Original Research Article

A System Thinking Approach to Human Resource Development in the Oil Industry

Abstract

Prerequisite for the development of production linkages in the oil and gas (O&G) industry is the existence of a skilled and experienced workforce. Resource-rich countries, however, are either in short supply or lack of the requisite local capacity. This paper adopts system thinking (ST) methodology to provide a comprehensive approach in identifying, analysing and understanding the interconnections and interrelationship among the variables affecting the challenge of human resource development (HRD) in the oil industry. The concept of feedback embedded in ST allows complex issues to be viewed as an interconnected set of circular relationship rather than the linear cause-and-effect. Consequently, ST tool of causal loop diagram (CLD) aids in visualising the understanding of HRD factors, their relationships in the causal factors and the strategies for sustainable development of domestic skills, know-how and local capacity. Policies for developing human resource in the oil and gas industry are recommended to policymakers and stakeholders.

1 Introduction

A UK based magazine, New African in its January 2012 edition entitled; the curse of oil, how oil companies have left Niger Delta in the lurch [1]. In the said article, it estimated that Nigeria had squandered about $500bn of petroleum revenue with the majority of its citizens living with daily oil contamination, underdevelopment, and corruption postulated to be the causes of instability in Niger Delta, Nigeria (ibid). This conundrum of the resource curse is not peculiar to Nigeria but most resource-rich countries in the form of price volatility, Dutch disease and poor governance etc. [2,3,4,5,6,7,8,9,10]. Consequently, Obiri and Bjeirmi (11) argued that resource-rich countries are promulgating local content (LC) policies to stimulate resource-based development by linking the oil enclave to the wider economy through four main pillars: employment creation, procurement of goods and services, knowledge transfer and skills development.

This policy, Kalyuzhnova et al., [12] argued it to be an industrial tool that empowers host countries' domestic producers to grow their activities, at least partially with domestic inputs and gain access to international technology and managerial expertise. Proponents of the LC policy argued that it corrects market failure in host countries, protect domestic infant industries and help create economic linkages and business opportunities for local entrepreneurs, employment and social purposes, license to

operate, [9,13,14]. On the other hand of LC debate, the policy violates WTO agreements such the General Agreement on Tariffs and Trade (GATT), the agreement on Trade-Related Investment Measures (TRIMs), the General Agreement on Trade in Services (GATS), and the Agreement on Government Procurement (GPA).

Notwithstanding WTO regulations, the LC policy has been legislated in almost all resource-rich countries in Africa. In Ghana, the policy was passed into law to aid in the gradual diversification and socio-economic development. This was widely seen to correct so-called "injustice" in the mineral sector after over a century of mining and allow Ghanaians to partake in all businesses along the oil and gas industry's value chain. However, the Ghanaian Local Content Policy and Participation Framework, 2010 identified the lack of human resource capacity to be a likely impediment to the LC policy implementation [15]. Studies show the aforementioned challenge of human resource development impedes the policy implementation in many resource-rich countries [9,16,17,18,19,20,21,22,23,24,25].

Broadly speaking, human resource capacity relates to "the development of knowledge, skills and attitudes in individuals and groups of people relevant in design, development, management and maintenance of institutional and operational infrastructures and processes that are locally meaningful" [26]. Resource-rich countries like Ghana turn to lack the requisite skills, experience and competencies for maximizing the benefits of the resources. The level of education and training are among the main

constraints to building a competitive domestic industry [25]. Here, two questions arise concerning (1) how to resource local universities and R&D centres financially and capacity wise to adopt and distribute technology transferred from IOCs to the domestic industry, and (2) whether local institutions (Schools and universities) are organized and managed efficiently to meet industry requirements.

To create the conditions for domestic companies to emerge, the host country's government has the primary responsibility to increase local skills, business know-how, technology, capital market development, wealth capture and wealth distribution [14]. Developing local capability in the petroleum sector, Kazzazi and Nouri [27] argued that strategies adopted must be based on existing capabilities within manufacturing, fabrication and services. Put differently, successful LC strategies determine which domestic products and services likely to be profitable in the industry. Here again, it must be stated how the availability of skilled labour locally plays an important role in technology transfer in developing countries. According to technology transfer does not diffuse only through formal R&D but also through the employment of skilled labour in general [28]. In other words, human capital facilities technology adoption in resource countries. Furthermore, human capital development creates a significant contribution to organizational competencies which enhance innovation. Studies show that business performance is positively impacted by the presence of human capital practices [29,30,31], and also human capital development is a prerequisite to sustainable business performance [32].

This study, therefore, uses the Ghanaian oil industry as the study area to illustrate the challenges in developing human resource and the sustainable strategies for addressing the issue thereof. To that end, system thinking and qualitative data are employed to unravel this phenomenon which differs from previous studies on the Ghanaian oil industry [11,23,33,34,35,36,37,38,39,40]. Consequently, the following objectives are set out for the paper:

- To develop a causal loop diagram (CLDs) for human resource development and establish the existence or otherwise of causal relationships in the diagram;

- Identify the key leverage points from the CLD to improve human resource development in the oil and gas industry; and

- Propose policy recommendations for addressing human resource development in the oil and gas industry.

The use of CLD helps in analysing the factors influencing the development of the phenomenon and more importantly, the interrelationships in the factors. Based on this, policies are recommended. The recommendation of this study is premised on the ultimate responsibility of the government in tackling the issue rather than foreign companies. By this, the study tries to change the narrative on local content literature (achieving mandatory targets and monitoring etc.) to a sustainable way of developing local capacity and know-how that transcends the life cycle of the oil industry. The next section introduces system thinking and the initial causal loop diagram and its attendant reasons. Section three, four and five deal with

the methodology, results and discussion, and the conclusion derived thereof respectively.

2. System Thinking

The coining of the term "system thinking" is widely accredited to Barry Richmond in 1987 [41]. System thinking, according to Richmond [42] is the "art and science of making reliable inferences about behaviour by developing an increasingly deep understanding of underlying structure" [41]. System thinking is analogously referred to as "seeing both the forest and the trees" by its proponent [42]. It can also be defined as a framework for seeing interrelationships and patterns of change rather than things and static snapshots [43]. In a nutshell, it allows a phenomenon to be studied comprehensively and holistically taking into consideration the various parts of the phenomenon under consideration. This helps to identify or clarify systematically the causes of a problem and challenge preconceived ideas from a non-linear perspective. The above underlining concepts in addition to the notions of interrelationship and interdependencies formed the basis for the adoption of ST to provide a holistic explanation to human resource development (HRC) challenge. Causal Loop Diagram, as one of the tools in ST, is used in modelling the variables the HRC.

2.1 Causal Loop Diagram

Causal Loop Diagram (CLD) is the diagrammatical representation of the interrelationships in a system based on a cause-and-effect scenario. System thinking and CLDs are premised on the concept of feedback loop

which the study considers appropriate and suitable in understanding the interconnected set of circular relationship in the HRD variables. Understanding these relationships is the surest way to disentangle HRD issue and proffer the appropriate strategies in that regard. To that end, the building of the CLD started with identifying the factors affecting HRD implementation [44]. Secondly, understanding of the relationships between the identified factors was achieved via direct observation, accepted theory, hypothesis and statistical evidence [45]. The above guidelines in addition to the stages outlined in the methodology were followed in constructing the initial CLD for human resource development as depicted in figure 1. Table 1 depicts the system boundary variables [the steps used in identifying the variables are explained in section 3] used in the modelling based on a review of the subject and the researcher's understanding of LC implementation and its challenges in the oil industry.

A system boundary essentially provides a complete picture of the various variables used and sets a limit to the variables included in the modelling based on variables that are essential to the phenomenon under consideration. This presupposes that variables without direct impact on the phenomenon are not considered. The arrows in the diagram represent causal relations, negative (-) indicates that the values of the variables challenge in opposite direction, and plus (+) the variables change in the same direction not necessary that the values increase. Figure 1 contains two important building blocks: a reinforcing loop (i.e. R1 and R2) and a balancing loop (i.e. B). A reinforcing loop is the one in which an action

produces a result which influences more of the same action, thus resulting in growth or decline at an ever-increasing rate [46] as indicated in figure 1. In other words, the reinforcing loop can be defined as when feedback increases the impact of change which can be classified as positive reinforcing producing virtuous cycles or negative reinforcing producing vicious cycles (ibid). Similarly, as shown in figure 1, a balancing loop generates the forces of resistance that limits growth, maintain stability and achieve equilibrium (ibid).
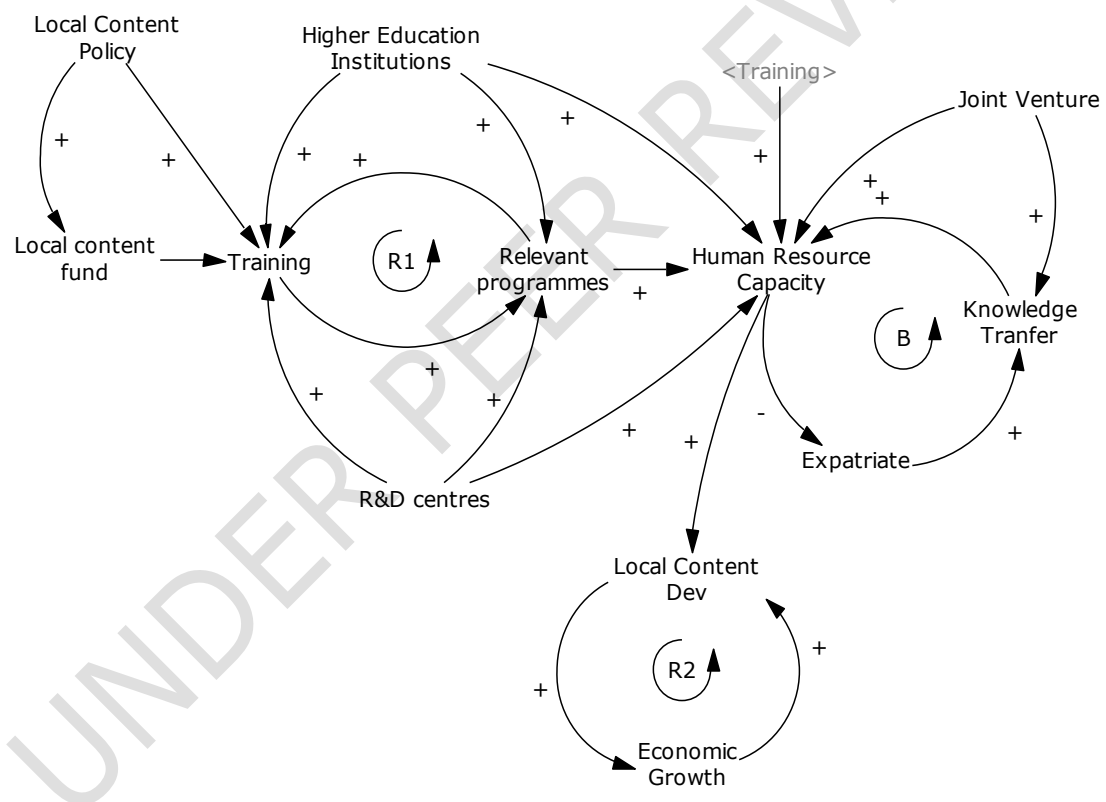

Figure 1: Initial Causal Loop Diagram for Human Resource Development Model

Challenge Code	Challenge Type
Human Resource Development (HRD)	**Type: Endogenous Variables**
HRD_1	Human resource capacity
HRD_2	Relevant programmes
HRD_3	Local content development
HRD_4	Expatriates
HRD_5	Knowledge transfer
HRD_6	Local content fund
HRD_7	Economic growth
HRD_8	Training
HRD_9	R&D Centres
	Type 2: Exogenous Variables
HRD_{10}	Joint Venture
HRD_{11}	Higher education institutions
HRD_{12}	Local content policy
HRD_{13}	Business development infrastructure

Table 1: System Boundary for Human Resource Development model

3. Methodological Framework of the Study

Figure 2 illustrates the methodological framework for the study that encompasses system thinking (ST) and qualitative data. ST, as explained in section 2, is adopted to explain and analyse the phenomenon of HRD in the oil and gas industry. The research is divided into two stages: identification of variables and subsequent initial development of CLDs, and the second stage, validation of CLDs. Stage one begins with modelling

using VENSIM software based on HRD variables to the oil and gas industry. In identifying the HRD variables, the following assumptions are made:

- Variables that are essential to the phenomenon under consideration,
- Variables with a direct impact on the phenomenon are considered for the creation of a small and manageable model size whiles variables without direct impact are ignored,
- Based on the researcher's understanding of the subject matter, herein, local content implementation and its challenges in the oil industry.

This small model size, therefore, facilitates easy tracking of the variables, and understanding and appreciation of the lessons thereof by policymakers. In modelling, numerical, written and mental (the richest of the three) are the three kinds of knowledge sources for modelling [47]. Model building begins with listing those factors that have a major influence on the output [45] and the other factors enumerated in section 2 to form the system boundary. In identifying the influences, the methods such as observation, discussion, interviews and existing data are can be employed [47]. Furthermore, the variables used in the modelling are sourced from local content policies and regulations in Ghana and around the world, and academic publications on the subject [11,14,15,18,23,26,33,39,40,48,49, 50,51,52,53,54] and others cited in section 1. Having identified the variables, the links in the CLD can be

constructed and justified through theoretical evidence, empirical evidence, and experiential knowledge [30].
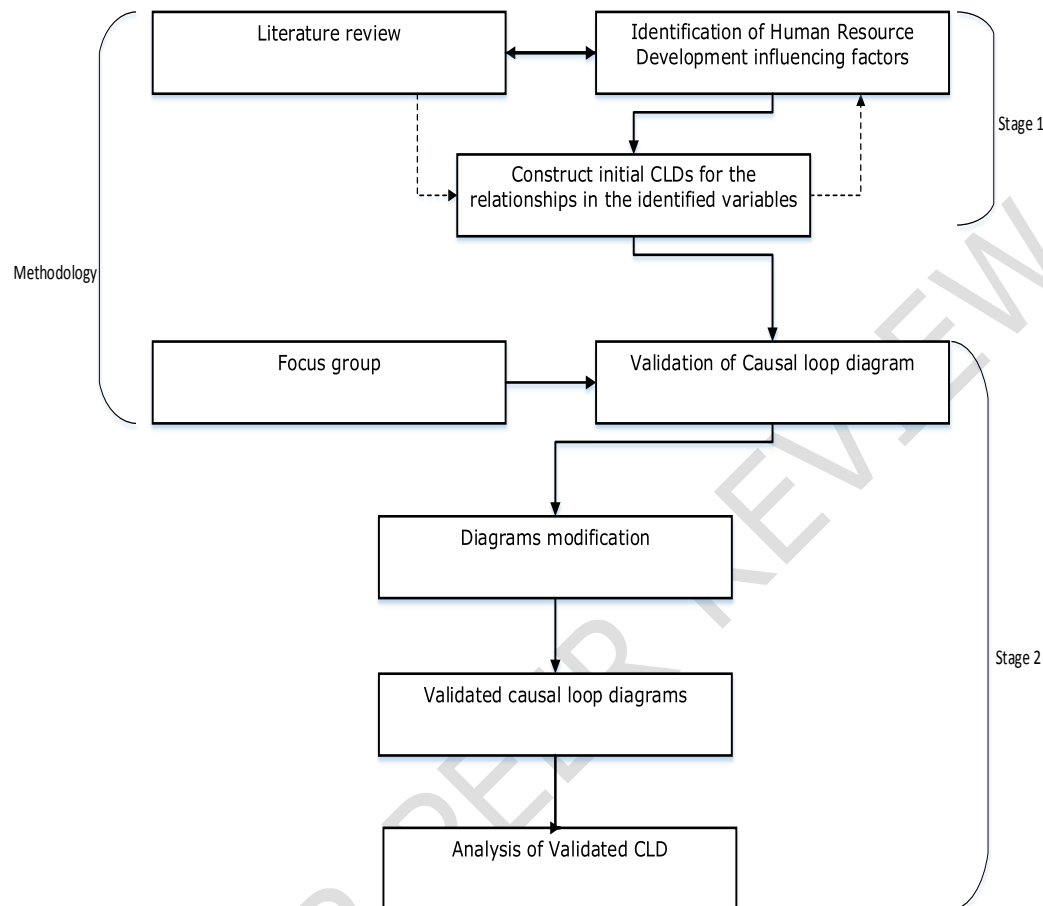

Figure 2: Methodological framework for the development of Human Resource Development CLD model

The second stage involves the validation of the model through a focus group. Focus group (8 participants) were used to gather the qualitative data needed to validate the CLD and the primary data on HRD strategies. These groups aided an in-depth discussion of the topic from different perspectives in one meeting which allows the participants to ask follow-up questions which elicited more information and saves time. Participants (Ghanaian oil and gas stakeholders) were selected using purposive

sampling who possess the requisite skills and understanding of LC implementation and its challenges. They were asked to verify the existence of a causal relationship in the model or otherwise and suggests any additional or missing variables. The above criteria are in-line with Goldrate's Theory of Constraints which identify criteria that determines the validity of CLDs [45,55]. These criteria include cause sufficiency, clarity, additional cause possibility, quantity existence, cause-effect reversal, tautology, and connection edge existence [56]. Issues emanating from the validated model in addition to the interview schedule (questions on strategies for addressing HRD) were discussed.

4. Results and Discussion

4.1 Validated CLDs

The focus group established the existence of causal relationships in figure 1. This means that the variables indicated in the diagram are crucial in addressing the phenomenon. Secondly, research participants recommended additional variables as indicated in figure 2. Figure 1 has three initial three feedback loops; R1, R2 and B1. Upon validation of fig. 1, the feedback loops increased to four as indicated in fig. 4. Figure 4 depicts the validated causal loop diagram for human resource development in the oil industry. The diagram disentangles the complexity and the various factors that can affect the development of human resource in the O&G industry positively or negatively. From the validated CLD, reinforcing loop, R1 illustrates that as training (for local workforce) increases (as a result of increases in local content fund, local content policy, succession planning, higher education institutions, and R&D

centres), it will in turn impact relevant programmes positively, which consequently will lead to relevant programmes being restructured to meet industry's standard finally impacting training positively.

However, as human resource capacity is being developed as a result of the above, human resource capacity will reduce the number of expatriates in the host country economy, expatriate, in turn, will aid in knowledge transfer, and as knowledge transfer increases in the local economy, it will impact human resource capacity positively forming balancing loop, B1.

In addition to the above, the diagram shows that expatriate is negatively affected by succession planning. Furthermore, training impacts human resource capacity positively as indicated in figure 4. Similarly, as human resource capacity is developed, it in turn impact local content development positively, which in turn increase economic growth, and finally, as economic growth increases, it will impact local content development positively which forms reinforcing loop, R2. At balancing loop, B2, as joint venture (between local and foreign) increases, it reduces the skill gap, which in turn impact joint venture positively. The effective strategies for dealing with the reinforcing loop is not to ignore it when the structure is producing a desirable result, thus virtuous cycle. The best approach is a good offence, by identifying the potential limiting factors to limits of growth (a structure that encompasses a reinforcing loop, and balancing loop that offsets the growth of latter at a certain stage) and eliminates it. On the other hand, one of the effective strategies for dealing with balancing loop is planning.
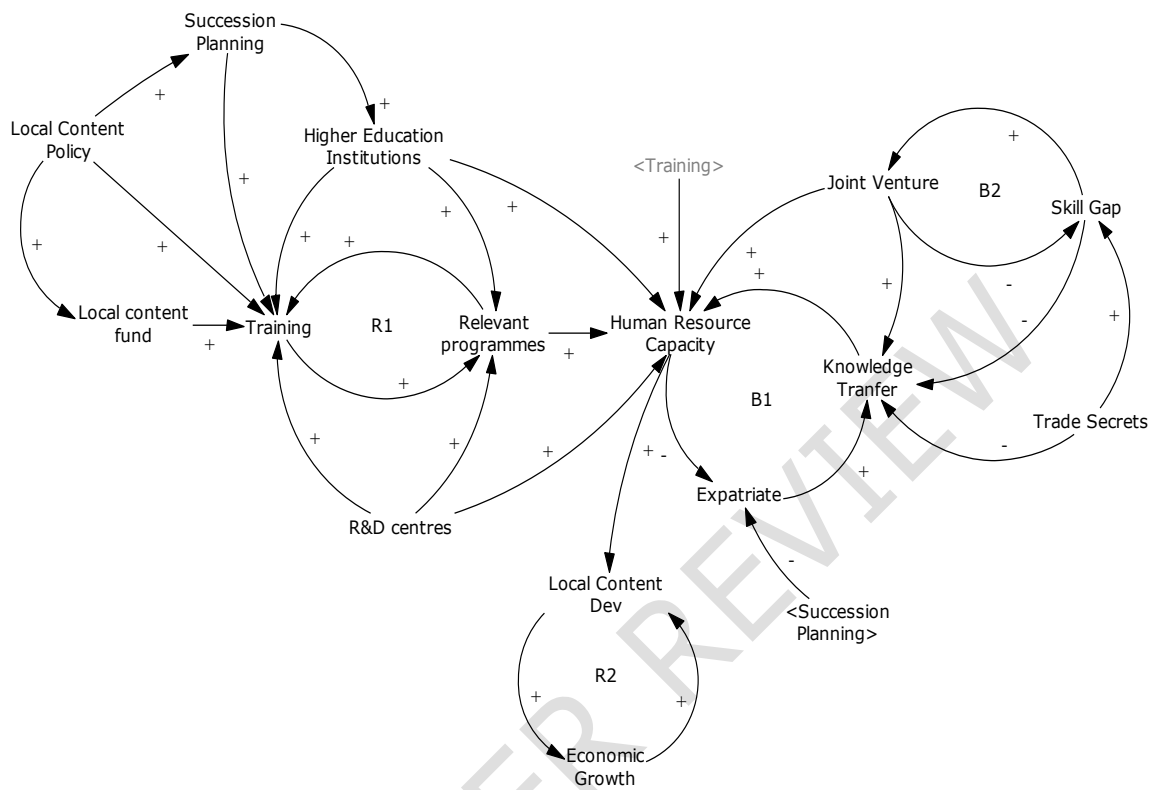
Figure 3: Validated Causal Loop Diagram for Human Resource Development Model.

Figure 4 below is the causes tree diagrams for human resource development extracted from Figure 3. The diagram depicts that human resource, which is at the end of the tree is influenced by variables such as R&D, knowledge transfer, training, joint venture, relevant programmes and higher education institutions. The above-mentioned variables constitute the high leverage points where the government should focus policy in improving human resource development in the oil and gas.
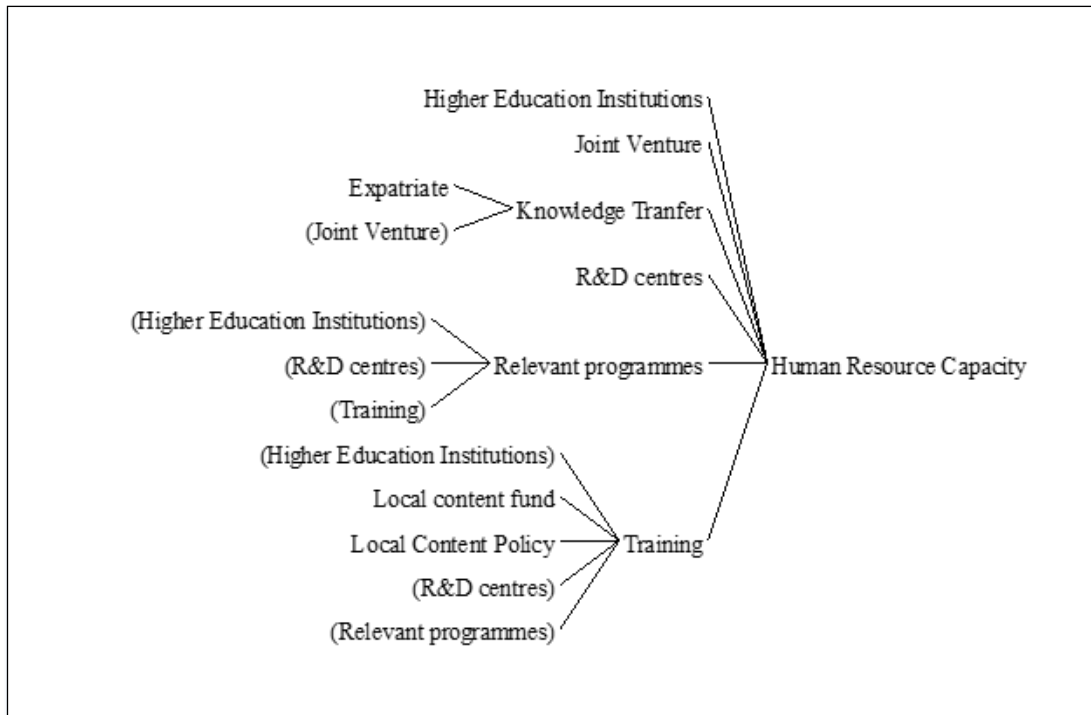
Figure 4: Causes Tree Diagrams for Human Resource Capacity

4.2   Policy recommendation for Human resource development

The next stage after the validation of the model is policy recommendation for its improvement. First of all, the government has the primary responsibility of addressing the issue which requires long-and-short term strategies. The long-term will require establishing an education fund to specifically resourced domestic R&D institutions, suppliers' development centres, and local universities for training and local capacity building. A specific amount from the Education Fund can be channelled into the Local Content Fund for training engineers and technical expertise etc. in the oil industry. In addition to the above, emphasis should be placed on vocational and technical education and improving educational infrastructure. This fund can be financed from proceeds from oil revenue, international development partners (World Bank, African Development

Banks etc.) and oil companies' contribution in exchange for tax waiver; strengthening regulatory institutions role and aligning educational curriculum with the industry's needs. Private participation in training should be encouraged in exchange for tax waivers and subsidies. In the short term, the LC policies and laws should come with sunset clauses, and regular review, i.e. 5 years to measure its progress and effectiveness. The LC should be seen as a short-term strategy and more importantly, it must be aligned with government overall strategy on human resource development. In encouraging JV between local and foreign firms to build local capacity, guidelines on beneficial ownership of the former must be part of the requirement for JV to prevent rent-seeking and state capture.

5. Conclusion

The adoption of system thinking aided in visualising the variables underpinning human resource development challenge in the Ghanaian oil industry and their relationships. This, in turn, provided a holistic approach in systematically analysing the variables in the causal loop diagram and their effects on policy. More importantly, it identified key leverage points in the CLD policy should be focussed. Long- and short-term strategies are, therefore, recommended in addressing local content implementation challenge of human resource capacity. The strategies proposed are premised on the fact that the government has the ultimate responsibility in addressing the issue. The local content policy should be seen as a stop-gap strategy and a complement to overall government strategy on addressing the challenge. And lastly, a long-term strategy should be

focussed on resourcing and restructuring the educational sector to meet the needs of the oil industry.

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