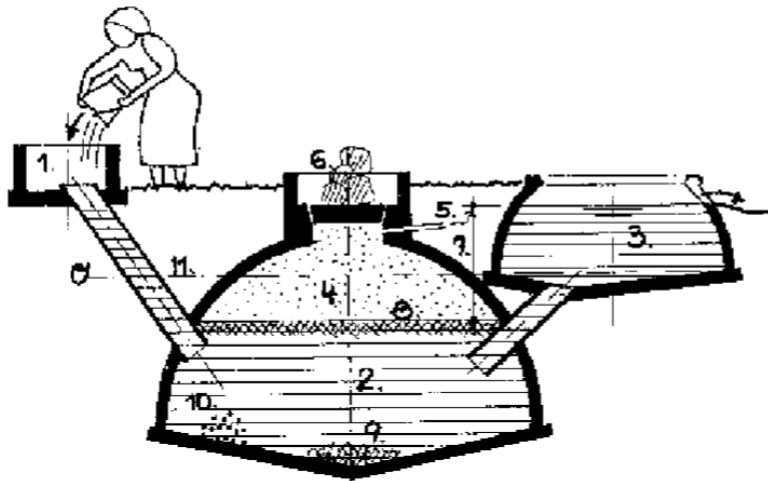


Figure 1. Fixed-dome plant 1. Mixing tank with inlet pipe. 2. Digester. 3. Compensating and removal tank. 4. Gas holder. 5. Gas pipe. 6. Entry hatch, with gaslight seal and weighted. 7. Difference in level due to gas pressure inside the digester. 8. Supernatant scum; broken up by varying level. 9. Accumulation of thick sludge. 10. Accumulation of grit and stones. 11. Zero line: filling height without gas pressure (Sasse, 1988)

#### Floating-drum digesters

A floating-drum digester is like the fixed-dome digester, but instead of a fixed-dome it has a floating drum that holds the gas. It floats either on water or on the fermentation slurry and is held in place by either a guiding frame or just its own weight. When pressure rises, the drum goes up and lowers again when the pressure drops. The weight of the drum ensures a constant gas pressure. Depending on the design and size of the digester, the contents can be agitated by rotating the barrel which will break up any scum formation. Drums up to 5 meters in diameter can still be turned by one person (Sasse, 1988). Figure 2 shows a possible design of a floating-drum plant with all its components.

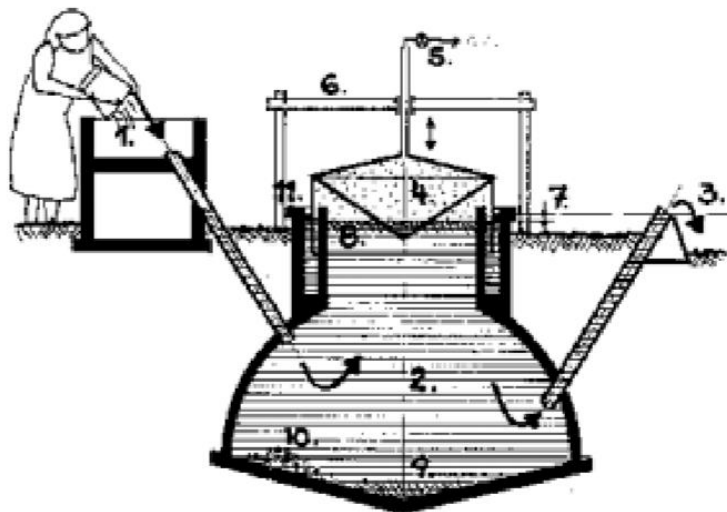


Figure 2. Floating-drum plant 1. Mixing tank with inlet pipe. 2. Digester. 3. Overflow on outlet pipe. 4. Gas holder with braces for breaking up surface scum. 5. Gas outlet with main cock. 6. Gas drum guide structure. 7. Difference in level due to gas pressure inside the digester. 8. Floating scum in the case of fibrous feed material. 9. Accumulation of thick sludge. 10. Accumulation of grit and stones. 11. Water jacket with oil film (Sasse, 1988)

Advantages of floating-drum plants are simple design and operation and they have in comparison to fixed-dome digesters a constant gas pressure and a visible gas level. The disadvantages are that they are more expensive due to the drum that is often made of steel. The steel parts also make the floating-drum design more prone to corrosion. Compared to the fixed-dome design they thus have shorter life times of up to 15 years. In tropical coastal regions, the drum will last about five years. There are alternatives for the

material used for the drum. Glass-fiber reinforced plastic and high-density polyethylene have been used successfully, but at higher construction cost as with steel.

#### Plug-flow digesters

Plug-flow digesters are horizontal digesters through which the feedstock flows as a plug. The feedstock is continuously fed at the entry side of the digester and the digested slurry is continuously discharged at the end. Typical feedstock is feedstock with high TS like chicken manure, grass, maize silage or manure with a high straw content. The cover of the digester can be made of a solid material, but plug-flow digesters are usually constructed as balloon digesters. Balloon plants are one of the most simple and cheap digester designs to construct. They consist of a rubber or plastic bag that acts as digester and gas-holder in one. The sludge is added through the inlet, that is just like the outlet directly attached to the skin of the balloon, and settles on the bottom of the bag. Figure 3 shows the scheme of a balloon digester.

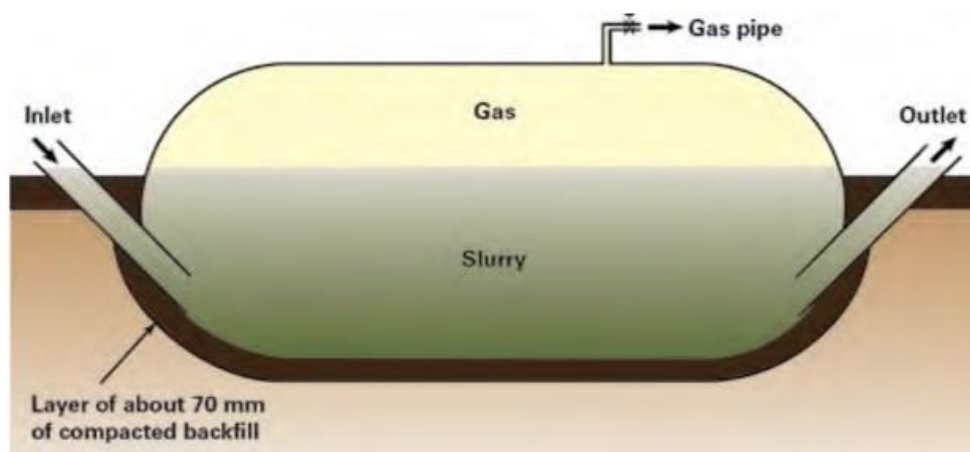


Figure 3. Scheme of a balloon digester (Vögeli, et al., 2014)

When elongated balloons are used, the sludge will flow through the balloon as plug. Active mixing is limited, although from outside the balloon the sludge can be mixed when taking care not to damage the skin. The gas is collected in the upper part of the balloon where it is also withdrawn. The elasticity of the balloon determines the gas pressure. By using a pump or simply adding weights on top of the balloon the pressure can be increased. The gas pressure can damage the skin of the balloon when it becomes too great so safety valves are needed. The material of the balloon must be weather and UV resistant, especially in warm climates. Plug-flow digesters have a limited digester size but can be run in parallel to increase throughput capacity.

The balloons have as an advantage that they can be easily transported, constructed, cleaned, emptied and maintained. As a disadvantage, they have relatively short lifetimes of two to five years and damages to the balloon can rarely be repaired by local craftsmen.

#### Garage-type digester

SSD as a batch process can be done in garage-type digesters with an airtight door. In a garage-type digester the microbial processes have to be started for each new batch by mixing it with a solid inoculum (already digested material) and percolating a liquid inoculum over it, as shown in Figure 4. This percolating continues during the digestion process. The percolate can be taken from other, older digesting compartments. Usually digester sizes are limited and multiple compartments are placed together (Kusch, 2008; Waltenberger, 2013). This allows for better liquid inoculum recirculation and a more constant biogas production as shown in Figure 5. Typical feedstock for SSD is material that is rich in structure like municipal organic waste, straw or manure fibers. shows the scheme of a garage-type dry digestion plant.

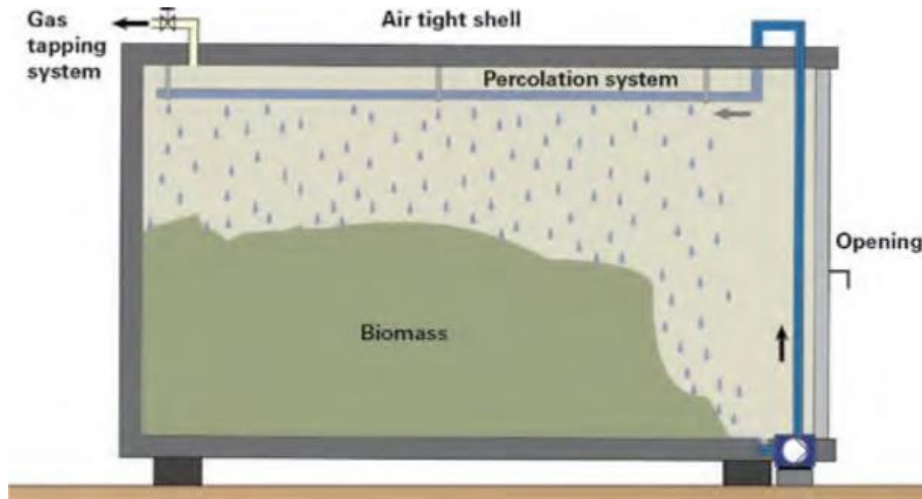


Figure 4. Scheme of a garage-type dry digestion plant (Vögeli, et al., 2014)

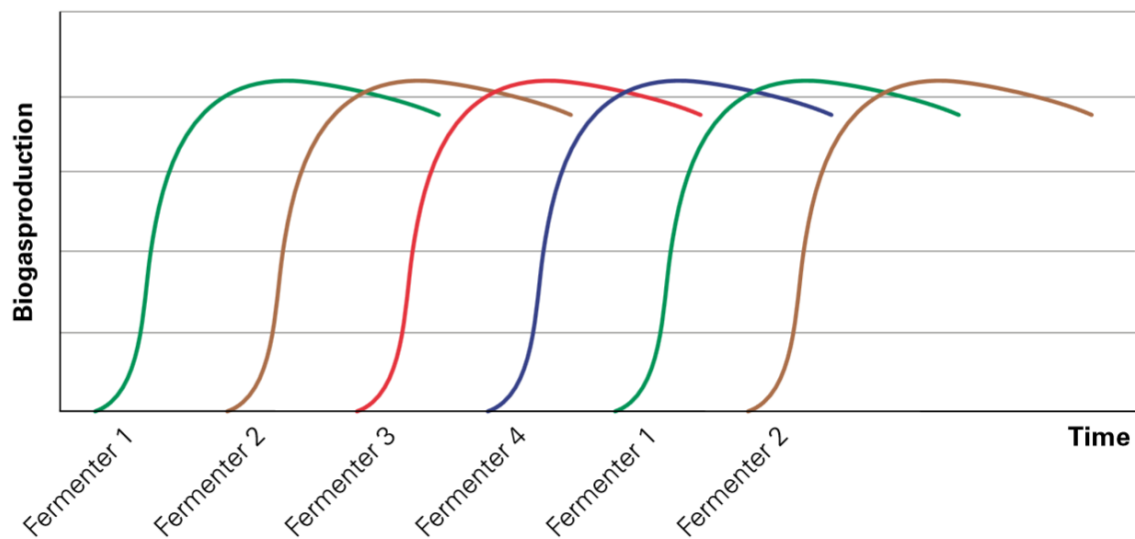


Figure 5. Temporal gas production in parallel operation of different batch digesters (Weiland, 2006).

Compared to wet digestion systems, SSD systems have simple process technology and are thus in most cases cheaper. Other advantages of SSD are a relatively high tolerance for contaminants (fibers or sand), less critical equipment and therefore also less maintenance requirements. By utilizing old shipping containers there is even the possibility to make mobile biogas plants, that can be transported to wherever there is a surplus of feedstock.

A disadvantage of SSD is that the contents of the digester are not completely mixed and thus have suboptimal conditions. This leads in most cases to lower methane yields compared to wet digestion. Another disadvantage of SSD is that the feedstocks are low in energy density due to the high ratio of structure rich material. This has consequences for transport costs, digester size and loading and unloading methods (Kusch, 2008).

#### 2.3.4. Complexity of biogas technology

A goal of this thesis is to find a level of technological complexity for a CBBE that is appropriate for implementation in Ghana. Complexity is understood as a factor in the chances for a technology to be adopted (Rogers, 2003; Kroesen & Darson, 2013). For this reason, this sub-paragraph will elaborate on the parameters that are used to determine the complexity of the selected biogas technologies as presented in

the previous sub-paragraph. AD process itself has already a certain level of intrinsic complexity because of the interdependency of the different bacterial communities and thus a certain level of understanding is necessary to operate any form of technology. Although the presented technologies are similar and low in complexity, it is still possible to order them in relative complexity.

The complexities of the technologies are determined based on three main parameters. These parameters are: simplicity of operation, maintenance needs, and simplicity of construction. These parameters were taken from Wood & Ashton (2010) and adapted to be more specifically aimed at biogas technology.

The parameter simplicity of operation is itself made up from different factors. Whether a technology is complex to operate depends on: the level of automation, i.e. the feeling of direct control of the operation; the number of interrelated components working together; the number of mechanical and electronic components; process rigidity, i.e. the amount of errors the system can handle before it shuts down; and the necessity of coordination between employees.

Maintenance needs can be explained as: the frequency of check-ups needed; the number of components that can fail independently like mechanical parts, pumps, electronics; the robustness of the system; and the possibility of local repair.

Simplicity of construction is based on: the level of detail in construction plans; the effects of construction errors on operation and gas yield; the range of possible construction sites; and the local availability of materials.

## 2.4. Community based biogas enterprises

Since it is the aim of this thesis to look at how a CBBE must be set up in Ghana, it is important to define what is meant with such an enterprise and which factors determine its success. In the following sub-paragraph 2.4.1, definitions will be given on community based enterprises together with some examples of innovative biogas enterprises. By combining these definitions and examples, the paragraph concludes with the definition that is used for this thesis. Paragraph 2.4.2 will go deeper into the components of a CBBE, based on a preliminary explorative study by Boerboom (2015a).

### 2.4.1. Definitions and examples of biogas enterprises

Community based enterprises are defined as enterprises that are owned and managed by the community with the intention of benefiting the community as well as the individuals within it (Armstrong, 2012). They are established in most of the communities as a strategy to create jobs and alleviate poverty (Norman, 2012). By the definition of Peredo & Chrisman, community based enterprises are created by community members acting corporately (Peredo & Chrisman, 2006). Morley (2014) adds that they differ from most conventional businesses in that they are not based on utilitarian economic models but have broader political, environmental, social and cultural goals and try to resolve pressing social problems (Morley, 2014).

Ownership is an important issue to determine for a community based enterprise. While community based enterprises are often started with pure and positive intentions, there are indications that issues can arise when the community is also owner of the enterprise. Community owned biogas projects in Ghana are more likely to fail because of issues related to ownership (arguments on who owns the gas, who is responsible for operation and/or maintenance, how should the gas/digestate be divided, etc.) and a lack of trust between community members (J. Lam 2014, personal communication, 24 July; M. Commeh 2015, personal communication, 22 January) (Bensah & Brew-Hammond, 2010; Njoroge, 2002). The definition of a community based enterprise as used in this thesis, will for this reason include single ownership to circumnavigate ownership-related issues.

When searching for examples of biogas enterprises, a whole range of different types can be considered. Most enterprises related to biogas are biogas construction enterprises, meaning they construct household

or institutional digesters. Biogas as the core business of an enterprise is not often done. It happens more often that biogas is used to treat waste streams. Sometimes it is deployed as a side-business by for example the Keekonyokie slaughterhouse in Kenya, using its slaughterhouse waste to generate and sell biogas (Karuga, 2015). There are however some businesses that are looking for innovative ways to utilize biogas technology to solve social and environmental problems. Simgas and B-Energy for example are companies that operate in East Africa, and are successful in disseminating biogas by having an innovative approach (B-Energy, 2015; Simgas, 2012). Simgas is a Dutch biogas company that operates in East Africa with a core business of selling low-cost, ready-to-use modular domestic biogas systems and offering after-sale maintenance service. By doing so they have found a way to successfully disseminate biogas throughout East Africa and grow their company. B-Energy's approach is similar. The German company operates mainly in Ethiopia and Sudan and have a core business of selling domestic biogas systems. Next to the biogas system they also sell biogas backpacks, the initial product that started the company. The backpack is a means to transport the produced biogas and enable the owner to become an entrepreneur by selling his or her biogas to others. By offering a micro-finance scheme B-energy also found a way to increase their market to low-income groups. Both companies work with local entrepreneurs by franchising their business. The biogas systems used by Simgas and B-Energy are based on a light-weight plastic fixed-dome and an above-ground plug-flow design respectively. These system-types will be further discussed in paragraph 2.4.

Another interesting biogas enterprise is CaribShare Biogas in Jamaica. They call themselves a social enterprise that uses waste from hotels and farms to supply a nearby residential community with electricity. By doing so they aim to lower energy cost and the dependency on petroleum imports (Lue, 2015). This approach is a good example of the closed-loop potential biogas technology has.

The last interesting biogas enterprise to be featured in this paragraph is Safi Sana. This Dutch company has created an elaborate network from which they collect their feedstock. This includes waste from public toilets, markets and slaughterhouses. In their factory, they produce electricity (from biogas) which they sell to the grid and organic fertilizer which they sell as compost or use to grow seedlings for sale. Currently around 9 tons of waste is collected which is converted to 2.200 kWh each day, but their planning to grow their facility to be able to handle 25 tons per day (Safi Sana, 2017). Biogas is used to generate heat and electricity at around 100 kW, which shows generating electricity is feasible for projects in the medium scale range.

The final definition of the concept CBBE is a selection from the above-mentioned definitions of community based enterprises from literature and is also inspired by the examples of biogas enterprises. The community based aspect will focus mostly on the amount and type of available feedstock to a Ghanaian community. Using waste flows from multiple different sources in a community is an approach like that of CaribShare and Safi Sana. Because of the intrinsic characteristics that biogas technology has, like social benefits, the ability to close loops and battle climate change, the other aspects of the definitions for community based enterprises will still apply. Perhaps battling climate change is not perceived as a very pressing issue in Ghanaian communities, it remains part of the definition since it is a nice bonus that biogas technology offers. So, it will be an enterprise with the intention of benefiting the community as well as the individuals within it, established as a strategy to create jobs and alleviate poverty, not based on utilitarian economic models but have broader political, environmental, social and cultural goals and try to resolve pressing social problems and finally have single ownership to circumnavigate ownership-related issues.

#### 2.4.2. Components of a community based biogas enterprise

In this sub-paragraph, the different essential components for a CBBE in Ghana are presented, based on a preliminary explorative research performed by Boerboom (2015a). In this study, possible options for business models were explored using the Business Model Canvas (BMC) by Osterwalder (2010). In Table 5

the canvas is presented with some guiding questions per block of the canvas. Following the canvas and the research by Boerboom (2015a), these options will be broadly presented for a CBBE, supplemented with additional literature if necessary.

**Table 5. The business model canvas with questions by Voorpostel (2015)**

Key partners	Key activities	Value propositions	Customer relationships	Customer segments
Who are our key partners? Who are our key suppliers? What key resources do we acquire from our partners? Which key activities do our partners perform?	What key activities do our value propositions require? Our distribution channels? Customer relationships? Revenue streams?	What value do we deliver to our customer? What problems are we helping to solve? What bundles of products and services do we offer each segment? Which customer needs are we satisfying? What is the minimum viable product and/or service?	How do we get, keep and grow customer? Which customer relationships have we established? How do they integrate with the rest of our business model? How costly are they?	For whom are we creating value? Who are our most important customers? What do our model customers look like?
	<b>Key resources</b> What key resources do our value propositions require? Customer relationships? Revenue streams?		<b>Channels</b> Through which channels do our customer segments want to be reached? How do other companies reach them? Which ones work best/ are most cost efficient? How are we integrating them with customer routines?	
<b>Cost structure</b> What are the most important costs inherent in our business model? Which key resources are most expensive? Which key activities are most expensive?		<b>Revenue streams</b> For what value are our customers willing to pay? For what do they currently pay? What is the revenue model? What are the pricing tactics?		

#### Customer segments

The customers of a CBBE can be many different people. Because it is a community based enterprise the customers are most likely people from within the community, but they do not have to be. Customers from other communities can also be attracted, provided that Ghanaian business culture allows for it. Some degree of a civil society will need to be present for open associations between two different communities. The number of customers is related to the size of the community, or communities.

What the envisaged customers have as common characteristic is that they cook on wood, charcoal or LPG, are in need for an economic boost (in the form of money), are active in an economic activity that can use an electricity powered machine, or grow plants and thus need fertilizer. An assumption has to be made on what percentage of the community would be interested in the value offered by the CBBE.

To get an idea of size of the market of an CBBE, it is useful to know how much biogas and fertilizer is needed by Ghanaian households and how these quantities compare to their usual consumption. The energy available in 1 m<sup>3</sup> of biogas is around 6 to 8 kWh. This roughly corresponds to 10 kg of dried cow dung, 5 kg of firewood, 2 kg of charcoal or 0,5 liter of LPG (Energypedia, 2017). Gas consumption for a five-person family for two cooked meals is between 1,5-2,4 m<sup>3</sup> (Kossmann, et al., 2012). Because the average household size in Ghana is 3,5 persons (Ghana Statistical Service, 2014), the value of 1,5 m<sup>3</sup> is most probable and is thus used in further calculations.

In Ghana, about half of the working force is engaged in agriculture. Still many farmers are categorized as subsistence farmers who primarily produce food for their own family, for the most part as smallholders with average holding sizes between 2 and 6 ha and (Quaye et al., 2010). Fertilizer use in Ghana is 7 kg per person per day (World bank, 2017). There is assumable 3 times as much digestate is needed because mineral fertilizers have around 5 to 10 times higher nutrient contents but also should be applied 2-3 more often than the digestate because leaching to the soil (Rosen & Eliason, 2005).



## Value proposition

The value proposition takes a central place in the business model. It is defined as the products or services that the company delivers to its chosen customer segments. It is important to realize that a company will only be successful if the products or services offer a clear advantage to the default situation, which for biogas are traditional energy sources obtained by households at low or no costs. Reliability and convenience play an important role in overcoming this cost barrier. In the case of a CBBE and the above described customer segments, there are various value proposition possible.

The first possible proposition for a biogas enterprise is obviously to offer biogas to the consumer. The gas can be used for cooking as substitute for wood, charcoal or LPG, or lighting with gas lamps as substitute for flashlights. The gas should be offered at a competitive prize and its, environmental, practical and health related advantages should be communicated clearly.

Two more value propositions are possible when using the biogas to generate electricity. Although at small facilities generating electricity is too costly, the case of Safi Sana shows that it is feasible for a 100 kW facility. At sufficient scale, a second proposition could thus be to use the gas to generate electricity. This electricity could be used to power a multi-functional platform (MFP). This MFP could perform a service which is in high demand within the community (Grimsby, et al., 2012). If for example the main economic activity in a community is to produce palm oil, a biogas-powered machine that processes the palm oil kernels will be in high demand. This option will make most sense in a community involved in an economic activity with a large organic waste stream and no connection to the national electricity grid.

As a third option, generated electricity can be sold to the national grid. The value proposition then becomes to offer customers money for their feedstock. Back in 2013, selling electricity to the grid was not yet a viable option because the feed-in tariff was too low (Boerboom, 2015a; GIZ, 2014). But in recent years this rate of 31,4696 GHp/kWh has doubled and is currently, depending on the source of the biomass, between 56,0075-63,2891 GHp/kWh (PURC, 2014). These developments make that the option of selling electricity to the grid might prove to lead to a feasible business model. This observation is strengthened by the fact that Safi Sana is currently already basing their business model on revenue streams derived from feeding electricity to the grid (Safi Sana, 2017).

Next to the produced biogas, another output of the AD process is the digestate. This can be separated into two phases: the solid phase which is valuable for its high moisture retention properties and can be used as soil conditioner, and the liquid phase which is high in nutrients and thus can act as substitute for fossil fuel based fertilizers. Substituting these fossil fuel based fertilizers decreases the ecological footprint of agricultural systems dramatically (Boerboom, 2015b; Møller, et al., 2009). A CBBE could be built around offering fertilizer as its main value proposition but it is more probable that offering fertilizer will be a secondary value proposition (Boerboom, 2015a). The fertilizer could be sold for a small fee or be traded for manure. By this it could be possible to acquire the manure for free.

Other possible value propositions related to AD are waste water treatment and sanitation. These are not included within the scope of this thesis as this was focused at the areas of energy and fertilizer production (Bensah & Brew-Hammond, 2010).

## Channels

The channels that are needed to reach the customer segments are dependent on the value proposition and on the already present (traditional) ways of doing business.

When for example gas is sold, this can be done by using containers or through a mini-grid in remote areas. Both options have their advantages and disadvantages. Selling gas in high-pressure containers could work if there is already a culture and distribution system with gas bottles. This would help with the acceptance of the biogas. It does however cost a lot of energy to compress it, and as biogas is up to 40% CO<sub>2</sub>, this means a lot of wasted energy. A solution with a low-pressure container, like the biogas backpack, would

be a good solution to this, although with a capacity of 1.2 m<sup>3</sup> they only allow cooking one meal a day (B-Energy, 2015). They also have a relatively short lifetime of around two years (SNV, 2013), which could become expensive as they currently cost 43,50 euro/piece (B-Energy, 2015). A mini-grid could also be a way to distribute the gas, although this will mean a big investment if no grid is present yet. Control of the mini-grid is crucial to ensure an equal distribution of power (Cameron, et al., 2014).

When biogas is used to power a MFP, the location should be carefully selected and should be close to where it is most needed.

Selling electricity could also be done through a mini-grid but again this will mean a big investment if no grid is present yet and this will be too much to have a feasible business (Lam, 2014). Selling to the national grid is thus a better way.

The digestate can be sold when dried or separated as organic fertilizer in bags. The wet fraction can also be sold separately. If the location allows for it, pipes and gravity could be used to transport the liquid fertilizer to the fields

#### Customer relationships

Because the CBBE relies on mostly on feedstocks from within the community, it is important that it becomes an intrinsic part of daily life in the community. Long term contracts should be closed as much as possible to ensure a constant supply of feedstock. If compliance is an issue, other measures should be taken to control the supply of feedstock. This could be special offers like higher rates for bringing feedstock at certain times or gifts at certain quantities delivered (this requires a more accurate accounting system). Events could also be organized around the digester to increase its social status. These solutions do have a price tag and should thus be accounted for.

#### Key resources

There are four different types of resources, namely physical, financial, human and intellectual. Physical resources for a CBBE are the digester, its location and feedstocks. The digester includes the whole digester system from front to back and a building for activities like accounting and sales. Depending on feedstocks used, the type of system, and the selected value proposition, auxiliary components are necessary. These additional components can include a pre-mixing unit, a H<sub>2</sub>O- and H<sub>2</sub>S-removal unit, a generator, a compressor, a truck, or a MFP that assists a community in their main economic activity. Where possible, these physical resources should be sourced locally to benefit the community and the environment and by that complying with the definition for a CBBE as constructed in paragraph 2.4.1.

The land where the digester is built is also an important resource that should be chosen carefully. This is because a bigger plot gives more room for activities and a location close to the biggest source of feedstock or the most difficult to transport gives the operation more financial feasibility. Utilizing gravitational potentials could also give the operation more financial feasibility. This means placing the digester on higher ground and using gravity to transport slurry downhill to reduce transportation costs.

Feedstocks open to a CBBE in Ghana are crop residues, manure, municipal waste (solid and liquid), organic waste streams from industry or market and slaughterhouse waste (Aklaku, 2007; Bensah & Brew-Hammond, 2010; Duku, 2011). In Table 6, the availability and biogas potentials crop residues, manure and municipal waste are given.

Table 6. Biogas potential of selected residues in Ghana (Thomsen, et al., 2014)

Feedstock		Availability (Mt/year)	Biogas potential (Mm <sup>3</sup> /year)
Crop residue	Field based	9,6	2667
	Processing	4,2	1250
Manure	Recoverable	2,9	167
Municipal waste	Solid (MSW)	4,2	767
	Liquid (MLW)	1,12	57
Total		22	4907

Human fecal matter could also be added by connecting a toilet block to the digester. But because this related to the value proposition of sanitation, it is not included in the model as it also has complications like higher pathogen concentrations and possible social stigmas on the use of digestate from fecal matter.

Water is an important resource that should not be overlooked, especially in Africa, where water can be a scarce resource. It is best if the digester is close to a source of water like a river or a lake. Biogas programs in Nepal and Vietnam use the criterion that a suitable water source should be within 20 minutes walking (Heegde & Sonder, 2007). However, care must be taken when utilizing these resources as lesser gods or divinities are believed by some indigenous people of the Ashanti to dwell there (Appiah-Opoku & Mulamootil, 1997).

Labor is an important human resource to keep the digester fed and running. Operators with knowledge on operating a medium scale digester are needed around the digester on a daily basis. The complexity of the digester system determines the necessary capacities the operators. The chance of finding capable operators increases with lower technological complexity.

A logistical and an accounting system are important intellectual resources. These must be organized in a smart way to ensure a constant supply of feedstock.

#### Key activities

The key activities describe what needs to be done to realize the value propositions. These activities can be categorized into networking, production or problem solving. For a CBBE, there are five key activities that need to be done.

One of the most important activities is acquiring feedstock by organizing a supply chain. This acquisition includes finding suppliers by either creating a network or building on existing networks. Officially, the size of the final digester is determined by the quantity of available feedstock, and not the other way around. So during the planning phase, information concerning the community like infrastructure, water supply, waste management and agriculture within the community should be collected (Koottatep, et al., 2003). The acquisition also includes the collection of the feedstock. This can be done by either collecting it as part of the business or by outsourcing it to external parties, for example by having suppliers bring the feedstock themselves. Vehicles of appropriate size should be used, considering the amount of feedstock that has to be fed to the digester. When assuming a digester size comparable to that of Safi Sana, 9 tons of feedstock per day has to be collected and thus a small (tanker) truck will be useful. The digester needs to have a constant supply of feedstock for it to produce biogas. This requires a well-tuned degree of planning, as feedstocks also have a seasonal and geographical component to them<sup>3</sup>.

<sup>3</sup> In the north is one rainy season from April to September. In the south there are two rainy seasons: a major one from April to July and a minor one from September to November (August is usually quite dry). The dry season is from November to February or March throughout the whole country, when the harmattan, the north-

If the amount of feedstock fed decreases, the biogas production will halt and with it the whole business. When operating a digester as a business, it is important to close contracts with the suppliers to secure this supply. If contracts are not a common thing or there is no institutional safety net in the form of a universal rule of law, other methods have to be conceived to ensure a constant supply of feedstock. When suppliers come from different tribes, the degree of a civil society becomes also of importance as the level of cooperation could be compromised.

Operating the digester is also an important activity. This includes mainly feeding the digester, monitoring the digester's health and occasionally stirring the contents of the digester. This activity is dependent on the used technology and the corresponding complexity. Feeding the digester is done manually but a pump will be necessary at bigger digester sizes. Activities like process control (controlling parameters like temperature, acidity, retention time) and sampling the feedstock and digestate to obtain a stabilized end product can also be added. These will ensure a higher biogas yield but will also increase the digesters operating complexity.

Quality assurance by managing the feedstock and digestate is another key activity. Because the digester needs a constant daily feeding rate and it is probable that the amount of feedstock collected per day fluctuates, a storage facility is needed. This makes accounting also into a key activity. Also, pre-treatment steps to make the feedstock entering the digester smaller in size and uniform in composition, and post-treatment steps to upgrade the gas and digestate are a part of this activity. Upgrading the gas involves washing out Sulphur compounds and water vapor, which could corrode a generator. Upgrading the digestate can be done by drying it in a basin with alternating layers of digestate and organic material to produce high quality compost. For this, enough space must be available onsite.

Maintaining the digester is a key activity that needs extra attention because a lack of proper maintenance is a problem in biogas projects in Ghana (Bensah & Brew-Hammond, 2010). The maintenance needs are dependent on the chosen technology and will increase when the number of moving parts increases. A CBBE can perform maintenance activities itself or it can be outsourced if there are partners with right capacity are present locally.

The final key activity of a CBBE is the marketing and selling of the produce and adapting to the regulatory environment. Depending on the value proposition, the produce (gas, electricity, digestate) has to be properly advertised. This can be done by using posters, radio or tv commercials, mouth-to-mouth, etc.

#### Key partners

Parties with a lot of influence when it comes to planning a CBBE are the municipality and the chief. The municipality is charged with urban planning, and however these are less strictly organized than in Western countries, they are the formal party with influence to convince. Especially when setting up a project of a medium to large scale that is the first of its kind, permitting and licensing can be a slow process. Informally, the chief is the one to convince. Traditionally, chiefs have a lot of decision-making power within communities. They should be informed of everything that happens in the community and will have to give a blessing before a project can proceed. When the chief is optimistic towards a CBBE he can be an important ally. Vice versa he could also stop the whole project when he is not kept happy. When for example a location for the digester has to be found, the chief, who is in trust of deciding what happens to the land that is owned by the community, should be asked for counsel (Appiah-Opoku & Mulamoottil, 1997).

Maintenance and feedstock collection services are also possible partners. If these activities are outsourced, there is less demanded from the CBBE's own employees. By paying a company to regularly check the digester and ensuring their paycheck for a longer period, digester failing can be avoided. For the

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east trade wind from the Sahara, comes down and sucks all the moisture out of the vegetation. This results in droughts that can last for weeks (Ward, 1948).

collection system, multiple options are possible, with a single or multiple partners. It could be one company collecting feedstock from every possible source. Another option would be to have the owners of the feedstock bring it themselves. A third option could be leaving the collection system as a vacuum and setting up a reward system for bringing feedstock to the digester. Making use of the mechanics of market economy, this could lead to a self-organizing system with many different independent actors. The reward should be something making the trip to the digester worthwhile, like an economic reimbursement.

The ECG (Energy Company Ghana) is an important partner when electricity is sold to the grid. A connection to the grid must be made, it must be regularly maintained and a monthly payment should also be arranged properly. It is assumed the ECG will be happy to comply considering the goals of the government regarding the stimulation of renewable energy and the increase of the feed-in tariff.

Shops that sell the products of the CBBE like gas containers or bags of fertilizer can also be important partners as it will increase the market. If the gas is used to power a MFP, a partner company could also be involved to operate it.

#### Cost structure

The costs of a CBBE are the combined costs to realize all the previously mentioned parts. For a CBBE the most important fixed costs will be the initial investment for the construction of the digester system. Also a pre-mixing unit, a H<sub>2</sub>O- and H<sub>2</sub>S-removal unit, a generator, a compressor, a truck, or a device that assists a community in their main economic activity could be included in the cost structure.

During operation, the most important variable costs are those for the collection of feedstocks and paying employees' wages. The compensation for the suppliers depends on their willingness to cooperate and should be investigated thoroughly. Other costs are maintenance costs and promotional activities. The costs of collection should be low enough to make the business model feasible but high enough to get the feedstock transported to the digester.

#### Revenue streams

The revenue streams are dependent on the value proposition. This can be selling gas through containers or a mini-grid, selling a service or selling power to the grid. The pricing of these goods should for the most part be lower than the price of the goods its substituting. Regarding the selling of biogas, these goods are firewood, charcoal and LPG. When a service is sold, the price depends on the type of service and the economic capacities of the community and should be determined per situation. When electricity is sold through a mini-grid, the price can be similar to that of the ECG, as it offers a connection to electricity which is more constant than the national grid. The price of the fertilizer is dependent on the price of mineral fertilizer and its relative nutrient content. The prices of all relevant products are given in Table 7.

**Table 7. Prices of products for which a CBBE could substitute for (D.K. Ampadu 2017, personal communication, 18 June)**

Product	Quantity	Price (GHS)	Price (euro) <sup>4</sup>
<b>Firewood</b>	Heap of 10 kg	20	4,06
<b>Charcoal</b>	Bag of 25 kg	25	5,07
<b>LPG</b>	Cylinder of 17 kg	70	14,19
<b>Mineral fertilizer</b>	Bag of 50 kg	75	15,21
<b>Residential electricity tariff</b>	1 kWh	0,34	0,07
<b>Non-residential electricity tariff</b>	1 kWh	0,97	0,20

<sup>4</sup> Based on an exchange rate of 4,93216 GHS/euro (18-06-2017)

## 2.5. Conceptual framework

A conceptual framework was created to summarize and visualize the relations between the different concepts that are used in this thesis. This visual representation of the framework can be seen below in Figure 6. With arrows is indicated how the concepts influence each other.

As can be seen in the figure, the main interest of this thesis is the development of Ghana by the transfer of biogas technology. The complexity of the technology is dependent of the cultural and institutional capacity present in Ghana. If this capacity is present, entrepreneurs can freely innovate and disseminate biogas throughout the country. To be able to develop the right capacity or for it to be present, a culture needs to have the right set of cultural values. These values are universalism, egalitarianism, individualism, voluntarism, sequential time orientation and status by achievement and can be divided over the concepts of civil society and innovative entrepreneurship. The degree in which these values are present in Ghana will influence the type of entrepreneurship and the degree of complexity that a biogas technology can have when transferring it to Ghana.

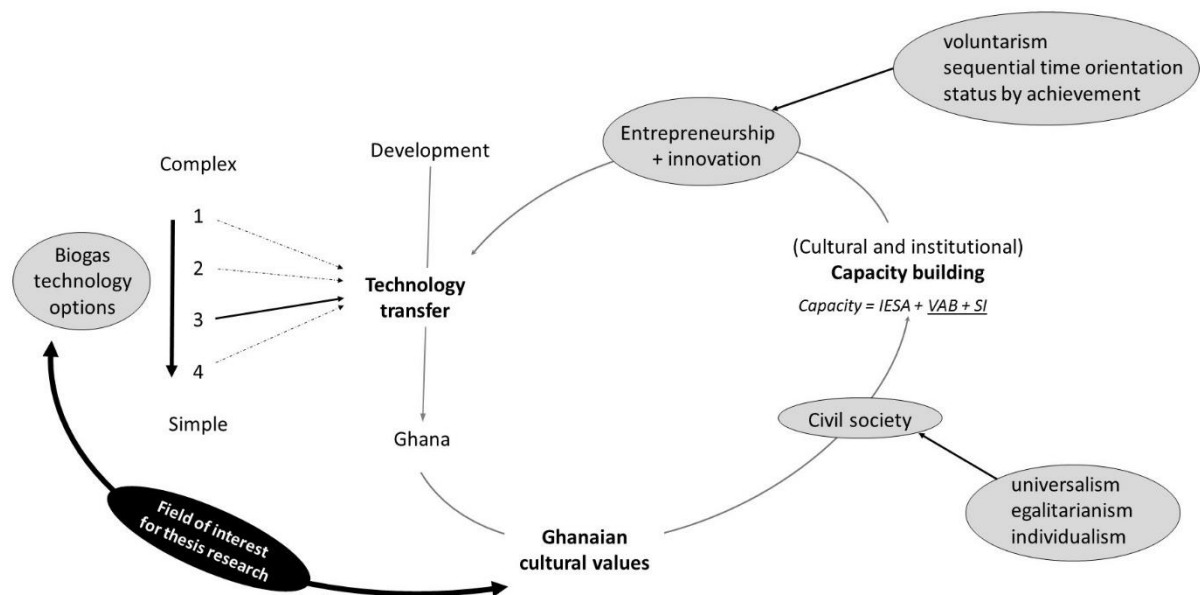


Figure 6. The conceptual framework as used for this thesis research





### 3. Methodology

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In this chapter the used methodology will be described. First, the setup of the study is discussed in paragraph 3.1. Secondly, in paragraph 3.2 the case studies that formed basis for the cultural analysis are briefly presented and the selection procedure is explained. Finally, paragraph 3.3 explains how the data was collected. The methodology is discussed in chapter 7.

#### 3.1. Setup of the study

To find an appropriate complexity and scale for a CBBE in Ghana, two analyses were done. A cultural analysis was done to identify Ghana's business culture and the possible cultural and institutional constraints (the limitations to the management style and business culture). A technical analysis was done to rank the possible technological options on their relative complexity, using a multi-criteria analysis (MCA). The business culture in Ghana and complexity of the technological options were then compared. The degree of innovative entrepreneurship and the resulting professional capacity were used to determine the possible complexity of the system. The degree of civil society and the state of infrastructure in Ghana were used to determine the possible scale of the system. To design a suitable business model for this CBBE, there was built on an analysis of business models in Ghana and a preliminary explorative study for community based biogas plants by Boerboom (2015a), for which a field study of one month was done in Ghana. The following three sub-paragraphs explain in more detail how the cultural and technical analyses and design of a suitable business model for the CBBE were done.

##### 3.1.1. Performing the cultural analysis

Following the field study in Ghana for the preliminary explorative study, an additional field study of two months was done to collect data for the cultural analysis. In this period, thirteen SMEs were visited and used as case studies to represent Ghanaian culture. The selection procedure for these companies and the justification for why they are representative for business culture in Ghana is further elaborated on in paragraph 3.2. The case studies themselves can be found in appendix A.

The cultural model as presented in paragraph 2.2 was used to qualitatively analyze this data. Each company was described based on the six cultural dimensions from the model and their internal management structure was identified. Notable examples from the company descriptions regarding the dimensions were extracted and collected in a table where they were each given a score between one and five. This was only a rough evaluation which fitted the purpose of an explorative study. There were multiple examples per dimension per company. These were taken together and used as base for the final

score for the dimensions per company. For the cultural analysis, all scores were ordered per dimension. The final score per dimension was based on the average of all companies.

### 3.1.2. Ranking the digester designs on relative complexity

A MCA was done to rank the digesters of paragraph 2.3.3 on relative complexity. By means of Table 8, the relative complexity of the four selected biogas technologies was determined by ranking them on an ordinal scale, based on the different parameters for complexity as presented in paragraph 2.3.4: operational simplicity, maintenance needs and constructional simplicity. Based on their importance, these parameters were ranked from one to three and were given a weighing factor based on the expected value method. By following this method each rank number was divided by the sum of the rank numbers so they would add up to one, after which the following quantitative weights were found:  $W_1=3/6$ ,  $W_2=2/6$  and  $W_3=1/6$ .

**Table 8. Data-input table of the MCA for ranking the four selected digester designs from simple to complex**

	Operational simplicity	Maintenance needs	Constructional simplicity	Final score on complexity
<i>Weighing factor</i>	<i>0,50</i>	<i>0,33</i>	<i>0,17</i>	
<b>Digester design</b>				
<b>Fixed-dome</b>				
<b>Garage-type</b>				
<b>Floating-barrel</b>				
<b>Plug-flow</b>				

Operational simplicity was considered the most important parameter, because it has a constant effect during the lifetime of the digester. Construction simplicity was considered the least important, because it only has an effect during the initial stage of the digester, and can be dealt with by having a biogas-expert around during construction. The digester designs were ranked from one to four per complexity parameter and also given a score based on the expected value method which all added up to one. The following quantitative scores were found:  $S_1=4/10$ ,  $S_2=3/10$ ,  $S_3=2/10$  and  $S_4=1/10$ .

A low score referred to a simple technology and a high score to a complex technology. The scores per parameter were multiplied with the corresponding weighing factor and summed up to arrive at the final score for each design in paragraph 5.1.

### 3.1.3. Calculations for the technical analysis

A technical analysis was done to investigate the possible size of a digester for a CBBE in relation to different community sizes and corresponding feedstock availabilities. For all calculations, Excel 2016 was used.

The size of the digester  $V_{digester}$  (m<sup>3</sup>) is calculated by multiplying the loading rate  $\dot{v}_{digester}$  (m<sup>3</sup>/day) with the retention time  $\tau_{retention}$  (days), as given by equation 1.

$$V_{digester} = \dot{v}_{digester} \cdot \tau_{retention} \quad (1)$$

The loading rate is in turn dependent on the feedstock availability, which is assumed to come from the community. No data on feedstock availability for a specific Ghanaian community was available, so the average feedstock availability per capita was calculated. As shown in equation 2, the average feedstock availability per capita  $\dot{m}_{daily\ average, per\ capita}$  was calculated by taking the total amount of available feedstock  $\dot{m}_{annual\ availability, Ghana, i}$  from Thomsen et al. (2014) and dividing it by Ghana's population  $p_{Ghana}$  of 28.607.378 people (World bank, 2017).

$$\dot{m}_{daily\ average, per\ capita} = \sum_{i=1}^n \frac{\dot{m}_{annual\ availability, Ghana, i}}{p_{Ghana} \cdot 365,25} \quad (2)$$

The available amount of feedstock included crop residues of the most common crops in Ghana, manure from the most common Ghanaian livestock and solid and liquid municipal waste. They also reported the amount of forestry processing residues but these were not included as this would require rigorous amounts of pre-treatment.

By multiplying  $\dot{m}_{daily\ average,per\ capita}$  by the number of people per community  $N_{community}$ , the feedstock availability of a community  $\dot{m}_{daily\ average,community}$  was obtained, shown by equation 3.

$$\dot{m}_{daily\ average,community} = \dot{m}_{daily\ average,per\ capita} \cdot N_{community} \quad (3)$$

Thomsen et al. (2014) also reported the product to crop residue ratios. Based on these numbers the annual crop productions in Ghana  $\dot{m}_{annual\ crop\ production,Ghana,i}$  were calculated. Combined with the yields (in t/ha) of these crops  $y_{crop\ yield,i}$  (MoFA, 2013) and the percentage of agricultural land in Ghana (World bank, 2017), it was calculated how much land was needed per person, based on their average feedstock availability.

$$A_{per\ capita} = \sum_{i=1}^n \frac{\dot{m}_{annual\ crop\ production,Ghana,i}}{y_{crop\ yield,i} \cdot pop_{Ghana} \cdot \% \text{ agricultural land}} \quad (4)$$

By multiplying  $A_{per\ capita}$  by the number of people per community  $N_{community}$ , the feedstock availability of a community  $A_{community}$  was obtained, shown by equation 5.

$$A_{community} = A_{per\ capita} \cdot N_{community} \quad (5)$$

To estimate the required traveled distance for feedstock collection, a square community area ABCD was assumed, as shown in Figure 7.

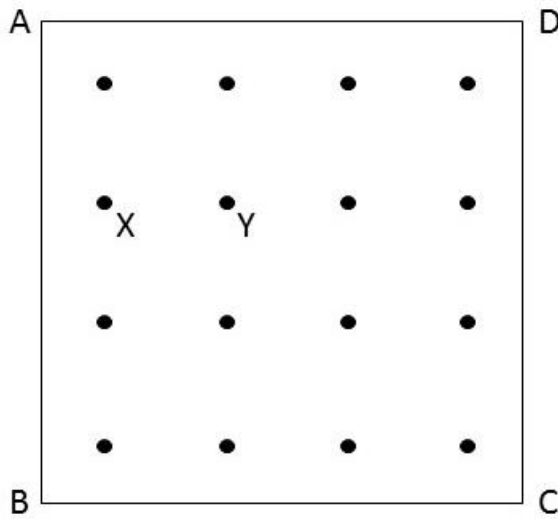


Figure 7. Square community area ABCD with N feedstock sources.

The feedstock sources, indicated with black dots in Figure 7, were assumed to be perfectly distributed over the area ABCD. The distance between the edges of ABCD and the outer sources was taken to be  $\frac{1}{2}$  the distance between sources. With a certain number of feedstock sources  $N_{sources}$ , the distance between sources (X and Y) was calculated with equation 6.

$$d_{between\ sources} = \frac{\sqrt{A_{community}}}{\sqrt{N_{sources}+1}} \quad (6)$$

To calculate the distance for one collection trip, it was assumed that a collection round could be made along all the different feedstock sources. The total distance was calculated with equation 7.

$$d_{total} = d_{between\ sources} \cdot (N_{sources} + 1) \quad (7)$$

To calculate how much feedstock was needed per source to break even on the energy balance between fuel consumption and biogas potential, the ecological quotient  $Q_{ecological}$  was calculated as given by equation 8.

$$Q_{ecological} = \frac{E_{BM}}{E_{fuel}} \quad (8)$$

Where  $E_{BM}$  is the potential energy content of the collected biomass, given by equation 10. It was calculated by multiplying the average feedstocks availability per capita  $\dot{m}_{daily\ average,per\ source,i}$  (equation 11) with the biogas yields for the specific feedstocks  $y_{BG_i}$  (m<sup>3</sup>/kg), the number of sources  $N_{sources}$  and the specific energy content of biogas  $e_{BG}$  (kWh/m<sup>3</sup>). An  $e_{BG}$  of 6 kWh/m<sup>3</sup> was assumed.

$$E_{BM} = \sum_{i=1}^n \dot{m}_{daily\ average,per\ source,i} \cdot y_{BG_i} \cdot N_{sources} \cdot e_{BG} \quad (10)$$

$$\dot{m}_{daily\ average,per\ source,i} = \frac{\sum_{i=1}^n \dot{m}_{daily\ average,per\ capita,i} \cdot N_{community}}{N_{sources}} \quad (11)$$

$E_{fuel}$  is the energy content of the fuel needed for transport, given by equation 12. The specific fuel consumption  $c_{vehicle}$  was assumed to be 0,15 l/km and the specific energy content of the fuel  $e_{fuel}$  (diesel) was assumed to be 11 kWh/m<sup>3</sup>.

$$E_{fuel} = d_{total} \cdot c_{vehicle} \cdot e_{fuel} \quad (12)$$

To calculate the minimum amount of feedstock needed per feedstock source to break even on the energy balance between fuel consumption and biogas potential,  $Q_{ecological}$  was set to 1. This allowed to solve for  $\dot{m}_{daily\ minimum,per\ capita,i}$ , as given in equation 13.

$$\dot{m}_{daily\ minimum,per\ source,i} = \frac{d_{total} \cdot c_{vehicle} \cdot e_{fuel}}{y_{BG_i} \cdot N_{sources} \cdot e_{BG}} \quad (13)$$

Because the CBBE was assumed to be based on feedstocks from a community, the relation between  $V_{digester}$  and  $N_{community}$  was investigated. However, before the digester size could be calculated (equation 1), the loading rate  $\dot{v}_{digester}$  had to be calculated using equation 14.

$$\dot{v}_{digester} = \frac{\dot{m}_{daily\ average,community}}{\rho_{feedstock}} + \frac{\dot{m}_{water}}{\rho_{water}} \quad (14)$$

In equation 13, the volume of added water was included because a wet digestion process with a  $TS_{target}$  of 15% would be needed, considering all the available feedstock types. In the calculations, a  $TS_{manure}$  of 15% and  $TS_{crop\ residues\ and\ MSW}$  of 70% were assumed. To calculate the mass of the added water, equation 15 was used.

$$\dot{m}_{water} = \frac{(1-TS_{target}) \cdot \dot{m}_{daily\ average,community,i} \cdot TS_i}{TS_{target}} - \dot{m}_{daily\ average,community,i} \cdot (1 - TS_i) \quad (15)$$

In this equation, first the mass of the water that would be needed based on the amount of solids fed to the digester and the  $TS_{target}$  of 15% is calculated. The amount of water that is already present in the feedstocks is then subtracted from this to arrive at the amount of water to be added.

The digester outputs were also calculated. The daily volume of biogas produced  $\dot{v}_{biogas}$ , for a community of  $N_{community}$ , is given by equation 16.

$$\dot{v}_{biogas} = \sum_{i=1}^n \dot{m}_{daily\ average,community,i} \cdot y_{BG_i} \quad (16)$$

To calculate the daily amount of electricity  $\dot{E}_{electricity}$  that could be generated with  $\dot{v}_{biogas}$ , it was multiplied by  $e_{BG}$  and an assumed generator efficiency  $\eta_{generator}$  of 35%. This is shown in equation 17.

$$\dot{E}_{electricity,daily} = \dot{v}_{biogas} \cdot e_{BG} \cdot \eta_{generator} \quad (17)$$

Another output of the digester was digestate. It was assumed that it was dried and sold as organic fertilizer. The dry fraction of the daily digestate output was obtained by doing a mass balance over the digester, and multiplying the found mass for digestate by the  $TS_{target}$ , as shown in equation 18.

$$\dot{m}_{digestate,dry} = (\dot{m}_{daily\ average,community} + \dot{m}_{water} - \dot{v}_{biogas} \cdot \rho_{biogas}) \cdot TS_{target} \quad (18)$$

#### 3.1.4. Calculations for financial assessment of the value propositions

For the financial assessment of the value propositions, three common methods were used. These were the Net Present Value (NPV), Internal Rate of Return (IRR) and the Discount Payback period (DPB).

The NPV method calculates the difference between the present value of cash flows  $C_t$  over a time period  $T$  and the initial investment  $C_0$ . The formula to calculate the NVP is given by equation 19.

$$NPV = \sum_{t=1}^T \frac{C_t}{(1+r)^t} - C_0 \quad (19)$$

For the CBBE  $T$  was chosen to be the same as the lifetime of the digester. By using the present values of the cashflows is taken into account that currency depreciates over time, according to the interest rate  $r$  set by banks in Ghana. The interest rate is based on value fluctuations of the currency and by that, the willingness of people to invest their money. The NPV is a direct measure of the financial contribution to the investors and if the NPV of a future project is positive, the project should be accepted.

Calculating the IRR is done to measure the profitability of potential investments. It is the discount rate for which the NPV can be solved to make it 0, as shown in equation 20.

$$\sum_{t=1}^T \frac{C_t}{(1+IRR)^t} - C_0 = 0 \quad (20)$$

IRR indicates the maximum discount rate at which a project becomes attractive to investors. If the IRR of a prospected project in a certain country is higher than that country's discount rate, it is for investors more attractive to invest in the project than to put money in the bank.

The DPB method calculated the payback period of a project, using discounted cash flows. The DPB can be acquired by rewriting equation 19, and solving for  $t$ . Rewriting gives equation 21.

$$\sum_{t=1}^T \frac{C_t}{(1+r)^t} = C_0 \quad (21)$$

### 3.2. Selection of case studies for the cultural analysis

Because of the explorative nature of the research, there was a lack of initial knowledge of the social systems to be researched. Instead of using superficial questionnaires with many respondents, there was chosen to do an in-depth research, with a limited number of thirteen SMEs visited during the fieldwork. These companies were used as case studies and were intensively studied. The statements, viewpoints and reasoning used by the investigated persons were of high importance. By going more in-depth, it was possible to follow the processes in the companies, whereas questionnaires would just give a snapshot of the situation. Using questionnaires or some other form of quantifying research could be done for follow-up research, to give more exact answers.

There were no biogas businesses available, so a diverse selection of businesses was visited to get a broad, all-inclusive description of the cultural aspects within Ghanaian SMEs and the characteristics of business models in Ghana. The companies as listed in Table 9 were selected based on having a workforce of between 5-50 employees and relatively low levels of technological complexity, as this was expected to be the same for the intended CBBE. This selection procedure was developed during the first month of field research in Ghana for the preliminary research by Boerboom (2015a).

Table 9. The SMEs visited during the field research

Company name	Company description	Location	Workforce	Technologies used
<b>Kumah Farms (KF)</b>	Farm, specializing in catfish and pig farming	Domeabra	18 fulltime	Pelletizer, dryer, generator (20kW), high pressure washing machine, 3 water pumps, hand tools.
<b>Nuamah Enterprise (NE)</b>	Paint distributor, repackaging and selling Western paint	Domeabra	40+ fulltime	Mixers, forklift truck
<b>Family Star Entertainment (FS)</b>	Movie production company in "Kumawood"	Kumasi	1 fulltime, 5-100 part-time/extras	Camera's, tripods, microphone, lights, crane, green/blue screen.
<b>Manco Industries Ltd. (MI)</b>	Production and sales of mattresses	Adako-Jachie	±8 fulltime	Big mixing tool, cutting machines, sowing machines, sealing machine, transport van
<b>Kumasi Institute of Tropical Agriculture (KI)</b>	Private agricultural training institution	Domeabra	11 fulltime, 24 part-time	Laptop, printers, educational management software, basic agricultural tools, projector (+screen), 2 biogas digesters, generator, mechanical dryers,
<b>Royal Chef (RC)</b>	Restaurant serving traditional dishes	Kumasi	18 fulltime (on trial)	Blender, knives, fridges
<b>The Pioneer (TP)</b>	Small semi-weekly newspaper	Kumasi	7 fulltime, 8 part-time	Hedleback machines (discarded), web-offset machines, computers
<b>Terracotta (TC)</b>	Slipper making workshop	Kumasi	1 master, 5 apprentices	Sowing machine, scissors, plyers, knife, hammer, brush, smoothing machine (handled by an external party)
<b>Kumasi Abattoir Company Ltd. (KA)</b>	Semi-governmental abattoir	Kumasi	125 fulltime, 20 part-time	Standing bocks, leg cutter, hide pullers, brisket splitting, carcass splitter,
<b>Star Company Ltd. (SC)</b>	Transport company	Domeabra	15 fulltime	Two big fords, three taxis, three trotros
<b>Tiptop Farms (TFa)</b>	Farm producing various vegetables and pigs	Anloga	4 fulltime, 10-50 farmhands	Hand tools, tube well irrigation system throughout the farm, 5m3 biodigester, 1,6kW solar pump, 0,2 kW PV panel, 1 kW wind turbine
<b>Tiptop Foods (TFo)</b>	Producer of tomato puree	Anloga	3 fulltime, 13 seasonal	2 t/h pulper, bottle cleaner, 8 gas pits for sterilizing
<b>Hortor Fishing Company (HF)</b>	Fishing company that operates from the shore	Anloga	2 fulltime, 40-50	Boat, beach seine net, rope



### 3.3.Data collection

This paragraph will elaborate on the different ways data was collected for this research. Data was collected in three different ways, namely through a literature study, in-depth interviews and participatory observation.

#### 3.3.1. Literature study

A literature study was done to collect data for the theoretical framework as already has been presented in the previous chapter, as well as extra input for the cultural and technical analysis and the design of a business model for a CBBE.

#### 3.3.2. In-depth interviews

To perform the cultural analysis, it was decided a literature study would not be enough and a field study was necessary to acquire the most relevant and specific qualitative information for the purpose of this thesis. A field study of two months was done and thirteen different SMEs in Ghana were visited. During this field study, data was gathered by in-depth interviews and participatory observation.

In-depth interviews were conducted with persons in managerial positions to get input for the cultural model. A questionnaire was taken and adapted from Vlieger (2013) and can be found in appendix B. The questionnaire started with some general questions on the company, then went into the business model of the company and ended with questions based on the cultural model. Sometimes questions were asked multiple times in different forms to verify the answers and to minimize the chance of socially preferred answers. The intended purpose of the research was communicated as generally as possible as it would also minimize the chance of socially preferred answers. A more specific purpose was communicated as was considered to help with getting access into the companies.

The interviews had a semi-open character. The questionnaire was followed as much as possible but there was deviated from it when an interesting topic came up or more clarification was needed on certain answers. The interviews were recorded and transcribed to maximize the data's reliability. A couple of experts in the field were interviewed as well during the orientation period.

#### 3.3.3. Participatory observation

Next to in-depth interviews, further data was constantly gathered during the field study by participatory observation (Swanborn, 1991). By emerging himself in the field of study, namely Ghana's culture, the author was enabled to study the interaction between Ghanaians and get a better understanding of certain behaviors, connected to the culture. By having a different cultural background, the author could also identify certain patterns of interaction that were specific to Ghanaian culture and were taken for granted by Ghanaians themselves. Most of the observed behavior is spontaneous and thus less chance of data becoming artificial or distorted. The most valuable data was gathered by doing mini-internships at the visited companies. The companies were asked if the author could spend one or more days at the company, followed by an in-depth interview, to see how business was conducted. While walking around on the workplace and participating in the daily life and work (if it was allowed), data was gathered by observation of verbal and non-verbal behavior.

Since the in-depth interviews were done with persons in management positions, other employees were also questioned in the context of participatory observation to be able to confirm or debunk answers given by the managers. The information from the participatory observation, together with the information from the in-depth interviews was processed into company descriptions that can be found in appendix A.



## 4. Cultural analysis

This chapter contains an analysis of Ghanaian culture. With this analysis is investigated what the cultural opportunities and barriers are for a CBBE in Ghana. The results of this analysis are summarized in paragraph 4.1. Paragraph 4.2 builds on these results and uses them as a guideline to fill in the cultural aspects of the business model.

### 4.1. Ghana's cultural profile

This paragraph gives an indication of Ghanaian culture. It does so by sketching a profile based on the cultural model (paragraph 2.2) and several case studies (paragraph 3.2 and appendix A). Below, the results of the cultural model are given per cultural dimension. For each dimension, a summary of the case studies is presented and given a score ranging from one to five (see paragraph 3.1.1). The scores of the separate companies on each dimension are visualized together with the average score in a figure at the end of each paragraph. Paragraph 4.1.7 brings together the cultural dimensions. Moreover, this paragraph determines the degree of a civil society and innovative entrepreneurship in Ghana. Chapter 6 uses the results of this chapter to design a business model for a CBBE in Ghana. A discussion on the business model and the results of this chapter follow in chapter 7.

#### 4.1.1. Hierarchy versus egalitarianism

Hierarchy is a common thing in Ghanaian culture and in daily life is most clearly expressed in the social structure of showing respect for elders and chieftains. Every village has a chief who is above all other villagers and although nowadays the role of a chief is mostly ceremonial, they still enjoy the respect of all their subjects. The traditional government of Ashanti for example, is shaped like a pyramid. In this government, a king heads the Ashanti Confederacy Council. The council is a group made of paramount chiefs who in turn preside over district chiefs. A district chief presides over a District Council of elders, which is made up of sub chiefs. Villages are brought together by a sub chief. Within every village there is a village head council made up of all the heads of households (West, 2003). Next to the hierarchical structure of the chieftainship, there is also an egalitarian component to it. Appiah-Opoku and Mulamoottil mention: *"Whenever the chief and his elders sit in council to deliberate on matters affecting the*

*community, each member of the community can make his or her voice heard either in person or through the representative of his or her lineage. There are also checks and balances within the indigenous political system. For instance, the chief is bound by custom to act with the consent and on the advice of his elders who are themselves representatives of lineages in the town or village and are subject to similar restraints from members of their own lineages. The chief and his elders are collectively responsible for the administration of the town or village. Public opinion is expressed at the council either through the elders who, as heads of lineages, are often in contact with members of their community or the Nkwankwaahene (leader of the masses)" (Appiah-Opoku & Mulamoottil, 1997).* Ghanaians will always be respectful and listen to their elders. Whenever there are big social events like weddings or funerals, the chief and elders take a prominent position in the center and the younger people will sit behind them and are expected to stand up and move further back when an elder arrives.

In business, Ghana's hierarchic culture is also clearly visible, although there are also enough examples of an egalitarian culture. Often the companies have a culture in which both sides of the dimension exist, which could indicate that Ghana is in a transition period.

The Kumasi Abattoir Company Limited is an example of a coming together of traditional and modern values. New in the way it is managed, with equality on the work floor as company regulation. Old because it is based on a Nigerian system with Islamic butchers who work with hierarchic methods. KITA is another example of a modern company with some traditional characteristics. For example, the students have a say in the height of the hosteling fee. Also, the director Samuel is always very helpful to everybody and his door is always open whoever wants to see him. But at the same time students are used to make or bring the management team food, which is easily accepted because the management team is above them.

At Manco, a mattress company owned by Issah and his cousin Vince, a clear distinction can be seen between the hierarchic production side led by Issah, and the more egalitarian marketing side led by Vince. Issah is the only one with knowledge on the production process and does not share this with anyone. The production workers are basically his assistants, there to help him make mattresses. Vince has worked for six years at a bank in Canada and this is visible in the way the sales team is managed. The sales team gets a lot of freedom and must show initiative by making their own planning. Only with the big clients Vince is called in to represent the company.

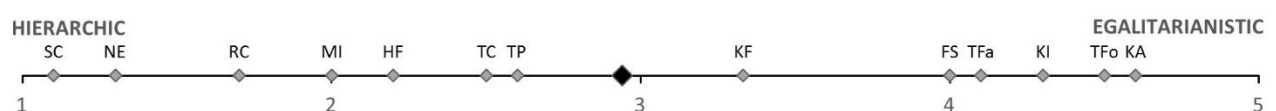
Sometimes hierarchy in a company makes a lot of sense. For example, at the fishing company Hortor, located on the Ghanaian coast at Anloga. All that the company is built around, is a boat and a net. The boat casts the net into the ocean after which it is pulled back onto the beach by around 40 to 50 people in a coordinated motion. This coordination is overseen by the manager, who also joins in the pulling while giving orders to which everybody listens. Slacking around would be noticed by either the manager or one of his trustees and pay would be deducted accordingly. Even though the manager held this position of power, it was interesting to learn that he received the same amount of payment as everybody else. This indicates that the manager has an equal standing with the other net pullers. When the fishes were to be divided (biggest fishes to the boat owner, bulk of the smaller fishes for sale and the leftover to the net pullers) the manager did get to take some the big fish home. Another example of hierarchy making sense is at Terracotta, where new employees are trained to be slipper-makers through a master-apprentice system. A clear hierarchy is intrinsic to this system and is also what makes it work. The apprentices could refute the master but this almost never happened as they accepted the master as their superior. The distance between the master and apprentice was further illustrated by the fact that apprentices did not always get paid in their first year and would have to find someone willing to sponsor them.

Some other examples of hierarchic cultures were found at Royal Chef, Kumah farms, Nuamah enterprise and Star Company. Nana Kwanfo at Royal Chef wants everybody to do as he says with little freedom for the employees. Mistakes cost employees a day without payment. Nana Kumah at Kumah farms is the boss and will not listen to his brother's advice on how to run his company, although Joseph has been to

business school and is officially in charge of the business side of the farm. The “Chairman” is the boss at Nuamah enterprise who, although he mentioned he was open to suggestions, tells how everything should be done to his workforce. The interview was constantly interrupted because many parts of the operation needed to check with him. It was literally *his* workforce, since all the workers lived together in a house owned by the Chairman. Drivers at Star company do not have any say in their routes. Nana Boameh, who is a fetish chief (a spiritual leader in the community) himself and therefore used to a position of power, just tells them their routes and they must follow. Whenever the drivers displease Nana, they run the risk of losing their job as Nana indicates that he will just pick another driver. If revenues fall short, Nana will recover the costs by lowering the driver his wages. The driver does not have a choice but to accept, an indication of hierarchy.

For most of the companies visited, employees were free to share their views. To what extent this really happened was questionable for some companies. At other companies, it was clearer. Apprentices at Terracotta for example were always able to introduce their own slipper designs. At Kumah farms and Tiptop farm employees were explicitly encouraged to share their views. Tiptop foods even claimed to have a flat organizational structure that included the students in the whole production process. If they had anything on their minds they could talk to Apolonia who had the same Togolese roots.

Ghana’s culture is mostly hierarchic, although in business there were a similar number of egalitarian examples as well, as can be seen in Figure 8. Because these examples represented almost half of the case studies, representing a possible transition of Ghana from a hierarchic to an egalitarian culture, **Ghana’s score for the dimension hierarchy versus egalitarianism is 3.**



**Figure 8. Results of the cultural analysis for the dimension hierarchy vs egalitarianism. Grey dots indicate separate companies, whereas the black dot shows the dimension’s average.**

#### 4.1.2. Communitarianism versus individualism

Daily life in Ghana is very communitarianistic, as for a major part it revolves around family. The family and extended family (aunts, uncles, cousins, neighbors, etc.) are constantly in closely interwoven relationships, giving a high degree of social control in Ghanaian communities. Especially in villages, the norm is to ask people how they are doing, even if they are not in your personal space yet. News travels fast because of this. This close interweaving of family can also be found within households. It is a significant challenge for an outsider to differentiate between friends and family in an average Ghanaian household. First because everybody calls each other brother, cousin, uncle or auntie, making it seem that everybody is related to each other. Secondly because it is not uncommon to take care of a child that is not yours if you have the means to do it. Sometimes half of all children in a household are adopted from other families. These are usually cousins but it can also happen that they are from parents from within the community who could not afford them. Although these children are often put to work in the household and not always enjoy the same treatment as the direct offspring, it does show a strong communal involvement.

Communitarianism in Ghana also shows from the way food is shared. If someone is eating something around others, it is considered decent to tell them they are welcome to join by saying: “you’re welcome”. Although not often is followed up on this invitation, it shows that eating should not be done alone and that food is more of a common good.

Other indicators of communitarianism in Ghana are funerals and weddings. These are big events, to which the whole community gets invited and which can last up to a week. The close family should prepare for at

least a week and will spend lots of money, even if it means getting into debt. The money is usually obtained from the extended family.

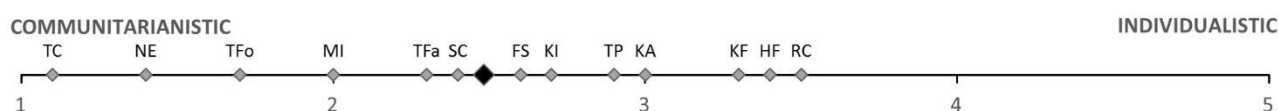
In business, communitarianism can also be found but to a somewhat lesser degree. At the majority of the visited companies there were family members working. This ranged from a son or brother-in-law being hired for repairs, to family members taking important managerial positions. Usually, the companies communicated using a combination of tribal language (Twi/Ewe) and English. There were however also companies that adapted the languages from their employees, who came from anywhere in the country. This did not happen much since most companies had Twi as their main tribal language which is the most well-known language in Ghana.

There were some other examples of communitarianism in business found. For example, when KITA had a financial success everybody would get a raise, showing the importance of the group interest. Another example is the butchering trade at the Kumasi Abattoir, which is dominated for decades by Muslim butchers from Nigeria. This shows a strong in-group mentality within the butcher community for which it is difficult to get into for outsiders from other tribes. At Tiptop foods, there was a similar situation. The workforce was made up only from graduate students from the nearby Togo. This was because they were relatively cheap and highly educated, but mostly because they shared a Togolese heritage with Apollonia, Factory Purchases and Sales Executive at Tiptop foods as well as wife of the owner Sena.

High levels of communitarianism were not found at every company. In contrast to Tiptop foods, Tiptop farms showed a very open mentality to out-group members, as Edward mentioned he likes cooperation with anybody. He was part of a farmer's organization with farmers from all around that share ideas. Also, anybody was welcome to join working at the farm as a farm hand. Everyday people would show up at the gate to work. Based on a first-come, first-serve principle people were chosen to work for that day. This was the similar for Hortor, where anybody could just come to help reeling in the fishing nets.

A more individualistic approach was also seen for the selection and contact with suppliers and customers. For most companies, this was just based on a combination of quality and price. Although relations with suppliers and customers was important, tribal background seemed to play no part.

Ghana's culture is mostly communitarianistic, although there are some individualistic examples as well. Because these were significant examples, representing the existence of an individualistic culture, **Ghana's score for the dimension communitarianism versus individualism is 2**, as Figure 9 confirms.



**Figure 9. Results of the cultural analysis for the dimension communitarianism vs individualism. Grey dots indicate separate companies, whereas the black dot shows the dimension's average.**

#### 4.1.3. Particularism versus universalism

Giving people a particular treatment based on who they are is a common practice in Ghana. This was clearly noticeable for the author during the time of the field study, who has a white skin. Of course, in a virtually all black-skinned country, someone with a white skin will stand out<sup>5</sup>. But it was notable that this was accompanied by specific assumptions and a corresponding special treatment in most interactions. Another clear observation of particularism were the bribes collected by policemen who regularly put up roadblocks. These roadblocks were officially put up to check cars for defects. However, it was common knowledge among all Ghanaians that handing over your driver's license together with some cedis would get them out of the examination. The presumption that the main purpose of these roadblocks was just to

<sup>5</sup> Ghanaians themselves use the terms white and black skin and have not yet invented political correctness, so it was copied for this thesis



collect bribes was reinforced by George of KITA, who advised the author when he was considering buying a car by telling him: *"Have you seen the cars here in Ghana? There are 99 things that can be wrong with your car, they will always find something if you do not pay them"*. One more indication of a particularistic culture are the disagreements between the different tribes in Ghana. Historically there has been distrust against people from other tribes, but nowadays there are signs of mutual respect for each other's customs (McCauley, 2017).

In business, this particularistic culture was also observed. Although examples of universalism were also distinguished (indicating Ghana could be in transition), particularism remained predominant. For example, family was hired at Kumah, Nuamah, Family Star, Manco, KITA, Pioneer, Terracotta, Star Company, Tiptop farm and Tiptop foods. This was the majority of the companies and thus indicated that family was an important connection to exploit for Ghanaians in business. In addition, the family also seemed to be receiving special treatment. Being well-connected in general was mentioned to be important by Nuamah, Family Star, Royal Chef, Pioneer, Abattoir, Star Company, TipTop farms. It also seemed that tribal associations played a part in this, since local language was spoken at most companies. However, this presumption is difficult to solidify as all companies indicated they did not take tribal origins into account for their hiring procedure. The fact that the workforce of some companies were all-Ashanti or all-Ewe was most probably the result of the workforce being made up from local people, who happened to be all-Ashanti or -Ewe. There were also companies like Kumah Farms, KITA, Family Star and Abattoir that spoke more languages to communicate with their employees, who came from all over Ghana.

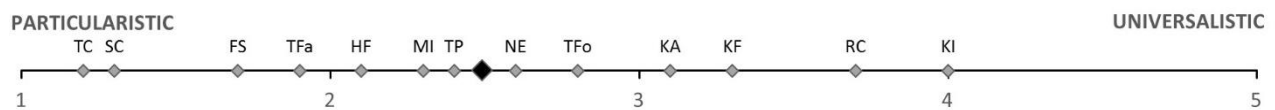
Some more specific cases of patronage systems were observed at Family Star, Hortor, the Abattoir and Star Company. The actors and crew at Family Star was selected based on previous associations and also got special treatment by Rosalinda. At Hortor, there was a patronage system for choosing a boat on shores of Anloga. In principle, it was possible to help pull any net on the shores but people usually came to the same boat to help pulling because they knew the manager who was their patron. A similar patronage system existed at the cattle market of the Abattoir. The client-patron relationship between the merchants and the landlords has been around for a long time and was instrumental in the decision of the merchants to choose a certain landlord. Also Nana from Star Company had a similar preference for drivers he knew before certified drivers offered by the station.

Governmental regulations in Ghana are present, but non-compliance of these regulations was present as well. Environmental regulations for example were mentioned to be present by the Chairman from Nuamah. But these were clearly not strictly followed, as on a daily basis plastic was burnt all around the premise of the company. Similarly, safety gear was present at Manco (to be used to protect the employees during the production process from the fumes), but these were only occasionally used. One employee was observed looking at the rising foam rubber during the production process with red eyes, while the author already felt his eyes burning after one second with a gas mask on. At Terracotta was indicated that, besides the fact that Ghana was corrupt (*"even our mothers are corrupt"*), there were no governmental rules present of any kind. Kodjo and Jaw from Terracotta said jokingly that they would shoot anyone from the government who came to them.

There were also universalistic features found in Ghana's culture. Except for Terracotta, who hired only family, no language or tribal distinction was made at any of the companies. Nuamah enterprise and Kumah Farms only looked at muscles when hiring new employees. In contrast to Nuamah, where environmental rules were not strictly followed, at Kumah environmental rules were set and also followed up on. At KITA there were four levels of governmental rules to adhere to, which they did. Samuel mentioned that being well-connected used to be important, but nowadays treatment is based on capability. This was confirmed by Manco, where Vince put ads on the internet to hire people for his sales team. A universal approach for hiring was also done at Tiptop Farms and Hortor. At Tiptop Farms farmhands were selected by a first come first serve principle and at Hortor anyone could come help pull

the net. At Tiptop foods there were equal opportunities for all employees, although they all are Togolese. To acquire funds, Sena used official channels like development agencies instead of his network.

Summarizing the above, particular treatment is common in Ghana. Not per se based on tribal associations but on the existing patronage systems, the sporadically followed regulations, and corruption in governmental institutions. There were some exceptions however, like that one police officer who got offended when he was offered a bribe by a taxi driver. The officer arrested the taxi driver and after noticing that his license was fake and that he had been drinking he started a lecture about the values of the country. In front of the author, he stood up as a protagonist for a universalistic Ghana where corruption had no place. Although this anecdote shows that to some degree a universal culture is present in Ghana, a particularistic culture still has the upper hand. As also can be seen from Figure 10, **the final score for this dimension is 2.**



**Figure 10. Results of the cultural analysis for the dimension particularism vs universalism. Grey dots indicate separate companies, whereas the black tot shows the dimension's average.**

#### 4.1.4. Traditionalism versus voluntarism

Ghana's culture is characterized by traditionalism and a lack of innovation in business. Daily life in Ghana is filled with traditions and ceremonial activities, expressed for example in clothing, dancing, symbols or events like weddings and funerals. Wherever you are in Ghana, these traditions are closely followed. This traditionalism also expresses itself in business. There are many similar companies and shops around who all are selling or making the same good or service. Ghanaians tend to pick a safe choice when starting a business instead of innovating. This was also noticed when interviewing companies for this study. None of the companies indicated an innovative approach as their main value, but always high quality or good customer care.

The trotro business, where Star Company is a part of, is a good example of a traditional business. The transportation service is mostly offered by private car owners, who have trotros or taxi's all over the country. Although there is the occasional trotro that has a DVD-player in the back, every trotro basically offers the same service without feeling the need to innovate. Also at the Kumasi Abattoir traditionalism can be found. The credit system between the merchants, landlords and butchers with associated chiefs of the market and chief-butchers has remained virtually unchanged in the last century. It is a case of conducting business based on "how it always has been" i.e. based on tribal relations and an informal accreditation system. This also applies to Hortor and all the other fishing companies on the Ghanaian shores. During the mid-19th century beach-seine nets were introduced, in the 1960s the boats were motorized. No other big innovations have taken place since. Fishing is a way of life for most Ghanaians living in the coastal area of Ghana and is a very traditional profession, meaning they all use the same techniques.

Preparation of the fish, or any other food, is also a very traditional practice in Ghana. Ghanaian food is eaten by hand and usually consists of two components: a starchy staple food combined with a sauce or soup (most popular are palm nut and groundnut soup) which contains a protein source like meat or fish. The starchy food is taken with the hand and used to scoop up the soup. Royal Chef served solely traditional dishes, which could be considered a safe bet.

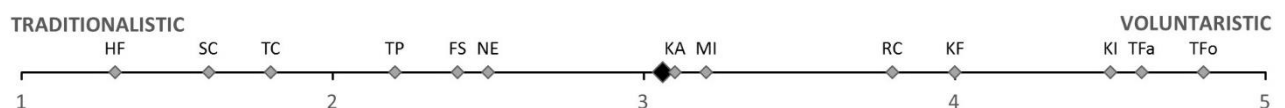
Royal Chef was located next to Kejetia, the largest outdoor market in West-Africa where also slipper makers like Terracotta resided. These slipper makers were sitting in large numbers in their workshops along the small winding lanes of the market. Slipper making is a traditional craft and it mostly stayed the same as in the olden days. The slipper makers did join together in a union to increase their impact as an

act of voluntarism, but Kodjo from Terracotta indicated that they were having trouble finding new markets and that this was the governments fault for not helping them. This was an example of a fatalistic mindset i.e. not seeing themselves as pivotal points of change but feeling dependent of whatever the government might or might not do for them.

The Pioneer and Family Star Entertainment also had trouble because of this type of mindset. The small newspaper from Kumasi, The Pioneer, was still relying on their traditional business model of being a platform for funeral advertisements but for example did not have a website. They were being pushed-out by the bigger, more modern newspapers because of this. At Family Star Entertainment, the movie production company, all shooting stopped during power-outs and they wanted to shoot a scene inside. Since power-outs are a frequent phenomenon in Ghana, this meant a considerable delay in production. Even though the author suggested changing the order in which the scenes were shot, the delay was accepted as it was too much of a set back and there was nothing they could do about it.

Within this framework of traditionalism, there were also enough examples of voluntarism to be found. This indicates that Ghana could also be in transition regarding this cultural dimension. Rosalinda of Family Star for example may have acted fatalistic towards the power-outs, she did built a movie production company from a dream to become an actress and educate people. Also the Kumasi Abattoir, which was first a slaughterhouse based on traditional practices, was upgraded to be more hygienic and a modern management board was introduced. This was done because SSNIT (Social Security and National Insurance Trust), one of the board members, wanted Ghanaians to eat proper meat and thus changed the course of events. The two visited farms, Kumah farms and Tiptop farms also were showing examples of voluntarism and innovative thinking. Kumah was once one of the first farms to look into cultivating catfish. It is now looking into agro tourism for the next step, trying to find an innovative use for Nana's hobby of collecting animals. Edward of Tiptop farms developed an irrigation system to deal with the difficult soil in Anloga. Moreover, he is moving towards self-sufficiency by making use of renewable energy technologies. Edward's brother Sena recognized the tomato waste produced by Tiptop farms and started his own company, Tiptop foods, to process the waste tomatoes into tomato puree. Noah of KITA did the same. He recognized an opportunity from an article he once read and stepped into the void for agricultural training, something that until that time was only done by the government. At Manco industries voluntarism was also showing, possibly by the time Vince had spent in Canada. Manco produced a new type of mattress by innovatively combining their normal foam mattresses with traditional sleeping mats. Manco also pushed the sales team to take their own initiatives.

Ghana has a culture mainly characterized by traditionalism, although Figure 11 shows that in business there are comparable examples of voluntarism to be found as well. Because these examples were found at half of the visited companies, the existence of an voluntaristic culture within the traditionalistic culture seemed to be emerging in Ghana. Because of this, **Ghana's score for the dimension traditionalism versus voluntarism is 3.**



**Figure 11. Results of the cultural analysis for the dimension traditionalism vs voluntarism. Grey dots indicate separate companies, whereas the black tot shows the dimension's average.**

#### 4.1.5. Synchronic versus sequential time orientation

Ghana's culture is mostly characterized by a synchronic time orientation, where time is easily made for each other, irrespectively of already planned activities. Time is not experienced in the same exact way as it is in Western countries, where people can lose their sanity if a train comes 10 minutes late. In Ghana, it is normal for a bus to leave an hour later than scheduled without anybody complaining. This attitude



towards time translates to every interaction between Ghanaians. Chances of someone being late in Ghana are relatively high and Ghanaians will anticipate on this and not hold a grudge because of it. Ghanaians usually jokingly refer to this as “Ghanaian time”. A good example of this was when the author was about to have a meeting with a professor on biogas projects at noon of a certain day. As this was in the first weeks of the field study, the author assumed a meeting at noon meant a meeting at noon. But when the professor was called because he was not at the meeting point, it turned out he was still at home. Two hours later he arrived and spent the rest of the afternoon with the author, answering all his questions. Because of people shifting their priorities and because of traffic delays, making a strict planning in Ghana is complicated. However, this did not seem to cause many problems for the visited companies. Most companies had a certain degree of planning, indicated to do bookkeeping and seemed to be able to work flexible around the synchronic time orientation in order to still reach their targets.

The synchronic time orientation was clearly noticeable when making appointments with the companies during the field study. An appointment had to be made at Nuamah, Pioneer and Abattoir. At the other companies, the author was welcome any time. These companies would make time if needed, and the author was welcome to walk in the same day or the day after. At Star Company for instance, the author visited the next day because Nana was eating at the moment of visit. At Nuamah, synchronic behavior was noticed during the interview with the chairman, as he was constantly interrupted by employees and the interview was halted. Samuel at KITA had a similar working ethic. From the first day of arriving at KITA it was made clear to the author that his door was always open to anyone at any time. He followed up to this promise and nobody was ever witnessed to be told to wait outside until a meeting was done.

However, there were also several issues due to synchronic time orientation observed. First of all, coming in late was an issue at Kumah farms, Manco industries and Family Star enterprise. At Kumah farms it was especially the farm manager that was causing trouble because he often came in late. He was reprimanded for this but it seemed to be an ongoing problem for which the management team did not know the right answer. At Family Star, probably the most synchronic company that was visited, shooting days could be heavily delayed because of actors coming in late, or not coming in at all. Sometimes a flexible solution was found, but most of the times the whole crew and all the extras just sat around and waited until the actor arrived. Due to messy communication, these delays could last for days. As the crew was paid per day, this led to increased costs.

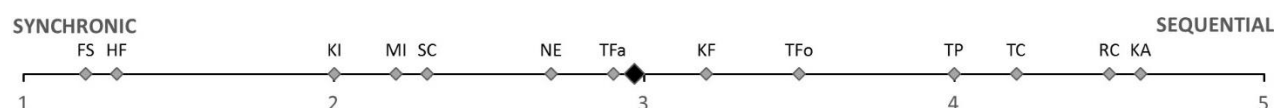
There were also companies that indicated having flexible working hours, which can be seen as synchronic management. Amongst these companies were KITA, Hortor, the Pioneer, Star Company, Manco and Nuamah. At KITA it was required to work 8 hours per day for the employees, but the starting time was not set. The timetables for the students at KITA were very precise and supposed to be strict, but the students did not follow the schedule as strictly as it was set up. People at Hortor could participate with pulling the net at any point of the day, although most people would come at the start, as payment was dependent on the duration of one's labor. For the drivers at Star Company this was the same. They could start whenever they wanted but they would usually start as early as possible in order to collect more fares. At the Pioneer, working days were flexible except for printing days. The sales team at Manco also had flexible working hours. Their expenses were paid and beyond that their payment came from 2% of each mattress sold. At the production side of Manco, no strict planning was possible due to power-outs. By using a generator, they could mix the chemicals and make the foam for the mattresses. However, for the cutting to size and sewing the covers had to be waited until the power came back on. Because of this, work seemed to progress in a random order, illustrated by the planned showroom that was half finished and overgrown by weeds. At Nuamah, the working hours were not flexible but there was a flexible day planning with an overarching week planning. This type of planning points to synchronic behavior as it gives the freedom to easily postpone work to the next day.

But not everything in Ghana's culture was geared towards synchronic time orientation. Next to the companies that had flexible working hours, Nuamah, Royal Chef, Terracotta, Abattoir and TipTop

farms/foods indicated to have strict working hours, which could indicate that Ghana is moving away from a synchronic towards a sequential time orientation. Absenteeism was by some companies actively addressed. To make sure people do not come in late, Royal chef had put a manager in charge of this. The Abattoir had a bus to collect employees. Family Star, Nuamah enterprise and TipTop foods even had their employees living on site so they would be on time. The permanent staff at TipTop farms had to give two weeks' notice and could get off for a maximum of one month. Many companies had monthly targets that got translated into daily targets, indicating a reasonable level of planning. This sense of long-term planning was also seen in the fact that companies like Kumah, KITA, Pioneer and Manco gave on the job trainings to their employees to keep their capabilities up-to-date or to prepare them for future plans. TipTop foods gave employees an effective drilling to ensure a good work ethic. At Royal Chef this was done by keeping employees on with a trial period. Most companies paid per month, except for Family Star, Tiptop Farms and Hortor, where employees were paid on a daily basis. Nuamah enterprise was the only company that paid per week. At the Abattoir, salaries were evaluated every two years, indicating a sequential time orientation. The Abattoir was, most likely because of their semi-governmental identity, the most sequential time oriented company visited. Next to their planning and the addressing of absenteeism, they had a very streamlined production line and a meticulously-planned UNIDO biogas project (Awafo, 2015).

Summarizing, Ghana is predominantly oriented towards time in a synchronic way but there are also some indications for companies having a sequential mindset as well. Moreover, because some of the companies were sufficiently small, a strict planning was not necessary and planning could be based on a synchronic time orientation. This type of flexible planning was also observed at Star Company, who had multiple trotros based at stations. These trotros (and all other trotros at stations in Ghana) only left the station when full, not at set times. Passengers had to wait until every seat was taken, which could take up to a couple hours. Usually one of the passengers would take one for the team and buy two seats. It was also possible to go to the street and take one of the many unregistered trotros. In this way, delays due to synchronic time orientation were circumvented.

Ghana's culture is predominantly synchronic and solves issues regarding synchronic time orientation with more synchronic time orientation. But as Figure 12 shows, in business there are a similar amount of sequential time orientation behaviors observed. **The final score for this dimension is thus 3.**



**Figure 12. Results of the cultural analysis for the dimension synchronic vs sequential time orientation. Grey dots indicate separate companies, whereas the black tot shows the dimension's average.**

#### 4.1.6. Ascribed versus achieved status

In Ghana, ascribed status traditionally has an important place in daily life, and chiefs and family are given high importance. The indigenous hierarchical structures are based on ascribed status, in which chiefs are born into their position and treated with utmost respect by their subjects. Family members that look out for each other get a higher status. This is still visible in the workplace, where people in positions of power (or people related to them) get status regardless of their achievements. However, Ghana is moving away from this traditional situation. More and more, the work people put in is valued rather than their status. Most of the visited companies were started from scratch by the owners. At these companies, promising employees were given more opportunities and managers were observed to be very involved in company operations.

However, ascribed status was still observed during the field work. Next to a restaurant and diaper shop owner, Nana Kwanfo of Royal Chef was also a chief of a town close by. This did not make him less involved

in his business, if anything he was probably the most involved manager observed, but his position did bring him many advantages in life. Also Nana Boameh from Star Company got his status partially by his position as fetish chief. Possibly because of this, he was not observed to be involved in daily operation of his company. An owner who was not involved was not common in the visited companies. The only other company where this was the case was Hortor.

Status because of being family was also observed in two companies. Samuel and Lovans were in important positions at KITA because they are the sons of Noah. Edward of Tiptop Farms was born into position of farm owner and also got his status ascribed by having been Chief Municipal Executive.

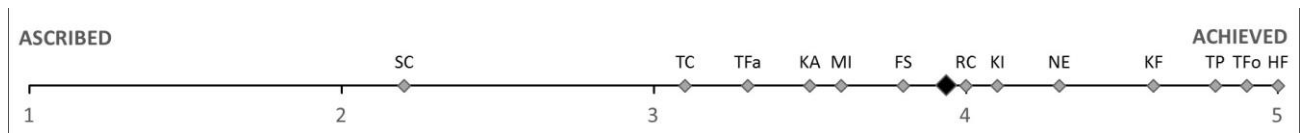
It was also observed a couple of times that work was halted when the boss or manager was away. Issah at Manco trusted no one but himself for the production of the mattresses and his employees were just there to assist him. Naturally, work was halted when he was away. Also at Terracotta, apprentices would not work when their master was away. Even at the streamlined production line of the Abattoir a carcass was noticed left unattended during the visit. However, this was immediately corrected by the manager who was giving the author a tour around the facility.

Although ascribed status was present in Ghana's culture, most of the companies visited showed signs of status by achievement. Kumah, Nuamah, Family Star, Manco, KITA, Royal Chef, Star Company and TipTop foods were all started from scratch. The owners got their status of boss because their achievement. Edward from Tiptop farms got his status because of his family position because of having been Chief Municipal Executive, but also from the irrigation system that he developed (and was asked to implement all across the region).

Hard work was mentioned as a value at Kumah, Nuamah, KITA, Royal Chef, Terracotta TipTop foods and Hortor and this was also translated into action by the management. Employees proven to be capable are in charge of the fingerling process at Kumah. Promising hardworking employees at Nuamah got help setting up their own paint store. Knowledge would improve your chances of climbing the ranks at the Abattoir and at TipTop foods, the most experienced worker would be put in charge when their boss Sena was away. At KITA, employees were hired based on personal experience rather than status and bonuses were output based. At the Pioneer, qualifications are important. Job candidates had to have proven themselves first before being considered for hiring. Actors and crew were selected based on previous work at Family Star.

Involvement of the boss and managers was observed at most of the companies. Rosalinda from Family Star was also a very involved boss, constantly in the forefront. At Manco, Vince helps sales team out when needed. B.B. at the Abattoir was constantly giving tips and advice to the line workers. Nana at Royal Chef was very involved and would be greeting all his customers to make sure they were happy. Apolonia is very involved with the employees at Tiptop foods, acting as their mainstay. The manager at Hortor did, next to coordinating all the employees, the same amount of work as the other net pullers. Also Obed, the farm manager at Tiptop farms, was doing the same work as the others next to his coordination work.

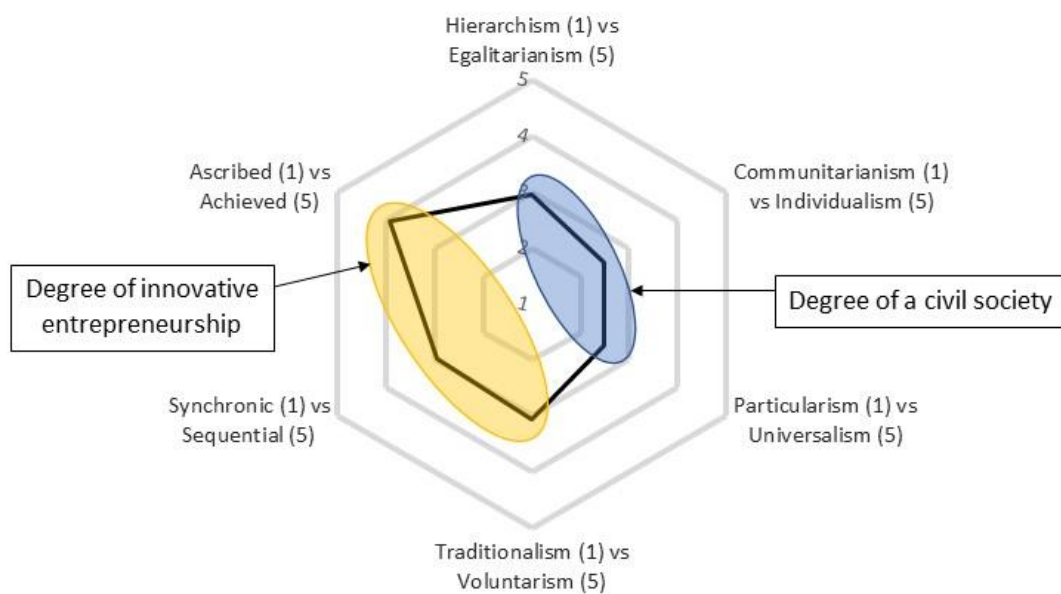
There is still ascribed status but in business, most of the people in Ghana indicated the value of hard work and most of the companies visited where achievements by the owners themselves. It was probably best illustrated by Samuel from KITA: *"Back in the days you would get hired regardless of your skills, it all depended on who you were and who you knew. But that is changing. Ghana is moving on. People are now paying people based on what they can do. Your paper might bring you to the table, but you will still have to convince the people behind the table."* As can also be seen from Figure 13, Ghanaians ascribes more status to achievement than position. For this reason **the score for this dimension is 4.**



**Figure 13. Results of the cultural analysis for the dimension ascribed vs achieved status. Grey dots indicate separate companies, whereas the black tot shows the dimension's average.**

#### 4.1.7. The degree of a civil society and innovative entrepreneurship

The average scores of the dimensions from the previous paragraphs were plotted in a spider diagram in Figure 14. This graph includes the values influencing the degree of a civil society and innovative entrepreneurship. A score of one for a dimension indicated a culture that is fully hierarchic, communitarianistic, particularistic, traditionalistic, synchronically oriented towards time or ascribes status. A score of five indicated a culture that is fully egalitarian, individualistic, universal, voluntaristic, sequentially oriented towards time or awards status by achievement.



**Figure 14. The degree of a civil society and innovative entrepreneurship in Ghanaian business culture**

Based on the previous paragraphs it became clear that Ghana was a traditional society. However, there were also many signs that the country was in transition towards a more modern society (from system I to system II)

The field study showed that in daily life, Ghana's culture is still very much aimed at family, community and traditions, patrimonial systems, synchronic time orientation, vertical networks and ascribed status. From the visited SMEs it showed that Ghana's culture only partly translated to its business culture. As Figure 14 shows, the values connected to a civil society (see paragraph 2.2.7) were not present in a high degree. This relatively low degree of civil society has consequences for a CBBE. When a CBBE increases in scale, feedstock not only comes from known sources from within the community, but also outside. The fairly low degree of civil society might thwart the necessary cooperation with other families or tribes. It will become an important part of the CBBE to focus on arbitrating potential quarrels between groups of people. A low degree of civil society might also result in an equal rule-of-law not being applied everywhere. This can have complications for setting up long-term contracts with feedstock suppliers.

Figure 14 also showed that the degree of innovative entrepreneurship is higher than expected in Ghanaian business culture. In the internal management structure of Ghanaian companies, the values of sequential time orientation and voluntarism are higher than in Ghanaian culture itself, but still on an

intermediate level. This indicates that, regarding their level of professional capacity, Ghanaians are able to make a strict planning (at least on a daily basis) and to some extent feel comfortable with taking initiative and venturing into new business opportunities. This is, however, not something they excel in. The value of status by achievement indicated that valuing labor and having involved management was an important part of the professional capacity. This willingness to work hard indicated that professional capacity is present to some degree in Ghana and this gives room to some level of complexity for the technology used in a CBBE.

#### 4.2.Cultural implications for a CBBE in Ghana

The analysis in the previous paragraph has several implications for setting up a CBBE in Ghana. This paragraph presents these implications for each of the cultural dimensions. The observations from this paragraph will be used as guidelines in chapter 6, where a business model for a CBBE is proposed.

The analysis showed that for the dimension hierarchy versus egalitarianism, Ghana is somewhere in the middle. Examples were found of hierarchical structures like the pulling of the net on the shores of Anloga, the apprentices working hard under the supervision of the master at Terracotta, or other companies like Royal Chef, Nuamah or Star Company where employees were obedient to the manager or boss. This obedience showed a level of (supervised) coordination was possible, which would be useful for coordinating the collection of feedstock for a CBBE. For the management of the digester a more egalitarian approach is needed. When the boss does not have the required knowledge, he should not use his power to interfere with the work of an operator. Companies like Family Star, Tiptop Farm, Tiptop Foods, KITA and the Kumasi Abattoir showed that an egalitarian approach would be possible in Ghana.

The dimension communitarianism versus individualism showed that Ghana is mostly communitarianistic, which could pose some problems for a CBBE. When starting a company, one should be aware that it is common for companies to hire family, especially since these family members are not always the most qualified for the job. Family members could get preferential treatment what could lead to other employees feeling less valued. The community itself is also an important factor for setting up a CBBE. It could for instance influence the choice of a location for the digester. Land belongs to a community, so chief and elders should be heavily involved in the planning phase. Most of the customer base would also come from the community, so a close community involvement could be used to increase the number of customers. When suppliers come from different communities, it could be at the cost of cooperation. However, literature states that this is mostly true for inter-tribal conflicts, so when communities belong to the same tribe this should not pose a problem.

Ghana is more particularistic than universalistic, meaning lifelong contacts are common and these often get in the way of a universal way of communication towards others. Since long-term contracts are important for feedstock supply, these patronage systems could prove to be useful. However, it could get problematic if suppliers cannot deliver feedstock in time. Weak governmental regulations could also pose problems, as improper storage of feedstock could lead to nuisance associated with smell, and improper storage of gas could lead to hazardous situations. A particularistic culture might also result in an equal rule-of-law not being applied everywhere by the government. This can have complications for setting up long-term contracts with feedstock suppliers.

The dimension traditionalism versus voluntarism showed that in business, although Ghanaians are happy to venture into new business opportunities to some degree, it is best not to diverge too much from known business models. To some degree, Ghanaians will also be open to using biogas instead of firewood or mineral fertilizer.

Regarding time orientation in Ghanaian business, the cultural analysis showed that companies are able to plan, but activities could also be halted if personal matters arise. The digester should be fed on a daily basis which from the analysis seems possible. However, funerals or weddings should not be a bottleneck

for managing the digester, as people could feel forced to attend and leave the digester. Based on the cultural analysis, this did not seem to pose a problem. Apart from occasional absenteeism, no problems were reported related to employees taking off for a longer period without notice. At Tiptop Farm for example, it was even required to give two weeks' notice when an employee wanted some days off. Planning is also important when it comes to feedstock management. Feedstocks like manure are available on a daily basis but also need to be collected directly as the methane yield decreases as the manure dries out. Feedstocks like crop residues can have an irregular availability due to seasonality and thus need a higher degree of planning to keep the digester fed constantly.

As a final result from the cultural analysis, the score for the dimension ascribed versus achieved status was high, meaning Ghanaians value labor. For a CBBE this is useful as collecting and feeding the digester requires hard work. The high level of involvement from managers and bosses also played a role in this. It was noticed that the chiefs who appeared in the analysis were, next to their ceremonial duties, also involved in business opportunities. This observation gives credibility to the notion that chiefs of a communities could be possible owners of the CBBE.





## 5. Technical analysis

This chapter contains the technical analysis, in which the technical side of a CBBE in Ghana is unraveled. The technical side of a CBBE concerns mostly the complexity and size of the digester, but also the logistical side. The most appropriate digester design is described in paragraph 5.1, based on the relative complexity of the selected designs and Ghana's cultural profile as presented in the previous chapter. The Ghanaian infrastructure is described in paragraph 5.2 to map the logistic options for the collection of feedstock. Paragraph 5.3 describes the sizes of Ghanaian communities and the amount of feedstock that is needed per source to justify transporting the feedstock. In paragraph 5.4, the feedstock availability of Ghanaian communities and the related digester sizes are analyzed. Finally in paragraph 5.5, the digester sizes and in- and outputs for six different alternatives are analyzed.

### 5.1. Comparison of possible digester designs on their relative complexity

In this paragraph is presented what would be the most appropriate digester design for a CBBE in Ghana. By using the MCA method as described in paragraph 3.1.2, the digester designs described in paragraph 2.3.3 were ranked on their relative complexity. The parameters on which they were ranked are operational simplicity, maintenance needs and construction simplicity. The results of the MCA are shown in Table 10.

**Table 10. Ranking of the four selected digester designs from simple (low score) to complex (high score)**

		Operational simplicity	Maintenance needs	Construction simplicity	Final score on complexity
<i>Weighing factor</i>		0,50	0,33	0,17	
<b>Rank</b>	<b>Digester design</b>				
1.	Garage-type	0,1	0,1	0,2	0,12
2.	Fixed-dome	0,2	0,2	0,4	0,23
3.	Floating-barrel	0,3	0,3	0,3	0,25
4.	Plug-flow	0,4	0,4	0,1	0,35

For operational simplicity, the garage-type design was deemed the most simple, as operation only consists of loading and unloading the digester and checking it for air-tightness. Another reason why operation was considered most simple for the garage-type digester was the fact that it has a relatively high tolerance for contaminants (fibers or sand). When biogas production does stop, it is relatively easy to just unload the digester contents and start a new batch. The fixed-dome and floating-barrel design were ranked second and third respectively because of their lower tolerance to contaminants. The difference between the two is the floating barrel of the floating-barrel design, which was considered making the design more complex to operate because it had more moving parts that could break. The plug-flow design was considered most complex in operation as the plug-flow system requires a deep understanding of process technology and the anaerobic digestion process (R.E.F. Lindeboom 2017, personal communication, 17 May).

The garage-type was also considered the design with the lowest maintenance needs because of the absence of critical equipment. The fixed-dome and floating-barrel designs were also deemed to have low maintenance needs, since their designs are simple and robust. Again, the difference between the two designs was the floating barrel in the floating-barrel design. Because it is made of steel and moves, the barrel can corrode and get stuck. The plug-flow design was again ranked in fourth place because of its relatively fragile digester skin. Also the fact that local repairmen are rarely able to repair damaged skin of the balloon contributed to ranking it most complex to maintain. This puts the floating-barrel design in third place.

For construction simplicity, the plug-flow design was put in first place because all that is required for its construction is laying down the balloon on a flat surface and connecting the gas pipes. Another argument the construction simplicity of the plug-flow design is that the balloon can also be placed on a hard bedrock as surface. This is in contrast to the fixed-dome and floating-barrel designs, which are built partly underground. The garage-type design came in second, because the construction of the digester mostly entailed adapting a shipping container by installing a percolation system and making sure the container is air-tight. It was not ranked most simple on construction because usually there are multiple containers running parallel to each other to achieve a stable gas production. These containers have to be connected to each other to circulate the percolate from one to another and start the digestion process for each new batch. When not constructed properly, this can cause issues in gas production. The fixed-dome and floating-barrel designs were considered most complex to construct, because of the precise masonry requirements involved that are crucial for a long lifetime of the digester. The fixed-dome design was considered relatively more complex because of the construction of the dome and the care that has to be put into sealing the inside to prevent cracks. Because the floating-barrel design has a steel barrel instead of a dome, sealing the inside is less important and thus it was placed before the fixed-dome design.



As can be seen from the results of the MCA in Table 10 and visualized in Figure 15, the garage-type design is the most simple design, followed by the fixed-dome design on the second place, the floating-barrel design on a third place and in the last place the plug-flow design as the most complex design.

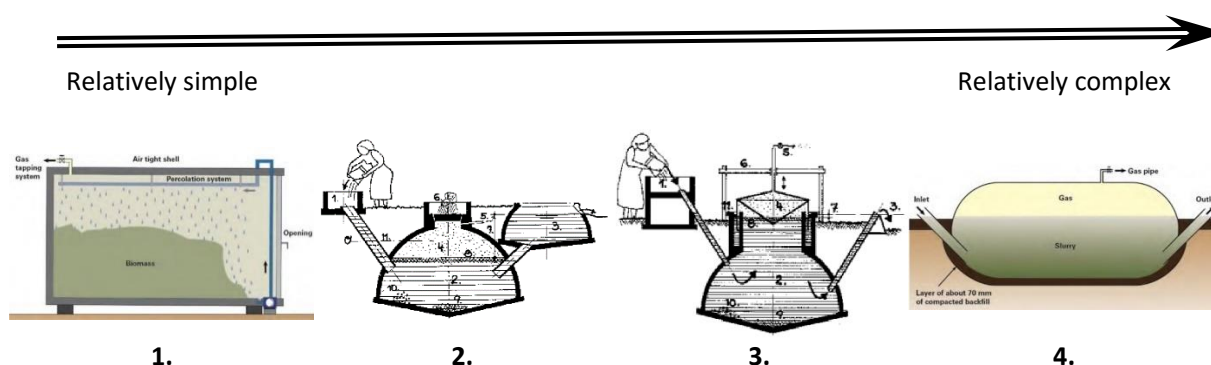


Figure 15. Ranking of the selected digester designs on relative complexity.

When selecting a digester design for a CBBE in Ghana, the most simple design should be chosen to increase the chances of success for a durable business model. Or in the words of Michael Commeh during the workshop (see Appendix C): *“keep it simple and stupid. If it’s complex you will run into problems”* (M. Commeh 2015, personal communication, 17 April). For this reason, the garage-type design would be most appropriate. However, a garage-type can only be used for SSD. If feedstock with a TS<15% like manure are used, a fixed-dome digester should be used. The cultural analysis (chapter 4) indicated that some level of complexity was possible, so when feedstock with a TS<15% is available for a CBBE, a fixed-dome digester would also be appropriate.

## 5.2. Infrastructure in Ghana

This paragraph will elaborate on the existing infrastructure in Ghana and the consequences the state of the infrastructure has for the possible scale of a CBBE. First is looked at the state of the road network and issues with safety. Then, the infrastructure of electricity and gas is analyzed. Finally, the development of Ghana is analyzed and what this development means for the future.

Logistic options for managing the feedstock and produce depend on the Ghanaian infrastructure. The poor road networks, the limited electricity grid and the absence of a gas grid constrain the logistic possibilities for a CBBE. The poor road network becomes clear when moving away from the urban areas towards the rural areas. In and around regional and district capitals the roads are still accessible, but in rural areas the road conditions are deplorable. Rural roads range from paved roads with a lot of potholes to sand roads or natural trackways that can only be accessed with off-road vehicles. The state of rural roads has affected the development of some areas of Ghana, because some vital destinations for development like schools, workplaces, markets or hospitals lack accessibility. Inaccessibility of markets can lead to decay of perishable produce. The inaccessibility of markets creates for that reason disincentives for farmers to produce (Jeon, et al., 2006; Quartey & Chýlková, 2012). This creates opportunities for a CBBE, since it offers the farmers a place where their perished produce still has some economic value.

In urban areas the roads are in better condition, but the road network itself is not equipped to handle the increasing amount of traffic. In 2015, the urban population of Ghana was 54% and annually growing with 3,4% (CIA Factbook, 2017). The corresponding rise of vehicle transport has caused major congestion in the big cities and the corresponding wear and tear of the pavement and a rise in air pollution (Jeon, et al., 2006).

Safety is another major issue on Ghanaian roads, and should be taken into account when designing the logistical system for a CBBE. Road traffic accidents are a major cause of death in Ghana. At least six people

are killed daily in road traffic accidents (Coleman, 2014). These accidents are often caused by the high driving speeds of poorly maintained vehicles (Afukaar, et al., 2003). Illiteracy causes a bad understanding of the road code and thus causes people to speed, overload their vehicles, drive without a license, misuse alcohol and cannabis or get into arguments due to road rage. Policemen regularly set up traffic barriers on intercity roads, which are mostly meant for people to pay their tributes to the police men on duty. This type of police corruption undermines the regulations (Coleman, 2014) and is thus a troubling factor when transporting goods for a CBBE to and from other cities or communities.

The electricity and gas infrastructure puts constraints on the logistic options for a CBBE. In 2014, the electrification rate in Ghana was 78,3% of the total population. In urban areas this was 90,8% and in rural areas 63% (World bank, 2017). Based on these low electrification rates, there are opportunities for electricity generation by an CBBE for local energy supply. The electricity demand in Ghana has been growing since roughly the last two decades and has exceeded the supply side. This growth is because capacity targets consistently have not been met on the supply side. This has led to structural power outages throughout the country (Energy Commission, 2015). Another issue with the electricity infrastructure is the transmission system which is in poor condition since it has badly aged and is increasingly unreliable. This may be due to the distribution companies not recovering all their costs through tariffs. Because of the number of defaulters, the distribution companies are not able to properly upgrade their transmission systems (Energylopedia, 2017).

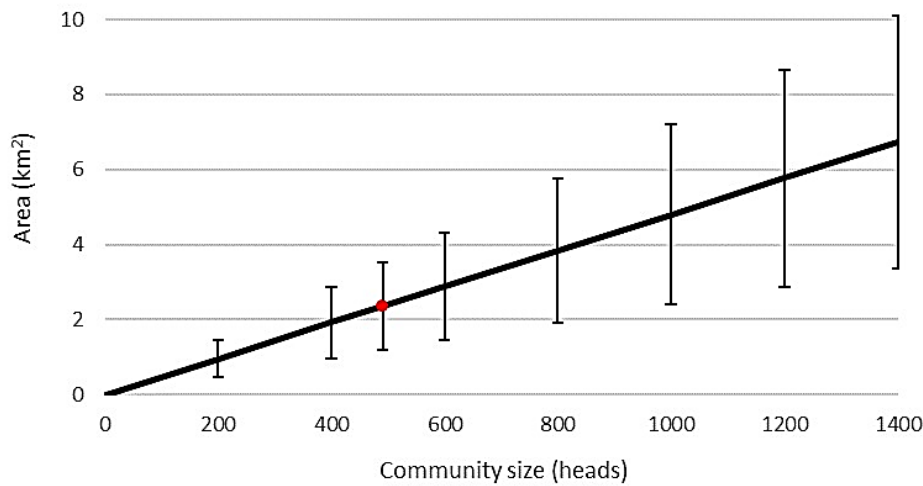
A gas grid is not present in Ghana. Instead, there is a culture of using gas cylinders for distributing LPG. Many shops sell LPG in gas cylinders and there are also delivery services where the cylinders are delivered with small flatbed trucks. This gas container culture could possibly be utilized for a CBBE for a value proposition of selling biogas in high pressure containers.

Although the Ghanaian infrastructure is in a relatively bad shape and can currently be assumed to be a bottleneck for large scale biogas facilities (which requires a very fine-tuned infrastructure to support collection, storage and transport of such vast amounts of biomass (Thomsen, et al., 2014)), there are opportunities for a CBBE by utilizing perished produce, increasing access to electricity and making use of the gas container culture. Also, the roads are assumed to improve in the future, which will influence the logistical options and the availability of biomass residues (Thomsen, et al., 2014).

### 5.3. Community size and transport of feedstock

Since the operation of a CBBE is for a large part dependent on the collection of feedstocks from within the community, community size and transport are important factors to take into account. From the previous paragraph it became clear that large scale projects are currently not feasible in Ghana because they require a very fine-tuned infrastructure. But on a smaller community level there are less requirements to the infrastructure as the amounts of feedstock and transportation distances will decrease. This paragraph will analyze the relation between community size in number of people and land area to see what the transportation distances are. Also an analysis is done to see what the minimal amount of feedstock from a feedstock source has to be, to justify collection from an ecological perspective. For this, the biogas potential of the feedstock and fuel consumption for collection are compared. The derived minimal amounts of feedstock are compared to the average availability of those feedstock to see which feedstock types are preferred for collection.

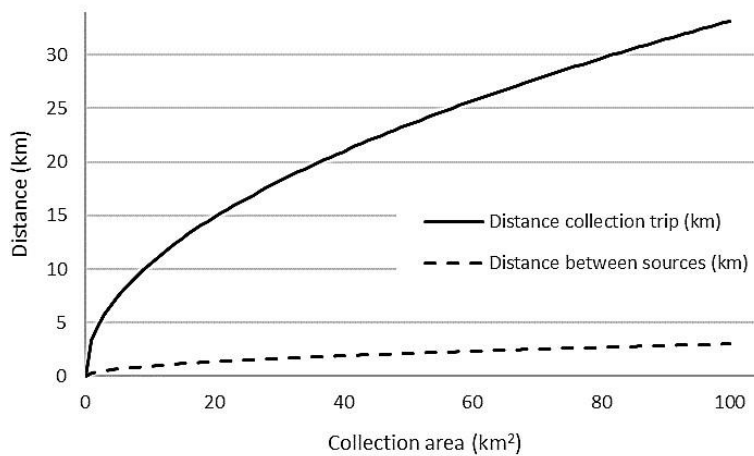
Only peri-urban and rural communities were assumed in this research since urban areas most probably do not have enough feedstocks available. The size of the communities was approached by calculating the average land use per capita, based on the average agricultural land use per capita. No extra land use for livestock farming was assumed since livestock is often either kept stabled or free-range. From the data on crop yields and percentage of agricultural land, a land area of roughly 0,5 ha/person was found. In Figure 16 this linear relation between the amount of people and the estimated community size in km<sup>2</sup> is shown. Since these are all very rough estimations, a 50% uncertainty range is indicated with error bars.



**Figure 16.** The estimated corresponding areas for different community sizes. The error bars represent a 50% uncertainty. With the red dot the size of an average Ghanaian rural community is indicated.

The distance between feedstock sources determines the necessary transport. The average rural community size in Ghana is 491 (Ghana National Spatial Development Framework, 2015). The figure shows that this roughly translates to around  $2 \pm 1$  km<sup>2</sup>. This would mean the distance between two sources at the edge of the community would be around 1-2 km when assuming a square area. The total distance to be covered for collection would then be twice that value. But it is unlikely that there are only two sources of feedstock. When assuming 10 sources of feedstock, the distance between two sources becomes 0,46 km (assuming a perfect distribution of the sources over a square area). The total distance to be covered for collection would then be 5,09 km.

If the collection area increases, the total distance to be covered for collection also increases. When for example the community falls short in providing the feedstock itself, it will become necessary to look for sources of feedstock outside the community to keep the digester running. A possibility would be driving to a neighboring community to acquire their feedstock. There are on average 10 rural communities per 100 km<sup>2</sup> in Ghana (Ghana National Spatial Development Framework, 2015). Using the same assumptions and calculations as before, this would mean the average distance between communities is 3,02 km. Collecting from all the communities would sum up to a total distance of 33,17 km. The relation of collection area and collection trip distance when 10 sources are assumed is shown in Figure 17.



**Figure 17.** The relation between the collection area and the distance of the feedstock collection trip, assuming a square area with a perfect distribution of 10 feedstock sources.

The  $Q_{ecological}$  was used to see if collection is justified on an ecological level. By setting the  $Q_{ecological}$  to 1, the minimum amount of feedstock from different sources was calculated. At this minimal availability, the energy used for fuel consumption does not exceed the energy that can be obtained by digesting the collected feedstock. In Table 11 the minimum quantities of livestock and daily yield of crop residues are shown for various collection areas. These quantities are compared with the estimated average quantities of livestock and residue available per feedstock source, assuming 10 sources. The area of 2 km<sup>2</sup> represents an average Ghanaian rural community and the area of 100 km<sup>2</sup> represents the case of collecting feedstocks at neighboring communities.

**Table 11. Minimum number of livestock and daily yield of crop residue needed per feedstock source to ecologically justify collection, assuming 10 sources per area. These values are compared to the average number of livestock and average residue availability per feedstock source.**

Feedstock collection area (km <sup>2</sup> )		1	2	5	10	100
Distance between sources (km)		0,30	0,46	0,67	0,95	3,02
Total distance to be covered (km)		3,32	5,09	7,42	10,49	33,17
<u>Livestock</u>		Number of livestock needed/ average number of livestock per feedstock source (heads)				
	Cattle	1/1	2/2	3/5	5/11	14/106
	Sheep	7/3	11/6	15/14	22/27	69/274
	Goats	6/4	8/8	12/18	17/35	55/353
	Pigs	2/0	3/1	5/2	7/4	21/39
	Poultry	166/35	255/82	371/174	524/348	1658/3476
<u>Crop residues</u>		Yield of crop residue needed/ average residue availability per feedstock source (kg/day)				
Cassava	Stalks	0,7/1,9	1,0/4,5	1,5/9,6	2,1/19,1	6,8/191,3
	Peelings	0,4/2,0	0,6/4,7	0,9/10,0	1,3/19,9	4,0/199,3
Plantain	Trunks and leaves	0,6/4,2	0,9/9,9	1,4/21,1	1,9/42,1	6,1/421,3
Yam	Straw	0,8/6,7	1,2/15,8	1,7/33,6	2,5/67,2	7,8/671,9
Cocoyam	Straw	0,8/6,7	1,2/15,8	1,7/33,6	2,5/67,2	7,8/671,9
Oil palm	Empty fruit bunches	0,5/1,0	0,8/2,3	1,2/4,8	1,6/9,7	5,2/96,8
	Kernel shells	0,5/0,4	0,7/0,9	1,0/2,0	1,5/4,0	4,7/39,9
	Fiber	0,9/0,8	1,4/1,9	2,0/4,0	2,8/8,0	8,9/79,7
Maize	Stalks	0,5/6,2	0,7/14,5	1,1/30,8	1,5/61,6	4,9/615,6
	Husks	0,5/1,0	0,8/2,3	1,2/4,8	1,7/9,7	5,5/96,8
	Cobs	0,4/1,4	0,6/3,3	0,8/7,0	1,2/14,0	3,7/140,4

The table shows that there is a higher chance to break even on the energy balance of fuel consumption versus biogas potential when collecting crop residues than when collecting manure. It has to be mentioned that the estimated quantities of livestock and crop residue needed assume that only that type of feedstock is available. Whereas for the estimated quantities for the average availability, every type of feedstock can present at the same time. The table also shows a trend that as the collection area grows, it becomes easier to break even on the energy balance.

#### 5.4. Digester size

In this paragraph is analyzed what the potential feedstock availability is for a Ghanaian community and what digester size is necessary to digest it. From dividing the amount of available feedstock from Thomsen et al. (2014) by the Ghanaian population, an average feedstock availability of 2,37

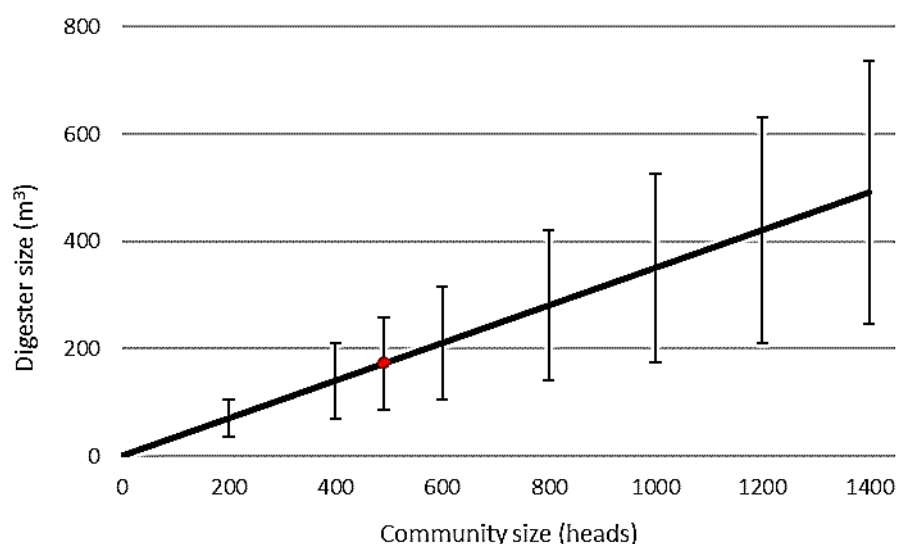
kg/person/day was found. This was made up from three different categories, namely manure, crop residues and municipal waste.

When only crop residues and municipal waste are considered, a garage-type digester could be used. But to utilize all the available feedstock and related biogas potential, a fixed-dome digester would be necessary. To have a continuous process, a feedstock mixture with a TS  $\leq 15\%$  is needed. Manure was assumed to have an TS of 15%, so no extra water was needed if only manure was used. But because a TS of 70% was assumed for crop residues and municipal waste, an additional 7,75 liter/person/day would be needed to make a continuous process possible. In Table 12, the average feedstock availability per capita and for an average community of 491 people in Ghana is summarized and given per feedstock category. Also is indicated how much water must be added to have an continuous process and what this means for the total loading rate in m<sup>3</sup>/day. Densities of 600 kg/m<sup>3</sup> for the feedstock and 1000 kg/m<sup>3</sup> for water were used. The feedstock density was based on the density of pelletized straw (Ptasinski, 2016).

**Table 12. Feedstock availability per capita and for an average community of 491 people in Ghana.**

Feedstock available	Unit	Per capita	Community
Manure	kg/day	0,25	125
Crops	kg/day	1,86	913
Municipal waste	kg/day	0,25	125
Water	liter/day	7,75	3805
Total feedstocks	kg/day	2,37	1163
Total loading rate	m <sup>3</sup> /day	0,012	5,7

To calculate the digester size, the total loading rate had to be multiplied by the retention time. Because of Ghana's tropical climate, a mesophilic temperature range could be assumed and a retention time of 30 days was used for calculations. In Figure 18, the linear relation between the amount of people and the estimated digester size in m<sup>3</sup> is shown. Since these are all very rough estimations, a 50% uncertainty range is indicated with error bars. With a red dot the size of an average Ghanaian community of 491 people is indicated.



**Figure 18. The estimated corresponding digester sizes for different community sizes. The error bars represent a 50% uncertainty. With the red dot the size of an average Ghanaian rural community is indicated.**

For the available feedstock from an average community, a fixed-dome digester size of 172  $\pm$  86 m<sup>3</sup> is needed. Fixed-dome digester volumes up to 200 m<sup>3</sup> are known and possible (Kossman, et al., 2012), so

one digester could in most cases be enough to digest all the available material. When communities are above average in size or have more than average feedstock available, there are two possible options. Either an extra digester is built or not all the available feedstocks are utilized. The first option would lead to more biogas production and thus more revenues but also extra costs for the extra digester. The second option would have lower revenues but a more secure supply chain as there would be a backup of feedstock available. It could be part of a strategy to introduce the digester to the community in phases. Another digester could still be built in a later stage, when trust is built with the community. Modular digester designs, like the garage-type would be more suitable for such a strategy than static designs like the fixed-dome digester. When feedstock availability increases in a community, it's easier to place another container than to construct a whole new masonry structure.

### 5.5. Digester in- and output for different alternatives

In this paragraph the digester in- and outputs are analyzed for different feedstock alternatives to see what the best alternative is for a CBBE in Ghana. In the analysis of the available feedstock in the previous paragraph, a recoverability factor was adopted from Thomsen et al. (2014). This factor was the difference in how much feedstock was theoretically available and how much could technically be collected. It was analyzed how the digester size and in- and outputs changed when assuming the theoretical instead of the technical availability.

For the manure collection Thomsen et al. used a factor based on the way how the animals are usually kept, either free range or stall-fed, and thus how much of the manure can be easily recovered. Cattle, sheep and goats were assigned a factor of 0,2 because they are usually kept free range and only a part is stabled at night. Most of their manure is thus not recoverable. Pigs and poultry (mainly chicken) were assigned a factor of 0,5 since they are mostly kept in intensive farming systems. Their manure thus is more easily recovered.

Next to distinguishing between free-range and stall-fed livestock, Thomsen et al. also identified crop residues as processing or field based residues. Depending on the crop, they estimated that between 25% and 80% of field based residues could be available for collection in Ghana. All processing residues were assumed to be available for collection as it involves already concentrated material. Cassava peels were the only processing residues given a lower recoverability factor as these commonly serve as livestock feed. Overall, only 22% of the produced manure and 72% of the produced crop residues could be recovered according to their assumptions.

Next to what the digester size and the related in- and outputs would be when assuming the technical feedstock availability, also other alternatives were analyzed. These alternatives were based on using the theoretically available manure and crop residues. There was also an alternative added for using a mono-digester, fed only with manure, and an alternative for using a garage-type digester, fed with only crop residues. Also for these last two alternatives the theoretically available feedstocks were assumed. Including extra manure would require a community in which all livestock is stabled. Including extra field based residues would require extra labor, which is argued to be a help the development of the community as it decreases unemployment.

**Table 13. Explanation on the different alternatives for feedstock availability.**

Alternative	Explanation
<b>Technical availability</b>	Baseline alternative, where only the technical available manure and crop residues are assumed. This alternative does not include manure from free-range livestock and a large share of the field based residues
<b>Extra manure</b>	This alternative assumes all manure is collected. This could for example happen in a peri-urban area where all livestock is stabled
<b>Extra crop residues</b>	This alternative assumes all field based residues are collected. For this alternative, extra labor, training and awareness campaigns on waste management are needed to collect all the residues
<b>Extra manure and crops</b>	This alternative is a combination of the two alternatives above
<b>Only manure</b>	For this alternative the use of a mono-digester is assumed which is only fed with (the theoretically available) manure, preferably from one type of livestock. A mono-digester is less prone to failure and thus would be useful in a system I society
<b>Only crop residues</b>	This alternative assumes only (the theoretically available ) crop residues are used. Because of the high TS of crop residues, this alternative assumes a SSD process in a garage-type digester.

The results of the analysis on digester size and related inputs (manure, crop residues, municipal waste and water) and outputs (biogas, electricity and fertilizer/dry digestate) for the different alternatives are shown in Table 14.

**Table 14. Digester sizes and the related in- and outputs for different alternatives. Values are for a community size of 491 people.**

	Technical availability (baseline)	Extra manure	Extra crop residues	Extra manure and crops	Only manure	Only crop residues
Digester size (m3)	172	194	233	254	28	67
<u>Inputs</u>						
Loading rate (kg/day)	1163	1589	1543	1970	551	1293
Manure (kg/day)	125	551	125	551	551	0
Crop residue (kg/day)	913	913	1293	1293	0	1293
Municipal waste (kg/day)	125	125	125	125	0	0
Water (liter/day)	3805	3805	5200	5200	0	0
<u>Outputs</u>						
Biogas (m3/day)	252	279	355	382	35	327
Manure (m3/day)	8	35	8	35	35	0
Crop residue (m3/day)	224	224	327	327	0	327
Municipal waste (m3/day)	20	20	20	20	0	0
Electricity (kWh/day)	529	585	745	801	73	688
Generator needed (kW)	22	24	31	33	3	29
Fertilizer (kg/day)	700	759	948	1007	76	630

The table shows that, as to be expected, adding extra manure or crop residues increases the digester size, loading rate and biogas production. More interesting, is the difference in adding extra manure or crop residues. The loading rate increases comparably for both alternatives, but the biogas production is

significantly higher for adding extra crop residues. This can be explained by the fact that the TS of crop residues is also significantly higher which thus means they have a higher biogas potential. The higher TS in turn does mean extra water has to be added, as also can be seen from the table. In the baseline alternative, the daily water requirements are already questionably high with almost 4 m<sup>3</sup>/day. With the increased water requirements, this even adds up to more than 5 m<sup>3</sup>/day. The extra water also makes that a much larger digester size is needed in the case of adding extra crops. Whether the revenues from the higher biogas production outweigh the costs of the larger digester and water requirements will be analyzed in chapter 6.

The alternatives of using only manure or only crop residues also show some interesting results. First of all, because in both cases no extra water had to be added (manure has a TS of 15% and for the crop residues a SSD process was assumed), the required digester sizes, and thus the investment costs, were also significantly smaller. Secondly, the outputs when using only crops are significantly higher than when using only manure. Comparing it to the other alternatives, the alternative of using only crop residues in a garage-type digester seems most promising, especially considering the facts that no additional water is needed and a relatively small digester size is sufficient. Also, from paragraph 5.1 it showed that a garage-type was the most appropriate digester design and from paragraph 5.3 it showed that crop residues had a better chance to break even on the energy balance of transport.

All these results combined make a strong case for using a garage-type digester for a CBBE in Ghana, fed with the available crop residues from within the community.





## 6. Design of a business model for a CBBE

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In this chapter the best possible business model for a CBBE will be presented, based on the cultural analysis, technical analysis, the case studies on SMEs in Ghana, the workshop on biogas as a social enterprise and supplementary observations during the field study. In the cultural and technical analysis, the most appropriate complexity and scale for the technology in a CBBE were investigated. In the technical analysis was also investigated on which feedstock alternative should be focused on. In paragraph 6.1 the different possible value propositions and feedstock alternatives are assessed by comparing them and calculating their NPV, IRR and DPB to see what would make the best business case. In a Ghanaian context, the best business case means doing it as cheap as possible. Therefore, the most financially viable value proposition and feedstock alternative were chosen for the CBBE and are explained in more detail as a business model in paragraph 6.2.

### 6.1. Financial assessment of possible value propositions and feedstock alternatives

In this paragraph, an initial financial assessment is done to see what value proposition and feedstock alternative are most viable. First the options of selling biogas in backpacks or selling electricity to the grid and the different options for transport are compared. The best options are then used to calculate the NPV, IRR and DPB of the different feedstock alternatives in order to find the most financially viable feedstock alternative.

### 6.1.1. Selling biogas in backpacks or selling electricity to the grid

Two options were compared by which revenue could be created from the produced biogas. These options were either selling the biogas in backpacks or by using a biogas-powered generator selling electricity to the grid, as depicted in Figure 19.



(a)



(b)

**Figure 19. Options for revenue creation: a) selling biogas in backpacks; b) selling electricity to the grid.**

The value propositions of selling biogas or electricity through a mini-grid or using the biogas to power a MFP were not included because estimations on the costs and revenues would become too arbitrary. A comparison of the two selected options was done to find the most beneficial option. The results of this comparison is presented in Table 15.

**Table 15. Economic comparison of the two selected options to create revenue from biogas.**

	<b>Selling biogas in backpacks</b>	<b>Selling electricity to the grid</b>
<b>Income per m<sup>3</sup> of biogas</b>	€ 0,20	€ 0,25
<b>Total discounted revenue (€/20 years)</b>	€ 72.885,60	€ 91.601,68
<b>Equipment needed</b>	Biogas backpacks	Generator
<b>Price</b>	€ 43,50/piece	€ 100,00/kW
<b>Price (baseline alternative)</b>	€9.126,28	€ 2.202,90
<b>Lifetime (years)</b>	2	10
<b>Total discounted costs (€/20 years)</b>	€ 32.585,41	€ 3.172,17

The income of selling biogas was based on the price of LPG in Ghana (see paragraph 2.4.2). By converting to m<sup>3</sup> of biogas on the basis of energy content, LPG costs around € 0,21/m<sup>3</sup>. For calculating the income from selling a cubic meter of biogas as electricity to the grid, an energy content of 6 kWh/m<sup>3</sup> for biogas was assumed, a generator efficiency of 35%, and a feed-in tariff of € 0,12/kWh (converted from 0,59035 GHS/kWh (PURC, 2014), using an exchange rate of 4,93216 GHS/€ (23 June 2017)).

As can be seen from the table, selling electricity to the grid is a clear favorite for generating revenue for a CBBE. Compared to selling biogas in backpacks, the revenues are higher and the costs are lower. The reasons for this are threefold. Firstly, the revenues for selling electricity were higher because electricity had a favorable feed-in tariff and biogas had to be sold at competitive prices to become attractive next to firewood, charcoal or LPG. Secondly, the costs for selling biogas were much higher because the (already expensive) biogas backpacks had to be purchased in high quantities, due to their low capacity. Also, because of their short life time they had to be re-purchased relatively often. Because of these reasons, selling electricity to the grid is used in the following financial analysis and design of the business model for a CBBE in Ghana.



### 6.1.2. Vehicle for transport

For the collection of feedstock, three common Ghanaian vehicles with different lifetimes, payload capacities and fuel consumptions were compared. A truck, van, and cargo tricycle were compared on their purchase price and fuel costs. Typical representations of the vehicles in Ghana are depicted in Figure 20.



Figure 20. Possible vehicles for transport: a) truck; b) van; c) cargo tricycle

To estimate the purchase prices, an inquiry on internet was done on common Ghanaian vehicle prices (Tonaton, 2017). The price of the cargo tricycle was chosen to be higher than what the inquiry showed, as its loading platform would have to be modified to hold the feedstock. The lifetimes were assumed to be the highest for the truck and the lowest for the cargo tricycle, based on the robustness of the vehicle and distance it had to travel. The payload capacities and fuel consumptions were based on specifications as stated by car manufacturers. The required distance to be covered by the different vehicles to collect all the available feedstock (baseline alternative) was calculated based on an average community of 491 people with 10 feedstock sources and 5,09 km traveled per collection round (see paragraph 5.3). The results of the comparison are given in Table 16

Table 16. Financial comparison of three common Ghanaian vehicles, to potentially be used for feedstock collection.

	Truck	Van	Cargo tricycle
<b>Price</b>	€ 20.000,00	€ 7.000,00	€ 2.000,00
<b>Lifetime (years)</b>	20	10	5
<b>Payload capacity (kg)</b>	7000	1500	250
<b>Fuel consumption (l/km)</b>	0,26	0,15	0,05
<b>Distance covered (km/day)</b>	0,85	3,95	23,69
<b>Fuel costs (€/day)</b>	€ 0,18	€ 0,50	€ 0,99
<b>Total discounted costs (€/20 years)</b>	€ 20.266,84	€ 8.470,03	€ 4.377,29

The comparison showed that the cargo tricycle would be most economic choice for the feedstock collection of a CBBE in Ghana. Only at larger feedstock availabilities would a van or a truck become of interest. However, for a community of 491 people, a cargo tricycle is sufficient.

### 6.1.3. NPV, IRR and DPB of the different feedstock alternatives

From the previous two sub-paragraphs followed that it was most economic to sell electricity to the grid and use a cargo tricycle for transport. These findings are used in this paragraph to assess which feedstock alternative has the most financial viability and makes for the best business case for a CBBE. This was done by comparing the NPV, IRR and DPB for each alternative. The results of this comparison are shown in Table 17.

**Table 17. Comparison of the NPV, IRR and DPB for the different feedstock alternatives.**

	Technical availability (baseline)	Extra manure	Extra crop residues	Extra manure and crops	Only manure	Only crop residues
<b>Investment</b>	€ 56.294,63	€ 62.354,71	€ 73.835,10	€ 79.895,18	€ 14.838,15	€ 17.364,88
<b>Cashflow</b>	€ 34.477,54	€ 35.514,84	€ 48.747,44	€ 49.784,74	€ 1.810,38	€ 40.639,70
<b>NPV</b>	€ 79.574,25	€ 77.590,34	€ 118.358,55	€ 116.374,64	€ -7.927,35	€ 142.797,40
<b>IRR</b>	49%	57%	66%	62%	10%	234%
<b>DPB (years)</b>	2,38	2,62	2,15	2,32	20+	0,53

The investments that had to be made were based on the price of the digester system, an additional post-treatment unit, a generator and a cargo tricycle. For the first five alternatives, the use of a fixed-dome digester was considered which was assumed to cost € 273,33/m<sup>3</sup> of digester. This price was established by scaling down the price of a digester designed to handle cassava waste, which was reported by Kemausuor et al. to be €82.000,- for a 300 m<sup>3</sup>. (Kemausuor, et al., 2015). This price was assumed to also include a pre-treatment unit and drying facility for the liquid digestate. For the alternative of using only crop residues, a garage-type digester was considered, which was assumed to cost € 1500/shipping container of 15 m<sup>3</sup>.

The annual cashflow was based on subtracting the costs of feedstock compensation, wages, fuel and water from the sales of electricity and fertilizer. The feedstock compensation was set on € 0,01/kg (Roberts, et al., 2016). It was assumed this low value would be possible since only waste streams were used for digestion. The wages were chosen to be 150% of the mean per capita income in Ghana, which is € 1.084,09/year (Ghana Statistical Service, 2014). This meant all the employees of the CBBE earned an average salary of € 1.626,14/year. For water, the commercial tariff was chosen for calculations, which was found to be € 1,70/1000 liter (GWCL, 2015). The revenues from fertilizer sales were based on a price of € 0,10/kg, which was based on the price of mineral fertilizer of € 0,30/kg. The price was set to be three times lower as the applicability factor was three times higher. The costs of fuel and revenues from electricity sales were already explained in the previous two sub-paragraphs. For all the calculations, the Ghanaian discount rate of 25% was used (CIA Factbook, 2017).

From the table it clearly follows that using only crop residues gives the best business case. With a NPV of € 142.797,40 after 20 years, an IRR of 234% and a DPB of a little more than half a year, it seems it would be very attractive to invest in a CBBE with this feedstock alternative. Although less attractive, the first four alternatives also have viable business cases, with IRRs double the discounting rate in Ghana. Also the DPBs of 2-3 years seem attractive, but for a Ghanaian situation they might still be too long (R.E.F. Lindeboom 2017, personal communication, 3 July). The only alternative that was not viable was the that of using only manure in a mono-digester. Only at a discounting rate of 10% it would become viable, which is unlikely to happen anytime soon in Ghana.

Summarizing the findings from paragraph 6.1 gives that the value proposition of a CBBE in Ghana should consist of:

- Collecting all the available crop residues from within the community with a cargo tricycle,
- Digesting the crop residues in a garage-type digester,
- Using the produced biogas to generate electricity and selling it to the grid
- Drying the digestate and selling it as organic fertilizer

## 6.2. Business model proposal for a CBBE

This paragraph will elaborate on the different parts of the business model of a CBBE, using the BMC by Osterwalder (2010). In order to expand the value proposition as presented in the previous paragraph into a comprehensive business model, the results of the cultural and technical, the case studies on SMEs in Ghana, the workshop on biogas as a social enterprise, and supplementary observations during the field study on Ghanaian society were used. The sections on cost structure and revenue streams were taken together and presented as a more detailed financial analysis of a CBBE with the selected value proposition.

### 6.2.1. Customer segments

Since the value proposition assumed the selling of electricity to the grid and organic fertilizer, the customer base consists of the ECG, who will pay the CBBE for every kWh produced, and crop farmers, who need fertilizer to grow their crops. The farmers are most likely also suppliers of the feedstock for the digester, which makes it possible to give them a discounted price in exchange for feedstock collection. This price could be based on a dynamic pricing mechanism. More than nine out of every ten rural communities (93.5%) have farming as main economic activity (Ghana Statistical Service, 2014), so it is expected that there is a sizeable market for fertilizer sales in most Ghanaian communities. Especially considering the average fertilizer use of 7 kg/person/day (World bank, 2017). Also the cultural analysis, and more specifically the score of 3 on the dimension traditionalism versus voluntarism, gives reason to believe that enough people might be willing to try organic fertilizer from the digester (the new kid on the block), instead of traditional mineral fertilizers.

### 6.2.2. Channels

To reach the ECG, a connection to the grid is needed. This means a CBBE with the value proposition of selling electricity to the grid can only be done in communities with a connection to the grid. To reach the crop farmers, the most obvious choice is to deliver fertilizer with the cargo tricycle, by combining its collection round with a delivery round. When correctly planned, no extra kilometers have to be made. To promote the CBBE within the community, word of mouth could be used. Also the cargo tricycle could have a typical Ghanaian slogan or logo hand-painted on it to promote the CBBE. This would make sense because the tricycle is already driving around the whole community and has the potential to become an integral part of daily communal life.

### 6.2.3. Customer relationships

Because the CBBE benefits from a constant feedstock supply without fluctuations, long-term contracts with the ECG and farmers should be entered into. For customers to be willing to enter into long-term contracts, a base of trust must be created. For this, a reliable product/ business operation is required. If farmers hand in their crop residues every week, but the feedstock collector arrives with an empty cargo tricycle, no trust will be built. It is crucial that fertilizer deliveries are consistent for a trust base to build, so that willingness to enter into long-term contracts is created. In order to have the CBBE be accepted by the community, transparent leadership is also required. Current barriers for community projects are a lack of trust, based on previous projects, and a lack of transparency in leadership. The Ministry of Food and Agriculture (MoFA) was aware of these problems and working on improving it (Benjamin Sagodo 2015, personal communication, 17 February).

### 6.2.4. Key resources

The most important physical resources of the CBBE are the digester system and its location, crop residues, the generator, a connection to the grid and a modified cargo tricycle. Important human resources are the operators, feedstock collectors and a mechanic for repairs. Important financial resources are the initial investment from an interested investor and income from electricity and fertilizer sales. Important intellectual resources are the licenses to set up a CBBE in a community. These can be formal licenses

provided by district assemblies, or informal licenses given by the traditional government and community itself in the form of acceptance and support.

From the technical analysis it followed that a garage-type digester of 67 m<sup>3</sup> would be needed to accommodate all the available crop residues from an average community of 491 people. As multiple digester compartments are needed to create a constant gas supply, five containers of 15 m<sup>3</sup> should be used instead of one large container. An important requirement of the containers is airtightness, which should be paid most attention when engineering the containers into digesters. To play it safe, especially when setting up the first CBBE, it might be best to acquire pre-fab digesters from Western countries. A drying facility for the wet digestate should also be constructed, preferable close to the digester. A post-treatment step to clean the gas is also needed because the gas is used to power a generator which could corrode when untreated gas is used.

The location of the digester is also an important key resource and should be picked carefully in close consultation with the chief, the elders and the rest of the community, as they communally own the land. Preferred locations for the digester are either a strategical position between all the sources of crop residue that minimizes the total distance for transportation or a location close to the biggest source of crop residue.

The crop residues available to a CBBE in Ghana come from the community and should be collected based on mutual agreements with the suppliers. A compensation of € 0,01/kg was assumed for the financial analysis but could be set based on a dynamic pricing mechanism. The suppliers should be willing enough to offer their feedstock because in the selected feedstock alternative, it was assumed that all field based residue was fed to the digester. This also means extra labor is needed and thus that hiring an extra feedstock collector should be considered. Market and municipal solid waste were not included in the feedstock alternative, but could be added over time. Because of the modular nature of the garage-type digester, capacity can easily be increased.

A generator and a connection to the grid are also key resources with regards to the selected value proposition. Based on a daily electricity production of 688 kWh, a 29 kW generator is needed. The generator should be of good quality as it is responsible for the main part of the revenue stream. A connection to the grid is also necessary as without it, no revenue stream is possible. This means this business model is only possible for communities that are connected to the grid.

For feedstock collection and fertilizer delivery, a cargo tricycle is needed. Because a maximum payload of 250 kg is assumed for every collection trip, the most heavy-duty model should be acquired. Cargo tricycles can be bought anywhere in Ghana because of their popularity but should be modified to have a larger payload capacity and be better equipped to transport the required feedstocks. Assuming a crop residue density of 600 kg/m<sup>3</sup>, the loading platform should be modified so that it is able to handle at least 0,5 m<sup>3</sup> of crop residue.

Operators who know how the AD process works and are able to run five garage-type digesters in parallel are crucial for a CBBE. To cover for possible social obligations based on Ghana's communitarian culture, two operators are proposed to run the digester. Preferably a senior and junior employee (or a master and apprentice, similar to the working relationship at Terracotta), which fits well with the hierarchic element of Ghana's culture of respect for elders. The senior employee would be the primary operator and teaches the junior employee how to run the digester. Since this places a lot of responsibility on the senior employee, a form of servant leadership would be required, as it should be clear (s)he is working in service of the CBBE and its employees. The junior employee would mainly act as assistant and as stand-in if the senior employee has other obligations. Over time, the junior employee reaches a senior level and attracts a new junior employee whom (s)he teaches the ways of operating the digester. This would secure a long lasting transfer of the necessary operational knowledge and makes for a sustained business model.

The feedstock collectors should possess good communication skills, as they are in practice the main contact points between the community and the CBBE. Constant communication with the community is vital to maintain transparency and keep up the long-term relationships. They also should have some basic knowledge on which feedstocks can go in the digester, as it should be assumed feedstock suppliers lack that knowledge and will try to give as much feedstock as possible, including residues that are toxic to the microbial communities in the digester. If long-term contracts are entered with suppliers, agreements can be made on which feedstocks are supplied, but this will not always be the case. Because additional field residue was considered for the feedstock alternative, an extra feedstock collector should be hired to help collection in the field.

Finally, a reliable mechanic should be hired, who is able to properly engineer the digester and make necessary repairs.

#### 6.2.5. Key activities

The most important key activities for the CBBE are operating the digester, running the supply chain, accounting for the feedstock, maintenance and training the workforce.

The operation of the digester consists of loading and unloading the digester and putting the organic fertilizer in bags of 20 or 50 kg once it has dried. Feedstock accounting can be done, simply by loading the digesters until they are full, while also keeping track of the number of times the feedstock collectors come by. For a community of 491 people it was found that five digesters of 15 m<sup>3</sup> would be needed. Such a community would have 1293 kg of crop residue available every day. Assuming a crop residue density of 600 kg/m<sup>3</sup> this means 15 m<sup>3</sup> would be available every week. This is coincidentally exactly enough to be able to start digesting a new batch every week. With five digesters this would mean every week one digester would not be in operation. This week should be used to empty the digester, clean or repair it if necessary and start filling it up until after a week its full and ready to go. In this way, no storage facility is needed as the digesters themselves act as storage facilities.

The supply chain should be well managed to make sure the digesters are fed on at least a weekly basis. The main job of the two collectors in the field is to make sure the weekly targets are met. They should be keeping close contact with the community to foresee any shortcomings. They are also in charge of growing the suppliers base by promoting the CBBE. This can be done by word of mouth advertisement, or by using typical Ghanaian methods such as drawing a colorful slogan on the side of the cargo tricycle or hanging posters around the community. On a weekly basis in an average community, 9053 kg of crop residues could be available. This would mean the collectors need to make 36 trips in total with the cargo tricycle. Making seven trips a day means they can have a two-day weekend. Making six trips a day, means a one-day weekend. When assuming the crop residues are collected from 10 sources, collection from every source is necessary once every two days. Assuming 36 sources, means collection from every source once every week. When there are more than 36 sources, collection points can be set up. People from the community could be asked to set up a collection point themselves and collect waste from their family and neighbors to earn some extra pocket money. Before they are allowed to start a collection point, these people should be trained on which feedstocks can go into the digester.

Maintenance is a very important key activity, as breaking down of digesters is a common theme in Ghana. One mechanic is proposed who is responsible for keeping the digester in one piece and airtight. Also the pipes and joints should be checked regularly for gas tightness. When leakages are detected they should be repaired immediately to avoid hazardous situations for the operators. On a weekly to monthly basis, condensed water should be removed from the pipes to ensure a good flow for the biogas (Vögeli, et al., 2014). Struvite, which is a magnesium ammonium phosphate, could also be formed in the pipes and cause clogging (AA.VV., 2014). It should thus be prevented from forming or be removed in an early stage.

Constant training of the workforce is also a key activity as they need to be able to work independently and have a professional attitude. They can be trained in cooperation, dialogue, proper work ethic, due

planning and precision in labor (Kroesen, 2016). For example, the relation between the senior and the junior operator is hierarchic, which works as long as the senior employee is around. But when the junior employee is alone, work should not be halted, as is common for a hierarchic culture. They should be trained to also be able to work on an egalitarian level. The same goes for the feedstock collectors, to prevent them from being bossed around by the operators. As their job description calls for a lot of individual judgement, they should also be trained to be more individualistic. For the mechanic it is important to be able to do regular checkups of the digester, so a training on sequential time orientation would be necessary.

#### 6.2.6. Key partners

Crop processing facilities and crop farmers in the community would be key partners of the CBBE as they would be the main source of feedstock. Agreements should be made with them to collect feedstock on a regular basis. District assemblies and traditional governments are also key partners as they should give their support in building and operating a CBBE. Other possible key partners could be the Ministry of Energy (MoE) or the MoFA to disseminate the CBBE model throughout Ghana, by creating a national biogas program that is based on the CBBE. MoE already had biogas on the agenda for a long time (Edward D. Antwi 2015, personal communication, 17 April) and would most likely be interested in finding a usable model. MoFA could be used for their dissemination channels, since they already have extension officers going round communities, giving training to farmers based on research findings (Benjamin Sagodo 2015, personal communication, 17 February).

#### 6.2.7. Financial analysis of a CBBE

This paragraph presents the financial analysis that was already briefly presented in paragraph 6.1.3, in more detail. In this financial analysis, the BMC blocks of cost structure and revenue streams are presented together. The calculations were based on an average Ghanaian community of 491 people. The considered value proposition was based on collecting all the available crop residues from within the community with a cargo tricycle, digesting the crop residues in a garage-type digester, using the produced biogas to generate electricity, selling it to the grid, and drying the digestate and selling it as organic fertilizer. The breakdown of the figures on the initial investment and annual cashflow are given in Table 18.

**Table 18. Initial investment and annual cashflow of a CBBE in Ghana, based on a community size of 491 people.**

	€
<b>Fixed costs</b>	
Digester system	€ 7.500,00
Post-treatment unit	€ 5.000,00
Generator	€ 2.864,88
Cargo tricycle	€ 2.000,00
<b>Variable costs</b>	
Feedstock	€ 4.723,80
Wages	€ 6.504,55
Fuel	€ 1.212,52
<b>Income</b>	
Electricity to grid	€ 30.059,36
Fertilizer	€ 23.021,20
<b>Initial investment</b>	€ 17.364,88
<b>Annual cashflow</b>	€ 40.639,70



The digester system makes up the largest part of the initial investment, followed by the estimated costs of a post-treatment unit. For the variable costs this are wages, followed by the costs for feedstock. The cost for fuel were rather small in comparison. It can also be seen that the sales of electricity and fertilizer are of similar size and are both much larger than the total variable costs. Even separately they would easily cover the variable costs. This gives room to think about improving the socio-economic situation in the community by increasing costs for feedstock compensation or to pay higher wages. This would however result in an extended payback period which decreases the chances of successful dissemination of the CBBE, so a balance between these two should be found.

In Table 19, the calculations of the NPV, IRR over a period of 20 years and the DPB for a CBBE in Ghana, based on a community of 491 people are given.

**Table 19. Calculations of the NPV, IRR over a period of 20 years and the DPB for a CBBE in Ghana, based on a community of 491 people.**

Year	Costs	Benefits	Cash flow	PV Cash flow	Balance
0	€ 17.364,88	€ -	€ -17.364,88	€ -17.364,88	€ -17.364,88
1		€ 40.639,70	€ 40.639,70	€ 32.511,76	€ 15.146,89
2		€ 40.639,70	€ 40.639,70	€ 26.009,41	€ 41.156,30
3		€ 40.639,70	€ 40.639,70	€ 20.807,53	€ 61.963,82
4		€ 40.639,70	€ 40.639,70	€ 16.646,02	€ 78.609,85
5		€ 40.639,70	€ 40.639,70	€ 13.316,82	€ 91.926,66
6		€ 40.639,70	€ 40.639,70	€ 10.653,45	€ 102.580,12
7		€ 40.639,70	€ 40.639,70	€ 8.522,76	€ 111.102,88
8		€ 40.639,70	€ 40.639,70	€ 6.818,21	€ 117.921,09
9		€ 40.639,70	€ 40.639,70	€ 5.454,57	€ 123.375,66
10	€ 4.864,88	€ 40.639,70	€ 35.774,83	€ 3.841,29	€ 127.216,95
11		€ 40.639,70	€ 40.639,70	€ 3.490,92	€ 130.707,88
12		€ 40.639,70	€ 40.639,70	€ 2.792,74	€ 133.500,62
13		€ 40.639,70	€ 40.639,70	€ 2.234,19	€ 135.734,81
14		€ 40.639,70	€ 40.639,70	€ 1.787,35	€ 137.522,16
15		€ 40.639,70	€ 40.639,70	€ 1.429,88	€ 138.952,04
16		€ 40.639,70	€ 40.639,70	€ 1.143,91	€ 140.095,95
17		€ 40.639,70	€ 40.639,70	€ 915,12	€ 141.011,07
18		€ 40.639,70	€ 40.639,70	€ 732,10	€ 141.743,17
19		€ 40.639,70	€ 40.639,70	€ 585,68	€ 142.328,85
20		€ 40.639,70	€ 40.639,70	€ 468,54	€ 142.797,40
<b>Net present value</b>					€ 142.797,40
<b>Internal rate of return</b>					234%
<b>Discounted payback period</b>					0,53

For calculation the NPV and IRR a period of 20 year was chosen as it was the assumed lifetime of the digester. After 10 years, profits should be reinvested in a new generator and cargo tricycle, as they have assumed lifetimes of 10 years each.

As it appears from the table, the CBBE has such a large cashflow that it would be possible to transfer the model to another community after only one or two years, since the annual cashflows are more than twice that of the investment needed.



## 7. Discussion

This chapter contains the discussion which consists of three parts. Firstly in paragraph 7.1, the limitations to the cultural analysis are given to indicate the known restrictions of the methodology, possible discrepancies with similar research are explained and possible weaknesses and uncertainties are identified. Secondly, the limitations to the technical analysis are given in paragraph 7.2. Also here, possible weaknesses and uncertainties are identified to put the results into perspective. Thirdly, the proposed business model from chapter six is discussed in paragraph 7.3, based on the limitations to the cultural and technical analyses.

### 7.1.Limitations of the cultural analysis

This paragraph will give a reflection on the methods used in the cultural analysis. Since an important part of this thesis was based on qualitative research, it is important to indicate the status of this research and the limitations it brings with it.

#### 7.1.1. Weaknesses and uncertainties in the data

There were several weaknesses and uncertainties identified in the data used for the cultural analysis. First of all, a lot of people are inclined to give the expected (or politically correct) answer. Especially when asking about tribal related issues, it is possible that the answers given were politically correct. This should be taken into account when interpreting the results of the cultural analysis.

It also has to be noted that the data on which the cultural analysis was based was not perfectly representative of Ghanaian culture, and had its weaknesses. Although the 13 case studies that were done were intensive and in-depth, it remains a small sample. Assigning conclusions on an entire culture, based on 13 case studies calls for heavy generalizations which in a lot of cases might not be correct.

The geographical boundary of the case studies was also not representing Ghana as a whole, as most of the cases were in the Ashanti region and some in the Volta region. It should be noted however, that more than a third of the rural communities (36.2%) are Ashanti (Ghana Statistical Service, 2014). This gives the data still a certain legitimacy.

Another weakness of the data for the cultural analysis was that not all SMEs were visited for the same period of time. Moreover, not everywhere it was possible to fully participate in the work. For example, the case studies of Star Company and Hortor had to be supplemented by literature study where they were lacking depth. Because of this, they did not have the same significance for the cultural analysis as the other SMEs.

A final weakness of the data was that it was mainly derived from SMEs in urban and peri-urban areas. The technical analysis and business model however, assumed the CBBE to be based in peri-urban or rural communities. Although there was an overlap for peri-urban areas, no further distinction was made for the fact that urban and rural communities could be different. Since people in cities and people in the country side have different lifestyles, it is probable that their internal management structures in SMEs are also different. It was unknown how much and on which cultural dimensions the internal management structure of urban and rural communities were different. Because of this reason, they were assumed to be similar.

#### 7.1.2. Discussion on the used method

Besides the weaknesses and uncertainties in the data for the cultural analysis, there were also limitations to the method for doing the cultural analysis. The cultural analysis was based on separate dimensions but actually they are all connected and intertwined. You could look at a country's culture as a meal. The ingredients within the meal symbolize the various dimensions. Each ingredient has its own taste, but once they are mixed together they influence each other's taste. This aspect was not included in the analysis but would have given it more depth.

It also has to be noted that all cultural data was observed from a western perspective, namely the perspective of the author. Having another cultural perspective was an advantage as it allowed for noticing certain normalized behaviors. However, being completely objective in judging the cultural values of another culture was difficult, since it was impossible to completely let go of the imprinted western values the author possessed.

The method of scoring the SMEs based on the cultural model also had its drawbacks. For half of the dimensions, the results showed high degrees of scatter. This scatter was due to the fact that at most SMEs visited, observations were done that associated to each side of those dimensions. To acquire a cultural profile that is representative for Ghanaian culture, it is important to be able to recognize which observations are deeper rooted in the culture. What is in the eye of the beholder becomes thus a crucial element of the method. The beholder should be familiar with the associated literature and use it as a guiding framework when assigning conclusions to certain observations in the field.

It has to be noted that, during the time of the field study, the author was lacking a full, comprehensive understanding of the literature used. This was due to the fact that in the first month of the field study, the aim of the research shifted towards a more cultural scope. By making use of a questionnaire taken from de Vlieger (2013), it was still possible to acquire cultural data. But the data, and the associated results of the cultural analysis and conclusions on possible complexity and scale for a CBBE in Ghana, was not as comprehensive as it could have been.

However, basing conclusions in the cultural analysis solely on literature should be done with care. When the research is guided by an assumed outcome, based on possibly outdated literature and associated prejudices, results can be wrongly interpreted. Prejudices can be very helpful for interpreting cultural differences, but unfortunately the human mind tends to focus more on the negative aspects. One should

be careful not to let negative prejudices on a culture get the upper hand over the positive ones. Otherwise these prejudices may become a barrier for potential opportunities in development.

Of course, the mission to eradicate negative aspects from a society is an important part of its development and should not just be dismissed as a barrier for it. Part of the reason a country like the Netherlands is as developed as it is, is because complaining is an intrinsic part of its culture. Having a worldview that is too optimistic will lead to less complaining, and in that could also become a barrier for development.

### 7.1.3. Comparison to similar research

To identify possible additional weaknesses and uncertainties in the research, a comparison was done to similar research. For the cultural analysis, there are two bodies of work that are of interest. First of all, of course the work of Hofstede should be taken into account. On his site, the cultural characteristics of Ghana can be found, based on the parameters of his theory (Hofstede, 2012). He indicates that Ghana has a culture of high power distance, low on individualism and high on uncertainty avoidance. This only partly agrees with the results of the cultural analysis of this research. The low level of individualism seems to be similar to Hofstede's findings. This was something that was concluded to be true in the whole of Africa, where extended family ties and moral obligations to family, clan and ultimately ethnic group are a common part of life (Muriithi & Crawford, 2003). The cultural analysis of this research also found that Ghana was next to hierarchic, which Hofstede calls high power distance, equally egalitarian. Likewise, the level of traditionalism, which Hofstede calls uncertainty avoidance, was lower than his findings. A possible explanation could be that Ghana is in a transition phase between values.

Another study of interest was that of Engelen (2016), who also did a cultural analysis of Ghana based on the same cultural model and method of giving a score between one to five for each dimension. Most of the scores were similar but three stood out to be different. For the dimension hierarchic versus egalitarian he gave a score of two, instead of the score of three in this research. A reason for that was that he asked employees what their supervisors did, which the author of this research failed to do. As many employees could not answer this, he assigned this to a high power distance and thus a hierarchic culture. For the dimension ascribed versus achieved status he gave Ghana a score of one. This is a world of difference compared to the score of 4 in this research. An explanation for this is that he defined status by ascription as people showing of money, whereas this research did not and focused mostly on the involvement of the managers and the fact that many Ghanaians indicated to value hard work. The last dimension that stood out to be different was traditionalism versus voluntarism, which he called similarly to Hofstede uncertainty avoidance. This research gave the dimension a score of three, whereas Engelen found Ghanaians rather traditional and scored it one. This was due to the fact that he, just like the author of this research, observed that Ghanaians prefer employment with a secure income. The difference was that for the cultural analysis, Engelen gave more value to this observation.

## 7.2. Limitations of the technical analysis

This paragraph will discuss the methods and results of the technical analysis. The weaknesses and uncertainties were indicated based on assumptions made in the analysis and consultations with experts in the field.

### 7.2.1. Discussion on the MCA method

The analysis of complexity of digester designs was done based on a MCA with weighing factors for three different parameters. The weight given to these parameters was explained in the methodology. To check the robustness of this analysis, it was investigated if different weighing factors would have resulted in different results on the complexity of the different digester designs. In Table 20, the results of assuming alternative weighing factors, based on a consultation with an expert in the field (Lindeboom 2017, personal communication, 22 June), and the effect that has on the relative complexity of digester design is shown.

**Table 20. Results on relative complexity of digester design assuming alternative weighing factors.**

	<b>Operational simplicity</b>	<b>Maintenance needs</b>	<b>Construction simplicity</b>	<b>Total score on complexity</b>
<i>Weighing factor</i>	<i>0,40</i>	<i>0,30</i>	<i>0,30</i>	
<b>Digester type</b>				
<b>Garage-type</b>	0,1	0,1	0,2	<b>0,13</b>
<b>Fixed-dome</b>	0,2	0,2	0,4	<b>0,26</b>
<b>Floating-barrel</b>	0,3	0,3	0,3	<b>0,26</b>
<b>Plug-flow</b>	0,4	0,4	0,1	<b>0,31</b>

The table shows that using these alternative weighing factors, the garage-type design still comes out as the least complex design, with no further large inconsistencies when compared to the original weights used. This indicates a certain robustness to this method. However, when other arguments are chosen to rank the designs on the three parameters, the method would result in a different order of relative complexity. This shows that this method also has an arbitrary component to it. Nevertheless, as all four designs were of similar complexity, this arbitrary component did not matter so much for the purpose of this research.

#### 7.2.2. Discussion on the estimations for feedstock availability, digester size and transport

The technical analysis was based on very rough estimations. In this paragraph is for that reason elaborated on the assumptions behind these estimations. There is also indicated what the consequences are when different assumptions are used.

Firstly, it has to be noted that the technical analysis of the available feedstocks in Ghana was only based on estimations of Thomsen et al. (2014). Although their paper included a review of other sources and was thus quite comprehensive, their estimations should be compared to other sources to validate the data. Thomsen et al. (2014) also indicated that their estimated potentials should be regarded as the maximum that could be obtained based on current technology. Although they did include recoverability factors in their estimations, this does indicate that the available feedstocks and the associated biogas potentials might be lower in reality. A reason why the potentials could be lower in reality is because the garage type design was considered for the final value proposition. This means that sub-optimal conditions for biogas production should be assumed (Vögeli, et al., 2014). This will have consequences for the biogas output and subsequent electricity sales, as is shown in paragraph 7.2.3.

A perfect distribution of the feedstocks over the country and a constant supply per day was also assumed in the analysis. This assumption gives a good estimate to work with but also has some uncertainties as feedstock availability has a spatial and seasonal component to it. In reality, communities will not have all the assumed feedstock types available. Communities in the north generally have more livestock and communities in the south have more crops available. Also, due to the growing seasons, not every crop is available all year round. Only a part of the southern part of the country is classified as humid area and has >270 plant growing days. Most of Ghana is classified as a sub-humid area and has 181-270 plant growing days per year (Fernandez-Rivera, et al., 2004). Including these components to the analysis would give for a more complete picture of the feedstock availability, but it would also add to the complexity of the model which was meant to give a more general picture within the boundaries of a master thesis.

The analysis on feedstock availability also assumed the use of the all available crop residues. However, taking extra field based crop residues could compete with traditional no-tilt agricultural practices. Although the use of organic fertilizer from the CBBE could be an alternative for the farmers, taking field based residues might have consequences for crop yields of subsequent years. The feedstock alternative included all theoretical available material because it had the highest economic yield, but it might be more

realistic to operate the digester without collecting extra field based crop residue, as also stated by Thomsen et al. (2014). A community of 491 people would then have 913 kg/day available, instead of 1293 kg/day. The necessary digester size would be 46 m<sup>3</sup> instead of 65 m<sup>3</sup>, the biogas output would be 244 m<sup>3</sup>/day instead of 327 m<sup>3</sup>/day and the fertilizer output would be 450 kg/day instead of 630 kg/day. Not including extra field based residue would reduce the work load of the collectors, although a reduction in workload could also be achieved by hiring extra collectors. This would even lead to a higher employment rate. Instead of including extra field based residue, forest residues could also be considered. These were at first not considered, as they would need pretreatment before being added to a wet digester system. Since a garage-type design was chosen, including them would be an option again.

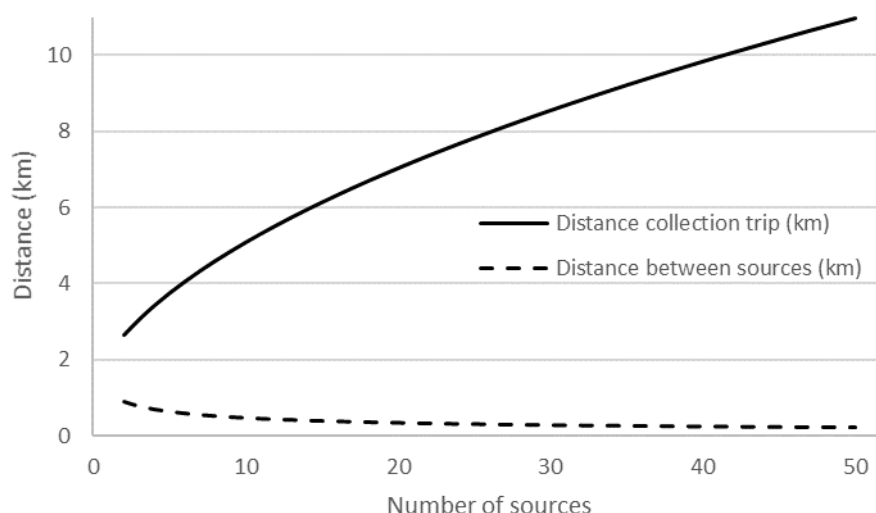
Due to the tropical climate in Ghana, mesophilic operation and a  $\tau_{retention}$  of 30 days were assumed for the digester. But as was indicated in Table 3, typical retention times for a mesophilic process range from 30 to 40 days. If a  $\tau_{retention}$  of 40 days is assumed, a digester size of 33% more volume would be needed. If a thermophilic operation is assumed,  $\tau_{retention}$  could be only 12-20 days. At shorter retention times, the necessary digester decreases. Having a thermophilic operation would make heating of the feedstock necessary. This could be done by using a CHP for electricity generation, but would also add to the complexity of the system.

For the calculations on water input and fertilizer output, a  $TS_{manure}$  of 15%, a  $TS_{crop\ residues\ and\ MSW}$  of 70%, and a  $\rho_{feedstock}$  of 600 kg/m<sup>3</sup> were assumed. This is a simplified version of the reality, as in practice these values will be different per crop type and batch of feedstock. Other values lead to a change in  $\dot{V}_{digester}$  and thus in  $V_{digester}$ . For a higher  $TS_{crop\ residues\ and\ MSW}$  or  $\rho_{feedstock}$ , a smaller digester size is needed. For a lower  $TS_{crop\ residues\ and\ MSW}$  or  $\rho_{feedstock}$ , a larger digester size is needed.

To approach the area that a community occupied, the crop yields of a selection of the crops in Ghana were used. This method would be more precise if all crops were included, but since the most important crops with the largest yields were selected, this would only be a marginal improvement. A bigger weakness of this method was that it assumed that a community only had agricultural land and non-agricultural land. Uncertainty bars of 50% were already indicated, but these might still be insufficient in some cases.

The assumption that communities had a square area with the sources of feedstock evenly distributed was done to make estimations on transport distance workable. This will be in reality of course not be the case. The costs for transport should be specifically calculated for each situation. Another assumption that was made to make the calculations for transport workable, was that  $N_{sources}$  was assumed to be 10. However, when more sources are assumed the distance of the total collection trip increases as can be seen in Figure 21. This has consequences for the fuel costs, as will be shown in the following sub-paragraph.





**Figure 21.** The relation between the number of sources and the distance of the feedstock collection trip, assuming a perfect distribution of the feedstock sources in a community of 491 people with a square area of 2,36 km<sup>2</sup>.

A final assumption made in the technical analysis was the use of a van, with a specific fuel consumption of 0,15 l/km, to calculate the minimum feedstock availabilities per feedstock source as given in Table 11. When the use of a MCT is assumed with a specific fuel consumption of 0,05 l/km, the minimum feedstock availabilities per feedstock source are cut down by a third. However, the difference between manure and crop residues is still the same. This means that the main finding of the paragraph (it is better to collect crop residues than manure) is still valid.

### 7.3. Limitations of the proposed business model

An interesting thesis related to proposed business model in this research was that of Castro (2009), who investigated the feasibility of large scale AD in Ghana and Tanzania. For this, he compared four different alternatives, of which small enterprise and community AD-systems was one. His analysis brought him to the conclusion that this alternative was the least feasible of all four, whereas this research was able to arrive at a feasible business model for a CBBE. This was due to the fact that he only looked at the use of manure as feedstock for the digester. From this research, it was clear that the use of crop residues made for a much stronger business case.

However, the use of only crop residues and required the use of a garage-type digester, for which suboptimal conditions should be assumed. Suboptimal conditions of the digester result in a lower electricity output. As also for the pumps of the percolation system electricity should be used, it is probable that the income for electricity is lower than was indicated in paragraph 6.2.7. When assuming an efficiency of 50% for the garage-type digester, income from electricity sales also decreases with 50%. However, because the income from fertilizer sales remains the same the DPB is still only 0,78 years. Even when assuming an efficiency of 0%, the DPB is only 1,89 years because of fertilizer sales and thus could still be a feasible business model.

An extra analysis was done to see what the effect was of using other assumptions for the feasibility of the business model. Various assumptions that were already indicated in the previous paragraph to have a possible effect were looked at. The results are given in Table 21.



**Table 21. Effect of using other assumptions on the feasibility of the business model, order from most to least feasible. The baseline business model was based on digesting all crop residues of a community of 491 people in a garage-type digester with a retention time of 30 days. The produced biogas was assumed to be sold to the grid. The dried digestate was assumed to be sold as solid fertilizer.**

Assumption	Initial investment	Annual cashflow	NVP (over 20 years)	IRR	DPB
<b>Baseline</b>	€ 17.364,88	€ 40.639,70	€ 142.797,40	234%	0,53
<b>200% feedstock availability</b>	€ 26.229,75	€ 86.779,47	€ 316.056,16	331%	0,38
<b>Lifetime of digester is 10 years</b>	€ 17.364,88	€ 40.639,70	€ 141.992,09	234%	0,53
<b>Double distance for collection trip</b>	€ 17.364,88	€ 39.427,19	€ 138.003,25	227%	0,55
<b>Retention time of 40 days</b>	€ 18.864,88	€ 40.639,70	€ 141.297,40	215%	0,58
<b>Single crop residue available (plantain)</b>	€ 14.868,36	€ 29.079,15	€ 99.691,83	196%	0,64
<b>Single crop residue available (yam)</b>	€ 14.464,86	€ 26.260,34	€ 88.993,43	182%	0,69
<b>No extra field based residue</b>	€ 14.963,70	€ 26.362,74	€ 88.845,91	176%	0,71
<b>50% digester efficiency</b>	€ 15.932,44	€ 25.610,02	€ 84.958,04	161%	0,78
<b>Single crop residue available (cassava)</b>	€ 13.118,72	€ 17.962,10	€ 57.512,78	137%	0,91
<b>50% feedstock availability</b>	€ 12.932,44	€ 17.245,15	€ 54.884,30	133%	0,94
<b>Price for feedstock is €0,05/kg</b>	€ 17.364,88	€ 21.744,50	€ 68.087,98	125%	1,00
<b>Only 181 plant growing days</b>	€ 17.364,88	€ 20.139,05	€ 61.740,19	116%	1,10
<b>0% digester efficiency</b>	€ 14.500,00	€ 10.580,34	€ 27.118,67	73%	1,89
<b>No extra field based residue, 181 plant growing days, 75% digester efficiency</b>	€ 14.472,77	€ 10.511,52	€ 26.715,67	73%	1,90
<b>Step-by-step digester acquisition over 5 years (cashflows indicated for the first five years of business; later years have cashflows similar to year five)</b>	(1) € 11.364,88	€ 4.577,00	€ 91.699,95	108%	1,99
	(2) € 1.500,00	€ 15.546,33			
	(3) € 1.500,00	€ 26.442,61			
	(4) € 1.500,00	€ 37.279,81			
	(5) € 1.500,00	€ 40.639,70			

The table shows that for most of the assumptions, the feasibility of the business model is similar to that of the baseline business model. An interesting finding was that having more available feedstocks, either from a larger community or a community with more feedstocks per capita, makes for a better business case. This showed from assuming 200% feedstock availability. Having the digester break down after 10 years, a double distance for the collection trip, or a retention time of 40 days all have a small effect on the feasibility. If a community has only one of the mayor crop types available (plantain, yam or cassava), the business model is still feasible. The same goes for using only the technical available feedstocks, having 50% digester efficiency or only 50% feedstock availability. This showed the model has a good chance to be also feasible for smaller communities with smaller feedstocks availabilities. This is because of the income from electricity and fertilizer were large enough to cover for the relatively cheap digester system and MCT. Even when the price for feedstock is €0,05/kg, only 181 plant growing days are assumed or no electricity is sold (0% digester efficiency), the business model could be workable. A combination of likely assumptions was also analyzed. By assuming taking no extra field based residues, 181 plant growing days and a digester efficiency of 75%, the business model was at the bottom of the table. However, just like the other business model assumptions, the resulting business model was still workable. As a final assumption, the modular aspect of the garage-type digester was assessed, by assuming the five containers (necessary for digesting the available feedstock) would be stepwise acquired. Assuming a stepwise acquisition of the containers could still lead to a workable business model, although it was the least favorable of all options. This was due to the fact that in the first years the cashflow was also smaller due to the smaller capacity.

The section above exhibited the robustness of the business model. Even when assuming lower feedstock availability or digester efficiency, the model was still feasible. The main reason for this robustness was the

combination of low investment costs for the digester system and the MCT with the high revenue streams from selling of electricity and fertilizer. But looking back at the issues currently facing Ghana, what does this value proposition help solve? By converting the biogas to electricity, the issues of deforestation, indoor air pollution and lower quality of life for women are not improved on, since these problems were connected to the use of firewood. What it does help improve, is the socio-economic situation in communities. This business model enables communities to valorize their waste flows. This initially only happens by offering a small feedstock compensation and possible employment opportunities. But once the right balance is found between the feedstock compensation and DPB, by using a dynamic pricing mechanism, the economic flows to the community can increase. Because of its robustness, the model has potential to be disseminated. At large-scale dissemination it could become a significant part of the energy mix in Ghana (up to 42% of the total energy mix) and by that, contribute to solving the energy crisis.

There are however some possible weaknesses to the model when it is to be disseminated on a large scale. First of all, there is a the weakness of the value proposition in selling electricity to the grid. The rural electrification rate Ghana is only 63% (World bank, 2017), so selling to the grid would not be possible for a third of the communities. However, it was already shown that the business would work without electricity sales, so the generated electricity could then also be used for other purposes. It could for example be used to power a MFP. More research should be done though, to check the feasibility of this value proposition. Selling biogas could also still be considered. To give the business model more viability, a scheme that includes a payment plan for the biogas backpack could be set up. The customers of the CBBE would take a biogas subscription that secures them in their daily biogas needs.

Another possible weakness is the culture in Ghana. The cultural analysis that was done for this research showed that the degree of a civil society was not yet very high in Ghana. The comparison to similar research indicated that it might even be lower. This may translate in having no equal rule of law, which would be troublesome for setting up long-term contracts for feedstock supply. It would also mean cooperation on a larger scale would be complicated. The dissemination of the model would be dependent on the people at the top because taking responsibility on an individual level will not be common. It will thus be vital to make the right connections within the concerned bodies of power. These would be MoE and MoFA for large scale dissemination and district assemblies and traditional governments for each separate community. Also the ECG is an important connection to be maintained. The cultural analysis showed that innovative entrepreneurship, or professionalism, was present to some degree in Ghana. However, the comparison to similar research indicated that this might not be the case. This means extra attention must be paid to training the workforce in cooperation, dialogue, proper work ethic, due planning, precision in labor. Especially training in planning should receive extra attention, since the seasonal component of crop residue availability makes it difficult to keep the digesters constantly fed. However, the cultural analysis did show that Ghanaians are good in flexible planning, so when a week is needed to fill up a digester compartment, they might find creative solutions.



## 8. Conclusions

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In this chapter, the conclusions of this thesis are presented. By first answering the sub-questions, an answer is given to the main research question as presented in paragraph 1.4 which was articulated as:

**What would be a realistic business model for a CBBE in Ghana, given the technological options and cultural institutional constraints?**

From the cultural analysis it appeared that although Ghanaians were used to hierarchical structures, egalitarian relations could also be possible within a business environment. The importance of family and clan, and the existence of patronage systems was confirmed from literature by the analysis. This led to the conclusion that the degree of a civil society might not yet be very high in Ghana, as open associations of individuals might be hampered by interference of family or state authority. The degree of innovative entrepreneurship on the other hand was more present in Ghana, which mainly came forth from the status that was given by achievement. The analysis showed that to a reasonable degree, Ghanaians were able to plan in a sequential manner and take initiative, but showed more strongly that they were willing to work hard to get things done. This indicated that the implementation of a CBBE, which is a relatively new phenomenon, could work at reasonable levels of complexity. The lower level of civil society indicates that the possible scale of a CBBE would be limited.

The technical analysis showed that the garage-type digester design, fed with the available crop residues within the community, would be most appropriate for a CBBE in Ghana. Regarding feedstocks, the analysis showed that using crop residue enjoyed the preference over the use of manure. By collecting extra field based residue, five containers of 15 m<sup>3</sup> each could be able to digest the available feedstock of a community of around 500 people with a corresponding area of roughly 2,5 km<sup>2</sup>.

The financial assessment showed that selling electricity to the grid made for a better business case than selling biogas in biogas backpacks. This was because of the favorable feed-in tariff of electricity from biomass and the low capacity and high price of the backpacks. Collection of the feedstock and fertilizer delivery was considered best to be done with modified cargo tricycles (MCTs), as they were the cheapest

option compared to using a truck or a van. The assessment finally showed that in addition to selling electricity to the grid, selling dry digestate as organic fertilizer should also be done, as it would make up almost half of the revenue stream.

Concluding whether the model is truly realistic should be done carefully. It should be kept in mind that all the conclusions are based on a very rough cultural and technical analysis. The uncertainties mentioned in the discussion indicated that, because the level of professionalism, particularism in governmental institutions, the lack of transparency in leadership and trust in community projects, the model might not be feasible in Ghana. Additional training in cooperation, dialogue, proper work ethic, due planning and precision in labor would be necessary for a proper operation of the digester and large-scale dissemination of the model. On the other hand, the model does include simple technology with low investment costs combined with a short payback time, which in turn increases its feasibility. Furthermore, the discussion was found that the model was financially quite robust, and that it would even be possible to start small and grow capacity over time because of the modular nature of the garage-type digester. This leads to the cautiously done conclusion that this model might be realistic and would have a chance of successfully disseminating biogas technology throughout Ghana. At the very least, a pilot plant could be set up to test it in the field.





## 9. Recommendations

In this chapter, the recommendations are made for further research. As this was only an explorative study, many of the conclusions made should be investigated more thoroughly.

The main value of this thesis was its focus on the intersection of culture and technology. This resulted in interesting findings that concluded that a CBBE in Ghana would be possible under certain conditions. However, because of its multidisciplinary nature of connecting two fields of science, the models used for both fields were purposely kept simple. Further research should thus focus on doing more thorough analyses in the two fields separately.

For starters, as already indicated in the discussion, the data on which the cultural analysis was based was not fully representative of Ghana and only gave a first glimpse. Studies should be done to arrive at a more complete picture, either by doing a full-scale extensive research to compare Ghanaian culture in all the different regions, or by zooming in on one region and doing a more intensive research. This research should include cultural data from rural communities.

As this research made many assumptions based on the average feedstock availability, research should also be done in order to give a better understanding of the specific availability of the feedstocks. This can be done by research that includes field tests on community waste in a specific community in Ghana or by doing a large scale research in order to create a database and visualize the exact feedstock distribution throughout the country. Also the seasonal component of feedstock availability should be included in future research.

Further research exploring options for SSD digesters should also be done, as the garage-type made up an important part of the proposed business model. Since a current disadvantage of the system is that it operates under suboptimal conditions, a robust design suitable for Ghanaian standards with a higher efficiency should be found.

Research could also be done to check the viability of a self-organizing system regarding feedstock collection points. When a feedstock compensation of € 0,023/kg is considered, people managing feedstock collection points could be paid €3,- per day, which is the daily mean per capita income in Ghana (Ghana Statistical Service, 2014). Since the DPB of the model with a feedstock compensation of € 0,023/kg is still only 0,60 year, further research is justified.





## Appendix A – Case studies in Ghana

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In this appendix, the 13 case studies for the cultural analysis are presented. First, the general information for each case study is described. This is followed by a description of their business and management model. Each description is concluded with a table where examples of the cultural dimensions that were found in the case study are summarized and given a score from one to five (see paragraph 3.1.1).



## Appendix A.1 - Kumah farms

### General information

Kumah farms is a farm in Domeabra, Ashanti region -situated next to KITA and Nuamah Enterprise<sup>6</sup>- that has been in business since 1998. It was started by Nana Kwaku Siaw (Martin) Kumah, whose grandmother was also a farmer. His father was working at KNUST<sup>7</sup> and Martin went to technical secondary school and worked at KNUST after obtaining his degree. Martin and his father were living in a bungalow on KNUST campus with a small piece of land where Martin started a backyard farm by cultivating the land for sugarcane, cocoyam and selling it. With the profits he bought his own house at Apromaso where he continued cultivating. He started breeding poultry (Guineafowls) and used proceeds to buy layer hens (poultry that lay eggs). After that rabbits were added. In 1998 he got an award for best farmer in Kumasi area. This price motivated him to buy the current piece of land and start Kumah farms. There he continued with poultry and rabbits and added a fishpond and a piggery, currently the two biggest sources of income. Oranges, coconut, cattle, a variety of animals and even a zoo all came after. Farming had always been a part-time business. In 2002, he stopped at KNUST after 20 years to fully focus on farming. The farms' vision is to be the best farm in the Ashanti region within 5 years' time.



Figure 22. Fishponds for catfish and tilapia

### Business & management model

The main values that Kumah farms offers are high quality, tailor-made farm products and consultancy services. To maintain relationships, customers get free consults when they buy something. They can call at any time to ask for any information they want or give feedback on for example a deceased pig. As mentioned in the previous paragraph the farm products mostly consists of pigs and catfish. Almost all their pigs provide lean meat which is attractive for customers looking to acquire pigs for further breeding. Kumah farms has five or six different male pigs for their own breeding which insures that they have no in-breeding (in-bred piglets are weak and can die quickly). They are also the market leaders in the Ashanti region for catfish. They have two or three awards for best fingerling (young fish) producer including a national award.

The farm employed 18 people during the time of the interview<sup>8</sup>, mostly youth from various communities. Twi seemed to be the main language but it was mentioned that it did not matter what language people spoke. As long as they were able to understand how to perform certain tasks. Because of religious reasons some workers don't come to work on Sunday. For the rest there was not much influence from religion. It would be more the other way around: there are some Muslim workers that after working at Kumah farms have started eating pork. Muscle was the most important capacity for the labor intensive farm work. Equipment that is

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<sup>6</sup> KITA (Kumasi Institute of Tropical Agriculture) and Nuamah Enterprise (paint company) are also part of this study.

<sup>7</sup> KNUST (Kwame Nkrumah University of Science and Technology) is the second biggest university of Ghana, located in Kumasi. At that time it was just a technical school called KTI (Kumasi Technical Institute) before it was turned into KNUST in 1961.

<sup>8</sup> The interview took place on the 1<sup>st</sup> of May 2015. In the meantime this has increased: according to their website which was consulted on the 2<sup>nd</sup> of February 2016 their farm has employed over 50 permanent people. Whether this difference comes from a peak in employment, wrong information or a smart use of sentence construction is unknown.

used on the farm includes a pelletizer (to make fish feed), a dryer to dry the feed, a 20kW generator, a high pressure washing machine, 3 pumps for water (one for piggery, other two for fish) and hand tools. New equipment is acquired when the need arises and when it can help the company. Maintenance on the equipment is done by an outside company who are contacted when needed. Intellectual resources are knowledge on catfish farming (especially fingerling production) and the name Kumah farms which is well known and acts as a brand name. The most important human resource is technical knowhow. Training is done on the job and sometimes a professor from KNUST comes by to train the workers on piggery and fish farmers. Capable employees are put in charge of the fingerling production process and are also encouraged to share their views. The agricultural knowledge of Martin and other experienced employees is put into use for the consultation services.

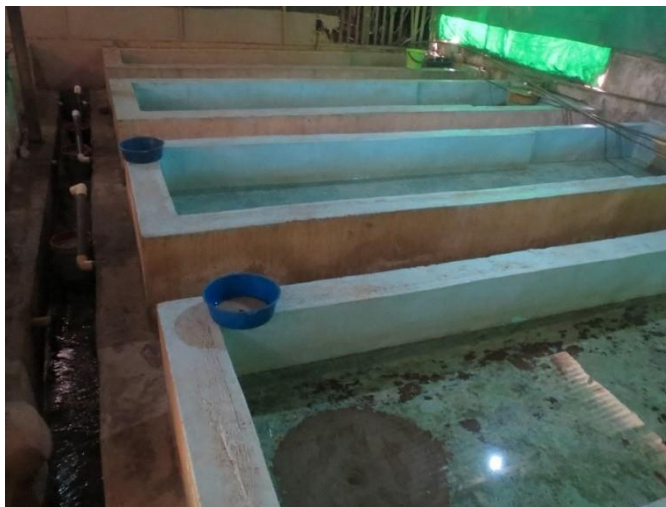


Figure 23. Breeding tanks for cat fish fingerlings

Further growth for employees within the company is not possible at the moment because all positions are filled, but if they would be promoting employees it would be done based on experience. Several family members help on the farm for their livelihood. Martin's mother helps with some small tasks and his brother Joseph<sup>9</sup> manages the business side of the farm. Joseph went to a business school in Germany and when he couldn't find a job there he came to work for his brother.

The most important customers of Kumah farms are wholesalers and other farmers who use the consultation services. Within these customer segments they are very diversified. Martin is a collector and seems to want to cultivate and breed as much vegetables and animals as possible. Their portfolio includes a long list of crops and animals and as mentioned even includes a zoo<sup>10</sup>. The zoo together with a planned restaurant are part of expansion of the business model into ecotourism. They already give tours around the farm in exchange for a small fee. This diversification is to the displeasure of Joseph who would like to see the farm more streamlined and only focused on the fish pond and piggery, the only two farming activities that actually bring in money at the moment. Feed is the biggest cost of the business. Fields where will be cut down first are the Ostriches or decrease the amount of feed that goes to the pigs and catfish what will lead to smaller animals.

All in all Kumah farms as a business is constantly growing. The startup was financed with own money and the company developed slowly but steadily by investing previously generated income into new fields of interest. No loans had to be taken. The process of getting a loan is hard and is the reason they don't take them. Joseph explains: "They tell you to bring this, and that and that and that... they tried it once and gave all the things but at the end of the day the bank didn't even approve it and then they gave up". As a farm, Kumah farms is also dependent on the weather: if the rains stay out, crops can fail and the bank sees this as a risk. The higher the risk, the higher the interest rate. Next to the weather the power-outs also affect

<sup>9</sup> The interview was done with Joseph

<sup>10</sup> Their crop portfolio includes cassava, yam, plantain, cacao beans, coconuts, palm nuts, citrus fruits, mango, papayas, figs, and many more. Their animal portfolio includes pigs, catfish, tilapia, goats, sheep, a horse, cattle, turkeys, rabbits, guinea pigs, rats, a couple of small monkeys, hawks, parrots and ostriches. The zoo includes two pythons, a giant turtle, an alligator and some deer and antelopes. These animals are found in the area and brought to Martin because people know he will pay for them.

their operations. During power-outs they use a generator that uses about two to three gallons of gas for a day. There are also some external regulations from environmental protection agencies. They make sure that the water bodies don't get polluted. Also the smell of the piggery is an issue because the area is becoming an peri-urban area. It is mostly the pig blood that smells hence environmental rules are set to reduce nuisance.

Working hours on the farm are from 07:30-12:00 – 13:30-17:00. The beginnings are strict but end times can be flexible if the work is done early, however the farm manager has a tendency to come in late. There is a week and day planning. Feed and other necessities are usually planned longer in advance. But usually people can come and order products and is to be arranged within a day. Activities like taking care of the feed stock and spraying fertilizer over the citrus crops are also planned (and executed by the farm manager). There are some issues with absenteeism, especially with the farm manager. The planning is usually kept but if not the management team tries to come back to it. The farm has a fixed monthly salary for 6 days a week, with an option to work an extra day. No bonuses are given except for free supplies sometimes.



Figure 24. Ostriches at Kumah farms

The farm produce is sold at the door (when people buy pigs they usually collect them themselves), or delivered by VIP bus to Accra. Kumah farms also has a retail shop at Oduom where produce is sold. Marketing is done by word to mouth, the website<sup>11</sup>, advertisements in newspapers or radio talk shows (where phone numbers are shared) and by attending agricultural fairs. Joseph is in charge of customer relations, as well as finance and marketing. Key activities, next to maximizing crop yields, are maintaining the customer base and finding new markets. Another is exploring new possibilities for growing crops and breeding animals, but as mentioned before this is an issue where Martin and Joseph differ in opinion. For finance Kumah farms is dependent on working capital, sales of pigs and catfish.

Transport of products to market is outsourced. Suppliers come from the open market. There is somebody that supplies them with groundnuts what they use for pig feed. And there is an agreement with Guinness for the used malt and barley. There are also agreements with KITA regarding student activities. Kumah farms receives labor from KITA's students in exchange for training on for example catfish or pig farming. Communications with partners go by phone, in person or with mail. Trust is built by repetitive positive experiences, which is important because trust is needed before deals are done. Cooperation with other farms was considered a good thing because it creates a sort of cartel (which Joseph thinks is a good thing). It also keeps up the quality.

Table 22. Scores of Kumah farms on the cultural dimensions.

Dimension	Examples	Score (1-5)	Explanation
<b>Hierarchy Egalitarianism</b>	- Capable employees put in charge of the relatively more complicated fingerling process and are trained by a KNUST professor.	4	Knowledge is respected and employees who show promise are given more responsibilities.
	Employees encouraged to share their views.	4	Boss not hesitant to listen to employees.

<sup>11</sup> [www.kumahfarms.com](http://www.kumahfarms.com)

	Joseph's displeasures regarding the widely diverse range of farm produce have no effect on Martin's views on how to manage the farm.	2	Joseph went to business school and has knowledge on how to run a business but his brother goes his own way.
<b>Communitarianism - Individualism</b>	Free consults for customers.	5	Paying customers get free service/consultancy, regardless of their tribal/family associations.
	Twi main language, but hired as long as most important tasks can be explained. If person doesn't speak Twi, they switch to English.	4	People from other tribes get accepted, as long as there is someone on the farm that can explain the farm operations (operations are not very complicated).
	Several family members help on the farm for their livelihood. Joseph in charge of customer relations, finance and marketing.	1	Family closely involved in farm management. In the case of Joseph, it could also be that Martin was helping a brother out.
<b>Fatalism Voluntarism</b>	- Agro tourism is the next step to be taken.	5	Going from farm business to looking into agro tourism is an example of entrepreneurial activity.
	Being a farm, Kumah Farms is dependent on the weather	2	They indicate that the farms' fate is in the hands of nature. No urge to keep their fate in their own hands.
<b>Synchronous Sequential</b>	- Joseph is trying to streamline the company.	4	Probably because of his German education, Joseph wants to streamline the company. This is a goal he sets that requires planning into the future.
	Some employees (especially the farm manager) have the tendency to come in late.	1	This is a very Ghanaian characteristic and is an indication of synchronic planning (making time for other business if it comes along, not defining clear priorities).
	Growing crops comes with a reoccurring week and day planning. Other necessities are planned longer in advance.	4	Strict planning necessary to get good crop yields, but not full sequential because the planning is based on rhythm of the seasons.
	A professor from KNUST comes in to train employees on the important farm processes.	5	Having a professor coming over to train employees shows a clear goal and vision for the farm.
<b>Position Achievement</b>	- Employees have chances to grow if positions open up. Experience is leading factor for promotion.	4	Experiences as leading factor indicates achievement is more important than position. However Joseph got his status partly because his position as brother.
	Martin built the farm from scratch.	5	Martin's status is completely based on his achievements, since he started from nothing.
	Capable employees put in charge of the relatively more complicated fingerling process.	5	Employees first have to prove themselves before they are put to work in the more complicated operations.
<b>Particularism Universalism</b>	- Muscles are only criteria.	5	Since muscles are only criteria, all other criteria are insignificant.
	No distinctions made between languages.	5	Employees speaking a different language are not treated any differently.
	Environmental rules are set (and followed) to reduce nuisance mostly regarding smell of pig blood.	4	These are universal rules from the government.
	Joseph put in important position.	2	Having a brother in an important position indicates particularism.



## Appendix A.2 - Nuamah enterprise

### General information

Nuamah enterprise is a paint distribution company in Domeabra, Kumasi that orders large containers of paint from Western countries to subsequently resell it in smaller containers to Ghanaian customers. The company was started in 1998 and is still run by a man known as “the chairman”. He got into the business because of his uncle who was also into paint. At the time, he just finished secondary school (where he followed a management course) but had no further experience. The startup was financed with the chairman’s own capital. A couple of times it was necessary to take a loan which was not very difficult to obtain. The bank only checked his capital and his books to see if the loan should be granted. The chairman’s goals with the company are to make profit, provide the country with good quality paint and provide youth employment. He envisions an expansion to triple the size of the company within 10 to 15 years.



**Figure 25.** The courtyard of Nuamah Enterprise where the paint is stored and all operations take place.

### Business model

The main value that Nuamah Enterprise delivers to its customers, and at the same time what supposed to set it apart from its competitors, is good quality paint from Western countries<sup>12</sup>. Another value of Nuamah Enterprise is the possibility to get customized colors for which they have mixers on site.

The selling of paint is the only form of income for Nuamah Enterprise. It is mostly bought in large quantities by paint stores. Other customers are individual people wanting to paint their new built house.<sup>13</sup> Painters are hired to do the job, act as middlemen between the house owners and Nuamah and receive a commission for this. The painters are important partners because they provide Nuamah enterprise with clientele. The paint is delivered by trucks all around the region and also to Accra. By being a known name in the area customers are able to find the company. The brand name of the paint, Nanyitex, is an important intellectual resource. Because of word of mouth being so successful for Nuamah Enterprise it is not necessary to use other types of advertisement very often. The chairman handles the customer relations together with two employees. They are always friendly and hospitable to the customers to maintain relationships and ensure word to mouth. The relations with the costumers usually have a short nature because when somebody has bought paint, it will last for 10 to 15 years so they do not need to

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<sup>12</sup> The use of Western paint is popular among paint companies in Ghana and this is marketed extensively. For example the face of President Barack Obama can be seen in many places at paint stores along Ghanaian roads to imply those stores use American paint.

<sup>13</sup> Nearly every house in Ghana is built in the same way and order, starting with concrete blocks, then a wooden roof structure that is covered with metal (usually aluminum) corrugated sheets and to finish the walls are plastered and painted (except for houses in rural areas that are still built with wood, straw and clay). When people in Ghana build houses they don’t save up until they have enough to pay for everything at once but as soon as money comes in they will buy start building step by step. Because of this Ghana is full of unfinished buildings which may seem strange to Western people, but there is logic behind it since the GHS has known a terrible depreciation the last decade so saving up would basically mean throwing money away.

come back anytime soon. When a batch is bad, which does not happen often, the enterprise will fix it by replacing it. For feedback, customers can always call the chairman as they all have his number.

When the chairman started his business, someone gave him an e-mail address of a paint company overseas and they have been partners ever since. Nowadays he gets his paint, the company's most important resource, from suppliers in the US, Canada and the Netherlands. He builds his trust through experience. He thinks he gets fair prices but he would like to visit the Netherlands to be able to talk directly to the companies who produce the paint and cut out the middleman (he is in business with intermediate parties). Other partners of Nuamah are its former employees. The chairman helps promising hard-working employees who have been working for him for a long time start their own paint stores to which



Figure 26. Operations involve moving paint from the large containers in the background into the smaller ones that can be seen in the foreground.

he is the supplier. They act as external sales channels. Because of the opportunity given to them they remain loyal to the chairman. Cooperation with other paint companies is not possible, they are only competition. Nuamah also has its own paint store which is run by two brothers of the chairman. A brother-in-law of the chairman sometimes comes in to work as a mechanic. He mainly has to repair the mixers or the forklift truck, the only pieces of equipment used in the company. Because that are the only pieces of equipment, the power-outs do not really affect the business. Operations consist mostly of redistributing paint from large to smaller containers, which is done by manual labor. Only the mixing requires electricity and this can be done at the moments when the power is on. Mixers are replaced two times a year with second hand equipment found in magazines.

The company employs around 40+ permanent staff, plus some extra woman who come by to clean the containers for some chop money. There is a big distance between the labor force and the management team at Nuamah, with the chairman being on top of it all. This distance is illustrated best by the fact that the labor force is only made up of young chaps who are very happy to just make a few cedi's a day and live together in a house that is owned by the chairman. They are selected on their ability to carry paint buckets, i.e. strong and able to follow orders. The chairman does not look at tribe or religion: there are Christians and Muslims working at the company but that does not matter to him because "in the end there is only one God". Some come from distant regions, some from the same region but no problems arise and local languages are spoken. The chairman has a stack of resumes of interested candidates to choose from, which shows his position of power. Another indication of power is the fact that one of the cleaning ladies was pregnant while working for the chairman, cleaning the empty paint containers. However, neither the young chaps doing the manual labor, nor the cleaning ladies seemed less happy than the management team. The employees are encouraged to present their own initiatives, good initiatives are rewarded with a bottle of coke. Sanctions for mistakes depend on the gravity of the offense and the chairman's mood at that moment. Directly under the chairman in the hierarchy are the managers (who were hired based on their credentials). The managers are in charge of the day-to-day administration. Then there is the accountant who keeps track of the bills, invoices, money counting and paint stock. The supervisors are in charge of the workers (who make up the lower layers of the hierarchy) and make sure the outgoing orders are always in order. A final check of the orders is done by the security guard when the trucks leave the premises.

Because of the double-checks the deliveries are virtually always in order. On the rare occasions a batch is wrong they will replace it with a new one. Deliveries from Nuamah always have to be in order and on time. Because of this, Nuamah works with a day planning and employees being on time is a must. Since they all live in the same house this usually goes well. The work hours start from 07:00-08:30, half hour break, 09:00-11:00, one hour break, 12:00-14:00, one hour break, 15:00-17:00. The day planning can be flexible but there is also a week planning that is more strict. It states that the large paint containers have to be empty by the end of the week. If this is not the case something went wrong and they will have to find out what caused it. The chairman constantly has to make plans for the company. There is on the job training for the employees to get their skills up to date since the system is dynamic.

There are not many governmental regulations Nuamah has to deal with. There are some environmental regulations but these are not very strict (compared to Western regulations). The paint is free to spill on the ground and waste containers and other garbage is burned on the side of the premises. Duties and taxes that come with ordering paint from international sources are the biggest costs of the business. When revenues decrease the chairman will cut his coat according to his size.

When asking for an interview for this research an appointment had to be made for 4 days later when he would have time but still the interview was constantly interrupted by employees who wanted a decision from the chairman.



Figure 27. The mixing equipment at Nuamah Enterprise

Table 23. Scores of Nuamah Enterprise on the cultural dimensions

Dimension	Examples	Score (1-5)	Explanation
<b>Hierarchy Egalitarianism</b>	- The goals of the company and the chairman are the same.	1	Nuamah Enterprise is the chairman. He has complete power.
	Big power distance between chairman and labor force.	1	The young lads in the labor force are just muscle doing what the chairman tells them to do.
	Many parts of the operation need constant checking with the chairman.	2	The chairman is both the one with power and the one with knowledge.
	Chairman always open to suggestions.	4	The employees are allowed to refute the boss.
	Every one of the labor force lives in the same house.	1	The fact that the labor force lives in a house owned by the chairman indicates that he practically owns them.
<b>Communitarianism - Individualism</b>	Two of the chairman's brothers are in charge of running Nuamah's paint store.	1	Brothers in charge of the store indicates a closed group mentality.
	Brother-in-law hired as mechanic.	2	Indicates closed group mentality as well, although the brother-in-law did had the necessary skills.
	Local labor force speaks all Twi.	3	One language being spoken indicates closed group mentality but this is not more than logical since it is a local company with local employees.



<b>Fatalism</b>	- Good initiatives get rewarded with a	4	The reward for good initiatives creates an environment in which employees will take initiative quicker.
<b>Voluntarism</b>	- bottle of coke.		
<b>Synchronous</b>	- Day planning at Nuamah.	3	There is a planning for each day which points to a certain degree of vision .
<b>Sequential</b>	Day planning can be flexible, but week planning must be followed (big containers must be empty).	2	Day planning's are part of overarching week planning. This can lead to postponing of work.
	Being on time is a must.	5	By having all his employees on time at work he is able to make and execute plans.
	Appointment for interview had to be made for 4 days later.	4	No time could be made directly but an appointment was necessary.
<b>Position</b>	- Chairman started small and grew the company.	5	the chairman built his own status by achievement
<b>Achievement</b>	Promising hardworking employees get help from the chairman with setting up their own paint store.	5	Labor is awarded by helping the employee set up his own store.
<b>Particularism</b>	- When hiring only muscle power and the ability to follow orders are important.	5	Other factors that could play a role in the hiring process like tribe or religion are not paid attention to.
<b>Universalism</b>	Males and females are treated differently, have different roles.	2	Different roles for man and woman means no universal treatment.
	To be well-connected is important for business.	2	Knowing people in the right places will help you move forward faster.
	There are some environmental regulations.	3	Regulations from the government exist but when looking at all the plastic and paint being burnt on the side skirts of the property it is questionable whether these regulations are very strict.

## Appendix A.3 - Family star entertainment

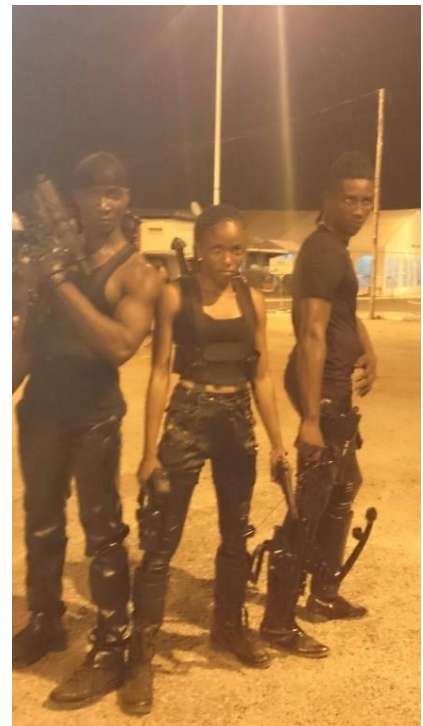
### General information

Family star entertainment is a movie production company startup in Kumasi that is basically build around Rosalinda Grace Egger, a young Ghanaian woman with a dream to be a star. She writes, produces and stars in all her movies. Her goal is to help others (the needy, development work) and uses the platform of movies to education people, make a name and ask for the necessary attention. She started halfway 2014 and hopes to put it all on a higher ground. At the time of the internship two movies were already done and almost released and two others were being shot and edited<sup>14</sup>. New plans are already made to produce a French spoken tv series to be broadcast in Ghana and Ivory Coast. Growing up with a difficult background, Rosa didn't go to school until she was 14, although she wanted to. It was a hard period in her life. Every time she tried to go, the school expelled her but she kept going back. This troubled childhood is her main motivation to make movies.

### Business & management model

The main value the business brings is that Rosa is able to tell the world what she thinks and that the movies make people like her. Next to that, it makes people act responsible and carefully. Nowadays the Ghanaian movies are divided into two groups, the local ones and the classic ones. The locals involve a lot of rituals and witchcraft, the classic ones are about romances. Her movies are a combination of both. She combines the two styles and with that appeals to a larger audience. For that reason she puts white people in her movies to also get that international vibe. Another value is the use of star actors to boost sales. She made use of rented cameras, tripods, a microphone, lights and a crane. A computer and green screen which were owned by her were also used. She was sole responsible for the equipment, meaning that if anything broke she had to pay.

The movies are aimed at the Twi-speaking population of Ghana. Twi is the main language in her movies, together with some bits of English. The movies are part of the growing number of Twi-movies (or Kumawood<sup>15</sup> movies) on the market. Within this segment no further distinctions are made: "We just aim at everybody", as Rosalinda put it. There is a lot of cooperation between different Kumawood companies. If Rosalinda needs more actors or equipment she can borrow them from other companies. The cooperation also helps to make good movies and educate people even better. To generate revenue, Family Star Entertainment has to make interesting



**Figure 28. A scene from one of Family Star's latest movies: An action filled zombie shooter. Rosalinda is the character in the middle**

<sup>14</sup> The two movies that were being shot and edited during the time of the internship were destroyed because of a faulty hard drive that contained all the footage.

<sup>15</sup> Ghana's movie industry is very suitably called Ghollywood. The Ashanti region has a sub-industry called Kumawood (named after the capital Kumasi) and these movies don't really make it outside of the region. Within the Ghanaian movie world they are viewed by some as bad pictures with an over-used storyline and no screenplay (Ghana Film Industry, 2014). Having that said, around nine million people speak Twi, mostly from the Ashanti region and within Ashanti communities Kumawood movies are very popular. The movies are played on TV, in busses or in bars and restaurants and movie stars are seen as royalty.

movies with big actors<sup>16</sup> and bring it out on DVD. The disks are made in Accra and transported by VIP bus to Kumasi. Rosalinda uses a taxi to transport the DVDs from the VIP station to her home. Further distribution is done by a distributor. The distributor sells them on the market or in shops ranging from 5 to 7 GHS per disk of which 1,40 GHS go to Rosalinda. For her last movie 10.000 disks were made. She gives them to the distributors and when they get sold she gets money. She can just drop by at any time to collect according to the number of sold copies. Marketing is done with commercials on TV and radio, posters and banners<sup>17</sup>. All Rosalinda's projects were financed by a benefactor who supplied Rosa with an interest free loan because he believed in her and her cause. The benefactor decided to give out the loan upon seeing her talent which made financing easy for this occasion. But if somebody like that doesn't comes by, getting a loan can be hard. Rosalinda is going to take a job on the side if necessary to help financing. If she runs out of funds the company will take a break from shooting until she has acquired the necessary funds. She mentions a couple of times that paying back her loan is the first point on the agenda so she can feel free, be independent and focus on new movies.

Direct relations with the customers is up to the distributor. They receive the copies and handle the rest. No extra service is provided (or needed). Feedback from the customers is obtained by screenings, acquisition and DVD sales. The two movies that are coming out are sold in a bundle which can be seen as a special promotion. By making movies people want to see customers are expected to keep coming back. Religion has a part to play when it comes to the content of the movies she makes. Some churches view the movie industry as a bad influence and they don't allow their members to join<sup>18</sup> (mostly Jehovah's witnesses, the other churches don't have that many problems with it). Being well-connected is also important, especially when it comes to arranging locations<sup>19</sup>. Another factor influencing the shooting of her movies are the power-outs. The power outs can screw up the whole day planning, especially when shooting inside or at night. And the costs of renting the camera just continues. Family Star once used a generator for three hours but the voltage was too low for the lights so they had to stop.



**Figure 29. During the shooting of Road Attackers. Rosalinda and the director behind the camera**

During the shooting of a movie Family Star can employ up to 100 people, ranging from the director, the actors or the camera man to extra's or people just hanging around on set doing miscellaneous tasks. Many of these people belong to the second group and could actually hardly be classified as employees. They got their expenses paid and were mostly friends (of friends).

Rosalinda hires somebody to cook the meals every day for everybody. The actors and crew get paid in advance after negotiations. They are selected based on their previous work and depending on what type

<sup>16</sup> For her latest movie, Road Attackers, she got Bishop Benard Nyarko, one of Kumawood's most popular actors to star in it. This is proven to be a good way to ensure DVD sales and is a very popular with all movies produced in Kumawood (Ghana Film Industry, 2014).

<sup>17</sup> This was done for the first two movies, but it has to be noted that the disks are still waiting for distribution due to copyright issues. She did pay somebody to take care of it but he took the money and took off so now it has been delayed

<sup>18</sup> Especially when the movie has scenes where there are woman, alcohol and parties involved. Rosa feels she can make whatever movie she wants, but when she includes certain religious or traditional practices from a negative point of view, she can get negative feedback from those groups which seemed undesirable.

<sup>19</sup> There is a lot of paperwork when for example she wanted to shoot a couple of scenes at Kumasi airport which was a very difficult process. If she had known somebody over there it would have been much easier.

of movie is being made. If it's a drama, she wants somebody who is good in drama, if it's an action movie she wants an action director. If the movie has both she wants both directors.

Everybody involved in the movies comes from Kumasi but tribe wise from all over the country. Because Rosalinda is new in the game and is fairly unknown, she hasn't got a strong negotiation position yet. The biggest share of her budget is used to pay the star actors, which she does gladly because famous actors are a guarantee for a successful movie. During the entire production of the movie the stars get special treatment (not much different than in Western countries). Rosalinda's family -her mother, brother and sister- are also involved in the productions but not in key positions. Her brother does play a part in the zombie movie but he also does look like an action hero and is called by many on set "the strongest man in Ghana"<sup>20</sup>.

Although Rosalinda is producer and also calls herself director. Sometimes she did seem to have trouble keeping control over the crew and actors. Especially messy communication between her and the director ensured many shooting days were delayed. Initiatives from employees were not encouraged as they confused the director<sup>21</sup>. It also happened that some of the actors didn't show up or many hours late which delayed the movie even more. The other employees (extra's and others) hanging around on set, usually also slept there so they were no problem. Rosalinda is involved in every aspect of the production and was also training herself in editing skills by looking how others were doing it to be less reliable on others when making movies.

**Table 24. Scores of Family Star Entertainment on the cultural dimensions**

Dimension	Examples	Score (1-5)	Explanation
<b>Hierarchy Egalitarianism</b>	- Rosalinda has difficulty keeping ascendancy over her crew.	5	It was possible for most crew members to argue with Rosalinda about the course of the shooting process.
	Actors sometimes came in a couple of hours late or not at all.	5	Coming in late gives a signal from the actor that they don't respect the power.
	Rosalinda tries to look at what the director/editor is doing so she can do it herself next time.	2	Rosalinda tries to do everything herself so she has nobody she has to listen to.
<b>Communitarianism - Individualism</b>	Family Star makes mostly Twi-spoken movies with bits of English and has plans to move into French-spoken movies for Ivory Coast.	3	They make movies in a certain language but are not reserved to try different languages.
	Family is involved but not in managerial positions.	2	Family involvement indicates closed group mentality.
	Crew, actors and extra's all from Kumasi but tribe wise from all over the country.	4	Crew made up from many different tribes.
<b>Fatalism Voluntarism</b>	- Rosalinda has a dream and acts upon it.	5	Rosalinda shows great initiative and aims at change.
	During power-outs shooting stops.	2	When the power is out nothing can happen and nothing is tried to still continue shooting.
	Most people sleep on set.	4	By keeping everyone close nothing is left to chance (fate).
<b>Synchronous Sequential</b>	- Company built around Rosalinda and her dream.	4	Rosalinda has a strong vision and goals and subsequently also a linear long term planning.
	Messy communication between Rosalinda and the director ensured many shooting days were delayed.	1	Many different views clashed during shooting resulting in every changing plans every day.

<sup>20</sup> He will take every spare moment to do some push-ups

<sup>21</sup> An example was a scene where Rosa liked it a certain way but the director wouldn't have it. So it didn't happen because she gave it to him because he is the director.

	Actors coming in late.	1	Coming in late was very normal, other business were more important.
	Payments are done per day, except for actor fees which are determined in advance by the actors themselves.	2	Payments per day shows a lack of financial plan.
<b>Position Achievement</b>	- Actors and crew are selected based on previous work.	5	Previous work = achievement.
	The whole company is set up by Rosalinda from scratch (by taking a huge loan).	5	Rosalinda had no status to begin with.
	Rosalinda is a very involved boss. She is involved in every aspect of production.	5	She works hard, hard labor is valued.
<b>Particularism Universalism</b>	- Family is involved in the production but not put in important positions.	2	Family gets different treatment.
	The big movie stars receive special treatment.	2	Different treatment for big stars.
	Knowing the right people would have shortened the paperwork process for example the airport scene.	2	Knowing people in the right places will help with paperwork.

## Appendix A.4 - Manco Industries Ltd.

### General information

Manco industries is a company that produces and sells mattresses at Adako-Jachie off the Kumasi-Ejisu road, owned by Issah Hayford and his cousin Vince Arthur, that came into business less than a year ago in 2014. Before Manco Industries was started, Issah had a smaller mattress business. He acquired more than 10 years of experience in producing mattresses and decided to start a bigger enterprise. By using own money he started Manco Industries Ltd. together with his cousin Vince, who had business experience from working at a bank in Canada<sup>22</sup>. Together they own Manco Industries, a plot of land of about a hectare with a factory building and a couple of office buildings on it and employ around 8 people. Their goal is to be able to compete with Latex Foam and Ash Foam, the two biggest mattress producers in Ghana.



**Figure 30.**The chemicals are mixed and poured in a container to produce latex foam

### Business and management model

Their main selling point are their high-density Dream foam mattresses<sup>23</sup> at competitive prices. This high-density foam is what sets the company apart from their competitors. The prices are based on the prices of these competitors, Latex Foam and Ash Foam, only lower. They also have another product line, the Nova foam mattresses, which have a special filling for extra comfort. The possibility to adapt to the customer's

needs by changing the density of the mattress is also a value offered by Manco Industries. The chemicals needed for mattress production are the most important resource and are bought from Dutch, British and Canadian companies who are contacted by phone and mail. Working capital is an important financial resource to be able to order the chemicals, Manco's biggest expense<sup>24</sup>. These chemicals consist of latex (the main ingredient), a foaming agent, a curing agent and a gelling agent (silicone gel). To produce the foam the chemicals are mixed in a barrel in absence of the gelling agent, which is added last. For the mixing process a big power tool (drill with mixing headpiece) is used.



**Figure 31.** The chemicals are measured by using a bucket. Issah (left) is watching his employees.

<sup>22</sup> Two years as a financial advisor and four years as an investment analyzer.

<sup>23</sup> The Dream Foam mattresses are the main focus of Manco Industries' slogan: "Dream foam... .. It's wonderful!"

<sup>24</sup> Buying the drums filled with chemicals are big capital investments for Manco Industries. Up to now it wasn't necessary to take loans but business is slow and unsold mattresses are stacking up. Manco is working hard to increase their customer base.



Issah knows all the ratios between the different components by heart and doesn't share this with his employees. He is able to change the density of the mattresses by combining latex from different barrels in a certain composition and changing the quantity of gelling agent. When the gelling agent is added, swift action is needed to mix it properly and immediately pour it into a large square container. In this container the mixed substance will expand and will change from a milky white liquid into a solid foam block<sup>25</sup>. After the foam blocks are produced they are cut in the right size by a horizontal and vertical cutting machine. At this point the mattresses are ready to be sold since Manco Industries offers the option to buy uncovered mattresses but the covered option is most common. In that case the mattresses are covered with a specially selected, high-quality fabric and finished with a professional sewing machine. For the final step a (very effective) makeshift sealing machine is used to pack the finished mattresses in plastic. Issah himself is in charge of maintaining all the machinery. Only the cutting and sewing processes are affected by the power-outs. Because of the irregular power-outs it is difficult to plan around them. Usually it can be decided on the day itself what has to be done. Foam blocks can be made without power (except for the mechanical mixer, for which they use a small generator), but the cutting machines require lots of power which cannot be delivered by regular generators. The cutting and sewing has to be done as quickly as possible when the power's on. This leads to lagging behind of production.



**Figure 32. Equipment at Manco. Clockwise starting top left: The mixing tool, the horizontal cutting machine, the sewing machine and the sealing machine.**

Manco Industries most important customers are mattress shops, hotels and institutions (like KNUST or KITA<sup>26</sup>). In hotels they aim at people who are in charge of stock and have to be persuaded to go for the new and unknown<sup>27</sup>. Manco Industries employs a sales team of two people that goes to all the shops and hotels in person to spread the word. Through this sales team the contacts are made, and if people are interested they can come to the factory or they are visited by their contact from the sales team. When dealing with big customers it can also happen that Vince comes along to show their commitment. As commercial manager Vince is in charge of customer relations which are maintained by phone and personal contact. The mattresses are transported by van or personal car (pickup truck). Service after purchase is done, for example it is possible to buy uncovered mattresses and let Manco pick them up to cover them up at a later time when it is deemed necessary. Marketing is done by the sales team and with promotional videos; during the internship a commercial was shot that was going to be part of the

<sup>25</sup> During this process there are some safety consideration regarding eye and skin irritation and inhalation (Polyone, 2014). Because the exact compounds used are unknown it can't be said which harmful compounds are produced but during the process the author immediately felt a burning sensation in his eyes. Manco did provide their employees with gasmasks and safety glasses but were not used by most of the employees.

<sup>26</sup> KITA became a customer of Manco Industries after they learned the author was doing an internship there. They were already looking into acquiring mattresses for their hosteling services and saw this as a wonderful opportunity for doing business.

<sup>27</sup> It is important that these people get acquainted with Manco Industries and also remember the name because the lifetime of mattresses is usually five years or more. It is only after this time that the hotels will have to think where to order their mattresses to restock and then the name of Manco should pop up.



advertorial section of an educational video for kids. In front of the factory there is a showroom planned but it is still under construction<sup>28</sup>.

The company is made up of two sections, the production and commercial side. Interaction between them is mostly kept separate. Issah is in charge of production and Vince of the commercial side with no further levels of hierarchy between them and their employees. There is a clear difference in how the two sections are managed. The way recruitment is done is a good example. For the sales team it is done by formal channels; adds are placed on the internet with a job description and a list of the qualifications that are expected (Jobberman, 2014). When people respond to these adds the interview process begins with a interview over the phone, followed by a face-to-face interview. The recruitment for the factory work is done



**Figure 33. Koby from the sales team visiting a furniture maker to inform him of the possibilities of working with Dream foam**

more informal. These are usually just people that live in the area, looking for work and knock on the factory door. Only the person that operates the sewing machine was hired based on previous experience. Working on the production side means mostly doing what Issah says. When he is not there, nothing happens. As mentioned before Issah wants to keep all knowledge of the process to himself and uses his employees only to assist him. Also the cutting process can only done by him because he doesn't trust anyone else to handle the machines<sup>29</sup>. Own initiative from the production workers is not appreciated. This is different for the sales team led by Vince, they are stimulated to present their own initiatives and go out to find new potential customers. They are rewarded with a bonus of 2% on each sale they make plus an expense reimbursement of 200 GHC each month<sup>30</sup>. These are set salaries but subject to review and can change over time, based on the employee's performance. By finding new customers the sales team is responsible for the company's growth and subsequently have more chances for growing within the company themselves. Where the production workers have strict working hours<sup>31</sup>, the sales team is free to independently make their own schedule. All employees have a chance to express their ideas during set meetings with the management but this is not something that happens very often.

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<sup>28</sup> Right now the construction has been paused and it is just bare walls with weeds growing in between. The mattresses are displayed in the factory and in an office space.

<sup>29</sup> An extra off the job training was given when new equipment was bought but since mistakes made during the cutting of the mattresses are costly, this is something Issah likes to avoid so he still does it all himself.

<sup>30</sup> Compared with Western standards 2% is pretty low, where Western countries usually pay commissions ranging from 5-15% (Higuera, 2012; Webster, 2009)

<sup>31</sup> There were some issues reported regarding absenteeism

**Table 25. Scores of Manco Industries on the cultural dimensions**

Dimension	Examples	Score (1-5)*	Explanation
<b>Hierarchy Egalitarianism</b>	- Issah and Vince are the boss and the employees have to listen (especially the factory workers).	2	Issah and Vince are clearly the boss and Issah doesn't even accept feedback.
	The sales team gets a lot of freedom and has to show initiative.	4	The sales team seemed to be more on the same line as Vince, their boss. They consulted with him before making their planning, but it was their planning.
	Issah is the only one with knowledge on the production process.	1	Issah doesn't trust anyone with his knowledge.
	The sales team gets 2% of each mattress they sell.	2	This is not a high percentage and indicates a high distance between employee and boss.
<b>Communitarianism - Individualism</b>	There is family in charge of the company.	2	Issah and Vince prefer to work with family. But no other family members were hired.
	Everybody speaks Twi.	2	This is a result of being a Kumasi based company, not a conscious decision.
<b>Fatalism Voluntarism</b>	- Sales team pushed to make their own initiative.	5	By offering the sales team a percentage of each sale it becomes attractive for the sales team to tread unbeaten paths. Of course 2% is very little, especially for Western standards, but when selling to a big order it can become an interesting deal for a sales rep.
	Chances for all employees to express initiative during set meetings with management, although this doesn't happen that often.	4	It is possible for all employees to show initiative.
	Manco Industries is trying to make a name for themselves with high density foam mattresses, an uncommon type of mattress.	4	Manco Industries offers a new type of mattress and get out of the comfort zone.
<b>Synchronous Sequential</b>	- There are some issues with absenteeism.	2	Indicates synchronous behavior.
	The sales team is allowed to make their own schedule.	3	This planning is made synchronic but based on a sequential motivation (high bonuses).
	Planning is dependent on power-outs.	2	A strict planning cannot be made because of the unreliable power supply.
	A showroom is planned in front of the factory and already partly built. Some time has passed and the structure is starting to get overgrown with weeds.	2	A plan was made and already partly executed but then not finished. (this is a common practice in Ghana, partly because of the depreciation of the GHS. See also the paragraph on Nuamah Enterprise).
<b>Position Achievement</b>	- Issah and Vince both have status by achievement.	5	Issah and Vince built their own company and have their status by having previous experience in mattress making (Issah) and working at a bank in Canada for 8 years (Vince).
	Only growth opportunities for the sales team.	3	Opportunities for achievement but only for the sales team.
	Issah is very involved in the operations of the company. He mostly expresses this by giving commando's.	1	He might be too involved and doesn't create a group feeling.
	Vince helps the sales team when handling big clients.	5	Vince helps the sales team out by going together to clients.

<b>Particularism</b> <b>Universalism</b>	-	Recruitment for the sales team is done via formal channels (internet adds).	5	There was a long list of requirements for the job position but none of them favored a specific group of people (except people capable of doing the job at hand).
		Production team is made up of local people who need a job.	3	Because they are local people there is a chance they are hired based on previous affiliations.
		Non-family is treated as subordinates but this is because they all are.	3	The bosses are family so it is logical non-family members are treated differently.
		Company does not regard origin of employees.	5	They indicated themselves to give no preferential treatment based on origin of employees.
		Issah only trust himself for the matrass production.	1	It is not clear on what basis he doesn't trust his employees but it is irrelevant in this case.
		There is safety equipment present for the factory workers but only used occasionally.	1	There is some form of safety regulations present but only followed sporadically.

## Appendix A.5 - Kumasi institute of tropical agriculture (KITA)

### General Information

KITA is a private agricultural training institution that has been in business since 1984 and was started by Noah Owusu-Takyi, who is officially still the director but in practice the school is led by Noah's son Samuel Owusu-Takyi. Next to agricultural courses, KITA also offers courses on business, renewable energy and environmental conservation. They want to enhance employable skills in agriculture for youth, women and farmers in general for a positive impact on renewable energy and sustainable development.

The idea to start up the institute came from a research report in 1976 which stated there was no training institute for farmers in Ghana. There was only one for extension officers (part of MOFA, the Ministry Of Food and Agriculture). At that time, Noah was giving a course in Agric Business at the school which is now KNUST. In 1979 he started 'the Agricultural Education Complex' in Obugu, but when it started to do well - due to some changes in regulations from a new government - the community pressured him to hand it over to the government. Eventually he was forced out by the community, also because he was on their premises. He then moved to a place close to Boadi Junction which he first had to renovate a lot<sup>32</sup>. They also had to move from that location because the landowner started asking too much money when the school was doing well.

In 1984 Noah moved to Domeabra to independently, in the course of two or three years, start KITA without any community or government support. KITA started training young men and woman in new agricultural employable skills. It started with 8 students from around the community. At that time there was no certification structure that was acknowledged by the government so Noah had to go to the government and give them his own curriculum which he already developed when he owned his previous school. They first frustrated him for a while until he met the commissioner of National Vocational Training Institute (the governmental body responsible for taking care of vocational training in Ghana). Eventually they based the new curriculum on what Noah was doing at the time. The startup of the company was financed by Noah's own money. Loans were taken, but only very few times as loans in Ghana have been very expensive. However it would not be hard for KITA to acquire loans because of their outstanding and long lasting relationships with the bank.



**Figure 34. Students at KITA planting carrot seeds and watering the ground. They have constructed a canopy to protect the vulnerable seeds from direct sun and heavy rains.**

The program started simple with being able to grow some vegetables and keep some animals, but Noah was also expanding into new territories and kept adding these new skills to his curriculum. At first only a one year program was offered but soon a two year program was added. From that time on there were always 30-50 students per year. The institute took a flight in 2011 when KITA received accreditation as a tertiary institution. Now they offer a one year certificate, a two year National Diploma and a three year

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<sup>32</sup> The place had been a radio school and collapsed 10 years before Noah entered it. Trees were growing in the classrooms. He did most of the renovation work himself, for example cutting down the trees and using the wood to make chairs.

Higher National Diploma (HND). The goal for 2015 was to have industries that train the students in specific sectors.

### Business model

From the beginning the main value KITA offers to its main customers, the students, is high quality practical skill training in agriculture for which diplomas are awarded. KITA is constantly improving and looking for new ways of generating income and offer value and now also offers short courses ranging from 1 day to 8 weeks for anyone interested, at KITA or on location. Consultation services by the projects team are also possible. All the produce grown by the students is another value that KITA has. The produce is sold by groups of market woman who come to KITA periodically to inquire about the grown crops<sup>33</sup>. Finally they are also involved in sustainable development in Ghana by doing contracts for the Power Africa Project by the USAID<sup>34</sup>.

Currently 11 fulltime employees work for KITA whom form the core staff, plus 24 part-time employees, the latter are mostly tutors and get contracts every semester. There are no strict working hours for the core staff, as long as they work at least 8 hours a day. Also if the targets are met, everybody will get a raise and the bonuses are output based. The employees are hired by Samuel based on personal selection and experience rather than qualifications. Samuel characterizes his employees as committed and praises their level of sacrifice. KITA is a family business where Noah's sons Samuel and his brother Lovans both hold important positions within the company. As mentioned before Samuel is acting director of KITA, a position also previously filled by Noah and also Lovans. Lovans is currently working as KITA's program director and is also employed by SNV, the Dutch development organization. He is trying to acquire accreditation give KITA the status of university. Samuel and Lovans both have enjoyed good educations and are very qualified for their positions<sup>35</sup>. The company policy is indifferent to tribal origin or religion, even though KITA has some Ashanti symbols and there is a daily morning prayer. English and Twi are the two prominent languages spoken on the premises, together with a bit of Ga<sup>36</sup>. Then there is Mr. Medjabo (81), who doesn't do much except for sitting in the administration building (right now it is more a form of social employment). Samuel has plans for him by



**Figure 35. Students adding worms to the compost as part of a permaculture class on vermicomposting**

<sup>33</sup> They are now planning to open a green market, a stall on the roadside where they can sell their produce. Dutch students are currently working on this project.

<sup>34</sup> Power Africa, an initiative led by the U.S. Government, aims to increase the number of people in of sub-Saharan Africa who have access to power by working together with African governments and private sector partners (like KITA) to unlock the substantial wind, solar, hydropower, natural gas, biomass, and geothermal resources on the continent (USAID, 2017).

<sup>35</sup> Samuel has done an MSc in social work and management at New York University plus some extra courses on the side on agricultural educational management and agricultural administration, prevention of violence in schools and counseling. Lovans has gotten degrees from the University of Ghana and the University of Education (Ghana).

<sup>36</sup> Ga is mostly spoken in and around Accra but in Kumasi it is understood by most. A part of KITA's students comes from Accra (and also other regions) and thus speaks Ga next to Twi.



putting him in charge of KITA's inventory.

KITA stands out next to the other agricultural institutions in the region because they are the only one out of 6 that is a non-governmental agricultural training institute. This expresses itself in employers (i.e. Kumah farms) stating that students from KITA are amongst the best students when it comes to their work output (writing reports, coming on time, communication skills). Being private also gives KITA less restrictions. They don't have to go through many loops to get approval for projects and can associate and disassociate with anyone they want at will. Aside from that, KITA still has to conform to many Governmental rules (on four different levels). Since KITA does not have subsidies, they are mainly dependent on student fees. The number of students is rising with a current student population of 87 but it hit a low in 2013 with only 49 enrolled students due to new regulations regarding the HND that the National Accreditation Board came up with. Because of that, KITA's diplomas lost their values and about



**Figure 36. Samuel Owusu-Takyi, KITA's acting director, looking at the progress of an internship project by students of the TU Delft on improved cook stoves.**

100 students left. This issue was luckily resolved the next year and students started coming back again. The students come from all regions in Ghana and have a lot of time in their schedules for setting up own initiatives but do have a strict table to adhere to. Every student gets two to three vegetable beds for which they are responsible and will be evaluated on at the end of each semester. KITA stands out in the many skills they teach the students, other institutions offer around 5 different projects where at KITA the number of projects is around 20<sup>37</sup>. Also KITA got an award in 2014 because of their outreach program<sup>38</sup>. They trained 95 groups of people with this program, which is a number unmatched by any other institution, as stated by Samuel. The project department is responsible for giving the training, but the current KITA students can also be used (they will be paid a fee and are also enthusiastic and trained to go the extra mile). The students take a very central role at KITA and also have a say in decisions. For example there is an organized student body which is formed every year with a board and regular meetings. When KITA decided to ask money for hosteling services<sup>39</sup> the students voiced their concerns and went on to negotiate the height of the fees.

KITA aims at two main customer segments. The most important customer segment is senior high school students and their parents (aka their sponsors)<sup>40</sup>. The other big segment is farmer groups that need training and support (these are given by KITA as a free, community service) and a host of farms and institutions that are in need of consultancy. Farmers that contact them for consultancy (and pay for it) usually want KITA to do everything for them. Other segments are the rural enterprises program and also Western volunteers who come to KITA to do an internship. New customers are mostly found through

<sup>37</sup> For example they have projects on: mushrooms, snails, bee keeping, rabbits, rural poultry, banana, plantain, citrus, greenhouse, tomatoes, cabbage, papaya, biogas, etc.

<sup>38</sup> In 1993 this community outreach program was started by Noah which involved the students in minor jobs in and around the community (like lining and pegging, packaging, pest control, etc.).

<sup>39</sup> The students have their own rooms on campus, a service KITA has recently started asking a fee for.

<sup>40</sup> These customers are characterized by being paperwork lovers (certificates instead of skills). Samuel adds that the paper will take you to the table, but you still have to show what you've got. This used to be different in Ghana and it was more dependent on knowing the right people to get a job. That mentality is changing and it becomes more and more important to be able to prove yourself in Ghana.



graduates and students<sup>41</sup>. If you bring in new students you get a percentage of their fee/ discount on your own fees. If people come by that cannot pay the fees, KITA forwards them to other organizations that have been started by KITA graduates.

Customer relations is divided into two groups. For the students it is the academic registrar, Mister Richard. For farmers, it is the extension team (the project team). KITA aims at giving good service by keeping track of their sold products and services. Policy is to let everybody leave KITA happy. Follow up calls are made to ensure everything functions properly and get feedback. They also effectuate long lasting relationships, where customers are made part of KITA's network meaning keeping contact and giving them clientele. Special promotions are not really offered<sup>42</sup>. Responsibility for contact with suppliers also depends on the focus area. If it's academic it's Mr. Richard, if it's a project it will be Mr. Frimpong (leader of project team) and when it involves high level partnerships it will be Samuel himself. Generally Samuel meets with everybody always and works very synchronic. He and Mr. Richard have a lot of persuasive power<sup>43</sup>. Credit is supplied based on trust from long term relations<sup>44</sup>.

Key partners of KITA are farms where the students are trained (like KITA's neighbor Kumah farms, that is discussed in the next section). SNV is also an important partner for KITA who works on many projects with them (partly because Samuel's brother Lovans works for SNV). They have donated a 40 m<sup>3</sup> biogas digester to KITA one year ago as a pilot project to see how biogas could work for institutions in Ghana. Startups by graduate students are also seen as partners by KITA (or as their babies) and KITA will often direct potential customers in their direction. Also when there is a topic that is not mastered by anyone at KITA they let somebody from outside come and do the training. Because they are neighbors KITA has a lot of agreements with Kumah farms. They are moving into more contractual agreements with other partners as well. Communications with partners go by phone, mail or in person. In general there is loyalty but looking for other partners is allowed. SNV is the only organization who tried to restrict KITA in this by giving them a contract to sign which would have made them first partner. This would mean that if KITA wants to enter a new partnership, they have to ask SNV first. The contract remained unsigned. Cooperation between competitors is seen as a good thing because you can copy/learn from each other. But it remains a bit ambiguous because they learn from each other but on the other hand they also try to stand out from the rest to gain advantage.



**Figure 37. George Ansah, the former projects manager at KITA doing a moringa training in a rural community.**

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<sup>41</sup> Also they tried radio advertisement but this didn't get the expected results (120 people called with interest but only 5 followed through). Radio advertisements are quite expensive: about 2500-3000 GHS for one month of 4-5 mentions a day.

<sup>42</sup> Regarding the student fees Samuel mentions that lowering them would make people assume the program isn't up to standard, so it should remain within a certain price range.

<sup>43</sup> They usually work from their offices in the administration building and have students bring them their food.

<sup>44</sup> An example of such a long term relationship is the "Chinese woman", a Ghanaian woman with slanted eyes from whom they buy their seeds. Chemicals that are used to fight diseases within their animal stock (like rashes and worms) are also always purchased from a specific supplier. With these parties they don't mind paying in advance or sometimes they can buy on credit.

KITA makes use of laptops, printers, educational management software, basic agricultural tools, a projector (+screen), 2 biogas digesters, generator and mechanical dryers. Safety risks of the machines are mainly due to poor handling in the beginning of a student's career. Another risk is that the tools can get stolen when the students don't store it properly. The project department, consisting of 4 people, is in charge of maintenance. Lectures are tasked with looking out for new techniques (smart technologies). On a school level, when there is a new technology that is applicable to their training (like water testing equipment for the greenhouse) they go for it. On average, a new technique is acquired at the start of every semester (when new capital arrives coming from the students)<sup>45</sup>. Next to acquiring new techniques, human resources are the biggest cost, followed by the lease on the land. When revenue streams decrease they will cut down the money that goes into projects. The power-outs make KITA's human resources less productive. Also the water stops flowing which affects irrigation and sanitation. They have a hybrid generator that was part of the donation by SNV which they use to burn biogas around 2-3 hours a day. After that they can switch to LPG, what will cost them 50 GHS for 9 hours.



Figure 38. Prince, a student at KITA, cooking his lunch on a biogas fired cooking stove.

Table 26. Scores of KITA on the cultural dimensions

Dimension	Examples	Score (1-5)	Explanation
<b>Hierarchy Egalitarianism</b>	- Samuel meets with everybody always and also listens to them.	5	No matter who it is, everybody is treated equally.
	Students are used to bring food.	2	Samuel and Richard use their positions to make students bring them their food (and sometimes also prepare the food).
	Students have a say in the height of the hosting fee.	5	The students are in a position where they are able to voice their thoughts and KITA takes them seriously.
<b>Communitarianism - Individualism</b>	Students are attracted from all different regions.	5	KITA doesn't have a preference for a certain tribe.
	The company policy is indifferent to tribal origin or religion, even though KITA has some Ashanti symbols and there is a daily morning prayer.	3	There are some Ashanti symbols around the premise and the morning prayer is for Christian students, but apart from this no other signs of groupings.
	English and Twi are the two prominent languages spoken on the premises, together with a bit of Ga.	3	The languages spoken are dependent of where a certain student comes from.
	Noah's two sons both have important positions within the institute.	2	Family in important positions is a communitarian trait. He put them through intensive educations before he put them in those positions.
	If targets are met or student numbers grow, everyone gets a raise.	1	Everybody is held responsible for the successes of the company.

<sup>45</sup> For the next two to three years the plan is to set up an organic market (with a cooler and juicer included).

<b>Fatalism Voluntarism</b>	- Noah stepped into the void for agricultural training.	5	Inspired by a research report, Noah started something that wasn't there before.
	KITA is constantly improving and growing/finding new ways of generating income.	5	KITA aims at change and taking initiative into new fields of agriculture.
	The students' strict schedule has some room reserved for extracurricular activities. These activities require own initiative by the students and they do this.	5	The students are trained to take initiative.
<b>Synchronous Sequential</b>	- There are no strict working hours for the core staff (they do have to work at least 8 h/day).	2	There's a partial flexibility for the core staff within which they can decide themselves what needs to be done first.
	The students have a strict timetable.	4	The students' schedule is set from 5:30 in the morning till 6 in the evening (see appendix) but the students don't always follow it.
	Samuel has a very synchronic work ethic, meaning anyone can come in at any time, even during another meeting.	1	From the start it was made clear if the author wanted to speak to Samuel he just had to knock on the door and Samuel would speak with him.
<b>Position Achievement</b>	- Bonuses are output-based.	5	There is a reward system in place for achievement.
	If targets are met, everybody will get a bonus. The same goes for growing student numbers.	4	Everybody is rewarded after collective achievement.
	Hard work is often mentioned by the students and teachers as a value to strive for.	5	Labor as a value is taught by the teachers and forwarded by the students.
	Samuel has got into his position by being the son of Noah.	2	Aside from the fact that Samuel is very well qualified for the job, it is also clear he has his position because of his father.
	New employees are selected based on personal experience rather than qualifications.	5	Personal experience means achievement.
<b>Particularism Universalism</b>	- Noah has put his two sons in charge.	2	Family in charge points at particularism.
	Company policy is to be indifferent on tribal origin.	5	Everybody is treated the same.
	English and Twi are the two prominent languages spoken on the premises, together with a bit of Ga.	4	Not a multitude of languages but no languages are excluded. It could happen that nobody can speak it.
	There are four levels of governmental rules KITA has to adhere to.	5	Governmental rules are for all.
	Knowing the right people used to be important in Ghana but it is changing. People are treated based on what they can do.	5	The patronage system is shrinking.

## Appendix A.6 - Royal chef

### General information

Royal chef is a restaurant situated on Roman Hill<sup>46</sup>, Kumasi that serves traditional Ghanaian dishes<sup>47</sup>. The restaurant opened in the beginning of 2015 and is owned by Nana Kwanin Kwanfo II, a chief of the Oyoko division in the nearby Ejisu-Juaben district<sup>48</sup>. Next to Royal Chef, Nana owns a diaper business in Accra and almost two years ago he started a diaper outlet on Roman Hill as an expansion of his business in Accra. Whenever he was at his new place in Kumasi and was getting hungry he had to go far away to get some good food. Then he was presented the opportunity to buy the third floor in the same building he had his diaper outlet in. Combined with a secret wish to start a restaurant this resulted in the start of Royal Chef. The restaurants motto is "Eating royally", hence the name<sup>49</sup>.



Figure 39. A typical way of serving a Ghanaian dish. The starchy balls in the middle of the plate and the soup around it with some type of meat in it (in this case crab)

### Business & management model

Royal chef aims at offering excellence combined with optimal 100% customer care. This manifests itself in Nana instructing his waitresses to always be friendly, help customers wash their hands before and after a meal and offer complimentary hand cream for when you have finished eating. At times, free candy is also handed out to the customers. Next to that there are many TV screens that always show football matches<sup>50</sup>. All this is offered against very moderate prices, another main value of Royal Chef. A meal costs around 4 or 5 GHS which is only a bit more than food bought on the street in chop bars<sup>51</sup>. Finally the restaurant is located on the third floor in a building on Roman Hill, which gives the restaurant a nice view over Kumasi's Central Market. All these values combined set the restaurant apart from its competitors.

<sup>46</sup> Roman Hill is a well-known place in the center of Kumasi. It owes its name to the Roman church St. Peter's Basilica which is located on the hill. Because it is on a hill it can be seen from far away. Next to the church, Roman Hill is home to many shops and stalls and one of the bigger trotro -Ghana's most popular form of public transport- stations of the city (when a trotro has Roman Hill as its destination the mate will shout "Roman, Roman!" out of the trotro's window to let people know where it is going)

<sup>47</sup> Ghanaian food is eaten by hand and usually consists of two components: a starchy staple food (this can be a doughy ball like the famous fufu, kenkey, banku or fried plantain/yam or rice balls) combined with a sauce or soup (most popular are palm nut and groundnut soup) which contains a protein source like meat or fish. The starchy food is taken with the hand and used to scoop up the soup.

<sup>48</sup> Nana has done a tertiary education in health and social care in the UK where he also lived and worked for 15 years.

<sup>49</sup> It could also be the other way around.

<sup>50</sup> Football is very popular in Ghana, especially the English Premier League and matches involving Barcelona or Real Madrid. When a match is broadcasted involving one of these teams the restaurant is packed. The Ghanaian national squad -known as the Black Stars- are also popular but not for the whole population. Especially people who disagree with the current government see the team as a governmental tool and refrain from supporting. Screenings of matches involving the Black Stars can even result in violent verbal conflicts between proponents and opponents of the government.

<sup>51</sup> Food at chop bars can already be bought starting from 0,50 GHS but if a piece of meat or fish is added it becomes easily 2-4 GHS. This was also the case at Royal Chef. A piece of meat or fish for 2 GHS and for each fufu/banku/rice ball you wanted it was 1 GHS.



Because of the moderate prices combined with high service and good prices the restaurant aims at mass market (“Everybody is treated as royalty”). Both people with low and high income come to eat in the restaurant. Roman Hill is next to a hill also a very busy trotro station close to the Central Market, which means loads of people walk by. The entrance is at first a bit difficult to find because it is situated in an alleyway but if you look up it is clear there is a restaurant and then the entrance can be found after some searching and asking around<sup>52</sup>. Nana is making investments to create brand awareness. Advertisement was done with radio and tv commercials<sup>53</sup>, but also by handing out leaflets and an information center at central market. He also did catering for a mother’s day event by a TV station he was sponsoring. This was to build his name and also as a pilot for a catering service. The restaurant also has a call and delivery service. No special promotions but maybe down the line. By direct asking customer feedback was received.

During the time of the interview there were 18 people working for him, officially all temporary. This was because they were all in their trial period and would become permanent staff after 6 months. In the meantime this has happened and all the staff is officially hired by Nana. There were no family members between them but new staff was attracted by asking friends of the current staff. Because of this all the employees come from in and around Kumasi and are from the Akan tribe with Twi and English as the common languages (for the selection process tribal origin was unimportant though).

The restaurant employs four different types of employees with increasing importance: the cleaning staff, service staff and kitchen staff and a manager. The cleaning staff is responsible for keeping the place clean (apart from the tables, which are the responsibility of the service staff), the service staff (waitresses<sup>54</sup>) is in charge of maintaining the relations with the customers and are selected on their ability to provide excellent service<sup>55</sup> and the kitchen staff is responsible for acquiring and preparing the food. The food is bought straight from the Central Market which has plenty of options for the cooks to get the best quality products for the best price. The kitchen staff is considered by Nana Royal Chef’s most important human resource which makes sense for a restaurant. There are no chances for employees to be promoted but there are group meetings held which gives them a voice in the company, for example they were asked to



**Figure 40.** The interior of Royal Chef. On the table covers are pictures of the dishes they serve together with famous football players from the English Premier League.

<sup>52</sup> The first time the author noticed the restaurant was when he walked towards the trotro station at Roman Hill and heard a football match being played somewhere. The sounds seemed to come from above and that made him look up and notice the restaurant. After that he asked around to be able to localize the entrance.

<sup>53</sup> The commercial can be found at <https://www.youtube.com/watch?v=TbUXsrB-3CQ>

<sup>54</sup> Waitresses working at Royal Chef receive 150GHS per month plus tips and have strict working days from 8:00 to 21:00. Coming late means a 5 GHS reduction and in general making mistakes can cost them 5 to 10 GHS.

<sup>55</sup> Nana breaks this down into being clever, decent, fluent and respectful.

pick the color of the shirt all the employees have to wear. The manager is in charge of the bar<sup>56</sup> and the day-by-day operations (making the work schedule and making sure it is followed).



Figure 41. The cooks dishing up food.

During the time of the interview (during the first month after the opening of the restaurant) the day-by-day responsibilities of the manager were not very apparent because Nana would also always be around taking over his tasks by standing close to the entrance to welcome customers and sometimes make a chat with them. While doing this he didn't differentiate different people (this could be due to his time spent in the UK), for example foreigners were welcomed just as hospitable as Ghanaians, whether they were dressed nicely or were wearing ragged clothes. To make them regular customers he would pamper them, befriend them and

serve them delicious food with excellent service. Nana seemed very driven to make his restaurant a success and for that reason was almost always around making sure everything went according to his wishes. Nowadays Nana relies more on the capacities of the manager and feels happy to leave the restaurant for a couple of weeks to take care of his diaper business.

This type of behavior was typical for Nana, who came across as a hard-working entrepreneur who was always on the lookout for new opportunities. His position as chief definitely helped him to get in front in life and got him certain advantages but his businesses were for an important part a result of his entrepreneurial spirit. Even when he just opened his restaurant he was already planning to open another (bigger) location. As his biggest barrier for growth he mentioned himself becoming lazy<sup>57</sup>. This drive to never become lazy was also something he pushed onto his employees. Him being always around during the first months of the restaurant was partly to train his employees to the Royal Chef standard and to acquire a constant quality assurance.



Figure 42. A younger Nana during a traditional ritual concerning his duties as chief. (picture from <http://www.appianyinase.org>, 2016)

The biggest costs of the restaurant are the ingredients which are about 10000 GHS every month. When times get hard the drinks are the first that will go off the menu as they are considered a luxury product in

<sup>56</sup> His job of bartender is an easy one because most people in Ghana satisfy themselves with just a sachet of water with their meal. Ordering a soda or a beer is not very common so a bartender usually does not have to do much.

<sup>57</sup> Next to the power-outs, barrier mentioned by all businesses (except businesses that don't need electricity, like the transportation business Star Company Ltd which will be discussed later).



Ghanaian culture. Equipment used includes a blender, knives, fridges, fans and TVs. When there are malfunctions he calls the repairman. Nana is currently looking to acquire a popcorn machine to become more attractive to customers. Because of all these electrical machines the power-outs also influence his business. Their most problematic effect is that the fridges don't work if the power is off. This is unacceptable for a restaurant of course. Also the lights, fans and TVs will stop. Especially eating in the dark is a difficult task. Luckily the building has its own backup generator which will turn on fairly quickly after the power has gone off. The costs for using the generator are 270 GHS on a weekly basis, which means it is more than 10% of the budget for ingredients. The registration of business names act and fire safety rules (smoke alarms, fire extinguisher) are external rules from the government Nana has to follow.

**Table 27. Scores of Royal Chef on the cultural dimensions**

Dimension	Examples	Score (1-5)	Explanation
<b>Hierarchy Egalitarianism</b>	- Nana was very involved in day-to-day operations although officially he hired a manager for that. He wanted to make sure everything went exactly how he wanted it.	1	Being always around making sure everything goes according to your plan also means that nobody is free to act on their own account.
	Making a mistake costs an employee a full-day's wage.	1	This harsh penalty shows how important it is for Nana that all his employees do everything according to his standard.
	Group meetings are held where employees can voice their concerns and make decisions on for example the color of their shirts.	4	Group meetings are a sign of an egalitarian system but it has to be noted that letting the employees decide which color their shirts will be is not the same as letting them partake in deciding company policy.
<b>Communitarianism - Individualism</b>	All employees are friends of friends and come from in and around Kumasi and thus all speak Twi.	2	Because all employees came from in and around Kumasi Twi was the main language, but if someone entered speaking a different language there was switched to English.
	No family members between the employees and no family members of Nana.	5	There were no family members holding up positions in the company
	Nana was very welcoming to anybody coming to his restaurant.	5	Everyone entering the restaurant was welcomed as an individual and valued as such.
<b>Fatalism Voluntarism</b>	- The restaurant served solely traditional dishes.	1	The type of dishes served at Royal Chef were copied from the past and no effort was made to change that. This is also because Ghanaian culture is very traditional regarding their dishes so it is a safe bet.
	Nana made investments to create brand awareness.	5	Because the restaurant was just new the restaurant had to build a name for itself. Nana recognized this and put a lot of effort into marketing.

	Nana is a true entrepreneur with multiple businesses. He noticed a deficiency (no good food around) and acted upon it by starting his own restaurant.	5	Nana bridged the gap between past and future by taking action.
	The main barrier for growth is within yourself (becoming lazy) so Nana works hard.	5	Nana views his own failure as his main barrier and thus also sees his successes as something within his own power and he isn't afraid to take responsibility.
<b>Synchronous Sequential</b>	- Employees get paid per month.	5	Paying employees per month instead of per day shows the presence of a financial plan
	The company has strict working hours (08:00 - 21:00) and there is a manager in charge of making and following the schedule.	5	Apart from the days being very long, them being strictly followed also indicates a certain degree of realization that a linear planning is necessary if change is wanted.
	Nana hired his employees with a six month trial period to see if they were fit for the job and train them to the standard he desired.	5	A trial period shows Nana had certain idea of what type of people he wanted and he chose for sequential approach.
<b>Position Achievement</b>	- Nana's position as chief of the Oyoko division in the Juaben traditional counsel has given him certain advantages.	1	Due to Ghanaian tradition town chiefs get tons of respect and status from birth.
	However he works hard to get even further in life. He can be described as a hard-working, involved boss who is constantly walking around to see if everybody is satisfied.	4	Nana is a boss who gives a lot of commando's but also involves himself in serving people.
	Hard work is not only valued by management, it is expected. Nana himself can be seen walking around, the manager is sitting in his spot behind the bar.	4	Nana expects hard work from his employees and leads by example. The manager however doesn't leave his station. This can be because he can't leave the bar unmanned or the fact that Nana is doing his job.
<b>Particularism Universalism</b>	- Employees are selected for a trial period if they are able to provide excellent service (if they are clever, decent, fluent and respectful) and not based on their tribal origins or family ties.	5	Employees selected based on their capacities instead of their social background.
	Twi is spoken together with English.	4	Since most people speak Twi in and around Kumasi the employees also speak Twi. If a non-Twi speaker enters they switch to English.
	All guest are treated equally	5	Everybody gets treated according to the same rules.

	The restaurant has to abide to 5 governmental rules such as the business registration act and basic fire safety rules like smoke alarms and fire extinguishers.	These governmental rules are the same for everybody.
	Being well-connected is important is 1 mentioned by Nana	This means a preferential treatment is given to people with friends in the right places.

## Appendix A.7 - The pioneer

### General information

The Pioneer is a small semi-weekly newspaper located in the center of Kumasi (Adum) that comes out every Monday, Wednesday and Saturday. The main goal of the paper is to inform, educate and entertain. Although it is one of the smaller newspapers in the country, it has been around for already 75 years. Back in the days they were the first independent newspaper in Ghana, started by the late John Wallace Tsiboe in 1939. Everybody at the Pioneer sees him as a great man and pioneer (hence the name). Being independent had some implications for the newspaper in the 60's. Kwame Nkrumah was president at the time who, after his achievements of making Ghana an independent state, became an authoritarian ruler and was inspired by Lenin's state-controlled news-apparatus. The independent nature of the Pioneer was reason for Nkrumah to shut the paper down<sup>58</sup>. When the army committed a coup in 1966 the Pioneer was able to issue newspapers again and thrive as a news source for multiple decades. During the last two decades the newspaper has been going through a rough time though. The paper has trouble tying ends together and from the old staff many have retired or had to be let go. They would like to intensify and double up the work to live up to the name of the company as the oldest independent newspaper in the country but it seems like -just like many newspapers all over the world- they will have to change their business model to survive the current socio-technological climate.



Figure 43. The entrance of the Pioneer at Adum, Kumasi.

### Business & management model

The official value the Pioneer offers to its customers is news but nowadays it seems the real value of the Pioneer is to offer a platform for people to announce funerals<sup>59</sup>. The paper is a well-known place for placing funeral ads. These funeral ads are a big part of Ghanaian culture, since funerals are one of the most important events that take a central place in the community life of every Ghanaian<sup>60</sup>. These are social events attended by large numbers of people, the more the better. So it is important reach as many people as possible when announcing the funeral. But it also works the other way around: because funerals are such a big thing in Ghana, people want to be informed about any upcoming funerals. Everywhere in Ghana you can see posters hanging to let as much people as possible know who passed away and to inform them of the festivities. These posters are put on buildings and cars and can also be printed in newspapers. So if the paper is a known place for funeral ads this is a reason for people to buy it.

<sup>58</sup> There are also some indications there were at the time other political forces playing roles behind the scenes (Ghanaian parties like CCP and UGCC but also the CIA and MI6) (Ghanaweb, 2008). However these are just rumors so shouldn't be taken too seriously as they haven't been checked thoroughly for this research.

<sup>59</sup> They used to also be involved in the printing of business cards and bookmarks but with the electronic age this has gone down.

<sup>60</sup> The way Ghanaian funerals are performed are in sharp contrast with the soberness of Western funerals. When somebody dies it is celebrated by the whole community with music and dance and the celebrations can last for over a week.



Figure 44. The front and back page of the Pioneer. This issue had 8 pages in total.

The paper can be bought for only 1 GHS, which is pretty cheap compared to the other newspapers which are sold for at least double the money. The Pioneer chooses this price because they want to aim at ordinary people and not the elite, so they need to be affordable. Because of their low price they rely heavily on the income of ads which are responsible for a quarter of the papers content. Regular advertisers also sometimes get package deals. The Pioneer is not a free newspaper but it's close and thus their business model is similar to newspapers like Metro<sup>61</sup>.

Their customer base is supposed to be in the whole of Ghana but effectively they mostly come from the Ashanti region (and some from Accra). This is most likely a consequence of them functioning as a platform for funeral announcements and for that reason are only interesting for people within the region. They use cars and motorbikes to transport the papers to vendors who are, next to word to mouth advertisement, the major channel responsible for the marketing of the paper. There are also some people who have a subscription and they usually sent somebody to the office of the Pioneer to pick up the paper.

Relationships with the readers are maintained by going out on the street to listen to what is happening in society. This way the paper can write what people want to hear. For feedback there are sometimes coupons in the paper or readers can sent there comments to the email address on that is on the back of the paper. Another way is for people to send in columns to be published. This makes the readers more involved with the paper and will boost the relationship. For the other customer segment, the advertisers, all contacts go through Tommy, a large amicable man who is head of the advertorial department. He is well known by everybody looking to place a funeral ad.

<sup>61</sup> Free newspapers rely heavily on advertisers to keep the paper running. But to attract advertisers the newspaper needs to have an established customer base. This customer base is for an important part based on the fact that the paper is free, so these customer segments are mutually dependent.



Figure 45. The middle pages of the newspaper with a funeral advertisement of half a page. In total they consisted of 2 pages in total.

There are several departments, each with its own responsibilities. Next to the advertorial department there are the editorial, accounting, circulation and administration departments. On top of the departments is the managing director (MD), who wasn't interested to be interviewed by the author. Instead, the interview was done with the chief editor Johnson Gyampoh. This had some implication for the acquired information since there were some topics that according to Johnson only could be answered by the MD. Johnson himself started working for the newspaper in 1987 as a reporter and worked his way up the ladder by showing initiative. To be working at the Pioneer as a journalist it is necessary to have at least a degree in journalism<sup>62</sup> and you need to have a professional presentation as well. The company has currently 15 employees but only 2 of them are fulltime journalists. The paper makes up for this low number by placing many pieces by (regular) columnists (after they have been screened first by Johnson). The salary of the employees is determined by a ranking system that is based on a combination of qualifications and experience. Their skills need constant renewal and the company also trains their employees when this is deemed necessary<sup>63</sup>.

Employees can come from all around the country but the main languages spoken are Twi and English. The paper is published in English, like all papers in Ghana. In the times of John Wallace Tsiboe, most of the journalist working for the newspaper had a Ewe or Fante (like Tsiboe himself) background which also had some political implications (Ghanaweb, 2008). The son of the MD is also working at the Pioneer in the business department.

<sup>62</sup> This made it also difficult for the author to arrange a mini-internship at the company because of his lack of a journalism degree. After a long and difficult explanation Johnson agreed to do an interview but no internship. The information acquired by observation came from the times the author had appointments at the newspaper with Johnson (there were many because of miscommunication).

<sup>63</sup> An example is when the paper switched from the old system to using a computer.



The most important partners are the vendors. These can be newsstands but also people selling items along the roads<sup>64</sup>. The printing of the paper is outsourced to Abura Printing Works Ltd. They used to have Heidelberg machines from Germany but they have been discarded and replaced by web-offset machines. Replacing machinery is only done when they are worn off (total loss). There is an external company in charge of machinery maintenance. Special arrangements exist with some partners due to long lasting contact. Communication is normally done by phone or in person. When new partners are contacted, only business related issues are discussed. Communication is also done in the form of networking, Johnson mentions that meeting the right people at parties for example helps a lot for the renewal of licenses. Next to licenses that have to be renewed, there are some other governmental requirements that the Pioneer has to abide to, such as labor rules that have to be followed and safety regulations when working with the printing press.



Figure 46. A vendor selling newspapers while walking between cars. (picture from: <http://accradailyphoto.blogspot.nl>)

According to Johnson, cooperation between different newspapers is good because otherwise you work in isolation. The competition makes you re-strategize and it prevents monopolies. The Pioneer is always open to healthy competition. New startups have come many times to Johnson to ask for advice.

Due to the strict deadlines of the paper one or two days before it comes out (depending on the content), appointments are usually kept. Deadlines are extra tight because of advertisement contracts, next to the fact that a newspaper always has to be printed, no matter what. The paper works with daily targets and when elections are coming up there are extra targets set and everybody has to work extra hard. The working hours are flexible except on printing days.

If they have to run the generator it is their biggest cost but the Pioneer is situated in the center of Kumasi on the boundary of three different zones so they are practically connected to a zone that has power. Other big costs are printing and salaries.

Table 28. Scores of The Pioneer on the cultural dimensions

	Examples	Score (1-5)	Explanation
<b>Hierarchy Egalitarianism</b>	- There were many subjects Johnson couldn't talk about since this was "up to the MD".	1	Even as chief editor there was a big gap in what Johnson could say himself instead of the MD.
	The newspaper is divided in different departments with its own responsibilities.	4	Responsibilities are divided over the different departments on an equal level.
<b>Communitarianism - Individualism</b>	English and Twi are spoken within the company and the paper is printed in English.	4	By writing in English no specific groups are targeted (tribal communities) .
	The son of the MD is working in the business department, a department not mentioned earlier by Johnson but it seemed an important	1	Indicates closed group mentality.

<sup>64</sup> When driving in Ghana this is a phenomena that you will see everywhere but especially in the cities around busy intersections. People walk through the cars carrying their wares with their hands or on their heads. These wares can be anything from food or water sachets to windshield wipers or newspapers. If somebody inside the car is interested in buying something they will call the specific vendor for a quick transaction.

	one.		
	There are only business related issues discussed with new partners (what are their expectations).	5	Group alliances are not important.
<b>Fatalism</b>	- The company trains new employees when transitioning towards a new system (e.g. computers).	5	By training the employees action is taken by the company .
<b>Voluntarism</b>	Showing initiative lets you move up in the company.	5	Initiative is necessary for entrepreneurship.
	Employees constantly have to renew their skills to keep up with modern day society.	5	The employees are pushed themselves to train themselves.
	The pioneer has no website.	1	The company is running behind technologically.
<b>Synchronous</b>	- There are flexible working hours, except on printing days.	4	It is a combination of synchronous and sequential planning with a focus on the sequential part because the synchronous planning is part of it.
<b>Sequential</b>	There are daily targets to be met.	4	Everyday something has to be finished to be able to get the paper ready on time.
	During election periods there are extra targets set.	5	It is recognized by the paper that election periods are causing a rise in sales so they put extra work into those periods.
	The paper wants to be able to live up to its name within a couple of years.	4	This is an example of a long term planning although a couple of years is not very specific.
<b>Position</b>	- Employees should have the right qualifications for the job and present themselves professional.	5	Qualifications are based on work previously done by people .
<b>Achievement</b>	Johnson worked himself up from a reporter to the chief editor in 28 years.	5	Position by achievement and taking initiative.
	Salary based on a ranking (qualifications and experience).	5	Ranking based on achievement.
<b>Particularism</b>	- Renewal of licenses gets easier when you meet people at parties.	1	Rules can be bypassed by meeting people in the right places.
<b>Universalism</b>	Employees can come from all around the country.	4	No selection based on origin, although most people come from the region.
	Labor rules and safety regulations have to be followed, otherwise they can sue you.	5	Rules set by the government have to be followed.
	The son of the MD is working in the business department, a department not mentioned earlier by Johnson but it seemed an important one.	1	Family businesses have high chance of particularism.

## Appendix A.8 - Terracotta

### General information

Terracotta is one of many slipper making workshops in and around the Central Market of Kumasi and has been in business since 1998. The workshops are owned and led by the masters, who are directing and training their apprentices in the craft of slipper making<sup>65</sup>. There are 52 masters at Kumasi Central Market, divided over a couple streets/areas called line one, two, and three. The masters are part of the Footwear Manufacturers Company Ltd. which is a larger association of small-scale footwear manufacturers in Ghana with its head office in Kumasi. It was officially registered in 2005 although operations started back in 1990. Their main objective is to pursue the business interests of all small-scale footwear makers in the informal sector. The estimated number of manufacturers in Kumasi alone is around 500 with about 2000-3000 employees. The annual turnover of all the operators is estimated at US\$5 million (Emmanuel Appiah Danquah, 2015). An interview was conducted with Kodjo who was a second year apprentice at Terracotta, and Yaw who became a master himself after being an apprentice for 6 years, also at Terracotta. The master of Terracotta was himself an apprentice for 3 years before starting on his own.



Figure 47. Terracotta's location looking out over Central Market (roughly indicated with the red square).

### Business & management model

The main value Terracotta offers is good quality slippers. The selling of slippers is their only revenue stream. They try to set their workshop apart from other slipper makers by using the best quality leather, glue and rubber (during the interview it is emphasized that all materials are of the best quality). Because in this business, when you use bad materials customers won't come back if you do a bad job. The largest customer segment consist of bulk buyers from Accra who are responsible for buying about 70% of all their slippers<sup>66</sup>. Foreigners from Nigeria, Liberia, Sierra Leone, etc. come to Accra to buy the Kumasi slippers. The rest of the slippers are sold in Kumasi at the central market by affiliated slipper stores. No advertisement is needed because the Central Market in Kumasi is a well-known place for anybody looking to buy slippers. They do need to make sure their slippers look attractive. The bulk buyers in Accra will give feedback on which slippers sell best. If Terracotta can make a model a certain customer likes, they will come back and long term relations are obtained. Customer relations are always handled by the master, and there is always a personal relationship established. Contact information is asked from customers and also business partners to make sure they don't just take slippers without coming back with the money. The customers from Sierra Leone buy directly from them and usually order around 2500 pairs per month. Because of this they will always treat them really good when they visit by buying them drinks and so on to keep them coming back. When customers buy in bulk they will get either a 10% discount or extra free pairs of slippers. Reparations after purchase are usually done free of charge. They will call if they have a phone number, otherwise they come to visit them in person.

<sup>65</sup> The most important thing is to know how to use the knife and scissors to cut the shapes of slippers and the sizing of the straps.

<sup>66</sup> The slippers that are sold to Accra are transported by VIP bus. One person will make the trip and will take a big bag of slippers with him.

Everybody at Terracotta is family of each other Kodjo and Yaw are cousins themselves. Because of this all employees are from the same tribe (Akan) and only speak Twi. It seemed this family-oriented apprentice selection was the case for most, if not all workshops at the central market. Next to being family you also had to be serious in your ambition to be considered for the apprenticeship. This master-apprentice



**Figure 48. Apprentices working in the workshop of Terracotta.**

system is similar to the system which originated in western Europe during the late Middle Ages and still is used to train new generations in a trade or profession. The craft of making slippers is very old and has stayed pretty much unchanged during the ages. There is a culture of respect for the masters by the apprentices and the apprentices always will have to listen to the master. He can open up to him but always should remain respectful. A master is always close to his apprentices and is also heavily involved in the production. If he's not around the work is stopped. They work with a day planning (based on a monthly planning) which is flexible and always kept.

If an apprentice wants to become a master and start a workshop for himself he should do so by setting a part of his salary aside and save up to buy a place to work from<sup>67</sup>. It was unclear what the exact ratio was between acquiring the right set of skills and the necessary amount of money for becoming a master but it was clear that the capital was the limiting factor. The masters will also help if they see promise in you by also putting in some capital. How the master treats you differs from master to master. Usually the apprentices are paid around from 5 up to 8 GHS per day, depending on which year of their internship they are in. There are masters that in the first years do not even pay wages, the apprentice first has to prove himself. For these first years, the apprentice will have to find sponsors to get by<sup>68</sup>. But however you do it, you will always have to startup small and grow slowly. Yaw did not take any loans for his business because he does not want to be dependent on them. According to Yaw and Kodjo getting a loan in Ghana is “beyond difficult”. The fact that Ghana is very corrupt (“even our mothers are corrupt”) doesn’t help much. In the future Yaw would like to move away from his spot at the central market to a bigger place.

For the production of slippers they make use of a sowing machine, scissors, plyers, knife, hammer, brush and a smoothing machine (that is handled by an external party). There are some hazards involved when for example handling a hammer<sup>69</sup> or knife. Also inhaling the glue all day long can bear some health risks. When the sowing machine breaks down they let a sowing expert come for repairs. For smoothing they always go to the same person and have special arrangements with him. For their supplies they go to different parties and this varies every time. Supplies are only selected based on quality. If the quality is better somewhere else they will buy from another supplier. Their suppliers usually come from the Central Market. The master decides which materials are bought. The different masters use each other’s slipper

<sup>67</sup> Yaw mentions that it is very important to be able to save up. During his time as an apprentice he used to save up a third of his weekly income (the rest was used as chop money) which allowed him to start his own workshop after six years. In the beginning his master also helped him to invest in supplies to get started.

<sup>68</sup> An example of such a sponsor is Samuel Owusu-Takyi from KITA, who also takes care of a boy who is training to be a slipper maker without getting paid.

<sup>69</sup> Kodjo hit his thumb quite recently with a hammer.



designs/styles. Without reimbursement the pattern is given to his brother<sup>70</sup>. There is also competition which ensures higher quality slippers. They give each other tips on which slippers sell better and also give tips on how to make them better.

The biggest costs are purchasing the necessary supplies. When the market is smaller than anticipated, the investments made to make a certain amount of slippers will be too high because they cannot sell them and in effect they will lose money. For this reason it is always most important for them to anticipate on the market correctly. If the revenue streams do decrease they will have to decrease their next material investment and make less slippers. During power-outs production of half-fabricated slippers will stack up, especially the queue for the sewing machine. It creates many problems. They don't own a generator, but their partners who smoothen the slippers do have a generator.



Figure 49. Typical Ghanaian slippers

All the masters are clustered in the Footwear Manufacturers Company Ltd. to increase their chances of reaching foreign markets. But although the cluster officially already exists from 2005, there seems to be no real shared direction between the different workshops. Kodjo and Yaw would like to see more cooperation and preferably someone who will stand up to unite the clans. The government wants to put more emphasis on made-in-Ghana products to increase their economical position, and Ghanaian slippers are part of this. These efforts by the government are not felt by Yaw and Kodjo, who are not very fond of the current government to say the least<sup>71</sup>. Yaw would like to see the government act as an exporting agent to reach potential markets in Nigeria, Liberia and also other African countries. This would compensate the company's sales numbers during moments the demand within Ghana is low.

Table 29. Scores of Terracotta on the cultural dimensions

Dimension	Examples	Score (1-5)	Explanation
<b>Hierarchy Egalitarianism</b>	- Master-apprentice system.	1	It is by definition a hierarchical system.
	The boss (master) is constantly involved in production.	5	The master is not just giving commands but is doing the labor himself as well (leading by setting the example).
	The apprentice should always listen to the master. He can open up but should remain respectful.	2	It is not easy for an apprentice to refute the master (possible but not easy).
	An apprentice can suggest his own designs.	4	The master is open to suggestions in design.
	It can happen that apprentices don't earn anything in their first year.	2	If a master can let someone work for free it indicates a high power distance.
<b>Communitarianism - Individualism</b>	All apprentices are family of each other.	1	There were no non-family members working at Terracotta.
	Mostly Twi is spoken, together with a little bit of English.	1	All from the same family means all from the same tribe as well (Akan) and thus they all speak the same language.
<b>Fatalism Voluntarism</b>	- Lack of capital is main barrier for growth. Methods for dealing with this are effective management, reducing expenditures and good bookkeeping.	5	The lack of capital is a fact they have to deal with and Yaw mentioned many methods to take this matter in his own hands.

<sup>70</sup> Brother in this context means colleague.

<sup>71</sup> When asked if there were any governmental regulations to abide to they responded (jokingly) "If they come here we'll shoot them". This statement was in contradiction with the company's motto: Peace, only peace.

	If there is no market for their slippers it is difficult for Terracotta to make ends meet.	2	Terracotta is not capable of dealing with a lack of market.
	The government is lacking in its duties. They should be acting as an exporting agent to help Terracotta reach potential markets in Nigeria, Liberia, etc.	2	They want the government to do their work for them.
	All the masters have joined together to form the Footwear Manufacturers Company Ltd.	5	Although this overarching association is not yet living up to its full potential (the association doesn't have a direction that is widely supported by all the masters) it does show a willingness to change their conditions for the better and break away from old.
	Both Yaw and Kodjo indicate that if they make enough money they want to expand to a bigger place, away from their small workshop in the central market.	4	By moving to a new place they want to renew themselves and this takes initiative and entrepreneurship.
	Making slippers in an old craft in Ghana and has remained mostly unchanged over time.	2	Part of being a slipper maker in Ghana is to do things as they always have been done. This also shows from the fact that there is not much variation in slipper designs and most workshops have a uniform feel to them.
<b>Synchronous Sequential</b>	- Per month targets are set and supplies are bought accordingly. The monthly targets are translated into daily targets.	5	Each month the masters have to predict how much slippers they need to produce and make a planning to reach these goals.
	The goal of every apprentice is to become a master.	5	The life path of starting as an apprentice towards becoming a master is a one that is been walked many times before and has become paved and linear.
	There are strict working hours (06:30-17:00) and employees are usually on time.	5	The workshops have a strict daily schedule to reach their monthly targets.
	The daily planning/targets are flexible but always kept.	4	For each day they have left some room for flexibility but make sure to finish their targets.
<b>Position Achievement</b>	- Salary is based on years of experience as an apprentice and also on the master.	4	If you just start you don't earn much but you get more by putting in years of work.
	Labor is highly valued.	4	Working hard is noticed by the master and the master must be kept happy.
	If the master is away work is stopped.	1	The apprentices need constant guidance.
	An apprentice can suggest his own designs.	4	There is room for the apprentices to be creative and leave their mark.
	Growing to become a master and owning your own workshop is done slowly and by saving money (your own master might help with financing the first necessary investments).	4	Becoming a master by saving money means working hard and achieving your goals.
<b>Particularism Universalism</b>	- All employees are family.	1	Because no non-family members were working at Terracotta it is assumed that they are not given the chance to work there.
	Being serious in becoming a slipper maker is the only criteria.	4	If the first criteria of being family is met then you just need to show that you are serious
	Everybody speaks Twi and English only once in a while.	1	It can be seen as a closed group.



There are no rules from the government to which Terracotta has to abide to.	1	Although said jokingly, Kodjo and Yaw made clear by saying "If they come here we shoot them" regarding government officials that they are not bothered by governmental rules.
Ghana is very corrupt.	1	"Even our mothers are corrupt" was said to indicate the level of corruptness. A corrupt society is a particularistic one.

## Appendix A.9 - Kumasi Abattoir Company Limited

### General information

The Kumasi Abattoir Company Limited (KACL) is a semi-governmental company that started operations on the 1<sup>st</sup> of April 1998. Before that it had been a slaughterhouse for 46 years called Mayanka. They wanted to change the operations of the slaughterhouse because of its outdated hygienic standards by requesting funding from the government. This came with a grant from the Canadian government, which made them able to upgrade the slaughterhouse to an abattoir by buying the necessary equipment<sup>72</sup>. The difference between a slaughterhouse and an abattoir is mainly about hygiene. In an abattoir the carcasses are not slaughtered on the floor but are hanged on a hook that moves over a rail through the production line. The Kumasi Abattoir has the capacity to slaughter 400 cattle, 100 pigs and 250 sheep and goats each day and is in scale the largest enterprise analyzed for this study<sup>73</sup>. They want to be one day the sole supplier of meat in Ghana and even the whole of West Africa. At the moment this is not a reachable goal but they do reach for the stars. More facilities will need to be opened in other places to be able to reach the whole of West Africa. They're also thinking about taking over slaughterhouses to upgrade them into abattoirs.



Figure 50. End of the line at the Abattoir

### Business model

For a relatively small fee of 25 GHS the Abattoir slaughters and dresses carcasses for butchers as a service. The butchers come from in and around Kumasi but also from other parts of the country and even from neighboring countries like Ivory Coast, Burkina Faso, Mali and Niger. They are known to be the most hygienic place for slaughtering in Ghana and there is a certainty that your animal will be sold which attracts customers from all over. They also have a singeing platform where the fur is burned off the animals but the skin is left on the meat<sup>74</sup>.

There is a system of merchants, landlords, butchers and line workers associated with the KACL that originated in Nigeria and has existed for more than a 100 years. The butchers are the Abattoir's main customers and indirectly also the landlords, merchants and farmers. The merchants buy the animals from the farm and bring them to the cattle market that is located about 150 meters from the Abattoir. There, the animals are taken over by the landlords<sup>75</sup> who act as host for the merchants, creditor and will do the negotiations with the butchers<sup>76</sup>. They have knowledge on all the different butchers and assign credit to them based on that knowledge. The butchers are people with their own store or a market stall and will be

<sup>72</sup> This equipment included rails, standing bocks, leg cutters, hide pullers, brisket splitters, carcass splitter, etc.

<sup>73</sup> The semi-governmental nature of the KACL makes the company size actually too large in comparison with the scope of this research and the other companies analyzed. It was still decided to include this case because it gives good insights into how companies with a more complex structure in cooperation with the government operates.

<sup>74</sup> It is common for people in Ghana to eat "leather", meaning to eat meat with the skin still attached.

<sup>75</sup> The merchants usually go the same landlord every time they arrive at the market since there are longstanding client-patron relationships involved (Cohen, 1965).

<sup>76</sup> For a deeper and very interesting analysis of the economic, political and tribal interactions between the landlords and the butchers on the cattle markets of Ibadan, Nigeria and Kumasi it is recommended to read the works of Cohen (1965) and Hill (1966).

looking for the best animals at the cattle market for the best price possible. If a butcher and a landlord have come to an agreement about the price, the cow will be taken to the Abattoir to be slaughtered<sup>77</sup>. This will be done by the line workers who work on a very streamlined production line. The meat is sold by the butchers all over Kumasi area who process it further in their own shops.

Since 4 years the Abattoir also offers processed meat on a small scale<sup>78</sup>. The Abattoir has two stores where it sells the processed meat itself and also some partner stores. They also sell from the back of the cooling truck to restaurants. One of the biggest customers of the processed meat is GSS (Global Sourcing and Supply) who cater for mining companies. Also big hotel chains like Golden Tulip and restaurants like Las Palmas are customers of the processed meat. A grilling service is provided on request. During events like the world cup they will put up a stall and sell meat next to the big screens for promotion purposes. For customer feedback they have telephone numbers on billboards and Q&A's on radio shows, although the main purpose of these was also promotion. The KACL also has a website<sup>79</sup>, but it is not fully functioning since information is lacking on most pages. The Abattoir has a marketing department in charge of these advertisements and events that works with monthly targets, not only for the amount of processed meat that is sold but also for the number of animals slaughtered per day. They were looking into a reward system that rewarded the butcher with the most animals slaughtered to motivate the butchers to bring more animals through the Abattoir instead of other (less hygienic) places.



**Figure 51.**Line workers preparing the carcass while the butcher (right) discusses the price of the intestines and head of the cow with an interested external party.

The marketing department is only one of the many departments in the elaborate company structure of the KACL. Because of the company's size and semi-governmental nature there are many different departments and a board of commissioners made up of all the different stakeholders. The managing director (MD) administers the different department heads who are all in charge of their own department. The KACL has an administration manager, production manager, financial manager, human resource manager, marketing manager, general services, security and an internal audit (external audit comes once a year) who all report to the MD. There is also an engineering department that is in charge of maintenance of the equipment used in the Abattoir. Equity on the work floor is a value propagated by the management team of the Abattoir. All employees must coordinate and cooperate with the main goal being to always serve the customer. This is also illustrated by the fact that if an employee has an idea or

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<sup>77</sup> Halfway during the slaughtering process there is often a second negotiation between the butcher who will try to sell the head of the animal plus it's intestines (which are collected by placing a wheelbarrow under the carcass when the line operators cut it open) to any interested buyers.

<sup>78</sup> The KACL will then themselves buy animals from the cattle market and process the obtained meat into meat products like bacon, sausages, minced meat or steaks.

<sup>79</sup> <http://www.kumasiabattoir.com>

initiative it will be passed on to the MD and everyone in between will involve themselves in the discussion whether it is a good idea or not.

As mentioned before there is also a board that has representatives of all the different stakeholder groups. The KACL was set up with help of the Canadian government who released machinery to Ghanaian government to upgrade the facility. The Ghanaian government added social security (SSNIT<sup>80</sup>) to put up the building. The building is property of social security, the government (department of finance), KMA (Kumasi Metropolitan Assembly) who owns the land, and the butchers. The butchers are organized into seven different unions, three of which have a delegate in the board. This to maintain the relation with the butchers, the Abattoir's main customers. SSNIT is involved on behalf of the government and also produces the board chairman<sup>81</sup>. If the Abattoir needs anything they use this chairman, who is based in Accra, as it is the fastest way to get things done. Being tightly involved with the government also means there are many governmental rules to be followed. Social security is well arranged (which makes sense because of the involvement of SSNIT) and also other basic regulations like health and safety procedures<sup>82</sup>. The KACL is a member of the Ghana Employers' Association<sup>83</sup> who provide all sorts of training for their employees (Occupational Safety, Health & Environmental Management). These training sessions are usually in the form of a seminar with the purpose to increase skill level or to maintain standards. There are also always health inspection officers around to check the health of every animal moving through the Abattoir by checking the liver of every animal<sup>84</sup>.

In total the Abattoir employs 125 fulltime and 15-20 part-time staff, most of which work as line operators. Employees came from all over the country. Criteria differ per department, but generally there is looked at qualifications and experience. For the line operators a high school diploma is a minimum requirement. Because of the many departments at the Abattoir there is the possibility to grow in the company<sup>85</sup>. To grow you have to be knowledgeable. People will recognize this and respect it. Knowledge can be taken from the internet. Salary is fixed and paid monthly. Every two years the opportunity arrives to discuss salary. Every year in between some cushioning wage opens while you wait for the salary discussion year. If you're too late your pay will be reduced. Because the abattoir works with a tight schedule they want to reduce the amount of latecomers and thus have a bus picking up all their employees. For other offences you first are asked to explain yourself. If the gravity of the mistake is high like theft, it will be taken up to the MD and possibly a committee is set up.

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<sup>80</sup> Social Security and National Insurance Trust is a statutory public trust charged under the National Pensions Act 2008 Act 766 with the administration of Ghana's Basic National Social Security Pension Scheme and to cater for the first tier of the contributory three-tier scheme. The trust is currently the largest non-bank financial institution in the country (SSNIT, 2017).

<sup>81</sup> The slaughtering fee of 25 GHS should actually be around 50 GHS to balance the Abattoir's accounts but SSNIT invests money to keep the fees low and competitive. For them it is more important that people (who have their pensions with them) eat proper meat and will live longer. More people will live to see 65 and in return feed their pension fund.

<sup>82</sup> There were many hazards observed at the Abattoir ranging from kicking cows on a slippery bloody floor to big knives, saws, axes and flamethrowers. Because of this there was always a safety and first aid officer around. Also, all workers know how to handle a fire extinguisher.

<sup>83</sup> <http://www.ghanaemployers.com>

<sup>84</sup> However, it seems that keeping the hygiene situation at the Abattoir at a constant high level is not always possible (Frimpong, et al., 2011; Dapatem, 2015).

<sup>85</sup> B.B. Zobil, a man from the Upper East region of Ghana, with whom part of the interview was done is a good example of this. He started at the Abattoir as a health inspector, then became production manager and has been administrative manager since 2014. During the tour through the premises he gave the author he was constantly keeping the line workers busy, showing them what they had to do (this had to do with the fact he had filled the position as production manager for a long time and also mentioned he missed that compared to his new function of administrative manager where he was mainly sitting behind a desk). During the tour there was a carcass unattended and B.B. immediately put a line worker on it.

All employees have to be able to speak English (and are able because they all have their high school diploma), which is also the official language at the abattoir, but there is switched to local languages if needed. This can be Twi but also Hausa -a language from the north of Nigeria- is often used because the butcher trade came from Nigeria and still many butchers are Nigerian. The north of Nigeria is predominantly Muslim and this resonates through to the butchers active at the KACL, where religion plays a big role in daily operations. Because of the Islamic background of the butchers, all the animals are slaughtered halal<sup>86</sup>. The abattoir was also in possession of a stunbolt gun, used to stun the animals before killing them, which they were happy to use but the butchers didn't let it happen because it was not in line with traditional halal practices. The butchers could make these demands because of their strong position within the board. Communication of demands or grievances from the butchers usually go through the chief-butchers. These are senior butchers who represent the different butcher unions, some of which also have a position on the board.



**Figure 52. Landlords at the cattle market next to the Abattoir.**

Main income comes from the fees taken for the slaughtering service. Second is the selling of processed meat, which is already significantly smaller. There is also a small income from tolls taken from people who come to pick up the meat with a taxi or private car. The investments by SSNIT are also an important source of income but this number is unknown. The biggest cost of the business is maintenance and replacement of the equipment. Especially because all the equipment that was funded by the Canadian government now one after another gets worn off. Compressors used for cooling the meat started to use



**Figure 53. The biogas plant under construction in December 2015. (picture taken from myjoyonline.com, 2016)**

more energy as they became older so in the beginning of the 2015 they were all replaced. Also the carcass cutter that was bought in 2004 is a huge cost. The blade which costs around 400 GHS has to be replaced almost every week. Gas for singeing the carcasses is another big costs. A final cost is the disposal of the slaughterhouse waste, for which the abattoir is responsible as agreed upon with the butchers. During economic recession there will be cut down on general expenditure. Expenses on security can be cut in half, cleaning of the abattoir can be outsourced and many parts of the operation can be done by manual labor. The power-outs have a negative effect on the

<sup>86</sup> This means that the animals are killed by slicing their necks with a well-sharpened knife without sedation. During this process the head of the animal should be directed towards Mecca and the person performing the slaughtering should be Muslim. They are subsequently hoisted up by their back legs on a rail to bleed out. In this process the animal will be heavily kicking around with its free legs and squirting blood all around. When the animal stops moving it is moved along the rails and the line operators start the butchering process. When asked about these (for Western standards) gruesome practices of hoisting alive animals in the air to let them bleed to death, the author got the following answer: "No he is not alive, he has just trouble dying"



business. If there is a power-out during the night the cooling will stop (since the generator has to be turned on manually) so there is a chance of the meat getting spoiled. The generator is used during power-outs but as little as possible because it needs 9 gallons of diesel per hour.

The KACL has been looking into implementing biogas technology into their operation to reduce costs on waste disposal and gas for singeing, as well as generating income from the selling of biogas and organic fertilizer. Since 2014 they have been involved in a UNIDO<sup>87</sup> project involving biogas, for which they have been selected as the potential pilot project site based on several criteria including availability of data, commitment of the management, expected positive impact on the local environment, and potential high visibility of the project due to its large size. More will be elaborated in the following chapter.

**Table 30. Scores of the Kumasi Abattoir Company Ltd on the cultural dimensions**

Dimension	Examples	Score (1-5)	Explanation
<b>Hierarchy Egalitarianism</b>	- Equality on the work floor is a company regulation.	5	Equality is a value in itself.
	Initiatives are welcome and passed on to the MD. Everybody will have a look if it is a good idea.	5	There is discussed and listened to everybody from different levels in the company's hierarchy.
	All the different departments have different responsibilities and all have to report to the MD who in return will listen to everyone's opinion.	5	Decisions are delegated to others with more knowledge on the subject.
	The Muslim butchers do not listen to the management when it comes to their way of slaughtering, although slaughtering without pre-stunning has the potential to compromise animal welfare.	2	With three representatives on the board the butchers are in a position of power. Being in this position of power they do not listen to the management regarding their techniques. This is an issue that is playing a part in many places in the world today. It is a discussion between conventional and spiritual meat quality, religious versus scientific arguments and lies outside the scope of this research.
<b>Communitarianism Individualism</b>	- The butchering trade at the KACL is dominated by Muslims, mainly from the north of Nigeria.	1	For many decades there has existed an immigrant community from Nigeria that has been active in and around the cattle markets of Ghana. (Hill, 1966)
	English is the official language, but there can be switched to local languages like Twi or Hausa if necessary.	4	The employees are able to talk to most butchers coming from different places.
	Employees come from all over and no family members reported.	5	KACL did not care where employees came from, only requirement was a high school diploma. B.B. Zobil came all the way from the Upper East region and managed to come all the way to administrative manager (a position formerly held by the current MD, J.O. Boadi).
<b>Fatalism Voluntarism</b>	- SSNIT wanted to give their clients proper meat and took action to make Mayanka into an abattoir.	5	This is a good example of actively changing the current course of events.
	Animals are butchered halal because most butchers are Muslim.	1	In a way, religious practices are always to be seen as fatalism/traditionalism.
	The credit system between the merchants, landlords and butchers with associated chiefs of the market and chief-butchers has remained	1	It is a case of conducting business based on "how it always has been" i.e. based on tribal relations and an informal accreditation system.

<sup>87</sup> United Nations Industrial Development Organization, who is implementing a 3-year biogas industry development project in Ghana titled "Supporting green industrial development in Ghana: Biogas technology and business for sustainable growth" (Awafo, 2015).



		virtually unchanged for over a 100 years.		
		KACL is moving into processed meat and biogas as new value propositions.	5	Their mode of business was purely slaughtering, but they are looking into new ways to expand their business.
		Ghana Employers' Association provides training.	5	The KACL constantly wants their employees to be up to date with the current standards.
		Line workers are picked up by bus every day to make sure they don't come in late.	4	The management realizes that it is vital to have all the employees coming on time to be able to facilitate all the butchers that bring animals to the abattoir.
<b>Synchronous Sequential</b>	-	Salary payment determined every two years with a cushioning wage every year in between.	5	A scheduled biennial salary negotiation is a characteristic of a well-defined time structure and thus indicates a sequential planning.
		Marketing department works with monthly targets.	4	The marketing department has targets for every month and have to plan accordingly to meet these targets.
		Abattoir has very streamlined production line.	4	The streamlined production line is a result of a sequential planning.
		The UNIDO biogas project is very well defined.	5	As can be expected from a project from the UN it is a project with a clear implementation scheme.
		Butchers are on very tight schedule and line workers are picked up by bus.	5	This tight schedule of the butchers puts external pressure on the management of the abattoir to plan accordingly.
<b>Position Achievement</b>	-	You have to be knowledgeable to grow within the company. People will recognize it and respect it (can be taken from the internet).	5	Showing your knowledge on certain topics will be recognized by others and will grow you within the company.
		Carcass was unattended and BB immediately put a line worker on it.	2	It showed that without of someone of the management team present, there was the potential of line workers losing focus. It was probable though that the line workers just temporarily lost track of the carcass since they had been working hard all morning (it was carcass #60 after two hours of operation) and B.B. walking by was just bad timing from their perspective.
		While walking around BB was constantly giving tips and giving the right example to the line workers (probably because of his former position as production manager)	5	He showing signs of being very involved in the process and this motivated the workers
<b>Particularism Universalism</b>	-	English is official language, but can be switched to local languages like Twi or Hausa if necessary.	4	The line workers are able to speak with customers/butchers from different tribal origins.
		No tribal issues within the company, BB himself is from the Upper East of Ghana.	5	Even coming from a faraway region it is possible to acquire a high position within the company.
		The client-patron relationship between the merchants and the landlords at the cattle market.	1	The relations are very specific and switching between landlords is no usual.
		The butchers can choose freely to which landlord they will go to purchase an animal.	5	Different from the merchants, the butchers have no specific relations with certain landlords at the market.
		Their chairman (from SSNIT) is used to get things done because he has the right connections.	2	The chairman is well-connected in high (governmental) places and this is used to arrange business issues for the KACL.
		There are many governmental regulations that have to be followed.	4	These are rules for everybody and since the KACL is semi-governmental they have to pay extra attention to following these rules.

## Appendix A.10 - Star company Ltd.

### General information

Star Company Ltd. is a transport company owned by Nana Boameh from Domeabra. Nana operates within the public transport sector in Ghana, a self-regulated privately owned system that is dominated by taxis and trotros. Nana is a so-called car owner and started back in 1968 with one car and now owns 15 cars, although almost half of those are old and written off. Eight are still operational: three taxis, three trotros and two big fords (big trotros)<sup>88</sup>. The trotros are (primarily secondhand) minibuses<sup>89</sup> with an average age of 15-20 years and have roots in Ghanaian public transport that go back all the way to the 60s<sup>90</sup>. They are stripped of all unnecessary material for the purpose of weight reduction as well as space creation and can be easily recognized by the colorful (usually religious) text written on the back window. Depending on the size of the bus, there are as many seats as possible installed within its interior. The smaller ones have three seats per row and three to four rows behind each other<sup>91</sup> and are mostly used for short trips, while the bigger models have four or five seats per row and four to six rows behind each other and are used for long distances (for example intercity trips between Kumasi and Accra). All the different car owners and drivers are unionized in different transport unions to cover all regions<sup>92</sup>. Nana is part of multiple transport unions, including the biggest one, the Ghana Private Road Transport Union<sup>93</sup>.



Figure 54. A waton kyini, already decorated with a text on the back.

### Business & management model

Trotros and taxis are the most common and cheapest mode of transportation in Ghana. Trotros and taxis can be boarded at stations, which can be found in every town and at big intersections, or can be hailed while standing on the side of the road<sup>94</sup>. Formally there are designated places for them to stop alongside the roads, but in practice they will stop anywhere. At every station there are unions organizing the multiple trotros going to various destinations. There are set places for where a trotro with a certain destination will wait and also a que of trotro waiting until it is their turn to take that spot. Trotros are driven by a driver and his mate. The driver will mainly focus on driving while the mate sits between the

<sup>88</sup> This is a relatively large fleet, whereas in Ghana about 80 percent of all car owners only have one vehicle (World bank, 2017).

<sup>89</sup> This is a common phenomenon all over Sub-Saharan Africa, where the use of second, imported minibuses has flourished in the last decade, expanding by 11 percent per year in some cities (World bank, 2017).

<sup>90</sup> They started as flatbed trucks with some wooden benches in the back and were called boneshakers (because they would shake your bones). The comfort level increased a little bit after the introduction of the waton kyini, which also had a wooden roof structure and curtains to protect passengers against rain. After the waton kyini, the first trotros were introduced.

<sup>91</sup> In its first days a (small) trotro would carry four people per row, but the norm has changed to three. Except for situations like heavy rain, when it will happen that more people are taken along.

<sup>92</sup> For example all car owners that operate in Domeabra and its neighboring village Apromase are unionized to coordinate local transport.

<sup>93</sup> In 2001 all the big unions came together to form the Ghana Road Transport Coordinating Council. The umbrella organization was set up in an effort to coordinate activities (Accra Mail, 2001).

<sup>94</sup> There are a couple of hand gestures known by every Ghanaian that are used to indicate where the trotro is going and where passengers need to go to. Pointing down means you have to go to the closest big station. Pointing up means you are going uptown. For some stations there are special gestures, like in Accra, when you are going to the centrally located station Circle you make a downwards circular movement with your hand.

passengers and handles customer relations. The mate is picked by the driver who is responsible for paying him and giving him chop money. The mate sits next to the sliding door which he<sup>95</sup> open and close for passengers. While driving, the mate will often stick his head out of the window in order to shout the car's destination to possible passengers, often in combination with hand gestures<sup>96</sup>. People standing alongside the road listen to the mates in the passing trotros and when the right trotro approaches they will let it stop by using the right hand gestures. Due to the vast amount of trotros on the road it usually does not take more than a couple of minutes to find a trotro that goes the right direction. The main goal of the driver and mate is to always have the trotro as full as possible. It is for example not uncommon to wait for over an hour in a station car because there is still a place left<sup>97</sup>. Once in the car the driver will continue the route and the mate will ask new passengers where (exactly) they want to go and the correct amount will be paid<sup>98</sup>. The mate handles the money but the big money is kept by the driver, who also will deal with the police when they are being held<sup>99</sup>. When a passenger has to get out the mate will knock on the roof to let the driver know to make a stop.



Figure 55. A mate calling for passengers

Taxis can easily be recognized because they will always have their side panels painted orange. There are two different types of taxi, the shared and the drop taxi. Any taxi can be both, but it has to be discussed with the driver right after boarding. Drop taxis are the fastest, most expensive option and are like taxis in the Netherlands that will drop you off at a specific place. Shared taxis are shared with multiple passengers<sup>100</sup>, usually drive fixed routes and wait at stations until they fill up or pick people up along the road. When hailing a taxi, the drivers usually try to take you as a drop taxi (at least when being a foreigner) because it will save him time and thus make him more money<sup>101</sup>. The rates of a shared taxi is about one and a half times higher than that of a trotro and therefore trotros are preferred by most Ghanaians.

<sup>95</sup> There are female mates, but it's probably less than one percent.

<sup>96</sup> This can be the final destination or multiple destinations if the final destination is far away.

<sup>97</sup> A trotro will only leave the station once it is completely full. It can occur that somebody decides to pay for the last remaining seat because he or she would like to go.

<sup>98</sup> Usually the exact amount is given as prices for the various routes are common knowledge among Ghanaians. If not, the mate will give change which will not always happen right away. The mate will then not have the right amount of change ready and waits until more passengers have paid. Although this system is successful in most cases, there are also places that have small change standing by at the stations to ensure the mates are always able to give change.

<sup>99</sup> Everywhere on the road in Ghana there are police blockades and especially in the big cities these mainly seem to serve as a way for policemen to shake down Ghanaian drivers and make some extra money. Because of the rickety state of most cars in Ghana, police will always find something wrong with it. It is an unofficial agreement that when they hand over their driver's license, drivers add one or two cedis for the police to let them be on their way.

<sup>100</sup> The fare of a shared taxi is based on that of a one way drop taxi ride divided by four.

<sup>101</sup> It can also be that on a certain track a small chance exists of finding additional passengers, what will make the driver hesitant of agreeing to be a shared taxi.

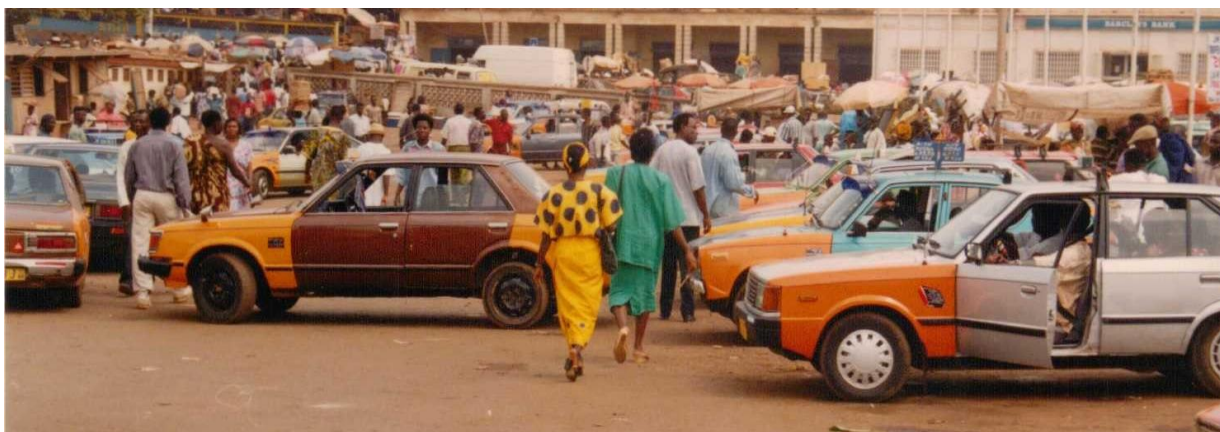


Figure 57. Taxis at a station in Kumasi in 1995 (picture taken from ghanabooksjwp.com, 2011)

Nana employs 15 people in total for his business of which the drivers are most important ones. They can come from anywhere, even from other countries, as long as they have a driver's license and Nana feels they can be trusted. Trust between the car owner and the driver is very important. When a trotro breaks down (trotros have a history of breaking down often because of the state they are usually in<sup>102</sup>), work has to be halted and the car has to be brought to a shop for repairs. Two things happen next: the driver cannot generate income anymore for the car owner and the driver has to pay for the repairs, sometimes with an advance from his own money. In these situations it is important for the car owner to be able to trust that the driver really had car trouble and didn't just use the repair as an excuse for having a bad day on the road and for the driver to know the car owner will pay him back. There were cases reported where these situations led to frictions (Hollataintment, 2011). If Nana ceases to trust a driver he will let him turn in the car and goes looking for another driver. But the search for an experienced and trustworthy driver is not easy<sup>103</sup>. To bypass this problem Nana put his son in charge of maintenance of the cars. When there is a problem, the driver takes the vehicle to him to get it repaired. Next to fuel, the cars make up the biggest costs of his business as every time a car breaks down he has to buy a new one, but he mentions that if you take care of a car it can last for up to 10 years. If a car does break down he will get compensated as all his cars are properly insured and getting a loan from the bank is also not a problem for Nana because they know him which makes it easy.



Figure 56. A trotro station in Kumasi.

There is no official system for allocating the routes the trotros will cover. This is all informally organized through the unions. Nana decides where the drivers have to drive dependent on if it is a popular route and the number of cars already driving that route, together with in which stations he has friends through

<sup>102</sup> Trotros are almost always second hand cars in not the best of conditions so there are definitely some risks involved. Especially on cars that go to other cities can drive in high speeds and then there are many risks around like bad roads, big slow trucks that need passing by, big busses that easily can topple trotros over and off course the risk of popping a tire while speeding. It is a common sight in Ghana to see cars lying higgledy-piggledy alongside the road. Because of this, it sometimes happens that people will let cars in a very bad condition pass but even so, those cars have no problem finding passengers willing to take on the risk.

<sup>103</sup> There is the possibility to get a licensed and trained driver appointed to you through the station but Nana prefers to find his own drivers.



the union as all trotros have to be registered at a station<sup>104</sup>. For example Nana has cars in Domeabra, Oduom, Tech, Adum and some other places in and around Kumasi and his two Ford cars drive between Kumasi and Accra. In all corresponding stations he has connections and he even has his daughters working in one of the stations selling tickets.

The fare prices range from 0,50 to 2,00 GHC for trips within the local surroundings and can be around 10 GHC for intercity trips. The prices were set by the unions some time ago and now just react to fluctuations in oil prices<sup>105</sup>. Every car is supposed to bring in around 80 GHC per day for Nana. This is a lot of money for the driver to collect in one day which puts a lot of stress on him and his mate. They will have to work hard to reach the target every day and you often see mates of trotros passing by stations trying to outdo each other in the fight for passengers. The trotros do not have strict working hours but will start early in the morning anyway as in those moments the roads are still empty which enables them to cover more distance<sup>106</sup>. They will generally drive around until 8 pm and do this every day including holidays, except for Sundays and Christmas. At the end of the month the drivers are typically paid a salary equivalent of two days' work (Hollataintment, 2011), which in Nana's case would mean 160 GHS per month. This is very little, seeing as the drivers are also responsible for paying the mate and taking care of his chop. This leaves the drivers virtually no room for savings or the opportunity to take initiatives. Nana even mentions that if income decreased he will lower the wages first. Even though he receives more than 90 percent of cars' income, he currently has no capital to grow.



Figure 58. Nana Boameh together with the author.

Next to being a car owner, Nana is also a fetish chief<sup>107</sup> in Domeabra, a position that gives him a lot of status within the community and probably as well with the drivers. It is said he is able to perform magic actions like sleeping in a coffin for a week without water or food and then comes out, flying in the air; making white eggs fly; chopping someone's head off, letting the person bleed and then putting the head back on which results in the person being totally fine and walking away without any damage. These practices were reported but no evidence has been found.

Table 31. Scores of Star Company on the cultural dimensions

Dimension	Examples	Score (1-5)	Explanation
<b>Hierarchy Egalitarianism</b>	- The drivers don't have any influence on where they drive and mates have even less input in the business.	1	Nana just gives directions which the drivers have to follow. The mates just tag along with the drivers have even less to say.

<sup>104</sup> Unregistered trotros do exist but are viewed as less safe and not every Ghanaian is willing to board them.

<sup>105</sup> The unions are still the official channel to communicate a change in price. If oil prices rise and trotros increase their prices without an official statement from the unions, passengers will not always accept this which can lead to disputes and heavy discussions.

<sup>106</sup> There will be enough passengers in the early morning as a normal day in Ghana already starts at 6 am, which is the moment the sun rises throughout the year, bringing daylight within minutes.

<sup>107</sup> There are chiefs and fetish chiefs in Ghanaian culture. Chiefs are the highest ranked members of their community and maintain traditional customs and ceremonies and deal with disputes. They are often selected by the elders of a community from among candidates who are descendants of the appropriate lineage. In contrast, fetish priests are often people selected from a specific family who may be "possessed" by a god. They rarely wield the political power the chiefs have but provide the community with a medical service.

	Nana picks drivers whom he can trust. If that stops they have to hand in the car and he picks someone else.	1	The drivers always run the risk of displeasing Nana and lose their job.
	Wages are lowered first when income decreases.	1	The drivers don't have a say in this and will just have to accept.
<b>Communitarianism - Individualism</b>	Nana's son in charge of maintenance and daughters work as ticket sellers at the station.	1	Nana keeps a closed group.
	Wages are lowered first when income decreases.	4	Nana is not concerned with the wellbeing of his employees and keeps a strict regime to ensure his own wellbeing. Maybe this more egocentrism than individualism.
	Every passenger is welcome in the trotro, no discrimination.	5	No passengers are denied because ethnic background.
	Drivers can come from anywhere, even from abroad.	5	Nana makes no distinctions based on ethnic background.
	Even though he can get trained drivers from the station, Nana prefers to use people he knows.	1	He likes to keep it within his own circle.
<b>Fatalism Voluntarism</b>	- There is no room for initiative for the drivers because they are preoccupied reaching their daily targets.	1	The drivers are not enabled to take initiative.
	The trotro business is traditional with not much diversification. Although they might have different car owners, two random trotros will have basically the same work method (except some rare cases where a trotro can have airco on board or a DVD-player as an extra service for the passengers).	1	All trotros do the same thing without any real efforts for innovation.
	Most people will get into any car, even the cars in the worst condition possible can get passengers.	1	Ghanaian passengers will take the trotro as they come.
	The drivers and even Nana don't have capital to grow.	1	This is maybe more a reason for them to stay within their traditional doings.
	Nana started with one car and has grown his business significantly.	5	Nana has taken initiative and is an entrepreneur with a relatively large fleet.
<b>Synchronous Sequential</b>	- There are no strict working hours, as long as the drivers reach the daily target of 80 GHS per day.	2	There is no real planning involved.
	Employees start early to make more money.	4	The only form of planning in the day of a trotro driver.
	The daily rhythm of a trotro is the same for every day of the year (except Sundays and Christmas).	1	It is a repetitive lifestyle without any plans for change.
<b>Position Achievement</b>	- Besides being involved in maintenance, Nana is just involved in collecting money.	2	Nana mainly just gives orders and is not very involved.
	Employees work hard every day (because of high daily targets).	4	Among drivers and mates working hard is common, although it comes forth from tight targets.
	Nana has his status ascribed because of his occupation as fetish chief. Car owners in general have ascribed status because they can afford a car.	1	His status comes forth out of tradition.
<b>Particularism Universalism</b>	- Drivers need to have a license and have to be trusted.	4	Those are the only factors important to Nana, so which makes it a level playing field for drivers. Whether he will like and trust you is another story.
	Drivers can come from anywhere.	5	No preferential treatment based on ethnic background.
	Nana's son in charge of maintenance to bypass trust issues with drivers and daughters work as ticket sellers at the station.	1	Nana prefers to employ his offspring. They are given better chances.



Even though he can get trained drivers from the station, Nana prefers to use people he knows.	1	People Nana knows are preferred to unknown drivers from the station, even though they are trained as trotro drivers.
Nana has friends at the station and at the bank which helps him with his business.	1	This is based on a patronage system within the unions and stations.
There are universal rules and agreements between the trotros/taxis and passengers.	5	These are the same for everybody.
The unions are expected to announce price changes.	5	The prices need to be the same for everybody, passengers have accepting changes in price from individual trotros.

## Appendix A.11 - Tiptop farms

### General information

Tip Top Farms is a farm owned by Edward Kofi Ahiabor, located on the coast of the Volta region in Anloga, Keta, close to the border with Togo. The farm produces many different vegetables and also has a piggery. With 10 ha it is one of the bigger farms in the region. It is a family farm that was started by Edward's father<sup>108</sup>. Nowadays, the farm is characterized by investigating and investing a lot in renewable energy technologies, which comes forth out of his dream of becoming self-sufficient<sup>109</sup>. The farm has a 5 m<sup>3</sup> bio digester, which is fed with waste water from the cleaning the piggery<sup>110</sup>. The gas that is produced is



Figure 59. The biogas digester at Tip Top farms.

used for cooking and burning gas lamps. A 1,6 kW solar pump, 0,2 kW PV panel and 1 kW wind turbine<sup>111</sup> are used for electricity generation. The generated electricity is used to power another feature that the farm is known for: a tube well irrigation system that runs throughout the farm. The whole Keta district where Anloga is part of, is a strip of land between the Gulf of Guinea and the Keta Lagoon. It has to cope with the salt water from the sea and little rains throughout the year, so irrigation is crucial for successful farming in the region. Edward has been a pioneer with his system<sup>112</sup> and farmers from all over come to him for advice<sup>113</sup> and he is part of a farmers organization to share ideas on how to run a farm<sup>114</sup>.

### Business & management model

The main value of the farm is to produce well grown vegetables in an area where irrigation is difficult. The farm does crop rotation and usually three crops are grown at the same time. They grow tomatoes, okra, chili peppers, onion, shallots, watermelon, butternut squash, carrots and lettuce. The farm also grows coconuts but they are for own consumption during the breaks. Also some small-scale processing is done: pepper drying and sweet potato drying to make powder<sup>115</sup>. Another value they offer are pigs for slaughtering. Mainly during Christmas there is a peak in pig sales. The farm owns on average 400 pigs, but during the time of the interview there were only 200 because the Christmas holidays just past. The pigs

<sup>108</sup> The Ahiabor family in one of the more wealthy families in the area.

<sup>109</sup> Edward has done an MSc in soil technology. Before he acquires a new technique he will always first investigate it by going through scientific articles. At other times, it happens with the help of the Energy Commission where he got connections. Most of his technologies were 50% funded by the energy commission who want to use his farm as case study. The author contacted Edward through Wisdom Togobo (former project-leader of the Apolonia project) who was holding the position of Director of Renewable Energy within the Ministry of Energy and wanted show a good example of renewable energy use in Ghana. Next to connections within the government, Edward is also closely involved with the municipality as he was the Municipal Chief Executive between 2004-2008, a position that still gives him prestige to date.

<sup>110</sup> The manure is dried in the sun to be used as fertilizer later on.

<sup>111</sup> If something is in need of maintenance, Mr. Bagini is responsible.

<sup>112</sup> He developed the system from an early age. As a young boy he had to wake up a 4 am to irrigate the family farm by getting water from a well with a bucket for a couple hours. In his teenage years he made the resolution to make an irrigation system to change this tedious job (MAFS-Africa, 2016).

<sup>113</sup> In the region, Edward's farm is seen as an example. His accomplishments with the tube-well irrigation system gave him the status of Volta Hero in 2015 (Daily Guide, 2015)

<sup>114</sup> He likes to cooperate with other farms because sharing ideas will increase the overall quality of all farms involved.

<sup>115</sup> The farm grows a lot of tomatoes. All the tomatoes that are unsuitable for sale are processed into tomato puree by Tip Top processing, a company owned by Edwards younger brother Sena. That company will be discussed hereafter.

are usually grown to 8-10 months and then sold. There are 20 grown female pigs and 1 grown male pig. The pigs are bought by butchers for the meat. During holiday seasons like Christmas there are also individuals who come and buy the pigs. The vegetables are sold to market woman who come and collect it



**Figure 60. Renewable energies at Tip Top Farms. The wind turbine (middle) and PV cells (roof) power the pumping system for which water is stored in the black tanks on the roof. The wiring of all the technologies is housed in the shed.**

at the farm. Most of the produce is sold directly at the farm but Edward sometimes uses a truck to deliver produce. On top of everything he sometimes also generates income from his consultation services (on small-scale irrigation systems of 1-4 ha) what gives the farm an average monthly profit of 4000 GHS. The farm has relatively low costs because water, one of the most important resources due to the farm's location, is pumped out of the ground. The energy involved with this is reduced by using renewable energy technologies<sup>116</sup> which, in turn, were half funded by the Energy Commission. Seeds were mostly collected from previous harvests, so the main costs that remained were the wages and pig feed.

There are four permanent staff working at the farm and 10 to 50 farmhands helping, depending on the season. The farmhands are an important resource for the farm as they provide manual labor. Most farmhands come from the area and some come from Togo. For this reason mostly Ewe was spoken, together with English and a bit of French, as the Togolese spoke French but were also Ewe. The selection of these farmhands goes through informal channels. People come every morning to the gate at 6 am and depending on the work that needs to be done, a number of them is selected based on a first come-first serve principle<sup>117</sup>. The usual reimbursement for a day's work is 6 GHS, although it can vary: jobs that take more energy are paid a bit more and there are also jobs based on the quantity of work delivered<sup>118</sup>. The farmhands can work in teams on different activities that need to be done<sup>119</sup>. Teamwork is built by singing on the job and having a team target for the day. A usual day lasts till 5 pm but if the target is reached, the team can go home.

Edward is manager<sup>120</sup>, but because he is not always available there is also farm-manager Obed in charge of the day-to-day business. He started as farmhand and was chosen by Edward to follow an agricultural education where also management courses were given. He seemed very involved and also experienced

<sup>116</sup> The rest of the electricity is taken from the grid. For some reason the area does not have too many power-outs so the farm is not affected that much by them. On top of that there are the renewable energy technologies that supply a part of the power if it does happen.

<sup>117</sup> Around 60% of the farmhands come on a regular basis.

<sup>118</sup> According to Edward, in the coastal regions the pay for farming is relatively higher because it has to compete with the fishing business. Farmers need to pay enough to ensure people won't choose for helping on the beach with fishing. Despite this fact, 6 GHS was still only the minimum wage (Mywage, 2017). Many farmhands indicated the payment being too low as their only grievance and would like to be paid 10 GHS per day. The fact that staffing was not a problem at the farm and people apparently still choose for the farm rather than fishing tells something about the income generated from fishing. Also, working on the farm is physically less demanding than fishing.

<sup>119</sup> These activities include plowing, fertilizing, planting, weeding, harvesting, feeding (the pigs) or irrigating. Growing onions needs the most manual labor and irrigation needs most attention on a daily basis.

<sup>120</sup> His official title is Production and Quality Control Manager.

(because he was already one of the most promising workers before becoming manager). New farmhands are always first instructed by Obed, after that the other farmhands (with experience) will take over. Obed is one of the four permanent workers employed by the farm. They enjoy privileges like housing and free access to utilities. In return they are asked to do overtime when needed, especially at night. There is direct communication at least once a week by group meetings under the almond tree. The permanent staff will be informed when they get extra jobs like ensuring the irrigation runs smoothly (during dry periods or when the farm runs on 100% capacity). They have to communicate at least 2 weeks in advance if they want to be off work because a replacement needs to be arranged and can stay away for a maximum of 1 week. The farmhands are involved in an informal on-the-farm union and communicate with management through a spokesman. This can be advice on opportunities to grow new crops. The union-spokesman also communicates wishes for paychecks. When they are found to be reasonable the wishes will be granted<sup>121</sup>. There is complete freedom of speech on the farm but when farmhands step out of line<sup>122</sup>, the sanction procedure was to set up a tribunal. The most senior farmhand chooses 2 others to form the tribunal. If farmhands have to come before the court and are found guilty they have to pay drinks for everybody.



Figure 61. Edward Kofi Ahiabor.

As it is a family farm, Edward's family is also involved. The Ahiabor family seemed to be quite large as many people indicated to have a connection with the family<sup>123</sup>. His younger brother owns Tip Top Foods Ltd. He processes tomatoes from Tip Top Farms, as well as other sources, unfit for sale into tomato puree to increase their shelf life<sup>124</sup>. His cousin Isiah often helped at the farm as a farmhand and was also given the easy task of showing the author around, which meant a nice break from work<sup>125</sup>. It seemed Isiah could take more breaks as the other farmhands, a position brought forth by his position as cousin. But when he was working he was working hard, just like all other farmhands who all indicated hard work as a value<sup>126</sup> and would correct farmhands that were slacking.

Table 32. Scores of Tiptop farms on the cultural dimensions

Dimension	Examples	Score (1-5)	Explanation
<b>Hierarchy Egalitarianism</b>	- Chance for farmhands to communicate grievances under the almond tree through spokesman.	4	Everyone has the opportunity to have their say, though it is through a spokesman.

<sup>121</sup> The company also has a small-scale insurance scheme going, which consists of 50% of shared capital from the employees and 50% is deposited by the farmer. This is not very common among other farmers though. Holiday money is also given. As a Christmas bonus a pig is shared by everybody.

<sup>122</sup> Like stealing (taking fruit or vegetables without asking) breaking stuff or slacking around during worktime.

<sup>123</sup> Not only on the farm but also in the village. Of course big families in Ghana are large and on top of that do many people call friends also brother and sister so it can be difficult to differentiate.

<sup>124</sup> This following case study will be about Sena's company Tip Top Foods, Ltd.

<sup>125</sup> Not only because the author is such a likeable person but also because it meant sitting beneath the almond tree with Edward, eating nice meals and drinks while other farmhands were busy in the field.

<sup>126</sup> Some farmhands even had their own small-scale farm on which they worked before they came to work.

	For sanctions a tribunal of farmhands is put in place. If found guilty the guilty party has to buy drinks for everyone.	5	The farmhands are deemed to know the best work ethics themselves and are put in charge.
	There is complete freedom of speech at the farm.	4	The employees don't have to avoid certain topics.
	Farmhands give Edward or Obed advice on opportunities for crops.	4	The farmhands can be just as knowledgeable on agricultural topics, especially since some farmhands also have a small farm of their own. So Edward and Obed gladly listen to them if they have advice or comments.
<b>Communitarianism - Individualism</b>	Virtually all employees are Ewe and mainly Ewe is spoken, together with English and a bit of French.	2	Because the farm is located in an area where mostly Ewe live, this is a consequence of that. Ewe from French speaking Togo are also welcome.
	It is a family farm and family members have more privileges. There are many people with a connection to the Ahiabor family.	1	Making family members manager or giving them other privileges can point to a closed group mentality and is a feature of communitarianism.
	Edward is part of a farmers organization to share ideas on how to run a farm and he likes cooperation between farms as it will increase the quality of all farms involved.	4	Edward feels responsible as an individual for farmers in the region.
<b>Fatalism - Voluntarism</b>	Farmhands give Edward or Obed advice or comments on opportunities for crops and also get feedback on this by them.	4	Giving advice on growing other crops or using that advice to change your crops is a form of taking initiative.
	When Edward was young he had to irrigate the field using buckets and he wanted change. He persisted and developed a successful irrigation system.	5	He took initiative and made an important change.
	Because of a dream to become energy independent Edward started to introduce many different renewable energy technologies on the farm.	5	Because of a self-sufficient dream he has successfully implemented many innovations on his farm.
<b>Synchronous Sequential</b>	Work starts every day at 6 am sharp until around 5 pm (or until the work is done by setting team targets for motivation purposes).	4	Targets are set for a day that starts at a fixed time. The work is defined beforehand.
	Permanent staff has to give two weeks' notice and can get off for a maximum of one week.	5	Losing the permanent staff for max one week has to be known two week in advance to be able to plan accordingly and arrange replacement.
	Permanent staff is asked to do overtime when needed, especially at night.	2	When the circumstances ask for it, the permanent staff has to work extra. Being flexible like that is a feature of a synchronous experience of time.
<b>Position Achievement</b>	Edward was born into his position of farm owner (in a wealthy family)	1	His position has given him status from the start.
	His achievements on irrigation systems gave him widespread recognition (Volta Hero)	5	His achievements have given him even more status.
	Edward's former position as Chief Municipal Executive still gives him prestige today	2	This is status based on a position he held a decade ago but during that time he also achieved things.
	Obed is an involved farm manager who is always working on the field himself.	5	Obed gives the right example which motivates the others.
	Working hard is viewed as a virtue and often repeated by farmhands.	5	The farmhands get enjoyment out of working hard.
<b>Particularism - Universalism</b>	Edward's former position as Chief Municipal Executive and contacts with the Energy Commission (possibly because of this position) helped him fund the technologies on his farm.	1	His connections help him get opportunities other farmers don't have.

Virtually all employees are Ewe and mainly Ewe is spoken, together with English and a bit of French.	2	No people from other tribes where around since only Ewe live in the area. No distinction was made between Ghanaian or Togolese Ewe.
Family gets a preferential treatment.	1	Within family businesses there is more chance of particularism.
Farmhands are selected with a first come, first serve principle at the gate.	5	First come, first serve means no distinction is made based on other factors than your position in front of the gate.



## Appendix A.12 - Tip top foods Ltd.

### General information

Tip Top Foods Ltd. is a company located in Anloga, Keta that processes tomatoes into tomato puree<sup>127</sup> (called TomaFresh™) to increase their shelf life. It started out as the processing side of Tip Top Farms<sup>128</sup> in 2002 and grew out to become its own business, with tomatoes coming from many different farms in the Keta district, the nearby Ada Foah district and the Ziope district<sup>129</sup>. It is owned and managed by Edward Ahiabor's younger brother Sena Ahiabor<sup>130</sup>, his wife Apollonia Ahiabor and Selasi Cobblah<sup>131</sup>. Sena sought out ways in which he could improve the incomes of farmers in the village where he grew up<sup>132</sup>. They began preserving tomatoes in 2002 using a hand-pulper that was powered by a modified electric-power drill. Over the years, he has proven to be very resourceful in arranging funding to reach his goal. In 2004, the Ministry of Food and Agriculture (MOFA) awarded Tip Top Foods Ltd. with a grant that made him able to purchase a two ton per hour, two stage tomato pulper to expand production<sup>133</sup>. While this pulper was capable of drastically increasing production, the grant did not provide operating capital or the additional machinery that complement the pulper. Sena gradually acquired equipment to cook tomatoes and bottle the processed puree which enabled him to scale up his process, though the equipment rarely operated at full capacity. With the profits from a limited production, Sena began developing, branding and building a reputation as a professional food processor<sup>134</sup>. In recent years, three large-scale tomato-processing plants that served Ghana, Togo, Burkina Faso, and Cote d'Ivoire have closed down or downsized significantly. The closures have created excessive supply of tomatoes, and have left the tomato farmers of Ghana with limited markets. However, the closures also created an opportunity for Tip Top Foods to expand.



Figure 62. Sena next to the tomato

### Business & management model

The main value Tip Top Foods Ltd. delivers is ensuring an all-year market for tomatoes<sup>135</sup> by processing the waste or excess tomatoes into puree<sup>136</sup>. The puree is mainly interesting for customers in the off-

<sup>127</sup> These can either be tomatoes that are unfit for sale or excess tomatoes, of which there are a lot since tomatoes are a highly perishable product. It is not unusual for tomato farmers to see at least one fourth of their batch perish in the journey from farm to market. They rather make that part into puree and add value in that way.

<sup>128</sup> See previous case study.

<sup>129</sup> Tip Top Farms is still the most important supplier of tomatoes.

<sup>130</sup> Just like Edward, Sena has enjoyed a proper education. Sena has obtained a BSc. Degree in soil science from the University of Ghana, Legon and has done a 3 year internship in general agriculture in Switzerland.

<sup>131</sup> Sena is Chief Executive Officer, Apollonia is Factory Purchases and Sales Executive, Selasi is Marketing Executive.

<sup>132</sup> The company's slogan is "Support our farmers, prepare that tip top meal with TomaFresh™ puree"

<sup>133</sup> Next to the funding of MOFA he also applied for the Trellis Fund and recently he requested funding from The National Board for Small Scale Industries (NBSSI) to acquire more equipment for puree production like a gas heating jacketed kettle, a discharge mixing tank and a filling machine. He also received a loan from Lumana, a young microfinance company.

<sup>134</sup> Somewhere in the last five years, Sena passed the Food and Drug Authority Certification to have his canned tomatoes sold in large grocery chains, which was a major milestone in scaling his business.

<sup>135</sup> Tomatoes are an important part of the Ghanaian diet as they are an important component of most soups and stews. For that reason there will always exist a market for tomatoes in Ghana.

season of tomatoes because of its storability. The most important customers are stores who buy the puree in bulk<sup>137</sup>. But also boarding schools, hospitals and restaurants are big customers, buying the jerry cans of puree since they have to prepare meals for hundreds of people at the same time. Because the company can only produce puree during the tomato season from August to October, they are using their packaging capacities during the off-season for packaging other farm produce for shopping malls in Ghana (mainly Accra). They do not have a generator but also do not experience many power-outs. The products are transported by truck to stores in the area from the Keta district to the Greater Accra district<sup>138</sup> and a tricycle is used for transportation over short distances.

Tip Top Foods has a very well defined plan for the coming years. They intended to increase production in 2015 through increases in packaging inputs, operating capital, and industrial equipment. In 2016, there was going to be a container of bottles imported and miscellaneous packaging material. Also, they wanted to invest in a filling machine and other equipment upgrades such as an extension to the processing area and warehouse and a paved driveway for easy delivery. Around 2017-2018 they are planning to establish an organic fertilizer warehouse to supply the local farmers with high quality fertilizer and help them increase production. Finally they have the plan for 2019 to set up a mobile processing plant that can follow the tomato harvest season into middle and northern Ghana (which have a different season for tomatoes).



**Figure 63. The waste and excess tomatoes. They will be washed, pulped, cooked, bottled, labeled, transported and sold.**

Tip Top Foods has always maximized returns using a traditional system: by purchasing tomatoes on credit. This allows the farmers to receive income during the planting season (when no produce is sold), while also allowing Tip Top Foods to sell product before paying for inputs. However, as production expands, Tip Top needs additional suppliers, and the credit system requires time-consuming negotiations and oversight. Operating capital for tomato purchases will ensure that no purchasing negotiations interrupt production. This operating capital, together with the equipment are the biggest costs of the business<sup>139</sup>. From the profits from his business, Sena can slowly and steadily acquire operating capital and equipment but Sena is also skilled in writing proper project proposals by which he tries to speed up the financing process.

The company employs 13 seasonal employees who come in during the tomato season and three permanent staff who mostly stay on to do the packaging in the offseason. The seasonal employees are undergraduate students from Togo who are hired because of their high skill set and are cheap labor. They also have a preference to Ghanaian undergrads because Apollonia is also Togolese which makes communication very easy. Because of their shared Togolese background the seasonal employees can have an open communication with her and share any grievances they might have. This is important because the seasonal employees will live onsite for the full three months of the tomato season due to tight seasonal deadlines. During this time they are paid 10 GHS/day next to food and housing<sup>140</sup>. They used their earnings to pay their school tuitions. The employees are selected based on if they can work hard and

<sup>136</sup> Visit <https://www.youtube.com/watch?v=Jt9n5MbED0Q> for an interview with Sena and a look into his business.

<sup>137</sup> The company offers three different packages: 300ml bottles, 1000ml wide-mouth jars and 25l jerry cans.

<sup>138</sup> Selasi is responsible for making contact with the stores. He is mostly on the road and responsible for customer relations. Dedicated personal contact is used to maintain long term relationships.

<sup>139</sup> The tomatoes are mostly waste from farmers and thus can be acquired fairly cheaply.

<sup>140</sup> They can choose to work overtime for 1 GHS/hour. Bottle washing is paid based on quantity.

behave properly. Before new employees started their work they first went through an effective training (read: drilling) and had a trial week which ensured a good work ethic<sup>141</sup> and a smooth operation.

The company has a flat organization structure with Sena being open to advice from anyone<sup>142</sup> and he even involved his employees in decision making on a regular basis. Despite this, only necessary information is supplied (through Apollonia) because it is most important that the work gets done. All employees have equal opportunities, although there are not many chances for growing in the company<sup>143</sup>. When Sena is away, the most experienced employee (with four years of experience) is put in charge. The workers always work hard and even more so, their only grievance is that they would like to be able to work more. They often indicate that they would like to work on Saturdays, their day off, but Sena won't let them because he wants them to rest.



Figure 64. Sena in the storage room with the finished product, a 300 ml bottle of tomato puree.

Table 33. Scores of Tiptop Foods on the cultural dimensions

Dimension	Examples	Score (1-5)	Explanation
<b>Hierarchy Egalitarianism</b>	- Sena indicates that knowledge should be shared to grow and is open to advice from anyone.	5	Sena acknowledges that he cannot know everything and is willing to listen to advice from others.
	There is a flat organizational structure and employees are involved in decision making on a regular basis.	5	No explanation necessary.
	Employees communicate openly with Apollonia.	5	Open communication makes the employees feel accepted like equals.
	Only necessary information is supplied and most important is that work gets done.	2	At the end of the day, the employees just have to work hard.
<b>Communitarianism Individualism</b>	- Undergraduate students from Togo are hired because of their shared background with Apollonia and thus only a Togolese language is spoken (most probably Ewe, possibly a different dialect as Sena).	1	The preference for people with a same background is an indicator for a closed group mentality.
	Company is run by Sena and his wife.	1	Family members are both managing the company.
	There is a tight connection with Tip Top Farms, the farm of his brother Edward.	2	The company came forth out of a family connection and still is heavily dependent on this connection
<b>Fatalism Voluntarism</b>	- Sena saw there was a market for processed tomato's and went after it.	5	Sena acted as an agent of change. Voluntarily.
	The company has until now always used a traditional accreditation system for tomato purchasing but with the business expanding it becomes a barrier, as negotiations take	5	He is looking to change the current system.

<sup>141</sup> No sanction procedures were needed and up until the time of the interview no cases of absenteeism had been reported.

<sup>142</sup> "Cooperation is key, because nobody can know everything, knowledge should be shared to grow."

<sup>143</sup> No chances yet, but since Sena is constantly looking for opportunities to grow his company like starting a plant in the North of Ghana or acquiring funding for new equipment, there might be new job openings on the horizon.

		time and oversight. Sena is looking to acquire operational capital to overcome this barrier.		
		Sena is experienced with putting forward project proposals.	5	The very act of proposing a project is clear case of voluntarism.
<b>Synchronous Sequential</b>	-	Sena is able to gradually grow his company with the help of a well-defined planning.	5	Sena uses a sequential way of ordering his business.
		Seasonal employees live onsite during the tomato season and work hard with a tight schedule to reach the seasonal deadline.	4	Because of a tight seasonal deadline the employees have to be constantly working which takes a meticulous planning. It is however seasonal based, which hints towards a synchronic planning.
		An effective drilling is applied to ensure a good work ethic.	4	The employees are drilled as a preparation of the work to come. It can be seen as the first step on a linear path, with many more to come.
		The employees develop a strong relationship with Apollonia during their stay onsite.	2	Synchronic cultures put more value on close relationships with customers/supervisors.
<b>Position Achievement</b>	-	Most experienced employee is put in charge when Sena is away.	4	This employees has earned Sena's trust by his achievements on the work floor. Also it shows that work can continue if the boss is away.
		Employees would also like to work on Saturday, their day off.	5	Work (or in the case of the employees probably the payment) is highly valued, and the employees would prefer to work three months non-stop.
		Because of the drilling and communication with Apollonia the employees work hard.	4	They work hard because of an involved boss and by being given the right example.
<b>Particularism Universalism</b>	-	There are equal opportunities for all employees.	5	Everybody is treated according to the same rules.
		Solicitors are selected based on if they can work hard and behave properly.	5	No other matters are important.
		The company is run by husband and wife, Sena and Apollonia.	1	Family businesses have higher chance of particularism.
		All employees come from Togo, just like Apollonia.	2	No equal chances for Ghanaian and Togolese employees. (but since all employees are Togolese there are no differences between them)
		Sena uses official channels (proposals) to acquire funding.	5	No use of patronage.

## Appendix A.13 - Hortor fishing company

### General information

Hortor Fishing Company is located on the shores of Anloga, Keta in the Volta region. Companies like Hortor Fishing Company can be found all along the Ghanaian coast<sup>144</sup>. It is basically just a boat and a net, with many people helping to reel in the net. This particular boat has been in operation for over 10 years. They use a beach-seine net<sup>145</sup> which was introduced in the region between 1850 and 1860 by Afedima, a female entrepreneur from the Anlo<sup>146</sup> town of Woe, that enabled the Anlo to overcome their diffidence towards fishing in the heavy surf along their coast. The introduction of the net made it possible for the people in the region start fishing in the heavy surf along their coast. The beach-seine net is deployed by boat while a large group of fishermen on the beach drag the huge net to the beach, capturing all the fish that are in its path. In the early days of its introduction the net + rope could be up to 300 meters long and over the years the sizes have only increased (Akyeampong, 2002). Artisanal fishing is a very traditional sector with very little changes over the years. The last technological innovation was the motorization of the fishing boats in the 1960s. Small improvements on the nets have been the only improvements ever since. Figure 65 shows the different fishing techniques and ethnic groups practicing them along the Ghanaian coastline.

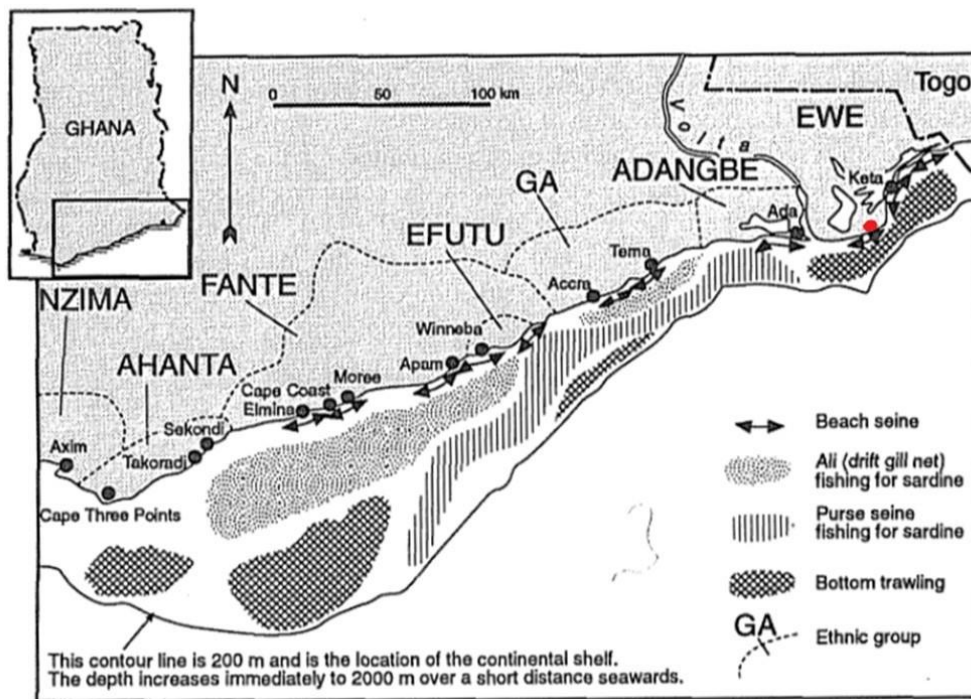


Figure 65. Ethnic groups fishing along the coast of Ghana, and fishing techniques and fishing grounds on the Continental Shelf. Anloga is indicated with the red dot on the right side of the picture (Overå, 1993).

<sup>144</sup> Artisanal fishing is a very old tradition in Ghana and one in which they excel. Because of this, Ghana has the largest number of fishermen in all of West Africa (Lawson & Robinson, 1983). Ghanaian fishermen, especially from the Anlo, Fanti or Ga tribes are known for their knowledge and skills and can be found in many migrant fishing populations all around West Africa (Akyeampong, 2002).

<sup>145</sup> In local language known as a *yevudor*.

<sup>146</sup> The Anlo are a subgroup of the Ewe tribe.



## Business & management model

In coastal towns like Anloga, fishing is the main economic activity<sup>147</sup>, practiced by a large part of the population. The fish that is caught is distributed all over the country<sup>148</sup>. In Ghana, fish takes up 16.4% of food budgets (Mensah & Antwi, 2002). Because of this there is a big market and thus it is a logical step for many people to pursue a life as a fisherman. For Anlo people the sea takes a central role in their life as they have been growing up with it. It thus has become more than an economic activity, it is a way of

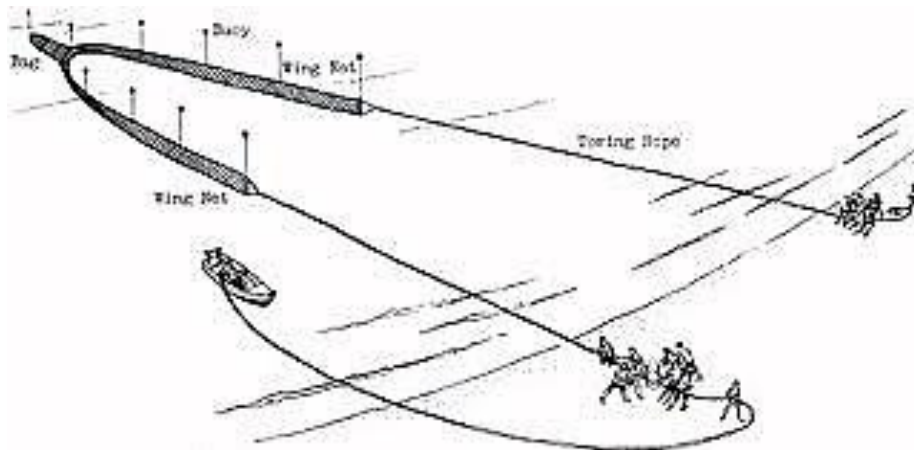


Figure 66. A beach-seine net, as used by Hortor Fishing Company.

life<sup>149</sup>.

There is a standard hierarchy involved in the artisanal fisheries in Ghana. The boat and net are owed by the boat owner<sup>150</sup>, who is usually not involved in the fishing operations. This can be fishmongers<sup>151</sup> who buy their own boats to secure their supply, or fishermen who have been successful in their business or have taken a loan from fishmongers, the main source of finance and loans for the fishermen (Walker, 2002). There is a manager on the beach who handles the fishing operations. The manager of Hortor had been to manager school and had been manager of this boat for 10 years (probably from the moment the boat was first deployed). He will make sure all the fishermen pulling the net are doing their job and keeps track of the duration of their labor. The manager himself will also help pulling the net for most of the time. There seemed to be an unofficial hierarchy between the fishermen based on certain fishermen being confidants of the manager (possibly based on seniority) and helping him disseminating orders and keeping others from slacking around. For the fishermen applies a voluntary joining principle, meaning

<sup>147</sup> The agriculture, forestry and fishing sector employs 36% of the population in the Keta municipality (Ghana Statistical Service, 2014)

<sup>148</sup> Mostly in the Southern half of Ghana is fish part of peoples diet. In Northern Ghana this is replaced with meat since the ocean is too far away and livestock farming is more abundant in those regions.

<sup>149</sup> For the Anlo-Ewe tribes the sea is sacred space and rituals and sacrifices were made to ensure that fishing seasons were successful. The sea was further seen as a custodian of morality, and its sacred power was specifically invoked, for example, in the ritual ablutions that separated an Anlo widow from a deceased spouse. In Anlo religion water symbolized peace, fertility and growth (Akyeampong, 2002).

<sup>150</sup> For various reasons, the boat owners are often women. In the fishing sector women have taken up positions of relative wealth and power within their local communities, a phenomena that is not common throughout Ghana in other sectors (Overå, 1993; Walker, 2001).

<sup>151</sup> Fishmongers are exclusively women and because of this women are often boat owners thanks to these economically favorable positions.





**Figure 67. Fishermen pulling the net of Hortor Fishing Company.**

they can choose every day if they want to help pulling in one of the nets along the beaches and for how long<sup>152</sup>. There are usually around 40-50 fishermen dragging the net every day. They start early in the morning and try to throw out the net as many times as possible. This usually is around 4 to 5 times but it is heavily dependent on the direction and power of the currents<sup>153</sup>. It is important for the manager to maintain a good relation with the fishermen. Because all the different boats offer them the same, the only differentiation factors are personal (whether the boat's manager is likeable) and geographical (is the boat close to where I live?). It can happen that people decide to go to another boat. The boats operate next to each other with around 300 meters distance between them what makes it is very easy for people to switch. But most people do tend to stay with the same boat where they know the same people and have built up trust with the manager which in return will give them certain privileges based on a patronage-system<sup>154</sup>. For extra teambuilding and motivation the fishermen would sing songs during the work. The fishermen predominantly come from nearby communities and are (Anlo-)Ewe. Because the neighboring country Togo is in close proximity and also has a large Ewe community, there are also many (French-speaking) Togolese around<sup>155</sup>.

The catch is after it's reeled in directly divided into many different piles on the beach. The woman who act as fishmongers come to the beach to collect the caught fish to process it<sup>156</sup> and sell it on the market. The catch is split into three non-equal parts: one for the owner (the biggest fish in the net are part of this), one for selling by the fishmongers (this is the biggest share) and a 'leftover' part for fishermen. It has to be noted that this part was significantly smaller than the other parts. For the last two parts the ratio must have been 30 to 1. Payment is dependent on the catch. It ranges from nothing for a whole day up to 300

<sup>152</sup> Most fishermen will come for the whole day. This is because they are heavily dependent on the income the fishing provides them. But it wasn't uncommon for people to show up or walk away halfway the day.

<sup>153</sup> If the current moves towards the beach the fishermen will pull the net, if the current moves away from the beach the fishermen will do their best to stand their ground. This way the net is reeled in, slowly but steadily, on the rhythm of the waves. If the direction of the current is perpendicular to the beach, the fishermen will have to do their best to keep the net in the right position by moving jointly along the beach in a corresponding fashion.

<sup>154</sup> The author was after just three hours of pulling the net rewarded with two of the largest fish within the net.

<sup>155</sup> At Hortor the manager only spoke French (and Ewe) and because of this the interview was done with the help of one of the fishermen who was actually a teacher in the Western region but came to help out his family whenever he came to visit them in Anloga. The Ewe and Togolese background of the manager could potentially pose difficulties for people from other tribes/ who didn't speak French but this was covered by other fishermen by translating his orders.

<sup>156</sup> The fishes are processed by either smoking, salting or drying the fish in the sun, giving them a longer shelf life.

GHS per person. Income is shared equally<sup>157</sup>, also for the manager. Only the manager gets the better fish to take home.



**Figure 69. The result of a couple of hours reeling in the net.**

six in the morning until sometimes seven in the evening. But usually most people will come back the next day as they accept that their fate is dependent on the ocean. One fisherman mentioned the declining fish population to be the main barrier to growth of the sector but that there was nothing they could do about it. Ironically, they are partly themselves to blame for the declining fish stocks that have been a problem since the 1980s.

The Ghanaian fish sector is an example of the tragedy of the commons for which the foundation was laid down by the European settlers with their introduction of the Freedom of the Seas principle. This made the ocean, the Gulf of Guinea, a shared-resource system where individual users act independently and rationally according to their own self-interest and contrary to the common good of all users by depleting that resource.

Together with the costs of petrol for the boat, paying the fishermen is the biggest cost of the business since the boat and net have quite a long life time over which the large initial costs can be amortized. If the net breaks there are people around who can fix it. Payment to the fishermen is the first field in which will be cut when ocean is unfavorable and catch is small. It can happen that all the fishermen go home after a day without any money. They will even have to pay back their 1 GHS chop money that they receive each morning on credit from the boat owner<sup>158</sup>. Especially on those days, being a fisherman can be hard as this type of work has a high intensity, with working hours from



**Figure 68. Distributing the fish over multiple stacks.**

**Table 34. Scores of Hortor Fishing Company on the cultural dimensions**

Dimension	Examples	Score (1-5)	Explanation
<b>Hierarchy Egalitarianism</b>	- Everyone listens to the manager without protesting him.	1	The manager had authority over how the net was pulled and this was also necessary because there were 40-50 people who need to make a coordinated movement.
	Slacking will be noted and pay will be deducted accordingly.	2	The manager was constantly checking if everyone was working hard and also had the power to make them by controlling their payment.
	Manager gets bigger fish.	2	This is a symbolic gesture to show the manager is above the other fishermen.

<sup>157</sup> Except when people come in late, leave early or are slacking around this will be noted by the manager, resulting in a pay deduction.

<sup>158</sup> Which they can spend on bread or drinks from the merchants walking around the beach, making their living based on the presence of the fishing boats.

		Manager gets paid the same amount as all the other fishermen.	5	This was a very surprising observation and a clear example of egalitarianism.
<b>Communitarianism - Individualism</b>		All fishermen come from nearby communities.	1	Although it was possible for a fishermen to go to any boat on the shore, it was common practice to go a boat close to your own community.
		Voluntary joining principle ensures everybody is able to join.	4	At any time, people can join in from any place.
		The fishermen would sing songs during the pulling of the net.	2	The singing of songs creates a group feeling what could be perceived as a closed group by any outsider. Although that is unlikely that this would be the effect of laughing and singing. If particular songs from a tribe (Anlo-Ewe) are song this does might make people from other tribes feel second-range.
<b>Fatalism Voluntarism</b>	-	Mid-19th century beach-seine nets were introduced, in the 1960s the boats were motorized. No other big innovations have taken place since. Fishing is a way of life for most Ghanaians living in the coastal area of Ghana and is a very traditional profession.	1	A classic example of traditionalism.
		Declining fish populations are main barrier to growth but there is nothing they can do about it.	2	A classic case of the tragedy of the commons. Everybody sees it happening but nobody sees themselves as the pivoting point of change.
		When the amount of fish caught is low and nobody gets paid everybody accepts it and tries again the following day.	1	There are no other options than letting it happen and accepting your fate.
<b>Synchronous Sequential</b>	-	The number of times the net is reeled in is dependent on the current.	1	They have a planning based on the tides.
		Every the planning is the same, starting around six in the morning until around seven in the evening.	2	Daily rhythm is the same every day. No specific plans are made grow beyond the position of fisherman.
		Everyone is free to come and leave at will, although it will affect the height of their payment.	1	Coming and going as you please, as was observed for some fishermen, is an example of a synchronic planning.
<b>Position Achievement</b>	-	The manager gives directions and also joins in the work by pulling the net.	5	Working hard was highly valued and the manager gave the right example.
		When a person is slacking, others will point out to him that he should be working.	5	Although slacking would mean an individual sanction many fishermen would feel compelled to make sure everyone was working hard.
		Coming often to help pull the net will give you more status within the company.	5	You earn status by coming often and putting work into the company.
<b>Particularism Universalism</b>	-	Everybody is welcome to join and those who don't speak the same language as the manager will be helped by other fishermen who do.	5	It was most important that you would pull the net and work hard. Other factors like your tribal background were ignored even facilitated by translating.
		Choosing a boat to help is based on a patronage-system (from an employee perspective)	2	Employees go to a certain boat because the manager is their patron.
		Mostly people from the Ewe tribe around.	2	The situation in Ewe territory is more favorable for other people from the Ewe tribe.
		The author was rewarded two big fish for just three hours of pulling.	2	Not a case of treating everybody according to the same rules.

## Appendix B – Questionnaire

This appendix presents the questionnaire that was used for the in-depth interviews (adapted from de Vlieger (2013)).

### The primary production process

#### Product

- What is the main goal of your company?
- How long are you in business?
- With what idea in mind was this business started and how did it evolve? (also applies to Uncertainty Avoidance)

#### Employees

- How many employees do you have?
- What is your own educational background/experience? (manager/business school)

#### Technique

- What kind of machinery do you use?
- When do you purchase a new technique?
- Is there somebody in charge of machinery maintenance?
- Do the machines bear risks?

#### Differentiation factor

- What is the vision/motto for your company?

#### Religion

- Does church or religion influence any company practices?
- Are there religious practices performed in the company?

#### Sectorial cooperation

- Is there any cooperation between various actors going on in the sector?
- Do/ Would you think that cooperation between competitors is a good thing for the market?
- Why yes/no?
- Do you cooperate with companies in your sector or are you only competition?

### The business model

#### Value proposition

- What is the main value you offer to your customers?
- Do you offer other values as well?
- How does your product/service stand out next to your competitors? What makes your business special?
- *How was the idea of this business born?* (also applies to Uncertainty Avoidance)

#### Customers

- Who are your most important customers? (specific type?) Do they belong to one or multiple customer segments?
- What is the psychological profile of your customers?
- How did/do you find your customers?

#### Distribution channels

- How do you reach your customers? Where are your products sold?

- How do you transport products?
- *How do you market your products?*

### Customer relations

- Who is in charge of your customer relations?
- How do you maintain your relations with your customers?
- Long or short term relations?
- Do you provide (maintenance) service after purchase?
- Do you have special promotions? If yes, how often?
- Do you have mechanisms of getting customer feedbacks concerning your goods?
- What do you do to keep a customer coming back to you? Is there in general a lot of customer loyalty you think?

### Revenue Stream

- What is the model for your earnings?
- How was the startup of the company financed? (own money or subsidies, loans, other aid)
- Was it necessary to take loans at any given time while in business?
- Is it hard to get a loan?
- Did you need collateral?

### Key activities

- What are key activities of your enterprise? (production, problem solving, platform management)

### Key resources

- On which resources do you depend?
- What are the most important resources?

### Key partners

- Do you outsource any parts of your business?
- Who are your suppliers?
- Any other partners?
- Do you have special arrangements for your enterprise with a specific supplier?
- How do you communicate with them? (mail, phone, face to face)
- What do you do when the supply is not completely in order?
- How are appointments kept between partners?
- Is it common to communicate when an appointment is not possible to keep?
- Is there loyalty?
- Or is looking for other optional partners allowed?
- Do you think you get fair prices?
- Who carries the responsibility to ensure that things go well between you and your supplier?

### Costs

- What are your biggest costs of your business?
- In what fields are you cutting down (first)?
- How do the power-outs affect your business?
- How much diesel do you use and what type of generator?

# Cultural values

## Hierarchic/Egalitarianism

- How is the hierarchy in the company? / How many levels? (Supervisors, Departments, Functions)
- Who is responsible for what?
- How is the interaction between departments/functions/roles?
- Do employees just do what they are told by a manager or is discussion possible?
- What happens when a mistake is made? (Is it reported? To who?)
- What are the sanctions for making a mistake?
- Do employees discuss among each other what they cannot discuss with the manager? (to be observed)
- Is there complete freedom of speech among employees? (to be observed)
- Do employees have the opportunity to climb in the hierarchy of the company?
- Do employees have a voice in company policy? How?

## Individualism/Collectivism

- Where do employees come from? (Same tribe/different tribes?, Same region/different regions?)
- Are there groupings amongst the employees?

## Uncertainty avoidance

- What are some of the most important company regulations? (written &/or unwritten)
- How strictly are these regulations followed?
- Are working conditions safe? (to be observed)
- Is there a caretaker for safety?
- Are employees trained for calamities?
- How is your/your employee's job security?
- Are you happy with the current size of the company?
- Do you invest for further company growth?
- *What are your plans for growing your company?*
- What makes this type of company preferable? Do you look to expand into other types of businesses?

## Synchronic/Sequential time orientation

- When do the employees get their salary? (monthly, weekly)
- Are employees paid a fixed salary or per delivered product?
- How are salaries and secondary conditions determined?
- Does the company work with targets?
- Does the company work with bonuses?
- Does the company provide special training programs for management/employees?
- What is the format and what is the goal & purpose?
- *Is there a long term view for the company?*
- *Are there investments involved with this?*
- What do new employees have to learn about the company?
- Is the manager able to share the company vision with employees?

## Universalism/Particularism

- How are employees selected? What criteria?
- Are there relatives working in the company?



- Does the company have any policy with regard to tribal issues?
- Is it allowed to speak in tribal languages? (vernacular)/ What language is spoken in the company?
- Is an interviewee asked which tribe he/she originates from?
- Are there rules/regulations from the government for the company?
- Is it important to know well-connected people in order to get the work documents (for example permits & licenses) that the company needs?

#### Specific/ Diffuse involvement

- Do employees come together in their private time?
- Are they friends?
- Are employees aware of each other's private situation?
- How often do you call upon your employees outside working hours?
- What do you want to know of a business partner before deals are discussed?
- Are there topics you always want to know of a person in order to have trust?

#### Achieved/Ascribed Status

- How do you grow in the company?
- What are requirements to perform certain functions?

#### Sequential/Synchronic Time

- Are there strict regulations regarding punctuality?
- Does the company have strict working hours?
- Are employees usually on time?
- Is there a day planning for the work?
- Who makes a planning for the company?
- Is the planning being kept?
- Who ensures that this actually happens?

#### Traditionalism/Voluntarism

- Are employees encouraged to make their own initiatives?
- Do these employees get feedback on their initiatives?
- What is the main barrier for the growth of your company?
- How do you deal with this?
- What happens during power cuts?

## Appendix C – Data used for technical analysis

In this appendix the data are presented that were used in the technical analysis to estimate the available feedstocks in an average Ghanaian community. The data consisted of three feedstock types: manure, crop residues and municipal waste. All the data were taken from (Thomsen, et al., 2014).

### Appendix C.1 – Livestock

**Table 35. Data on manure availability in Ghana (Thomsen, et al., 2014).**

<b>Livestock</b>	<b>Population</b>	<b>Manure production</b>	<b>Recoverability Factor</b>	<b>Theoretical potential</b>	<b>Technical potential</b>
	<i>1000 heads</i>	<i>kg/head/day</i>	<i>g/g</i>	<i>Mt/year</i>	<i>Mt/year</i>
<b>Cattle</b>	1454	12	0,2	6,37	1,27
<b>Sheep</b>	3759	1,2	0,2	1,65	0,33
<b>Goats</b>	4855	1,5	0,2	2,66	0,53
<b>Pigs</b>	536	3,6	0,5	0,70	0,35
<b>Poultry</b>	47752	0,02	0,5	0,35	0,17

**Table 36. Data on the biogas potential of manure in Ghana (Thomsen, et al., 2014).**

<b>Livestock</b>	<b>Total solids</b>	<b>Bio Methane Potential</b>	<b>Theoretical biogas potential</b>	<b>Technical biogas potential</b>
	<i>%TS</i>	<i>m3 CH4/ kg TS</i>	<i>Mm3/year</i>	<i>Mm3/year</i>
<b>Cattle</b>	12%	0,22	280	56
<b>Sheep</b>	25%	0,22	151	30
<b>Goats</b>	25%	0,22	244	49
<b>Pigs</b>	11%	0,22	28	14
<b>Poultry</b>	25%	0,22	32	16

## Appendix C.2 – Crop residues

**Table 37. Data on crop residue availability in Ghana (Thomsen, et al., 2014).**

Crop	Residue	National crop production	Residue to Product Ratio	Recoverability Factor	Theoretical potential	Technical potential
		<i>Mt TS/year</i>	<i>g/g</i>	<i>g/g</i>	<i>Mt TS/year</i>	<i>Mt TS/year</i>
<b>Maize</b>	Stalks	1,7	1,59	0,8	2,703	2,162
	Husks	1,7	0,2	1	0,340	0,340
	Cobs	1,7	0,29	1	0,493	0,493
<b>Rice</b>	Straw	0,47	1,66	0,25	0,780	0,195
	Husks	0,47	0,26	1	0,122	0,122
<b>Millet</b>	Stalks	0,18	1,83	0,8	0,329	0,264
<b>Sorghum</b>	Straw	0,29	1,99	0,8	0,577	0,462
<b>Groundnut</b>	Shells	0,48	0,37	1	0,178	0,178
	Straw	0,48	2,15	1	1,032	1,032
<b>Cowpea</b>	Shells	0,24	1,75	1	0,420	0,420
<b>Cassava</b>	Stalks	14	0,06	0,8	0,840	0,672
	Peelings	14	0,25	0,2	3,500	0,700
<b>Plantain</b>	Trunks and leaves	3,7	0,5	0,8	1,850	1,480
<b>Soybean</b>	Straw and pods	0,16	3,5	0,8	0,560	0,448
<b>Yam</b>	Straw	5,9	0,5	0,8	2,950	2,360
<b>Cocoyam</b>	Straw	1,3	0,5	0,8	0,650	0,520
<b>Sweet potato</b>	Straw	0,044	0,5	0,8	0,022	0,018
<b>Oil palm</b>	EFB	2	0,17	1	0,340	0,340
	Kernel shells	2	0,07	1	0,140	0,140
	Fiber	2	0,14	1	0,280	0,280
<b>Coconut</b>	Husks	0,3	0,42	1	0,126	0,126
	Shells	0,3	0,25	1	0,075	0,075
<b>Sugarcane</b>	Leaves	0,15	0,11	0,8	0,017	0,013
	Bagasse	0,15	0,18	1	0,027	0,027
<b>Cotton</b>	Stalks	0,027	2,88	0,8	0,078	0,062
<b>Cocoa</b>	Pods	0,9	0,93	0,8	0,837	0,670

Table 38. Data on the biogas potential of manure in Ghana (Thomsen, et al., 2014).

Crop	Residue	Bio Methane Potential	Theoretical biogas potential	Technical biogas potential
		<i>m3 CH4/kg TS</i>	<i>Mm3/year</i>	<i>Mm3/year</i>
Maize	Stalks	0,268	966	773
	Husks	0,238	108	108
	Cobs	0,348	229	229
Rice	Straw	0,264	275	69
	Husks	0,232	38	38
Millet	Stalks	0,181	79	64
Sorghum	Straw	0,285	219	175
Groundnut	Shells	0,227	54	54
	Straw	0,154	212	212
Cowpea	Shells	0,65	364	364
Cassava	Stalks	0,192	215	172
	Peelings	0,323	1507	301
Plantain	Trunks and leaves	0,213	525	420
Soybean	Straw and pods	0,225	168	134
Yam	Straw	0,167	657	525
Cocoyam	Straw	0,167	145	116
Sweet potato	Straw	0,144	4	3
Oil palm	EFB	0,253	115	115
	Kernel shells	0,28	52	52
	Fiber	0,146	55	55
Coconut	Husks	0,141	24	24
	Shells	0,289	29	29
Sugarcane	Leaves	0,204	4	4
	Bagasse	0,221	8	8
Cotton	Stalks	0,225	23	19
Cocoa	Pods	0,8	893	714

### Appendix C.3 – Municipal waste

Table 39. Data on municipal waste availability and the associated biogas potential (Thomsen, et al., 2014).

City	Solid waste	BMP	Biogas potential	Liquid waste	BMP	Biogas potential
	<i>Mt/year</i>	<i>Mm3 CH4/year</i>	<i>Mm3/year</i>	<i>Mt/year</i>	<i>Mm3 CH4/year</i>	<i>Mm3/year</i>
Accra	0,72	80	133	0,29	8,7	14,5
Tema	0,5	56	93	0,039	1,2	2
Kumasi	0,54	60	100	0,078	2,4	4
Other 8 regional capitals	0,34	37	62	0,15	4,6	7,7

## Appendix D – Workshop “Biogas as a social enterprise”

This appendix presents the main outcomes and the list of participants for the workshop “biogas as a social enterprise” that was done during the field research in Ghana, on 17 April 2015. The workshop made use of the BMC and a diverse group of participants. The participants were divided into two groups and asked to brainstorm on possibilities for biogas as a social enterprise in Ghana.

### Appendix D.1 – Main outcomes of the workshop

Key partners	Key activities	Value propositions	Customer relationships	Customer segments
<ul style="list-style-type: none"> <li>-The community → create acceptance and supply feedstock</li> <li>-Farmers, factories, production sites → supply feedstock</li> <li>-Timber companies → supply saw dust</li> <li>-Construction companies → construction of the digesters</li> <li>-The media → promote the social enterprise</li> <li>-District assemblies and traditional governments → support in building and operating the business</li> <li>-Ministry of energy → create a national biogas program to help dissemination</li> <li>-Landfill sites</li> </ul>	<ul style="list-style-type: none"> <li>-Keep good contacts with the community → make sure the people like the digester/product/price</li> <li>-Waste management</li> <li>-Make fertilizer from liquid digestate</li> <li>-Engineering the facility → proper construction and constant maintenance</li> <li>-Export it to communities willing to be sustainable</li> </ul>	<ul style="list-style-type: none"> <li>-Biogas for an affordable price</li> <li>-Fuel for cooking or cars</li> <li>-Waste management</li> <li>-Fertilizer</li> <li>-Solid fuels → make pellets from the digestate</li> <li>-Fish feed</li> </ul>	<ul style="list-style-type: none"> <li>-Have a reliable product → be polite, honest and trustworthy</li> <li>-Create customer awareness → use mouth to mouth</li> <li>-Offer discounted subscription for long-term contracts</li> </ul>	<ul style="list-style-type: none"> <li>-Rural communities</li> <li>-Farmers</li> <li>-Schools</li> <li>-Combine rich customer segment with poor customer segment → use income from rich segment to help poor segment get biogas</li> <li>-Local gas retailers</li> <li>-Electricity companies → ECG/Gridco</li> </ul>
	<b>Key resources</b> <ul style="list-style-type: none"> <li>-Design should be simple and effective → if it's complex you will run into problems</li> <li>-Human resources → technical expertise</li> <li>-Facilities, land and equipment</li> <li>-Feedstock</li> <li>-A safe and healthy environment</li> </ul>		<b>Channels</b> <ul style="list-style-type: none"> <li>-Advertisement</li> <li>-Mini-grid (for urban areas)</li> <li>-Trucks for biogas distribution</li> </ul>	
Cost structure		Revenue streams		
<ul style="list-style-type: none"> <li>-Land/equipment/facilities</li> <li>-Funding to support the community</li> <li>-Licenses</li> <li>-Feedstock</li> <li>-Human resources</li> </ul>		<ul style="list-style-type: none"> <li>-Gas/fuel/heat/electricity/compost</li> <li>-Carbon credits</li> <li>-Investments from social entrepreneurs</li> </ul>		

## Appendix D.2 – List of participants

The phone numbers and email-addresses are known with the author.

<b>Name</b>	<b>Organization</b>
<b>Sander Bijlsma</b>	KITA/ HAS Den Bosch
<b>Jakob Spotl</b>	KITA/ HU Utrecht
<b>Carolina Halevy</b>	KITA/ HU Utrecht
<b>Obed Otoo Nenyi</b>	KNUST – TCC
<b>Dennis Kliaye-Akenteng</b>	KNUST – TCC
<b>Alexander Nuer</b>	Wageningen University/ ISSER
<b>George Ansah</b>	KITA/Trees for the future
<b>Dorothey Nyamesem</b>	KNUST – TCC
<b>Edwin Hli Badgeo</b>	KNUST – TCC/ ISEES
<b>Akua Amoa Okyere-Nyako</b>	SNV
<b>Alex Kwame Donyina</b>	SNV
<b>Margarite Owusu</b>	KNUST – TCC
<b>Samuel Owusu-Takyi</b>	KITA
<b>Bernard Walker</b>	KITA/TRG
<b>Michael Commeh</b>	KNUST – TCC
<b>Edward Antwi</b>	CEESD



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