UNIVERSITIES OF PAVIA AND BERGAMO

DEPARTMENT OF ECONOMICS AND MANAGEMENT (PAVIA) AND
DEPARTMENT OF MANAGEMENT, INFORMATION AND
PRODUCTION ENGINEERING (BERGAMO)

PHD THESIS

Open source technologies and local economic development: Exploring adoption factors in a Less Developed Country.

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A thesis submitted in fulfillment of the requirements
for the degree of Doctoral Research in Economics and Management of Technology
(DREAMT 30 Cycle)

2014/2018

Declaration of Authorship

I, Kudzo Woezo PARKOO, declare that this thesis titled, "Open source technologies and local economic development: Exploring adoption factors in a Less Developed Country." and the work presented in it are my own. I confirm that:

- This work was done mainly while in candidature for a graduate program at this University.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.
- I have acknowledged all main sources of help.

Signed:

Date:

"This work is first and foremost dedicated to God almighty for giving me the courage and insight to complete this program. The study is also dedicated to my father Mr. Georges K. PARKOO and my memorable mother Ms. Monique A. WOWUI, my sister and to my brothers, and to my loved ones Claire Adzoto PARKOO and her sister Gloria Elikem Afiyo PARKOO for their and less support and friendship."

""Education's purpose is to replace an empty mind with an open one"(Malcom Forbes), that is why "I cannot teach anybody anything, I can only make them think"(Socrates). In fact, through this dissertation I am inviting you to think with me in order to save our societies from possible collapse."

Abstract

A rapidly growing body of research is investigating the role and the adoption of Information and Communication Technology (ICT) in alleviating poverty. Many of these studies have focused on ICT with proprietary software. However, careful academic studies have been devoted to the adoption of Free Open Source Software (FOSS), since it is recognised as a unique opportunity for less developed countries (LDCs). Although the dramatic growth of open source software has posed both opportunities and challenges for developing countries, the problematic nature of FOSS adoption tend to come to the fore, with fairly frequent reports of difficulties.

In the face of issues such as high levels of poverty, illiteracy, poor health services and lack of ICT awareness, it is essential to examine how developing country policy makers and other key stakeholders make informed decisions about the benefits and implications of choosing open source solutions. To exploit the opportunities to the full, all players need to identify and understand the strategic factors and trends influencing the development and the deployment of an efficient FOSS industry in LDCs.

With this research goal in mind, the present doctoral thesis examines existing studies to ascertain the influence of a range of technological, environmental, organisational, social and individual factors on information technologies adoption and identifies the potential factors that influence FOSS adoption and use in small and medium-sized enterprises (SMEs) in Ghana. Future trends that are likely to impact efficient FOSS ICT growth and development in the country are then assessed. The methodology employed is a two-fold approach, involving a quantitative method with partial least squares of the structural equation model (PLS-SEM) and qualitative methods using a combination of Delphi techniques and SWOT analysis.

The quantitative approach sets out to identify the potential factors influencing the adoption of FOSS technology on the part of SMEs in Ghana. The results suggest that certain external variables, namely software complexity, government supports, education and awareness have a negative influence on users' acceptance of new information technology. Conversely, software quality, compatibility and capabilities, power distance, social identification and personal innovativeness in IT have a positive effect. In summary, the results obtained from PLS-SEM reveal that related external variables explain 86% of variance of intention to adopt, which in turn explains 58% of variance in usage behaviour. Based on the final form of the model, individual and social factors are the most prominent in exhibiting effect on users' behavioral intention to adopt FOSS.

In the qualitative approach, an analysis is carried out to understand how influencing factors are likely to affect the deployment of FOSS in order to build an efficient software industry that could help to boost local economic development in the country. The investigation is based on the internal and external factors identified through the progressive phases of the Delphi techniques, and additionally, a SWOT analysis is performed. The result reveals significant strengths within Ghanaian SMEs but less opportunity for the country of Ghana as a whole.

In response to these findings, policy recommendations are outlined. In addition to the recommended integration of FOSS strategy within the Ghana ICT4AD Policy approved in 2003, there is need for strong support by the Ghanaian government and for optimum collaboration among the key players (universities, public and private industry, government).

Acknowledgements

I am very grateful to my tutor Prof. Giorgio Rampa (Dean of the department of Economics and Management, and Deputy director of DREAMT) and to my supervisor Prof. Vincenzo D'Andrea (Scientific Director of the Trento Doctoral Training Center and Professor of ICT innovation in the Department of Information Engineering and Computer Science) for their frequent guidelines and unconditional availability during the course of this project. I am also indebted to my advisor Prof. Carlo Buzzi, Professor of methodology of research and Dean of the Department of Sociology and Social Research at the University of Trento for his assistance and his flexible schedules during my research period in Italy and in Ghana.

Special thanks to Mr. Lorenzo Frangi, Professor in the Department of Organization and Human Resources at the University of Montréal, Québec-Canada and Mr. Gianpaolo Garzarelli, Professor at School of Economics and Business Sciences in the University of Witwatersrand, Johannesburg-South Africa, for their critical reviews of my write ups with constructive critiques. Great thanks to Madam Jane Hughes (Translator – Directorate for translation at the European Economic and social Committee), her daughter Emily Ziglio, and my friend Joshua Ocansey for their relentless effort in editing this thesis dissertation.

My heartfelt gratitude also goes to various lecturers and researchers from different universities (Pavia, Bergamo, Trento, LUISS–Rome, Sussex, France-Conte, Cheikh Anta Diop, Accra-Legon, etc.) involved in this research work; the coordinators for granting authorization and questionnaire distribution; various company managers in Ghana for their cooperation during the interviews especially Mr. Chris Nordjo, the Head of Network Operation Manager, Aya Technologies Ghana Limited; lecturers for their help during the analysis and interpretations of the results, and other key informants in Ghana especially Mr. Akoto Nono Agbeko.

To my aunt Madam Kossiwa Enyonam Wowoui (Da Essi) I say thank you for everything, God bless you. I am also appreciative to my cousins, and to all my friends: family of Gilli especially Anna, Don Fabio and Bruno; not forgetting Don Flavio; families of Bini, Tomasi and Tasin especially Claudia Tasin for their diverse support and friendship. I can continue mentioning names but the list cannot be contained in this report and the only way to reach all of you is to say well done, you have done it.

I love you all.

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List of Abbreviations

BDS	**B**erkeley (university) **S**oftware **D**istribution
ERP	**E**nterprise **R**esource **P**lanning
FOSS or OSS	**F**ree **O**pen **S**ource **S**oftware or **O**pen **S**ource **S**oftware
FOSSFA	**F**ree **O**pen **S**ource **S**oftware **F**or **A**frica
GPL	**G**eneral **P**ublic **L**icense
HEIs	**H**igher **E**ducation **I**nstitutions
ICI	**I**nformation and **C**ommunication **I**nfrastructure
ICT	**I**nformation **C**ommunication **T**echnology
IS	**I**nformation **S**ystems
IT	**I**nformation **T**echnology
LDCs	**L**ess **D**eveloped **C**ountries
OECD	**O**rganization for **E**conomic **C**ooperation and **D**evelopment
OSI	**O**pen **S**ource **I**nitiative
UNDP-APDIP	**U**nited **N**ations **D**evelopment **P**rogramme-**A**sia **P**acific **D**evelopment **I**nformation **P**rog

Chapter 1

INTRODUCTION

1.1 Background of the study

The major interest of this research topic is in the field of social sciences and applied information systems technologies. It is specifically related to the adoption and use of information systems based on Free Open Source Software (FOSS) or Open Source Software (OSS) in a local economic development context. Research investigations and experiences have suggested that FOSS has particular features that are conducive not only to cost reduction, but also to supporting sustainable development of the software industry and capacity building (Rajani et al., 2003). In other words, FOSS can generate an exclusive chance for less developed countries (LDCs) to make progress through the creation of an efficient local software industry. Therefore, many opportunities and challenges have opened up for LDCs as a result the dramatic growth of open source software, but how do these countries benefit from FOSS advantages? To capture profitable business models for FOSS products for example, services and training adapted to the context of developing countries can become an emerging frontier in the African ICT sector. However, the gap between those which have access and control of technology and those which do not (the digital divide) is getting wider in African countries. Likewise, the introduction and integration of ICT at different levels of society remains a challenging undertaking, with issues such as a high level of poverty, illiteracy, poor health services, etc. To assist the possible FOSS ICT adoption and its capacity development in LDCs, it is necessary to understand processes that can help LDCs to bridge the gap and benefit from the promising advantages of FOSS. Therefore, it is deemed necessary in this research to identify potential factors that influence FOSS adoption on one hand and on the other, to examine ways of ensuring how these factors are likely to affect the current deployment and future trends in a less developed country. In other words, factors that affect users' behavior in FOSS adoption need to be assessed and emphasis also need to be placed on the resulting impact of these factors on local ICT capacity development in the country under consideration.
As FOSS adoption initiatives to improve national software industries and promote development outcomes are taking place with positive results through micro-enterprises in countries like Argentina, Brazil, Costa Rica, Pakistan, India, etc., (Georg et al., 2018), it is certain that the introduction of FOSS ICT in small and medium enterprises (SMEs) can bring real benefits to developing countries such as Ghana, to cite one example.

1.2 Problem statement

It is increasingly difficult to query the relevance of Information and Communication Technology (ICT) to civilization these days. ICT represents an important channel in information systems, one that helps to build communities and societies of knowledge. It incorporates powerful tools for spreading and sharing information and knowledge that contributes to poverty alleviation, income generation and empowerment. According to Harris (2004), given the right conditions, ICT has proved capable of stimulating social and economic development in terms of improved education, health care, agriculture, trade and local culture. Hence the information society is defined as a form of post-industrial society where knowledge is the central resource in the economy (Toffer, 1980), and the fast-changing environment of today's information society has created new insights and possibilities for a redefinition of how to run economies. These new changes are due to the growing integration of global business, the spread of internet access and fast-growing information technologies such as new software development. It has over time become essential for all economic actors to participate in the global knowledge network (OECD, 1996; Archibugi and Lundvall, 2001). Software is therefore considered to be one of the most important industries in an information society (Baltac, 2003), providing a wide range of benefits to LDCs as well as more developed countries, and also engendering a major challenge in terms of the availability of ICT infrastructure within organizations or enterprises. In fact, small, medium and large size enterprises using and developing information and communication technology nowadays are making significant investments in complex information systems such as: enterprise resource planning (ERP); enterprise content management (ECM); business process management and product lifecycle management systems; human resource management systems; shopping cart software; accounting software; office suites, etc. In other words, companies have increasingly invested in IT systems in order to enjoy the promising benefits. However, several IT systems projects in companies face constraints and subsequently result in failure (Chang, Cheung, Cheng, & Yeung 2008). In addition, vision is undeniably critical to introducing FOSS in the IT world.
Research investigations in this area have revealed that the adoption of FOSS provides important advantages for companies. These advantages can be exploited to overcome, for example, constraints that companies face in their IT project investments and implementations, especially in LDCs. Open source software creates opportunities for LDCs to achieve competitiveness in critical IT technologies while lowering the costs of ownership, improving access to IT resources, and easing adaptation to local needs (Ghosh, 2004). Since LDC governments recognized the potential benefits of adopting FOSS, efforts continue to be taken in order to make the most of this potential. Thus, governments, national and international organizations worldwide are looking for different strategies and policies, but despite this, *FOSS adoption is extremely sluggish* (Victor Van Reijswoud & Topi C., 2004; Victor Van Reijswoud, Arjan de Jager, 2008). To benefit from the opportunity that the free software movement philosophy offers, it is then up to each LDC to understand the related factors that affect FOSS adoption and the generation of an efficient national software industry capable of delivering and expanding FOSS advantages in a developing economy.

1.3 Rationale

1.3.1 Problem justification

In LDCs, a high level of poverty, illiteracy, poor health services, lack of ICT awareness and infrastructures, political instability, etc., are issues that affect development prospects and

the current challenges facing these countries. In conditions of such poverty and its attendant deprivations, how can policy makers and key stakeholders make informed decisions about the benefits and the implications of choosing open source solutions? FOSS offers solutions to many of these problems LDCs face, including unaffordable software prices, software piracy, and monopolies caused by software giants that prevented the local industry from expanding (Kayani, 2005). Findings demonstrated the pertinent advantages of FOSS for LDCs and the growing interest shown by some local governments in using FOSS, yet the roll-out of software is still very slow in these countries. Although some investigations were carried out in order to identify factors that prevent LDCs from benefiting from the software advantages, a more in-depth study is required in what are the factors that affect users' adoption of FOSS in a specific area in order to provide additional insight into how ICT academia, experts and business managers could make informed decisions about the benefits of FOSS. Only a few investigations have been conducted to follow up on this issue in the management and business area focusing specifically on local concerns and perspectives. For this purpose, the present PhD research aims to identify strategic influencing factors for adoption of FOSS in Ghanaian SMEs, and to plan how to support software capacity building and development in Ghana.

1.3.2 Why Ghana as a research field?

1. **From a general point of view**
   Ghana is considered a LDC since it fits the criteria that are used to identify such countries (World Economic Outlook Report, April 2015). In fact, carrying out research in LDCs can often be more problematic than in so called developed countries since researchers can face a variety of problems. Some of these problems were also observed by Pender, J. (1996):

   - Poverty, livelihood insecurity, vulnerability, and low income;
   - Lack of access to markets with subsequent low prices for the produce;
   - Inadequacy and unfairness of laws and regulations;
   - Lack of voice and power of ordinary people in the national and local policy-making;
   - Gender oppression and inequality;
   - Lack of recognition of rights, including: tenure over land and resources (customary and/or statutory); citizenship; civil rights; human rights;
   - Victimization of local people by powerful outside entities (e.g., government, military, private enterprises);
   - Problems related to environmental management and conservation (e.g., deforestation, restriction to access natural resources, climate change);
   - Insufficient and unreliable access to health care and education;
   - Conflict and war and natural disasters; etc.

   Indeed, since the shared vision of stakeholders is to address the above issues in order to boost sustainable growth, research in economically poor regions becomes absolutely essential. Research efforts should thus be proportionate to the severity of social, political, economic and environmental issues of regions. Moreover, increased knowledge of these issues is always valuable as a means of achieving greater research investigation and understanding.

2. **From a specific point of view**
   Ghana (a West African country with a surface area of 238,533 square kilometers) has sought to improve the quality of life of indigenous peoples and foster national development since the end of the colonial era:

   Country profile: Apart from the fact that Ghanaian people agitated earlier than other African colonies for independence, which led the country to be the first black African country to achieve independence in 1957, at the end of British colonization Ghana has become one of the few African countries to experience exceptional political stability and economic growth. This is proof of the will of Ghanaian leaders to shape their own future by democratic means in order to gain a place on the world's list of developed countries.

   Politics: Ghana is considered to be one of the more stable countries in West Africa since its transition to multi-party democracy in 1992. The country enjoys a high degree of media freedom and the private press and broadcasters operate without significant restrictions.

   Society: With a population of 25.5 million of people of whom the majority (58%) are under 25 years of age, the population life expectancy is about 64 years for men and 69 years for women. This means that the country has an important productive human capital. Moreover, the 3.4% annual rate of urbanization from 2010 has led a rise of the urban population equal to 54% of the total population (Sources: UN, World Bank, 2016).

   Education: In 1986, Ghana government kicked off a series of reforms in reaction to the degradation of the education sector. Consequently, the Education Sector Project (EdSeP) is rooted in a sectoral and macro-economic context. In recent years, the Secondary Education Improvement Project (SEIP) was approved and declared effective on October 2014 (Word Bank Education Projects, 2017). The development objective of the SEIP for Ghana is to increase access to senior secondary education in underserved districts and improve quality in low-performing senior high schools (SHSs) in Ghana, and comprises a number of pillars that include for example 'expanded ICT and Internet connectivity in schools'. (Sources: UN, World Bank, 2016/2017).

   Economics: Notwithstanding the various challenges that LDCs face, most of them (including African countries) often have significant and varied natural resources. The abundance of natural resources should provide a good basis for these countries to support and contribute to a good starting point for development. For instance, the Ghanaian economy has been blessed with plentiful natural resources such as industrial minerals and hydrocarbons. It produces high quality cocoa and is one of the largest producers of cocoa in the world. Gold, cocoa and more recently oil form the cornerstone of Ghana's economy. The nation's GDP at purchasing power parity (PPP) was estimated at $120.8 billion in 2016. The services sector accounts for 56.4% of its GDP in 2016 followed by manufacturing industry 24%; agriculture 19.5%; etc. More recently, its economy has been affected by a growing public deficit, high inflation and a weakened currency (Cedis), resulting in it seeking an IMF bailout. However, until 2013/2014 Ghana was hailed as a model for African growth (Sources: UN, World Bank, 2016).

   Information and Communication Technology: The Ghanaian government decided in 2003 to introduce the ICT for Accelerated Development (ICT4AD) policy with the vision of engineering an ICT-led socio-economic development process with the

potential to transform Ghana into a middle income, information-rich, knowledge-based and technology-driven economy and society (Gillwald, 2005). Moreover, different programmes focusing on ICT in Ghana managed to increase internet access from 23.5% of the population in 2015 to nearly 29% a year later in 2016 (Sources: UN, World Bank, 2016). Ghana is reportedly moving towards FOSS (Ikhemuemhe, Godfrey, 2003), however studies also showed that in the desktop environment, the Windows operating system for the most part prevails over FOSS operating systems (Wayan Vota, 2010). Institutions such as the Ghana India Kofi Annan Centre of Excellence in ICT and other user groups (Students Linux Space, Ghana Open Source Society, Ghana Bloggers Community, etc.) are advocating the adoption of FOSS in the country, but a lot more needs to be done (Worlali Senyo, 2010).

1.3.3 Why industry, especially Small and Medium-sized Enterprises (SMEs)?

Nowadays, small and medium-sized enterprises (SMEs) make a major contribution to the economy of every country. It has been empirically demonstrated that the adoption and use of ICT could prove to be highly advantageous in terms of efficiency, effectiveness, innovation, growth and competitiveness for enterprises. In fact, to benefit from the advantages of information technologies, companies should align their managerial and productive processes with ICT systems. SMEs represent the majority of companies operating within the industrial sector across the world. The choice of SMEs within the industrial sector is supported by the fact that large-scale industry has not been an engine of growth and a good provider of employment; these industries already receive enormous support through general trade, finance, tax policy and direct subsidies, while SMEs mobilize funds which otherwise would have been idle; SMEs have been recognized as a seedbed for indigenous entrepreneurship; they promote indigenous technological know-how and use mainly local resources, and thus have fewer foreign exchange requirements; they cater for the needs of the poor and adapt easily to customer requirements (Abor Joshua and Nicholas Biekpe 2006).
Globally, the definition of small-scale enterprise has been a very controversial issue. For example, enterprises in the USA businesses with fewer than 500 employees are termed as 'small and medium-sized enterprises', while in the European Union a 'small and medium-sized enterprise' is defined as one with a headcount of fewer than 250 employees (OECD, SME and Entrepreneurship, Paris, 2005). In Ghana, SMEs are broadly classified as rural or urban. The rural enterprises consist of individual artisans, groups of people working in the fields of pottery, basket weaving and dress making. Others include baking, blacksmiths, leather works and textiles. The urban enterprises are either organized or unorganized. The organized ones have registered office space and paid employees. The unorganized ones have no paid workers and often operate in occasional open spaces (Osei B et al. 1992). Nowadays, the principal activities of SMEs in Ghana are in agriculture, manufacturing, commerce and services. Therefore Ghanaian SMEs are capable of play a crucial role in stimulating growth, generating employment and contributing to poverty alleviation in the country. For instance in the service sectors, Ghanaian SMEs represent a competitive business environment (UN, World Bank report 2016). However, SMEs are not entirely exploiting the potential of ICT as do large companies (Al-Qirim, 2004; Girgin, Kurt and Odabasi, 2011). In fact, the adoption and the diffusion of ICT in smaller enterprises is low; FOSS adoption and IT systems innovation in SMEs industry are often in the embryonic stage of development (Girgin, et al, 2011). However, these companies have the advantage to be more flexible and adaptable to changes of market demand due to their less complicated structure (Assinform, 2010). To encourage ICT investment in these smaller companies it is necessary to opt for FOSS solutions since it could be argued that FOSS acquisition, labour

and switching costs (costs of ownership) are free or small (Ghosh, 2004; May, 2006); FOSS could help SMEs to be more independent from other companies' IT systems, compared to large companies that compete on a worldwide level; etc.
The above- mentioned reasons have given Ghana a privileged place as a research field among other LDCs and, moreover, fundamental evidence such as the researcher's familiarity with the different cultural scenarios in Ghana, and his experience in community and public relations will be significant assets that could help in such mapping and collection of data in the country.

1.3.4 What is the link between FOSS use in SMEs, ICT capacity building, economic development and the local context?

Today, successful developments rely on the software industry and the manufacturing sectors. That is, creativity, innovation and entrepreneurship, along with the software industry, are essential factors to remedy LDCs problems. Since the means for addressing socio-economic and environmental issues can be more limited in LDCs, the introduction of FOSS in these countries industries can provide more possibilities and opportunities in terms of solutions through the cost reduction offered by FOSS, flexibility, and skills development advantages. Thus, fundamental advantages of FOSS, unlike proprietary software, could complement efforts in ICT capacity building and generate socio-economic development. These efforts represent a circle of knowledge growth that emanates from the FOSS community which, according to Garzarelli et al. (2008), is nothing more than a learning community where the emergent knowledge has significant productive value. FOSS community is mainly about the exchange, production and re-use of one service: *knowledge* (Garzarelli, 2004). The exchange, production, and re-use of knowledge which represent the roots of FOSS ideologies could enable citizen (user) participation in shaping and developing local content. This is because FOSS ideologies provide a platform on which software development communities may start their own local efforts. In fact, offering a fully localized FOSS platform is the most viable solution for socio-economic development of LDCs to tackle their ICT dilemma (Jaffry & Kayani, 2005).
In addition, it is important to emphasise that the link between ICT capacity building, development outcomes (economic, social and human) and local context could be better achieved through the firm. In effect, Chesbrough's open innovation model posits the organization as the main actor that takes in ideas from outside and refines them in traditional research and development activities (Chesbrough, 2006). The concept of economic development has its roots in the economics of the firm. Specifically, micro-enterprises are important in assessing development outcomes from their use of ICT (Georg et al., 2018). Roztocki and Weistroffer (2016), have had clear confirmation of this point of view and claimed that through the use of ICT, micro-enterprises become more efficient, create more value, and affect development even more. It should be noted however, that development generated by the increasing use of ICT in SMEs could often be accomplished through FOSS. Because FOSS can be used for free, it enables micro-enterprises to try it out and build new services and products using it as a basis (Georg et al., 2018).

1.4 Research question and objectives

The scope of this PhD research is to conduct research which focuses on identifying factors that influence FOSS adoption in SMEs on one hand and on the other, understanding the FOSS adoption phenomenon as applied to a territory where there are credible elements to make it feasible, but where a proper investigation has not yet been conducted.In effect, the

thesis that the central focus is on FOSS adoption has given way to explore the factors that influence FOSS adoption in SMEs and its impact on ICT capacity building and development in Ghana. In other words, the scope is to identify and possibly explain what drives or blocks Ghana's entrepreneurship from using FOSS in order to provide IT professionals, academia, leaders, etc., (major stakeholders) with further insight into ways of making and improving the strategic decisions of FOSS adoption in SMEs for LDCs such Ghana, which has decided to increase ICT for development (ICT4D).
As previously mentioned, the principal actors in this study were restricted to organizations, especially small and medium-sized enterprises (SMEs), thus focusing on Ghanaian IT users and connoisseurs within SMEs. The central question which guided the research objectives is derived from all the reviewed literature discussed in the second chapter, and is:

> *What are the potential factors influencing FOSS adoption and the resulting impacts on local ICT capacity and development in Ghana?*

This central research question could in turn be broken down into two secondary research questions such as:

1. *What are the potential factors influencing FOSS adoption in Ghanaian SMEs?*
2. *How can these factors influence the deployment of effective FOSS ICT for development in Ghana?*

1.5 Plausible theoretical models

Technology acceptance model (TAM): To understand the complex adoption and implementation of new technology, there needs to be thorough assessment of user acceptance of that specific technology: Davis's technology acceptance model (1989). Several studies have replicated Davis's (1989) original acceptance model (Adams, Nelson et al., 1992; Davis 1989; Hendrickson, Massey et al., 1993; Segars et al., 1993; Subramanian 1994; Szajna 1994), and results have confirmed the validity of the instruments used by Davis. For example, given the effectiveness of the model, only 10 years after its publication, the Social Science Citation Index listed more than 400 articles that had cited both of Davis's introductory articles on TAM methodology as indicate by Venkatesh and Davis (2000). Since then, continued interest has been shown by several researchers (Van der Heijden, 2004; Bruner & Kumar, 2005; etc.), in the use of this model to come up with informed technological innovation decisions. Following Davis (1989), and other research works, it may be noted that user acceptance for new technologies is the sine qua non condition that allows decision-makers to identify what really constitutes factors influencing the adoption and the use of a specific technology. That is, the managers of firms or organizations need to assess the system adoption acceptance from the perspective of their users. This should help organizations that are willing to invest in IT, as well as FOSS, to prepare their IT users to face new challenges and learn how to make good use of the system to reap tangible benefits (Chang et al., 2008). Following on from this argument is the statement that justifies the consideration of the technology acceptance model (TAM) as a plausible and fundamental model for a good evaluation of user acceptance of IT in this study. Specifically, the adapted model of FOSS technology of Gallegoa, Luna and Bueno (2008) is taken into account in this research work.

Social identity theory (SIT): Moreover, the above argument has led to the consideration of social identity theory (Tajfel and Turner (1979) as the most focused theory in this study. Social identity theory could involve a number of elements, including individual

and social aspects of FOSS adoption. That is, since technology users involved in the investigation come from a specific context where they all share common historical origins, at the same time as being profoundly affected by national, socio-economic and cultural environment characteristics, social identity theory should be a valuable theory that could provide a specific and valuable contribution for this research, because it includes specific aspects and other elements to which they should conform.

Technology, organization and environment (TOE): Although TAM and SIT are considered as fundamental models involved in this study, the technology, organization and environment (TOE) framework (Fleischer, 1990) has not been overlooked. This is because even the technological dimension of FOSS has appeared as common characteristics (software flexibility, quality, compatibility, etc.), it describes both the internal and external technologies relevant to the firm, as well as organizational and environmental dimensions encompassing the specific geopolitical context. In other words, the managerial structure and the arena in which the firm conducts its business and dealings with the government (Tornatzky and Fleischer 1990) could also influence the process by which users adopt a new technology.

Based on each of these three models (TAM, SIT, TOE) that have already been used to assess studies in this field, factors derived from shortcomings of some of these theoretical models are identified. All the presumed factors of these models are incorporated into a single framework (see Chapter Three). This single framework should comprehensively cover the adoption factors of FOSS that are considered for this research investigation. In fact, several factors identified through the three models resulted in a range of hypotheses that will be developed in the literature review chapter.

1.6 Research methodology

The dissertation is mainly a scientific-gap driven research that comes to an end with some brief policy suggestions in the final chapter.

Based on the above rationale, a mixed method (quantitative and qualitative) approach is considered the most appropriate for this study. In other words, the research approach is both deductive and inductive. The overall methodology procedure comprises the following two main steps: data collection and data analysis. Data collection in general was basically done through various primary sources, involving key informants. The data was gathered using questionnaires and group interviews during the survey. Other data sources mainly covered different journals, such as those on Management Information Systems; Information Systems Research; Information and Management and Management Science; Social Science (Elsevier); Political Economy; etc. That is, pertinent publications were found in the literature of a number of academic domains including business studies, information systems, science and technology, sociology and strategic management, psychology, and political economy. Most of these publications take the form of research papers that include literature analysis studies on IT/FOSS adoption. Moreover, to ensure broad participation to the survey and to obtain consistent information from motivated participants, data collection was generally supported by academics and decision makers of some Ghanaian organizations. Likewise, anonymous questionnaires were introduced without prejudice to respect for the privacy of some participants, where appropriate. Data analysis was respectively carried out using two approaches: the quantitative approach involved the application of statistical methods that simultaneously analysed multiple variables (multivariate analysis using structural equation modelling), and the qualitative approach entailed a combination of Delphi and SWOT techniques which facilitated the participation of more effective experts and sought their opinions on specific issues in relation to the

research objectives. The techniques were employed in order to gain deep insight into the FOSS adoption phenomenon in Ghana. The justification for and key characteristics of these techniques of analysis are explained in more detail in the methodology chapter (Chapter Three).

1.7 Thesis structure

The thesis outline is presented in order to provide the reader with a quick overview of different stages to be included in the thesis as follows:

1. Chapter One: Introduction
2. Chapter Two: Literature review
3. Chapter Three: Research methodology
4. Chapter Four: Presentation and interpretation of the results
5. Chapter Five: Discussions, recommendations and conclusions.

The introductory chapter lays the foundations for the thesis. The chapter sets out the problem from which the topic of this study arises and provides a map for the investigation. In fact, Chapter One presents the general overview of the topic, announces the research problem and the objectives. Furthermore, the chapter explains the rationale underpinning the research, presents the possible models involved and briefly describes the methodology structure. In Chapter Two, the literature review explores what is already known in relation to the research topic and persuades the reader that there are unanswered questions which need to be addressed. Briefly, the chapter provides a definition of some key concepts, explores the emergence of the FOSS movement worldwide, its impact on software industry and consequently on development outcomes. Moreover, the chapter presents and discusses the plausible theoretical models mentioned, their derived factors considered in several FOSS adoption studies and the hypotheses they could involve. Chapter Three details the steps taken to answer the research question. Initially, the chapter discusses the empirical approach to the research problem and presents the justifications for the selected methods in terms of its advantages and disadvantages against other possible methods. Subsequently, the mixed method (quantitative and qualitative) approach is developed by detailing the respective data collection and analysis steps of each method. Chapter Four presents in general the results of the analysis and then uses the conceptual angle of a SWOT framework to interpret the results. The final chapter concludes the research work by summarizing the investigation undertaken and reflecting on policy suggestions for building a viable FOSS driven ICT capacity and development in Ghana.

In summary, to better understand the thesis and the chronology of its drafting process, it is deemed necessary to underline in this introductory chapter the theoretical and conceptual framework underpinning the topic. Therefore, the reader must bear in mind that in this thesis, the research questions hold central and fundamental attention to both the overall purpose and design of the thesis, and all the chapters are closely interlinked. In addition, a point that should not be underestimated and that shares fundamental concerns with the thesis when it comes to FOSS adoption in Ghanaian SMEs, is that, to the best of my knowledge, no one has written about this yet.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

This chapter defines some key concepts and provides an overview of previous research on FOSS adoption and its implementation. It also introduces the theoretical models for the case studies that bring out the main focus of the research described in this thesis. The main focus of this literature review work is to survey previous studies on factors influencing FOSS adoption in less developed countries. This is done with a view to delineate the key data collection requirements for the primary research, which according to Denscombe, (1998), formed part of the emergent research design process.

2.2 Part One: Information and Open source software technologies

2.2.1 General understanding: Concepts and definitions

In general, information and communication technologies (ICTs) refers to forms of technologies that are used to create, store, share or transmit, and exchange information. For years, information has become a major stake, and the settlement of automated ICT in companies or forms of organizing seems to offer an answer to these needs. All ICT structures (ICI[1] ; IT[2]) are associated with a substantial change in the way humans organize themselves for instrumental purposes. This change is explained by features that allow them to transcend barriers that the traditional communication technologies do not have: reaching many people simultaneously; overcoming geographic boundaries; overcoming social and literacy barriers; providing frequency and repetition of contact; storage of information for on-demand access; capturing the reality of events, by depicting them graphically and in real time; greater efficiency (lower costs) in sending and receiving information. For example, technologies such as the telephone, the railway and office paperwork have had profound effects on the structure of modern organizations. Computers have been applied to problems in medicine for several decades and in school education (Sproull and Kiesler, 1991). With the same vision, the Executive Director of Bridges.org also contends that ICT is a key weapon in the war against world poverty (World Bank, 2005). ICTs offer a great potential to empower people in LDCs to overcome development obstacles; to address the most important social problems they face and to strengthen communities, democratic institutions, a free press, and local economies (Peters, 2003). ICT is observed to include the

[1]Information and Communication Infrastructure (ICI) which refers to physical telecommunications systems and networks (cellular, broadcast, cable, satellite, postal) and the services that utilize those (Internet, voice, mail, radio, and television).

[2]Information Technology (IT) that refers to the hardware and software of information collection, storage, processing, and presentation.

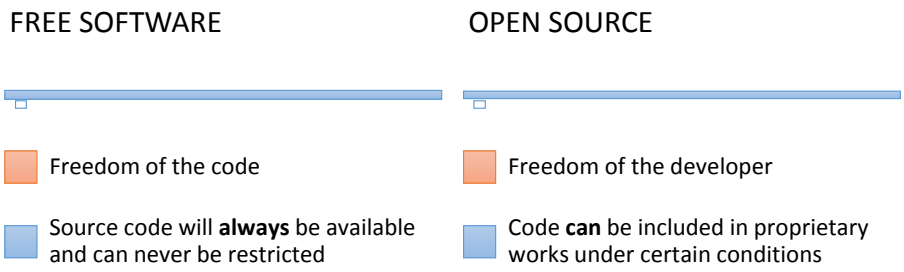
full range of electronic technologies and techniques which are used to manage the information as reported by the United Nations Development Programme (UNDP). ICTs are the engines that drive the deployment of knowledge and information and are also pipes and mechanisms, through which knowledge and information are transmitted. Therefore, access to the internet returns as an important component of the smart grid because it can support the transmission and the exchange of information.

Brief historical of OSS/FOSS

Just for a brief record, until the '70s software was seen like a natural component of a computer, which allowed to give a "possibility" to the hardware that was acquired with costly money. The developers that often worked in academic area, exchanged codes freely. It was only around the '80s that software was considered to be an added value and becoming an "owner", that is buyable separately from the computer, distributed already precompiled without sources codes and protected from licenses with legal valence that prohibit the unauthorized copy and distribution of it (Barbara Russo et al., 2009).
Starting in the 1980s, Richard Stallman[3] reintroduces the philosophy of shared ideas and program code in the software world. According to Stallman, four freedoms that must be respected to consider software "free" are: "[...] Freedom zero is the freedom to run the program as you wish, freedom one is the freedom to help yourself, in other words the freedom to study the source code of the program and then change it to do what you wish. Freedom two is the freedom to help your neighbor; that's the freedom to make copies and distribute to others, and freedom three is the freedom to help your community, that's the freedom to publish modified versions so others can get the benefit of your contribution. These four freedoms are all essential; in order to be free software the program must give you all of these freedoms." In 1989 R. Stallman synthesized these freedoms in license GNU General Public License (GPL). The software protected by such license can be unreservedly used, modified, copied and distributed (R. Stallman, 2002, 2007, 2008, 2009). Open source programs are typically developed by a community of developers without a specific commercial aim. In fact, according to Ron Goldman et al., (2005), doing open source requires transparency and openness. This means that it is necessary to be open to new ways of doing things, and this openness may result in benefits for all participants. The more an open source project encourages conversations and exchanges among all of its community members, the more benefits it will get from using the program. What is particularly important about open source is that the development process must be effectively open. That is, all users or developers, both internal and external of a specific environment, need to have the same access to the source code and be able to fully participate in discussions and decisions about its design. Over time, news terms (Open Source Software - OSS, Free and Open Source Software – FOSS) related to "free software" were born. Practically as a result, there is not a great difference between OSS and FOSS or derived terms (FLOSS, F/OSS, etc.). These terms often become confused or are used as synonyms, in different research works. Observing the following figure (Figure 2.1) presented below, free software more proposes a relevant approach to the topic that extends the field of computer science development, while the open source consists of a sort of compromise between these ideals and the practical requirements of market (Bernard Dione, Rejean Savard, 2007).

[3]Richard Stallman, graduated in physics to Harvard University in 1974, was a developer of talent in that year. He decided therefore to actively undertake a new plan aimed at the creation of an operating system called GNU that was compatible with UNIX, the system more diffused at that age, but completely free. (Sam Williams, (2002). Free as in Freedom: Richard Stallman's Crusade for Free Software. Jeffrey Holcomb, ISBN: 978-0-596-00287-9).

FIGURE 2.1: Free software vs. Open source.



Despite being fully aware of the confusion of these terms, the relevant approach suggested by the free software will remain the main idea in this research work. In others words, what interests us in this topic is not the confusion surrounding these terms, but instead the issue at hand is to understand how this technology with an overview sense could be more adopted and used in order to benefit from its promising advantages. For this reason, the term "free open source software" (FOSS) should be more used in this topic in order to involve the complete meaning of this technology in the research investigation.

Open source VS Closed source

Nowadays there are different producers of software. Some software is open source and others are closed or proprietaries. This distinction is related to the scope of use and constraints to take in consideration before using a software. In fact, the way of production affects different aspects of software usability, price, efficiency, efficacy, duration of use that can be long term or court term (Fabio Manenti, and Stefano Comino, 2003). For instance, while FOSS is usually distributed by single developer or new groups that are not looking to maximize their profit and offer different solutions for their users, closed/proprietary software is produced by potential firms that are able to advertise their products around the world by achieving a high number of clients and selling a huge number of product units with the main purpose to maximize the profit (Fabio Manenti, et al., 2003). In some public administrations for example, open source is supported not just for its best price but also for its possibility to increase the welfare of citizens (UNCTAD, 2003).
What makes the fundamental difference between FOSS and the proprietary software is the 'source code' in the producing process analysis. Source code in open source is offered for free. Open source gives the possibility to change and develop its source code and the possibility to share it as well another time. These properties of open source are the opposite of the closed source. With closed software there is no access to the code source. Moreover, it is conserved and supported by copyright[4] law.
There are other aspects to take into consideration in the process of production like the modularity according to Howard Baetjer, Jr, (1998); James W. Paulson et al., (2004) and others, (see the next section 2. for more details). Tim O'Reilly, (1999); Audris Mockus et al., (2000), state that open source production is more modular than the closed one. In fact, this explains why open source development fosters faster systems (Eric S. Raymond et al., 1999). Consequently, defects are fewer on the open source and frequent in the closed one, but usually these defects are fixed quickly with the proprietary software (Audris Mockus et al., 2000), and this explains the main purpose of profit and strategies used by closed software firms to win money.

[4]Copyright is a legal right created by the law of a country that grants the creator of an original work exclusive rights for its use and distribution.

2.2.2 Software industry, local capacity building and development outcomes

FOSS impact on software development and software industry

Software industry is in a phase of closing the merchantization stage with the introduction of FOSS (Pykalainen, 2007). In effect, the introduction of FOSS in software industry is threatening closed software companies' high profits. Different software characteristics such as the freedom enjoyed by its users; the free of cost; the customization; the system functionality at faster speed; etc., have led for example Linux[5] or its popularity and success in the software industry (Sources – The Linux Foundation). With a significant internet presence, the numbers of free open source software are increasing day by day, and have changed the paradigms of the software industry making the reality of FOSS a phenomenon. 'Open Source For You' Magazine of December 2017, notes that there exist numerous open source projects such as PHP; Python; PostgreSQL; Perl; MySQL; Mplayer; Apache; VLC; Audacity; Inkscape; GIMP; Enlightenment; OpenLDAP; and many others that have triggered numerous changes in the software industry. In general, this progressive increase is supported by the commercial sector that wishes to make profits from their investments. Though, a fundamental reason is well-founded on the coordinating distributed learning process that occurs during the software development. This strategy is known as modular programing[6] that forms the guiding principle behind most of the advances in software construction (Taylor, 1990). According to Bertrand Meyer, (1988), what makes a software design evolvable is the modularity. FOSS production usually is based on other components that exist before (Bruno Rossi, et al., 2015). These components are inputs available through preceding work of specialists who have built those inputs of which developers could take advantage to compile and build new open source programs. By doing this, software component as laid out by Howard B. (1998), constitutes working capital for developers, to be used in the construction of the software tools they build. Once a developer manages to achieve the final point of FOSS production, the code source of the program is made freely available for study, improvement, and redesign by other users or developers and so forth. In fact, this explains why FOSS development involves the community of developers without a specific commercial aim. Doing open source requires transparency and openness. It requires being open to new ways of doing things. This openness could result in benefits for all participants, to the extent that the more an open source project encourages conversations and exchanges among all of its community members, the more benefits it will get from using the program. What is really important to note about the impact of FOSS on software development and software industry is that the development methodologies bring by FOSS in the software industry must be effectively open. That is, all users or developers, both internal and external of a specific environment, need to have the same access to the source code and be able to fully participate in discussions and decisions about its design. By building software in a modular fashion, a relevant benefit for software evolvability is promoting. This goes beyond the evolvability of particular products (Howard B., 1998), that can be possibly adapted to local needs and specific sociocultural contexts.

[5] Linux is a Unix-like computer operating system assembled under the model of free and open-source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released on September 17, 1991 by Linus Torvalds

[6] According to Howard Baetjer, Jr, (1998) in his book Software as Capital, "Modular programming, then, is a manifestation of division of knowledge in capital. In modules, different sets of knowledge are embodied in such a way that they can usefully be shared across time and space. But of course, merely to divide knowledge into modules does not ensure success. The modules must be complementary to one another in use. That means both that they must fit, and also that people who use them must be able to see without too much trouble just how they fit"

Capacity building in software industry and its development outcomes

One can define local capacity building as the process aiming to facilitate, in conjunction with the local stakeholders, a consolidation of their capacities at an individual, organizational and sectorial level to allow them to evolve and adapt to the new contextual requirements and fulfil their role within a local governance structure (Cotonou Agreement, 2004). On the basis of this definition, FOSS capacity building in software industry can analogously be defined as the process that involves capacity of users or developers to use existing FOSS products, in adapting and developing new FOSS products for new contextual requirements. But, how does FOSS facilitate this change? In Bertrand Meyer's terminology, there are two main kinds of software evolvability for us to consider as a response to this question:

- extendibility – that means, the ease with which software products may be adapted to changes of specifications, and
- compatibility – that means, the ease with which software products may be combined with others (Bertrand Meyer, 1988).

In software engineering, modularity is acknowledged to be fundamental to software extendibility, compatibility, and reusability. This process leads us to view software development in itself as a learning process. According to Howard B., (1998), "if a system cannot be understood, then further learning in respect to it is hindered". Thus, a system must be designed so as not to impede access to its code and must be able to be easy to use. The freedom of the system (code) reusability is absolutely attributed to open source software production. Hence with code reuse, software that has been accomplished before does not need to be repeated, but rather it brings opportunity to adapt and improve existing software in response to changing needs. Indeed through capacity building efforts, modularity in software (FOSS) construction promotes evolvability in ICTs sectors. This could explain the reason why Beth Walter Honadle, (1981), sustains that capacity building is expedited by ICT technologies. Likewise, the purposes of several projects have drawn our attention to the role of FOSS as a technology that can help increase ICT use among various sectors involved in development activities (UNCTAD 12^{th} session, 2008).
In general, development could be defined as good outcomes in education, employment, shared values, public-private innovation, etc. In considering development outcomes, Hargittai, E., (1999) and other studies have shown that the rate of information technology diffusion is correlated to the general level of socio-economic development. At this point, capacity building based on existing capacities and competencies in the environment should be focused on human resource development (suitable skillset) and management (strategy, organization, knowledge and information) to prime the sustainable development. According to Pearce, D., (1988), sustainable development treats socio-economic and environmental issues, where the social factor takes in consideration work and revenue of local population; the economic factor has to maintain the welfare (security, education, health, democracy, participation, justice) distributed in fair way between different classes and genders; and the environmental factor maintains the natural resources quality and its reproduction. In fact, the concept of development outcomes can be grouped into the economic, social and human dimensions (Malaquias, et al., 2017), and capacity building focuses on improving the process of development of these dimensions and strengthening it.
In simpler words, one cannot discuss capacity building without highlighting the concept of development outcomes. To keep the on-going betterment of development, continuous improvement approach can be then envisaged through FOSS adoption since one of the

most important advantages of FOSS is the aspect of the software evolvability (extendibility, compatibility, and reusability) that gives the opportunity for arbitrary localization and customization.

2.2.3 FOSS technologies for organisations - SMEs

The onset of the internet and ICTs revolution are completely changing our lives in an unprecedented manner. ICT has changed in different activities the way we work and look at our administration. In industry world-wide, FOSS has matured and its acceptance and market growth have increased to the extent that it is considered a viable solution and a serious contender to proprietary software (Weller and Van Belle, (2007). Therefore, new business models have emerged as new types of entrepreneurship and new forms of leadership under the day-to-day integration of a wide range of information technologies tools in the sector. FOSS has then extended its roots deep into the different areas by offering a variety of software solutions (Kevin Johnston, et al., 2013). For example, number of FOSS have made significant impact in today's business world (Ephraim Nikoi, and Kwasi Boateng, 2014). FOSS systems are offering to organizations IT benefits at a reduced cost (Ellis & Van Belle, 2009). Among these organizations or companies, SMEs are playing an important role. In effect, since SMEs occupy an important and strategic place in economic growth and development in all countries (Abor and Quartey 2010), they are considered relevant in evaluating development outcomes from their use of ICT as laid out by Georg et al., (2018). At this point, better understanding of the organization environment is needed.
SMEs industry environment understanding is gained from a scan of internal and external factors and trends that have the potential to influence this sector. Companies that are chosen and involved in the use of open source platform, and perform a comprehensive analysis of the intrinsic features of each software in use, achieve the best managerial and organizational processes (Carvalho et al., 2009). Indeed, the competitive advantages that a community could gain from FOSS adoption in a specific sector or industry depend on the intrinsic characteristics of the specific technology in adoption. Both the advantages concern the internal and the external environment of the sector. For example advantages such as, *functional fit of FOSS* as technological proposition that is a resource of growth adjustment customization of work within the company; *flexibility of FOSS* which allows to answer for all clients' requests; *continuity of FOSS* that updates the best management of the company; *maturity of FOSS* that decreases the maintenance cost for the company; and *support of FOSS* that allows the company to plan its research and development, are the key macro-areas which under the use of FOSS technologies for managerial and organizational process could affect margins and profitability of the companies (Herzog, 2006). That is, open source's integrated management systems, through their intrinsic functionalities, could contribute to quality internally the organizational and managerial processes by reinforcing the internal coordination and giving opportunities to learning, reconfiguration and thus transformational change within the company. Additionally, with what concerns external environment advantages through the use of FOSS, company's efficiency, capacity and productivity are then seen as emergent outcomes that come from the complex interrelationships amongst internal and external components.
What matters most here is the significant impact of ICTs as well as FOSS on organizations. FOSS benefits are greater for IT systems than for any other kind of applications due to increased adaptability, decreased reliance on a single supplier, and reduced costs (Serrano & Sarriei, 2006). The full access to the source code is of benefit when implementing the software, when the IT system used need to be adapted to the business or the managerial processes, the local needs and regulations. This allows organizations to reduce dependency on proprietary product builders and distributors.

2.2.4 FOSS applicability and benefits for world countries

Due to the undeniable advantages of FOSS there is an increasing market orientation in the IT sector. In fact, Open Source Initiative's annual reports 2016 reveal that there is tremendous growth, in both open source awareness and adoption, and also in maturity across the broader IT sector. For example, on 28^{th} May 2015, Google announced that there are 1.4 billion Android users and 1 billion Google play users, active in May 2015. This changed to 2 billion monthly active users in May 2017 (Protalinski, Emil, 2017; Ng, Alfred, 2017). Governments around the world officially posted their orientation towards the free software. Some of them are presented here with their respective aims:
With the desire to make software a public good that everyone can freely share and modify (Kelty, C.M., 2008), and to benefit both from the private-collective method (collaborative and open approach) that is fundamental in FOSS development (Von Hippel et al., 2003) and the technological sustainability, the whole central administration of France passed to OpenOffice.org - the French Ministry of Defense (Sept. 2004) "has formed a consortium to develop a highly secure Linux-based operating system". In January 2007 "the Italian budget law encourages public administrations to use Open source software. The government in December introduced a provision (art.1, c. 897) that will favor projects using this type of software. During the coming three years, a total of 30 million euro is available for projects that stimulate the information society. Those using or developing free software will be given priority." In Japan, to make Linux and open source a priority for all IT procurements, starting from July 2007 - the central government of Japan says it plans to spend around $1.25 trillion yen, or $10.4 billion, on IT over the next year – in addition, the government has said explicitly it wants to decrease its reliance on Microsoft as a server operating system platform". To also reduce the dependence of public administration (Fugetta 2003) and enterprises on vendors (Lee, 2006), Singapore in 2003 "offers tax breaks to companies that use GNU/Linux operating systems instead of proprietary ones to encourage development of the local software sector". As creating a shared value occurs through policies and operating practices (Porter and Kramer, 2011), the Russian Ministry on Information Technology and Communications in order to strengthen the local software development industry and increase involvement of Russian programmers in the development of software for government and municipal needs, has held in 2008 meetings with local and multinational open source companies and plans to open "Competence centres", whose focus will be to transfer the best practices from other countries in the implementation of open source on the government level. Likewise, in June of 2006 Brazilian Ministry of Culture supports local cultural initiatives, called Culture Points, through funding of up to BRL 185,000 (USD 88,500) - some of these resources are used to train citizens in the production and exchange of digital multimedia using FOSS. In the United States to provide the critical benefits of FOSS such improvements in national security, transparency, sovereignty and with the specific aim of fostering broader military adoption of open source software, the Department of Defense (DoD) defined an Open Technology Development roadmap in 2006 - the Open Source Software Institute helped the Pentagon develop the roadmap. In Maghreb, to promote development in education for example, Tunisia's "objectives included encouraging migration to FOSS, including FOSS in school curricula, providing incentives to FOSS company start-ups, and ensuring that public procurement policies are not biased against FOSS". Initiatives have been also taken in that regards in a number of Sub-Saharan African countries. In LDCs, where labor costs are relatively high (the total cost of ownership outweigh the costs of software licenses), shifting from proprietary software to FOSS may generate small savings (Nihan Yildirim, et al., (2011). Consistent with the intent, the South African Cabinet in 2007 announced that it had approved a free and open source strategy and that government would migrate its current software to free and

open source software - this strategy will, among other things, lower administration costs and enhance local IT skills (CSIS, Report 2010). With the global mission of promoting the use of FOSS in Africa, specialized software and consulting companies have started up in Ghana, Kenya, Nigeria, Uganda, and other countries through FOSSFA[7] . FOSSFA effectively supports South-to-South cooperation in which students from Ghana to Egypt and Kenya to Namibia develop software that are then adopted by software gurus in Nigeria, South Africa and Uganda in order to narrow the digital divide. In Ghana governmental policies on ICT for development were taken seriously. For example, the Ghana ICT Accelerated Development (ICT4AD) Policy Statement fully takes into account the aspirations and the provisions of key socio-economic development documents (the Vision 2020 Socio-Economic Development framework; the Ghana Poverty Reduction Strategy – 2002/2004 and the Co-ordinated Programme for Economic and Social Development – 2003/2012), however we have realized that there are not any approved FOSS policy in Ghana (CSIS, Report 2010), and the existing procurement policy (Public Procurement Act, 2003 - Act 663) does not clearly stipulate terms for procuring software (Wayan Vota, 2010). In Africa in general, young professionals with a good background in computing are embracing FOSS approach and trying to reform the accepted practice of buying pirated proprietary software. This may also help to slowly abolish *unauthorized copying of software* while avoiding proprietary monopolies in software markets, and hence may reduce or abolish many barriers to industrial competitiveness that remain a threat to developing nations (Stoltz, 1999; Reed, 2006).
In summary, the core concept of this first part of the literature review is that open source technology can apply to the popular movement of individuals, companies and institutions that seek to put such software into mainstream usage. Moreover, FOSS is not just a beneficial and significant tool. It has, according to Rajani et al., (2003), the potential to boost democratization and find solutions to the most pressing problems faced by LDCs. Hence, free software movement emphasizes social and ethical benefits like 'freedom and social solidarity among the users and democracy' (Stallman, 2002; 2008). However, despite the avowed benefits of FOSS, there is only an apparent increase in the adoption rate of FOSS systems expressly in LDCs' companies, conversely to the high costs of proprietary systems. Although, FOSS is thought to improve cost effectiveness (Ogunyemi & Johnston, 2012), its use is still peripheral or quite limited in general (Ghosh, (2006); Gwebu and Wang, (2011).

2.3 Part Two: Determinants of FOSS adoption

Today LDCs have come to be a principal objective for IT vendors (Dezdar and Ainin, 2011). IT vendors continue to target LDCs for the purpose of identifying new sales growth locations (Hawari and Heeks, 2010). Nonetheless, LDCs are still lagging behind in ICT adoption because they suffer from human; social; economic and political challenges (Kamal and Qureshi, 2009; Kyobe, 2011); All these challenges include issues such as, limited skills in ICT; low levels of ICT research and development investment; lack of a critical mass of high-quality research to enhance innovation; high telecommunications' costs; lack of proper economic models for providing connectivity to the marginalized rural communities (Kyobe, 2011); absence of good quality data, lack of money, user resistance to change and cultural issues (Kamhawi, 2008; Soja, 2009; Hawari and Heeks, 2010); etc. How can decision-makers identify and measure the factors that influence FOSS ICT adoption or 'usage' in a specific context like Ghana?

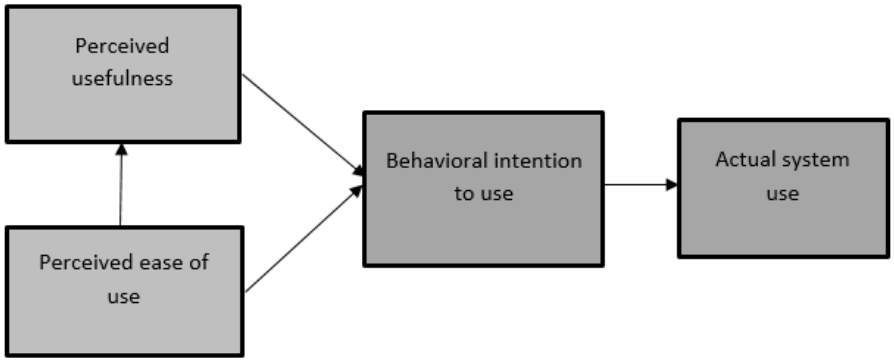
[7]Free and Open Source foundation for Africa (FOSSFA) is an initiative with good potential that tries to bring together scattered FOSS society in order to get open source on political agenda.

Usage behavior – (Usb) at this point appear in this study as an extremely dependent variable. In answering this matter, sequence of theoretical models that were used in the previous related investigations need to be reviewed.

2.3.1 Technology Acceptance Model (TAM)

TAM is a powerful model of users' acceptance for IT usage developed by Davis (1989), Bagozzi, Davis and Warshaw, (1992). Davis (1989) finds that the principal outcome in this model is an individual' behavioral intention. TAM is based on a general behavioural model - Theory of Reasoned Action (TRA)[8] developed by Azjen & Fishbein (1975). To shape a specific information about adoption behavior, TAM shifts many of TRA's attitude measures towards two technology acceptance measures: the measure relates to the ease of use called 'perceived ease of use (*peou*), and the measure relates to the usefulness called 'perceived usefulness' (*pu*). That is, TAM suggests that an individual's behavioral intention to use a new technology is determined by two technology-related antecedents or beliefs - '*peou*' and '*pu*' (Venkatesh & Davis, 2000). Bagozzi, Davis and Warshaw, (1992) claim that information technologies systems such as personal computers are new technologies that "[...] are complex and an element of uncertainty exists in the minds of decision makers with respect to the successful adoption of them, people form attitudes and intentions toward trying to learn to use the new technology prior to initiating efforts directed at using. Attitudes towards usage and intentions to use may be ill-formed or lacking in conviction or else may occur only after preliminary strivings to learn to use the technology evolve. Thus, actual usage may not be a direct or immediate consequence of such attitudes and intentions". To put it simply, the authors assume that when someone forms an intention to act, he or she should be free to act without limitation. However, reality shows us that he or she may face some behavioral elements' constraints like the 'limited freedom to act'. Consequently to easily examine factors that influence users' decisions, Davis (1989) summarizes these behavioral elements in two acceptance measures (*pu* and *peou*). The schematic of Davis' theory is presented here:

FIGURE 2.2: Davis' Technology acceptance model schematic (1989).



Based on the various acceptance measures that included the model, hypothetical relationships are envisaged:

- ***Perceived usefulness – (pu):*** *'pu'* is defined by Davis (1989) as the degree to which a user believes that using a particular system would enhance his or her job performance. Therefore, the variable 'pu' could also be intended as the extent to which

[8] TRA is a broadly planned model from social psychology which is concerned with the determinants of consciously intended behavior. In other words, it is more general theory that serves to understand an individual's voluntary behavior (Doswell et al, 2011).

one believes that using FOSS application will enhance his or her job performance. The wide range of advantages of FOSS make the software have in general the potential to enhance users' job performance more than proprietary software options. It is then certain that there is a strong relationship between external stimulus and perceived usefulness, and between perceived usefulness and behavioral intentions of users (Davis, 1989; Venkatesh and Davis, 2000).

- ***Perceived ease of use – (peou):*** '*peou*' refers to the degree to which a person believes that using a particular system would be free of effort (Davis, 1989). That is, the extent to which a user believes that using FOSS application will be free of effort. According to Davis (1989), perceived ease of use has a direct influence on perceived usefulness. He goes on to say that there is a strong relationship between '*peou*' and intention to adopt, both directly and indirectly (through its effect on perceived usefulness). In other words this relationship leads to intend that the less effort needed to use FOSS application, the more using this effort will probably further increase the job performance; and moreover, the less effort needed to use FOSS application, the more user announce their intention to adopt this specific technology. Consistent with this, we could assume that '*peou*' is function to users' behavioral intentions, and is also a function of '*pu*' since all things otherwise being equal - ceteris paribus.

- ***Intention to adopt – (Ia):*** intention to adopt an IT system stands for the user evaluation of the convenience of applying and using a specific technology (Lederer, et al., 2000). According to Pijpers, (2001), and on the basis of Davis' theory, perceived usefulness and perceived ease of use of an IT system have a significant influence on intention to adopt the specific technology. Intention could be also determined by the attitude of a person towards using ICT tools (Ambali and Bakar, 2014). For this reason, it could be also defined as a person's subjective probability to perform a specified behavior (Yi et al., 2006). With due regard to this reasoning, we could assume that external stimulus, '*pu*' and '*peou*' of FOSS have a significant influence on user' intention to adopt FOSS.

As stressed earlier in chapter One, the study follows the adapted model of Gallegoa[9] , Luna and Bueno (2008). The findings of Gallegoa et al. (2008) confirmed by Gwebu et al. (2011) have made important contributions when they revealed that the understanding of user acceptance of FOSS technologies adoption can be deepened through other significant determinants that are unique to FOSS. For this reason specific characteristics of FOSS are taken into consideration given that this particular IT system has some notable differences compared to the traditional proprietary software.

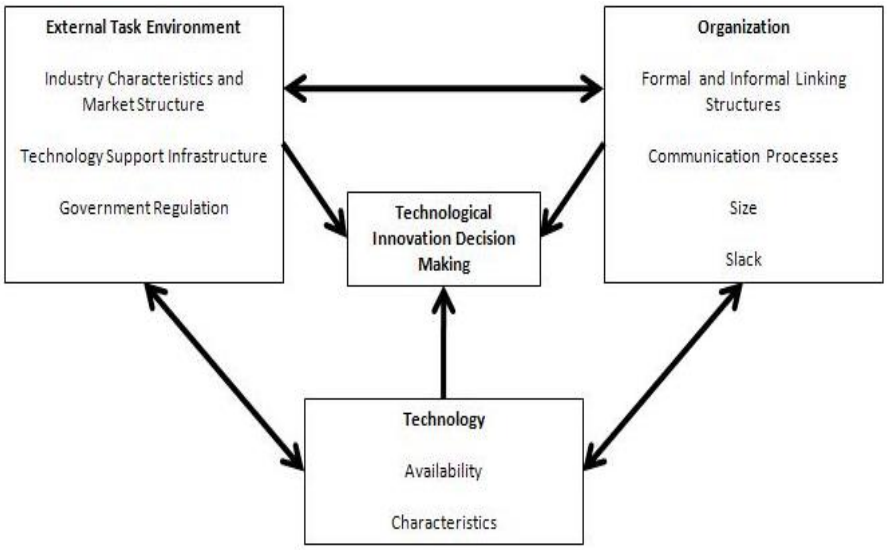
2.3.2 Technology-Organization-Environment (TOE) framework

Technology, organization, and environment (TOE) framework was developed in 1990 by De Pietro, Wiarda and Fleischer, (1990). For the last few years, TOE framework has been used as a tool to understand how organizations adopt IT. A number of scholars used TOE framework to comprehend different IT adoption. To name a few we can cite research works such as, Open systems (Chau and Tam 1997); Electronic Data Interchange – EDI

[9]Through Davis' technology acceptance model, Gallegoa, Lunab and Bueno (2008) empirically studies a user acceptance towards FOSS operation system (Linux OS). Their results suggest that perceived usefulness and perceived ease of use exert a strong positive impact on intention to use Linux, which subsequently predicts usage behavior. Perceived ease of use is also found to positively impact perceived usefulness. User perceptions of the technological characteristics such as flexibility, quality and capability are found to positively impact perceived usefulness and perceived ease of use while no significant relationship is found between social influence and users' beliefs on ease of use and usefulness.

(Kuan and Chau 2001); e-business (Zhu et al. 2003, Zhu and Kraemer 2005, Zhu et al. 2006a/b, Lin and Lin 2008, Oliveira and Martins 2010); business to business (B2B); e-commerce (Teo et al. 2006); OSS adoption (Morgan & Finnegan, 2007); enterprise resource planning (Pan and Jang 2008); web site (Oliveira and Martins 2008); e-commerce (Liu 2008, Martins and Oliveira 2009a, Oliveira and Martins 2009b); OSS-ERP adoption (Leo Tome, Kevin Allan Johnston, Alison Meadows, Mphatso Nyemba-Mudenda 2014); etc. TOE identifies three dimensions of a firm's context. Theses dimensions include technological, organizational, and environmental contexts that influence the process by which firms adopt and implement a technological innovation. The technological dimension includes the factors of cost; reliability; compatibility; complexity and performance expectancy. The organizational dimension includes the factors of human and financial resources; innovativeness and competitiveness. The environment dimension involves the factors of industry; competition; government; suppliers and customers (De Pietro, W. et al., 1990). See Figure 2.3 below for a graphical depiction of the framework.

FIGURE 2.3: Schematic of theory of De Pietro, Wiarda, & Fleischer, (1990).



As technological innovation decision in this research is based on a specific technology, adapted TOE' framework of Dedrick and West (2004) based on FOSS technology was referred. Close to the original framework Dedrick, et al., (2004), include in technological dimension, factors such as, compatibility; complexity; relative advantage; friability and observability. The organizational dimension includes factors like structure; resources and processes of the organization (Dedrick, et al., 2004); Morgan and Finnegan, 2007), and the environmental dimension refers to the way an organization conducts its business; its relationships with external parties and government; access to the industry; competitors and regulations (Dedrick and West, 2003). The three dimensions of TOE allow us to develop some appropriate exogenous latent variables, which are the hypothetical constructs that are invoked to explain the dependent variable (usage behavior):

Technological dimension/characteristic – (Tc)

- ***Total Cost of Ownership – (TCO):*** In traditional business practices, before making the adoption decision in any type of organization, a capital budgeting analysis may be required. Therefore, the financial estimate, as well as the total cost of ownership intended to help owners or decision-makers determine the direct and indirect costs

of a product or system, is significantly important to be considered especially when it comes to adopting new IT system. The TCO concept applied to software is based on the recognition that the acquisition cost for hardware and software, including license fees and others costs are incurred during the life cycle of the product. Specifically, these costs encompass costs such as: labour cost related to maintenance; integration; support and training; switching cost; etc. Despite costs apparently having a secondary role in adoption decision of FOSS technologies according to Johansson and Sudzina's (2008), costs viewpoint regarding the adoption decision remained central with continued high-level of attention especially in LDCs. Organizations in LDCs are not properly adopting, exploiting and taking advantages in the use of IT system due to financial and others constraints. However, the cost savings advantages of FOSS is central in providing appropriate solutions to the financial problems. Consistent with the above comments we can anticipate that significant cost savings in TCO that many organizations that have implemented FOSS have achieved (Nagy et al. 2010), could influence the adoption of the software.

- ***Software flexibility – (SoftF):*** When FOSS holders talk about software flexibility, they are quite simply talking about how software users are able to choose solutions suitable for their needs with the software. In a business context, flexibility comes to really mean "business flexibility opportunities". Obviously, users will make use of a system that suits their needs. Goode's (2005) research results on management rejection of FOSS in Australian top firms confirm that flexibility is an important factor in FOSS adoption initiatives. Software flexibility could allow users in LDCs to fit various ICT development projects for need and purpose. Since flexibility is one of the main advantages that a technological solution based on FOSS can offer (Carmichael & Honour, 2002; Davis, 1989), we can anticipate that software flexibility can influence the usage behavior.

- ***Software quality – (SoftQ):*** In FOSS engineering, quality is considered an important issue. In FOSS annual survey of 2013 for example, quality was one of the primary reasons for adoption of FOSS. Quality has improved to a point where the software has become more mature, strong, and efficient over the last few years. This significant improvement is due to the fact that FOSS products continue to meet the requirements of consumers. Quite often when technology users are meeting their requirements through technology products or services they are usually talking about "good technology quality". Therefore, quality should be considered as a determinant factor of the degree to which a user believes that using a specific IT tool based would enhance his or her job performance. This claim was earlier verified through empirical studies of Davis, Bagozzi, and Warshaw (1992). The latter have pointed out through TAM model that there is a significant relationship between quality perception of a technology and the user acceptance of this technology. In other numerous empirical studies of various scholars such as Chang, et al., (2005); Lin and Lu, (2000); Green, et al., (2005); Liawa and Huang, (2003); Lucas and Spitler, (1999), quality was taking into consideration as relevant influencing factor and was included in their theories as an external variable of TAM. Consistent with this, quality was also considered in this development as an external stimulus that determines the behavior usage of the system.

- ***System compatibility and capability – (SCC):*** By definition, compatibility is the degree to which an innovation is perceived as consistent with existing values, past experiences, and needs of potential adopters (Rogers, 1983; Premkumar and Potter, 1995; Compeau et al. 1999; Dishaw and Strong, 1999). It refers to four dimensions:

compatibility with existing work practices, compatibility with preferred work style, compatibility with prior experience, and compatibility with existing values (Karahanna, Agarwal, and Angst, 2006). In most LDCs, although many organizations referred to IT projects, one of the criticisms that linked these projects was the fact that a proprietary system was chosen instead of the open source system (Gianluca Misuraca, 2007). In fact, the introduction of new technologies to the existing could imply compatibility issues. Additionally, the most common problems in adopting IT systems are also related to the fact that the systems (i.e, ERP systems, etc.) do not usually fit the requirements of the organizations of these countries because of the difference of business practices, legal and government regulations as revealed by Nkosinathi, (2015). Business processes and IT implementation should be closely connected (Tsai, et al., (2010), because technology incompatibility negatively affects the system productivity, efficiency, employees' satisfaction, commitment, and motivation (Erensal and Albayrak, 2008). Besides, system compatibility could provide better capabilities at the system and the user levels. That is, system capability to execute a specified course of action, should be considered. In fact, if FOSS system capabilities could be guaranteed, it should be given the confidence that choosing this system solution will precisely give to the users the desired results they want in the amount of time required and with reliability. In others words, users of technology in a company are more fulfilled with the use of a technology if they believe that it will improve their performance and productivity (Mawhinney and Lederer, 1990; Vlahos and Ferratt, 1995). Consistent with the reasoning, system compatibility and capabilities will be taken into consideration as pertinent factors in this study.

- ***System complexity – (SCX):*** Quite often several management information systems are viewed as very complex and difficult to implement (Xue et al., 2005). Indeed, system complexity is most commonly discussed when it comes to replace existing systems with new systems or when it comes to combine the existing system with a new system. At this point, technological complexity could be defined as the extent to which a new technology is more complicated for its user than the previous technology used for the same or similar work. This represents an increase in the number of things the user must do at once (Aiman-smith and Green, 2002). Since proprietary systems in use in LDCs are more representative than the open systems, users of IT systems have become more and more accustomed to using the proprietary software. Consequently, moving to new systems can be much more complicated. Higher complexity results in higher mental workload and stress (Sokol, 1994), therefore, complexity is also expected to act as a relevant determinant of users' attitudes towards using IT system. Given these opinions, it could presumably be argued that the easier users perceive using FOSS, the more probable they would be willing to adopt it.

- ***Legal Issues – (LI):*** Open source software is freely licensed to grant the right of users to study, change, and improve its design through the availability of its source code. The specific availability of the source code is an important distinction between FOSS and proprietary software. However, restrictions on further use exist in both cases. To have the legal right to use software to achieve the required needs of users and to ensure the rights and limits in the associated software, software license tracking become serious for any IT organization. Indeed, open source licenses are critical concerns (Daniel A. Almeida and Gail C. Murphy , Greg Wilson, Mike Hoye, 2017), since the use of software is becoming increasingly a fundamental issue for freedom of association and the social economy's independence. The main licenses (i.e, Apache License 2.0; GNU General Public License (GPL); GNU Library or "Lesser" General Public License (LGPL); MIT license; etc.), to be approved, have gone through the

Open Source Initiative's (OSI) license review process. Nowadays, OSI-approved licenses are so many and the main difference between them is whether the license is considered copyleft[10] or not. The multitude of open source licenses available to developers creates a problem that must be handled with care. In fact, understanding their differences or their implications could be a good business for lawyers. Since companies that are using FOSS need to know how changes affect the use, the modification, and the distribution of the software system, particular consideration should be given to knowledgeable lawyer that could help these companies to understand FOSS licenses' complexity. With all this in mind, we can anticipate that there is a significant effect of legal concerns surrounding FOSS and their potential contribution to the legitimacy of companies that are adopting the software.

Organizational dimension/characteristic – (Oc)

- ***Organizational supports – (OS):*** Perceived organizational support is defined as employees' formation of global beliefs pertaining to how much the organization cares about their well-being and values their contributions (Jessica A. Junak 2007). The support could be then categorized into two types: technology support and management support (Lee et al., 2006). At this point, companies which support IT implementation are organizations which assist their users of computer hardware and software products with the willingness of top management support in order to ensure the necessary resources and consultancy for their projects success. More often organizations are easily persuaded to adopt new IT systems because they needed more time available to evaluate them and they had a limited budget available for ICT expenses. However, as the use of information technologies becomes more indispensable in any type of organization, especially the SMEs (Qiang, et al., 2006), new IT solutions such as FOSS solutions should have priority in decision- making around IT innovativeness in organization. It is important to promote the growth of companies by developing their innovativeness through new advantageous IT solutions. By doing this, the level of organizational innovativeness could indubitably influence the adoption consideration and timing of adoption of new technologies (Dedrick et al. 2003, Ellis et al. 2009, Yang et al. 2011, Spinellis et al. 2012). Organizational support is a crucial factor for successful adoption of a new system (Lee et al., 2010), and it could be significantly associated with the technology acceptance measures.

- ***Training – (TR):*** Training in ICT use must be a continual process to keep up with the rapid evolution of information technology. Complexity in IT systems is not evident solely when the operative system is based for example on licensed software, but it tends also to be unstable and shortage of an intuitive design with open source systems (E. von Hippel and G. von Krogh, 2003). This claim can be justified by the fact that many open source software are released at the pre- alpha, alpha or beta development stage[11] and are sometimes packaged inconveniently (Dedirick and West, 2004; Goode, 2005; Gwebu and Wang, 2010). In fact, using FOSS system could demand a

[10] copyleft: a general method for making a program free software and requiring all modified and extended versions of program to be free software as well. www.gnu.org/copyleft/copyleft.html. In the world of open source software exists a wide variety of licenses and each license carries with it a different set of requirements for using the software and outlines a different set of requirements for modifying the source code.

[11] In traditional software engineering, software development stage or a software release life cycle is starting by Pre-alpha releases that refers to all activities performed during the software project before testing (requirements analysis, software design, software development, and unit testing), followed by Alpha releases where it will still be introducing new features, while Beta releases will see no new features, but rather polishing up the existing stuff.

considerable capacity of cognitive effort. FOSS users should have a basic technical know-how to download, compile, configure, design, and or install the software before use. This capability is gained from experience during the past training schemes. Education and training influence users' beliefs toward IT systems in use. Training in particular increases users' confidence in their ability to use the systems (Gist, 1987). Although formal training and support are often lacking (Goode, 2005; Dedirick and West, 2004), FOSS users must be given the opportunity to continue learning throughout interfaces and functionalities, troubleshoot if needed, and follow the support and documentation materials by themselves (Gwebu and Wang, 2010). This could allow users to reduce anxiety and stress about the use of the IT system they are using, and provide better understanding about the benefits of the system for their tasks (Lee et al., 2010). Training is therefore an important factor for successful implementation process of an IT system in a company (Bingi, et al., 1999), and it could be seen as a determinant of the acceptance measures of the new technology in adoption.

Environmental dimension/characteristic – (Ec)

- ***Government supports and policies – (Egsp):*** Environment dimension encompasses the government regulation factor as a driver in technological innovation decision making (De Pietro, et al., 1990). However, very few studies that used TOE' framework in their empirical research have placed particular emphasis on political and government policies factors. Politics and government policies may also have serious implications in IT adoption process. Corrales and Westhoff (2006), have examined the incidence of political tendencies on IT adoption and reached the conclusion that ICT adoption is linked to significant questions of political liberties in different ways. For instance, knowledge-based technologies could contribute to liberties, democratization, human rights and social empowerment, etc. FOSS is as much about democracy as it is about technology. That is, FOSS ICT can defend and broaden accountability and transparency in e-governments (John Carlo et al., 2011). It offers the opportunity for technology to be socially shaped by citizens and associations. Globally, governments are in a unique position in almost any industry. That is, by the nature of their immense size and influential position, their actions may have far-reaching effects (Paul Baker, et al., 2009). In other words, the public sector remains an attractive customer mainly due to its great size. Hence, the large number of government service providers or contractors are compelled to adopt the government's software platform of choice, so they are eligible to work for them. This confirms how governments play a major role in determining the future destiny of a national software industry, whether they intend to or not. Government policies about incentives and supports for FOSS adoption, through social programs (i.e, technical education supports) and other programs aimed at improving the environment (i.e, infrastructure supports, etc.), are therefore fundamental inputs that should prepare new guidance to inform people about the emerging technology. Hence they could significantly impact users or citizens' acceptance of this specific technology.

- ***Education – (Eedu):*** Many LDCs' governments are more gradually aware of the need for education and they have demonstrated the desirability and the feasibility in order to fulfil welfare, economic growth and new democratic societies. Some governments have worked to improve upon their education policies in order to ensure equal access to education for all, especially girls, since illiteracy is particularly high among rural girls and women in Africa. Universities and/or schools are educating a homogenous IT workforce. Since they are agreeing that FOSS can lower the barriers

to the access of ICTs in education by reducing the cost of software and offering in the domains of school or university management several advantages (course and schooling; documentation; communication; collaborative pedagogy; contents Web, numerical platforms of work or teaching - e-learning; etc.), some national education systems are introducing FOSS in their policies and preparing educated and skilled labor force for national ICT industry (Tan Wooi Tong, 2004). Even though most FOSS systems are web applications and it could be download by users and install on their server, FOSS users need to have a technical skills and knowledge, otherwise there will be lack of familiarity with the specific technology, and how to use it inhibits its use. The availability of skilled human capital could facilitate and foster the development of communities and increase their mobilization. In addition, it could help skilled users to develop a vision, an adaptability of work and start up large-scale local and regional projects. For these reasons, a significant relationship could be anticipated between national education and FOSS technologies' acceptance measures of users.

- ***Awareness – (Eawar):*** To obtain benefits which arise from ICTs, each country, nation or economy may be ready in order to decide where to go or which kind of technology it is ready for. In other words, countries must show greater e-readiness and take the awareness dimension into account in their adopting patterns. In effect, awareness can be seen to serve as a useful starting point for LDCs. Good knowledge of IT tools prepare the countries to be e-ready. Awareness is then one of the important phases that could aim at converting good intentions into planned actions that bring real changes to peoples' lives. In a local area, to increase for example the adoption and the ability of FOSS systems to effectively adapt to the social and economic advancement, indigenous community must be aware of the characteristics of the specific technology in adoption. If people are aware of the technological benefits of FOSS, adoption will be very straight forward. In other words, if you are trying to increase FOSS adoption, a source of brand awareness and visibility should not be neglected. According to Sobh, (2010), awareness is a significant enabler of FOSS adoption. Based on this premise, significant relationship between awareness of a technology and users' acceptance of this technology should be accepted.

Although, dimensions of TOE (De Pietro, W. et al., 1990 and Dedrick, et al., 2004) have been defined, individual dimensions considered as fundamental factors in technology adoption (Goode, 2005; Morgan et al., 2007), are not properly elucidated. Individual dimensions explain behaviors such as personal rejection, personal resistance or fear, insufficient skills or experience (Goode, 2005), and cultural background (Qu, Yang & Wang, 2011). Morgan and Finnegan, (2007) state that these dimensions could have a significant influence on FOSS technology adoption. Consistent with this, appropriate theories are aimed at clarifying the individual dimensions in IT adoption matter.

2.3.3 Social Identity Theory (SIT)

Social identity theory[12] is defined by Tajfel and Turner (1979) as a social psychological theory of intergroup relations, group processes, and the social selves. According to the theory,

[12] As a backdrop, social identity theory is best described as a theory that predicts certain intergroup behaviors on the basis of perceived group status differences, the perceived legitimacy and stability of those status differences, and the perceived ability to move from one group to another (Tajfel and Turner, 1979). Conversely, Haslam; Ellemers; Reicher; Reynolds; and Schmitt (2010) realized that this description contrasts with cases where the concept of social identity theory is used to refer to general theorizing about human social selves. Additionally, although some researchers (Brown and Zagefka, 2006; Ashmore, Deaux, and McLaughlin-Volpe,

social identity of individuals is built through three processes functionally linked: categorization; identification and social comparison. Drawing on this theory, arguments that strengthen social influence and personal innovativeness characteristics with the adoption of FOSS are simultaneously developed.

Individual or Personal characteristics – (Pc)

- ***Personal Innovativeness in Information Technology – (Ppiit):*** In innovation diffusion theories, personal innovativeness (PI) and social influences are based on building a generic model for explaining general technology acceptance. Consider personal innovativeness within individual characteristics in this study, leads us to refer to a specific construct domain of PI developed by Agarwal and Prasad (1998), and mainly known in the so-called personal innovativeness in information technology. 'Piit' is expected to be an essential factor that could enable better forecasting of individual behavior in information technology than PI. This because PI is a global construct of individual innovativeness. Since 'Piit' is defined as a full tendency of an individual to try out and accept new technologies and innovations, it is also evident to note different characteristics with different reactions of individuals when it comes to try out any new IT. This is due to individuals' differences in innovativeness. In attitude theories, Triandis (1971) said that habits are considerable determinants of individual behavior, therefore, individuals high on 'Piit' will be more skilled and habituated to using FOSS applications helping them to be able to fully achieve their aspirations. As a persistent and general predisposition of an individual to try out and accept any new IT, 'Piit' then becomes a fundamental antecedent to computer self-efficacy (Agarwal and Prasad 1998). Thus, 'Piit' is unavoidably expected to have a direct significant effect on one's intention to adopt a new IT system (Yi et al., 2006), and on its usage behavior and also mediated by perceived usefulness and perceived ease of use of the IT system.

Social influence characteristics – (Sinflc)

Among the potential technological superiority of FOSS applications such as high quality, security, reliability, flexibility, low acquisition cost, and no vendor lock-ins (Fitzgerald, 2006; Gallegoa, Lunab and Bueno, 2008), FOSS surely share many characteristics with other types of software. This implies that factors identified as important in IT adoption and diffusion may play an equally important role in FOSS

2004) have treated it as such, social identity theory was never intended to be a general theory of social categorization (Turner and Reynolds, 2010). It was awareness of the limited scope of social identity theory that led John Turner and colleagues to develop a cousin theory in the form of self-categorization theory (John Turner; Oakes and Penny, 1986; Turner, 1999; and Haslam, 2001). Self-categorization theory was built on the insights of social identity theory to produce a more general account of self and group processes (Turner, 1999; Turner and Reynolds, 2010). Overall, these goals frame social identity theory and its more recent extension into self-categorization theory. In fact, social identity perspective is suggested for describing the joint contributions of both social identity theory and self-categorization theory (Turner, 1999; Haslam, 2001; Postmes, and Branscombe, 2010). This perspective positions that social behavior will vary along a continuum between interpersonal behavior and intergroup behavior, and the key statement is that individuals are intrinsically motivated to achieve positive distinctiveness. That is, individuals strive for a positive self-concept (Tajfel and Turner, 1979; Haslam, 2001) which is built up on related components such as individual mobility, social creativity and social competition. More explicitly, the perspective argues that social identification is a perception of oneness with a group of persons. In addition, it stems from the categorization of individuals, the distinctiveness and prestige of the group, the salience of outgroups, and the factors that traditionally are associated with group formation. And moreover, it leads to activities that are congruent with the identity, support for institutions that embody the identity, stereotypical perceptions of self and others, and outcomes that traditionally are associated with group formation; and finally reinforces the antecedents of identification (Blake E. Ashforth and Fred Mael, 1989).

adoption and use. However, open source applications present some particularities that should be considered as key unique features. Open source applications are more than just computer programs, they are community based innovations (Von Hippe, 2001; Fller, et al., (2006). That is, *communal and freedom nature* of FOSS should be considered as key features in users' acceptance studies. It could be addressed as a significant boundary condition[13] to the validity and applicability of TAM for the understanding of FOSS adoption factors.

As people often say: "no person is immune from the influence of the people or the groups he or she encounters", let us have no illusions by stating that every idea we have is unique, that every opinion we express is informed by facts alone. However, the truth is that we use others around us as a reference point for much of our attitudes and behaviors. Therefore, it is evident that critical mass (Rogers, 1995) or group belonging influences the adoption and the diffusion of communication innovations, both through network externalities and through sustainability of the innovation. For these reasons the following aspects are considered:

- ***Social identification – (SI):*** Social identification is considered with the interest to see how significant impact turn up, when we try to measure the relationship or the pressure that FOSS community has on their members' decisions regards the software usage. Indeed, as stressed in the definition of social identity theory, some psychologists theorized that social identification is the process by which an aspect of self-image is developed based on in-group preference or ethnocentrism and a perception of belonging to a social or cultural group (Tajfel and Turner 1986). Simultaneously with FOSS, we could define social identification as the degree to which the user, as belonging to FOSS community, construes himself or herself to be a member (Gwebu et al., 2010). Individual searching for identity tend to classify themselves and others into various social categories (Tajfel and Turner, 1979 pp 7-24; 94-109). Thus, since the FOSS community has its distinctive values, ideologies, and software development practices, the open source community's distinctiveness helps hence to increase the tendency of individuals to identify themselves with the community. According to Gwebu and Wang, (2011), favorable conditions are pervasive in the FOSS community for identification to occur. In addition, FOSS with its quality flagship products such as Linux and Apache and its widely publicized software development practice, the open source community is often associated with the prestige of indestructible products. This perceived prestige according to Tajfel and Turner' theory (1979) could further reinforce individuals' identification with the open source community through the enhancement of their self-esteem (Tajfel and Turner, 1979 pp 7-24; 94-109). Tajfel and Turner' theory (1979) also emphases that identification is likely to be associated with strong awareness of out-group(s) as it reinforces the awareness of one's in-group (Tajfel and Turner, 1979 pp 7-24; 94-109). Equivalently, the salience of out-group is also evident in FOSS members strong sentiments against firms developing or selling proprietary software, and the strong awareness of the proprietary firms increases in-group favoritism and leads to a stronger identification with the open source community (Gwebu and Wang, 2011). FOSS community by giving its members the chance to safely deposit the guarantee of a unique collective identity through conditions such as community distinctiveness and prestige, out-group salience, social interaction, and shared goals, lets social identification prevail.

[13]Results of Gallegoa, Lunab and Bueno' studies (2008) on Linux operation system might be an example of the boundary condition: the findings reveal that Linux operation system did not find any relationship between social influence and users' beliefs on ease of use and usefulness. This because open source adoption is often a voluntary decision and it is hence less likely to be influenced by subjective norm pressure (Bagozzi and Dholakia, 2006), but rather by FOSS' communal nature .

The predominance of social identification involves cognitive (through mechanisms of categorization), affective (through a sense of emotional), and evaluative mechanisms (through a sense of duty that develop feelings of self-worth and success) in the community (Tajfel et al., 1986). As empirical work from sociology and marketing demonstrate that social identification positively impacts user or group member behavior, including product evaluation, adoption, purchasing, word-of-mouth marketing, and member participation and engagement (Ellemers, et al., 1999; Algesheimer, et al., 2005), it is also obvious to assume in this study that powerful identification with the open source software community may significantly contribute to individuals' decision to adopt FOSS applications.

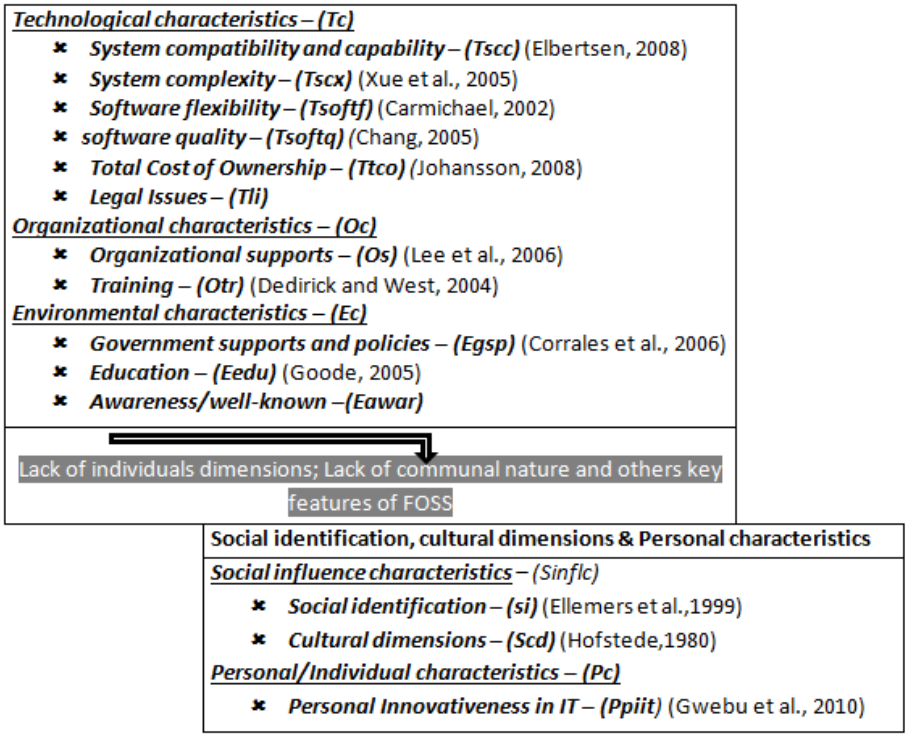
TAM and SIT shift more attention towards the individuals' behavior and intention with regards to the technology adoption. Several factors such as belief in personal relevance (Acevedo, & Krueger, 2004), past experience (Juliusson, Karlsson, & Garling, 2005), age and individual differences include socioeconomic status (Bruin, Parker, & Fischoff, 2007), cognitive biases (Stanovich & West, 2008), and an escalation of commitment (Staw, Barry M. 1976; Moon Henry, 2001; Woods et al., 2012), influence what choices people make, their decision making process and the decisions made in a specific context. These include, for example, traditional ideas, attached values, culture or national character that defined patterns of personality characteristics which need to be properly considered, especially given that, these factors are different from people to people, region to region, and continent to continent. Several authors such as Hogg (1992, 1993); Hogg and Abrams (1988); Tajfel and Turner (1979); and Turner (1982) have argued that social identity theory is specified in detail elsewhere and the basic idea is that, a social category (for instance, nationality, political affiliation, sports team, etc.), into which one falls, and to which one feels one belongs, provides a definition of who one is in terms of the defining characteristics of the category. Put simply in others words, a self-definition that is a part of the self-concept. Consequently, factors such as home culture, politics and State policies should not be overlooked in some specific contexts, especially in LDCs like sub-Saharan African countries, where, although the dual challenge of cultural diversity they are facing nowadays (western culture vs local culture), African reality continues to appeal to his own culture and imagination of his time. A case in point is that, technology acceptance model was firstly developed and tested in North America, when the same model was used by Straub et al. (1997) outside of the North America, for example in Japan; Switzerland; and United States, the results obtained as regards the users' acceptance are respectively correlated to each area or country of provenance and of origin (Straub et al., 1997; Rose & Straub, 1998; McCoy et al. 2005). This example provides evidence of the importance to consider cultural dimensions in the list of FOSS adoption determinants in this study.

- ***Cultural dimensions – (CD):*** Considered to be one of the major social influence characteristics, culture is intended here to measure the pressure that user has on their decision-making when faced with FOSS technology adoption. In a free paraphrase of Hofstede, (1980, 1984, 2001), and Straub et al., (2002), one can acknowledge that culture is concerned with the identities and values that shape the way people live, their behavior, their responsiveness to educational learning and training, and the degree to which they feel involved in preserving for the future. It was generally agreed that culture, also recognized as national character (Hofstede, 1980), should be reflected in artefacts such as the symbols, heroes, rituals, and values that are typically learned from the environment. These artefacts are fully recognized throughout learning that starts with the birth of a child and extends well into adulthood. Clearly it is mostly

considered that culture shapes individual values and affect behavior (Hofstede, 1980, 1984, 2001, Straub et al., 2002). Hofstede's study (1980) on national cultural was an exceptional scale attempt to classify nations based on broad value differences. Four principal dimensions have been used by Hofstede to measure national culture: 'power distance' (strength of social hierarchy); 'uncertainty avoidance' (related to anxiety, a need for security, and a dependence on experts); 'collectivism vs individualism' (relationship between the individual and the group); and 'femininity vs masculinity' (degree to which a society stress achievement or nurture). In fact, cultural issues such as uncertainty avoidance, power distance, masculinity and individualism can also affect FOSS adoption (Qu, Yang & Wang, 2011). However, for the purpose of this study, consideration will be given solely to power distance cultural dimension since the idea of power distance is an important cultural concept in LDCs. For example, in Ghana, cultural dimensions across Hofstede's measures have shown that power distance index is equal to 80% (which double that of USA – 40%), and is the most marked dimension for that country (source: The Hofstede Center, 2012).
Power distance dimension is the index that measures the extent to which the less powerful members of organizations and institutions, for instance the family, accept and expect that power is distributed unequally (Hofstede, 1991). In low power distance cultures, employees in companies believe that inequity should be minimized, while in high power distance cultures, there is an incredible level of inequity between director and employees. The employees tend to complete tasks given by directors even if they are uncertain of their merit or ethical value (Hofstede, 1980). Since they are convinced that their superior is right just because he/she is the superior. It could be then presumed that FOSS use could be influenced by the power distance dimension, since employee decision-making to run the software as he/she wishes (customization or adaptation of the software to his/her job activities) is a fundamental of the freedom nature of the software - particularly freedom zero (see the above section 1.1). Although higher power distance cultures have tended to decrease over time in different communities, Hofstede (1991, 2001) affirms that it is likely to be important to focus on this dimension because pertinent social inequalities or distinctions will continue to exist between individual, communities and countries, and rankings should remain roughly the same. Taking into account this rationale, possible impact of power distance culture dimension on user technology acceptance should be examined.

In summary this second part of the chapter reviews in general terms, elements of the plausible theoretical models that could lead to determine factors impacting the adoption of FOSS. As emerges from the above sections, some factors like home culture, politics and governments policies that lack in the available research are recognized and are deemed to be also addressed in the case of this study. The determinants of FOSS that could influence users' acceptance measures are therefore summarized in the following Figure 2.4.

FIGURE 2.4: Single framework.



Conclusion

In this chapter, existing literature reviews regards the specific of the topic of investigation are explored. In effect, a body of knowledge relating to ICT, FOSS and its adoption in general was reviewed. Given the importance of the various theoretical models, and considering the derived factors that come upon, it is needless to say that an understanding of potential factors that influence FOSS adoption in a specific context of Ghana should be assessed in order to mediate that as much as possible through a selection of process.

Chapter 3

RESEARCH METHODOLOGY

3.1 Introduction

From the conclusion of chapter [2], it is evident that there are still questions unanswered on the various strategic factors influencing FOSS adoption in LDCs. This chapter however, explores possible methods available to answer them, and arrives at a conclusion for the best way forward. Chapter [3] also describes data collection and statistical analysis tools used for the research and highligts how data and information are collected. In fact, this chapter addresses the empirical approach to the research problem, the justification of the methodology and appropriate techniques used in quantitative and qualitative approaches.

3.2 Empirical approach and methodology justification

3.2.1 Empirical approach of the research problem

As stressed in the introduction chapter, the scope of this research is to provide to users or IT professionals, academia and managers, a further insight into ways of improving the strategic decisions of FOSS adoption, since they are aspiring to build, increase and accelerate the ICT capacity development for their communities. To achieve the stipulated goals, potential factors influencing FOSS adoption in organizations have to be identified first, and secondly its effects on the socio-economical contexts in which the process of adoption is taking place need to be analyzed. Questions emerging from the review of the research literature - *What are the potential factors influencing FOSS adoption in Ghanaian SMEs? How these factors affect the deployment of an effective FOSS use in Ghana?* - lead us to consider both qualitative and quantitative approaches and data gathering techniques as appropriate method to collect data and to answer these questions. The selected approach is not only due to the dual nature of the research questions ('what' and 'how' questions), but also by the fact that the research intends merely to explore, with varying levels of depth, phenomena of FOSS adoption which little or no previous research has been done before within a specific context like Ghana.

3.2.2 Justification of the methodology

The philosophical assumptions underlying the theoretical underpinning and the empirical approach to the research problem could be backed by deductive and inductive reasoning. Based on this, research can be classified as positivist, interpretive and critical (Myers et. al., 1998):

- In information systems (IS) or information technologies (IT) research projects, positivist approach can be considered if there is evidence of formal propositions, quantifiable measures of variables, hypothesis testing, deducing the inferences concerning the phenomena from the representative sample to a stated population (Orlikowski

and Baroudi, 1991). Building knowledge through positivist approaches relies on deductive reasoning. The approach assumes that the relationship between social reality and humans is independent, objective of the cause and effect type. In fact, according to positivism holders, reality has its own existence independent of the researcher. The researcher is able to know this external reality which exists in itself and has an ontology[1]. However, this approach has been widely criticized in the literature on information systems for its treatment of organizational reality. Hence, organizational reality is considered to be very complex and does not lend itself easily to statistical deduction. It is also considered as being too deeply ingrained in structural functionalism [2] and too concerned with causal analysis at the expense of getting close to the phenomenon being studied (Galliers, 1991). In fact, even if principle of research paradigm of most appropriate epistemology for the information systems discipline was positivist according to some researchers, other recent investigations in the same discipline have shown that there was an increase in the use of interpretive approaches to determine IT inhibitors. For instance, the research done by Debreceny et al (2002) in e-business, used qualitative method as an alternative to a positivist approach as an appropriate methodology in open source software research.

- In IS research projects, interpretive approaches can be considered if there is clear evidence that knowledge of reality is gained only through social constructions such as language, shared meanings, tools, documents, etc. (Walsham, 1993). In fact, holders of constructivism (Berger, P. and T. Luckmann) sustained by Laura A. C. et al., (2009) in the book 'Handbook of Research on Strategy and Foresight', contend that the reality remains unknowable in its essence because one does not have the possibility of reaching it directly. Thus, one cannot seek to know reality because it is unrecognizable, it is dependent on the observer. One can just represent it or build it. According to Kaplan and Maxwell, (1994) there are no predefined dependent and independent variables in an interpretive research project, instead there is a focus on the complexity of human sense-making as the situation emerges. Therefore, social phenomena must be understood in the social contexts in which they are constructed and reproduced through their activities. That is, the understanding of social action must include the meaning that social actors give to their actions, activities, performances or conducts. For example in this study, the complexity of human sense and decision making on FOSS adoption and use must include the understanding of users' usage behavior. What we presume Burrell and Morgan, (1979) consider as a result of intentional actions constructed by the social reality. Furthermore, this research considered the acceptance model (Davis, 1989) and the social identity theory (Tajfel & Turner, 1979) as essential theories that enlightened the impact of the individual perspectives on adoption decision. In fact, individual dimension must be properly taken into account in the light of this research focus. Since we accept Leedy's thought that the strength of the qualitative approach is that "there is not necessarily a single, ultimate truth to be discovered, instead there are multiple perspectives held by different individuals with each of these perspectives having equal validity, or truth" (Leedy and Ormrod, 2010, p.135), an interpretive approach should be also considered as a strength in this research methodology.
  Interpretive approach include post-positivism, critical theory, constructivism paradigm, etc.,(Lincoln and Guba, (2000). Within interpretive approach there can be critical

[1] Ontology here means that it is relative, insofar as it depends on another knowledge.

[2] The structural-functional approach is a perspective in sociology that sees society as a complex system whose parts work together to promote solidarity and stability. It asserts that our lives are guided by social structures, which are relatively stable patterns of social behavior (Sociological theory – Wikibooks).

paradigm including if its main task is seen as being one of social critique, whereby the restrictive and alienating conditions of the status quo are brought to light (Klein and Myers, 1999). Critical theorists assume that social reality is historically constituted and that it is produced and reproduced by people, who can consciously act to change their social and economic conditions. In fact, Delphi technique is considered in this research for its interpretive features. The main focus of this technique is to achieve consensus through a process of iteration. Delphi process itself is concerned with opinions, ideas and words (Stewart, 2001) and its focus is in keeping with an interpretive approach. Group interaction in research is generally underpinned by an assumption that an individual's attitudes and beliefs are not formed in a vacuum and that people need to listen to other peoples' attitudes and understandings so that they can focus on their own (Marshall and Rossman, 1995; Reed and Roskell, 1997). Using the interpretive approach will allow us to increase our understanding of the critical, social and organizational concerns related to the adoption and the use of IT in different sectors of communities. In IS research, interpretive approach gives the research more possibility to address issues of influence and impact, and it helps to produce an understanding of the context of IS and the process whereby IS influences and is influenced by the context (Walsham, 1993).

In a broad spectrum, in spite of the reserves against the idea that science can and must be organized according to fixed and universal rules, it always continues to be organized in rules, and one often talks about paradigm. In social sciences researches for example, positivism and constructivism are two greats dominant paradigms in this regard. Our research approach is not going into the old debate between holders of two different paradigms because the opposition between positivism and constructivism is not necessarily any more justified. It is just a question of pointing out their vision and our position in this research work for an arranged paradigm. This arranged paradigm will consist to make use of elements from the two various paradigms. Tradition in research generally binds positivists research only to a quantitative approach and the constructivism with a qualitative approach, but because of our epistemological position, both qualitative approach and a quantitative approach are conveniently adopted in this research methodology development. This choice is once again supported by experiences and results of Miles and Huberman' (1994) works, which claim that both qualitative and quantitative approaches in a research analysis is a rigorous procedure that contributes to the validity and reliability of the research. Additionally, since this study fits the definition of an exploratory purpose and has been moreover investigated within business and IT management research field, a mixed method approach is deemed necessary and appropriate (Saunders et al. 2009). A combination of these research approaches that involve different survey methods helped provides more data to work with and ultimately a more accurate evaluation.
In summary, the selected research approach is deemed one of the operationally efficient and convenient methodologies among existing research traditions in information systems that may help to secure stronger results in our investigation and make the research work become more plausible and convincing to its target audience.

3.3 Quantitative and qualitative methods

In this section, the series of steps that the research analysis should progress through are provided and results are presented in the following chapter.

QUANTITATIVE METHOD

Quantitative method is an appropriate process, which is used to describe the quantitative relationships that exist among considered variables. These variables are generally categorized as dependent and independent.

3.3.1 Measurement

Measurements of variables in this study are based on multiple data items (Earl Babbie, 2012), that are combined to form a single composite score. Since the phenomenon that is supposed to be measured is abstract, complex, and not directly observable (in this case FOSS adoption), and thus their constructs are difficult to measure, one approach is to measure the constructs indirectly with a set of indicators (items) that serve as proxy variables. The relationships between latent variables (constructs) are described by the structural model. In contrast, the measurement models represent the relationships between constructs and their corresponding indicator variables. We can then talk about the measurement of endogenous or exogenous latent variables or constructs, where each item represents a single separate aspect of a larger abstract construct (Hair, et al., 2017). Generally, there are two different ways to measure latent variables (Gudergan, Ringle, Wende & Will, 2008). One approach with relationships from the construct to the indicators is referred to as a reflective measurement. That is, instances in which indicators are caused by the construct. The other approach with relationships from the indicators to the construct is called formative measurement. That is, instances in which the indicators cause the construct. In general, each construct in the proposed model (Figure 3.1) is a trait explaining their corresponding indicator variables. For this reason the model is estimated by reflective method. Indeed, endogenous latent variables (intrinsic variables of TAM) to measure the phenomenon are: '*Perceived usefulness – Pu*', is measured using four (04) items as proxy variables adopted from Davis (1989); '*Perceived ease of use – Peou*', is measured using four (04) items as proxy variables developed by Davis (1989); '*Intention to adopt – Ia*', is measured using four (04) items as proxy variables adopted from Davis (1989), Azjen et al., (1980), Agarwal et al., (2000), and Venkatesh et al., 2003); '*Usage behavior – Usb*' is measured using two (02) items as proxy variables adopted from Davis (1989).
The exogenous latent variables (external variables of TAM) to measure the phenomenon are: '*Total cost of ownership – Tco*', is measured using tree (03) items as proxy variables developed by Johansson and Sudzina's (2008); '*Software flexibility – Tsoftf*', is measured using two (02) items as proxy variables adopted from Carmichael and Honour, (2002); Davis, (1989); '*Software quality – Tsoftq*', is measured using two (02) items adopted from Chang, Li, Hung, and Hwang, (2005), Lin and Lu, (2000); '*System compatibility and capability – Tscc*', is measured using tree (03) items adopted from Elbertsen and Reekum, (2008); '*System complexity – Tscx*', is measured using two (02) items adopted from Thompson et al. (1991), and Xue et al. (2005); '*Legal issues – Tli*', is measured using two (02) items adopted from Tome et al. (2014); '*Organizational supports – Os*', is measured using tree (03) items developed by Lee et al., (2006); '*Training – Otr*', is measured using two (02) items adopted from Dedirick and West, 2004, Goode, 2005, Gwebu and Wang, (2010), and Davis, (1989); '*Government supports and policies – Egsp*', is measured using two (02) items adopted from Corrales et al., (2006); '*National education – Eedu*', is measured using two (02) items which are adapted from Goode, 2005; Gwebu et al., (2010); '*Awareness – Eawar*', measured using two (02) items which are adapted from Sobh, (2010); '*Personal innovativeness in information technology – Ppiit*', measured using tree (03) items developed by Gwebu et al., (2010); '*cultural dimension – Scd*', is measured using two (02) items from Hofstede,1980,1984, 2001; and Straub et al., (2002); '*Social identification – Si*', measured using four (04) items from Ellemers et al.,1999; Gwebu et al., (2010).

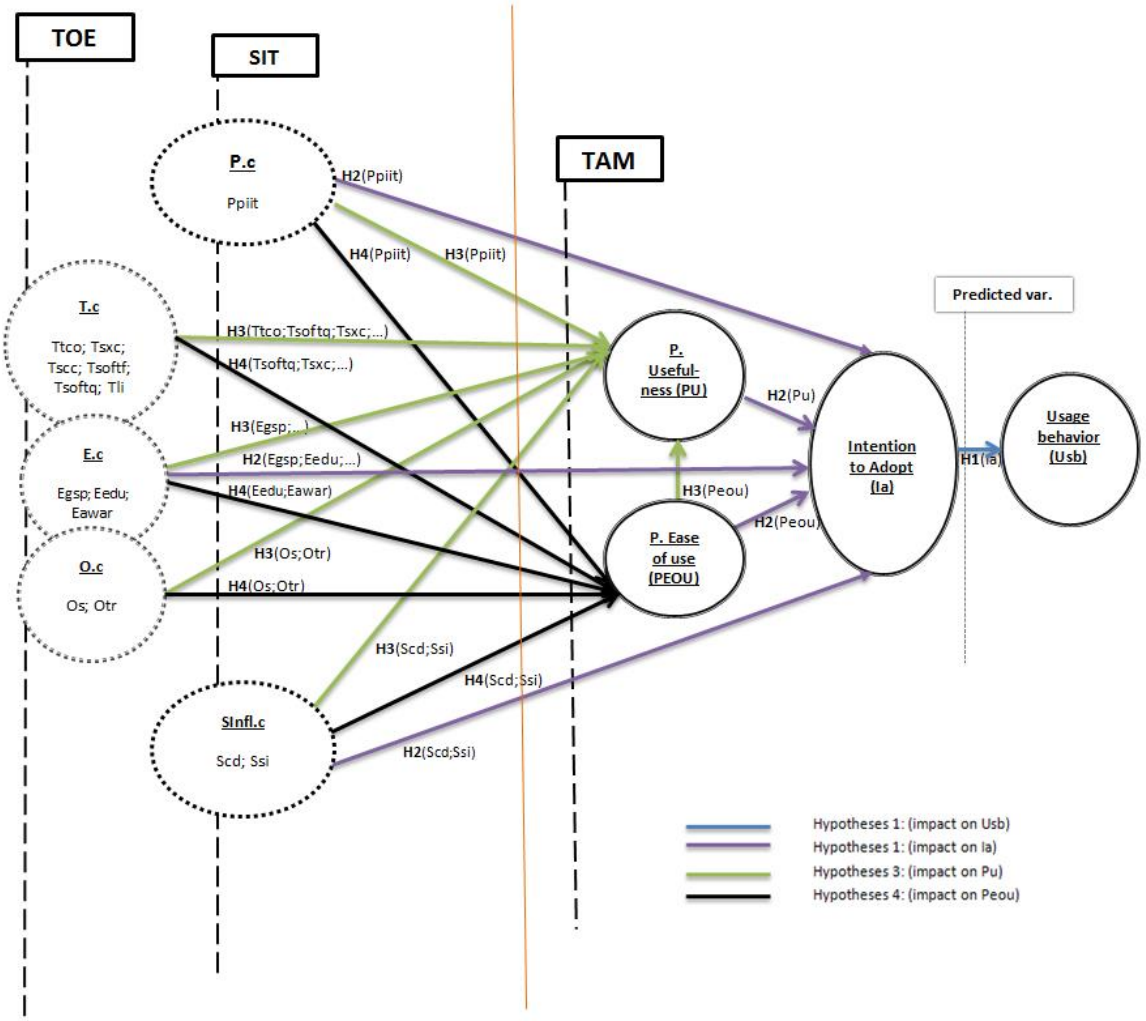
3.3.2 Research hypotheses and research design

In accordance with the previously stated objectives and consistent with related literature (see Part Two of chapter Two), this study tested the following hypotheses:

- **Hypothesis (H1):** IT users' behavioral usage of FOSS is affected by their intention to adopt.
- **Hypothesis (H2):** IT users' intention to adopt FOSS is affected by their perceived usefulness, perceived ease of use, personal innovativeness, social identification, cultural dimension, awareness, education, government supports.
- **Hypothesis (H3):** IT users' perceived usefulness of FOSS is affected by their perceived ease of use, personal innovativeness, social identification, cultural dimension, awareness, education, government supports, training and organizations supports, software legal issues, software flexibility, software quality, system compatibility and capabilities, system complexity, and total cost ownership.
- **Hypothesis (H4):** IT users' perceived ease of use of FOSS is affected by their personal innovativeness, social identification, cultural dimension, awareness, education, government supports, training and organizations supports, system compatibility and capabilities, and system complexity.

To empirically test the rational hypotheses developed above, the proposed model is designed to illustrate the relationships between variables.

FIGURE 3.1: The proposed model.



The proposed research model, which is graphically displayed in the above figure (Figure 3.1), summarizes all the aforementioned constructs, sub-constructs and their respective formulated hypotheses. The model is composed of nine (09) mains constructs separated in two (02) parts by a thin yellow vertical line. The first part encompasses the external constructs of TAM, that is TOE and SIT, and the second part is represented by the intrinsic construct of TAM. The arrows linking constructs (latent variables) specify hypothesized relationships in the direction of arrows. The arrows are colored in blue, red-violet, green and black, to identify the four (04) main hypotheses. Since we agreed with Geoffrey S. et al, (2002) that cognitive and affective responses of TAM largely mediated the effect of external stimulus on behavioral response, in this model, *perceived usefulness* '*pu*' and *perceived ease of use* '*peou*' can be considered as cognitive constructs, *intention to adopt* '*Ia*' might be considered as an affective construct. Meanwhile, usage behavior '*Usb*' could be regarded as a behavioral construct.

To make the model simple to comply with space constraints, observed items have been excluded from the figure.

3.3.3 Instrumentation - measurement scales and coding

To test the proposed model that represents the various hypotheses relationships, a questionnaire (Appendix 1a) is designed as the necessary tool to obtain the information that would allow us to carry out the present assessment. The instrument is developed based on the objectives of the study and the previous literature reviews. In fact, we initially went further to carry out reviews of literature of some researchers (Leo T. et al. 2014, Gwebu et al. 2010, Gallego et al. 2008, Ngai et al. 2007, Green et al. 2005, Lu et al. 2005, Amoako-Gyampah and Salam 2004, Calisir and Calisir 2004, Hubona and Burton-Jones 2003, Liawa and Huang 2003, Riemenschneider et al. 2003, Venkatesh and Davis 2000, Davis, 1989). These reviews of literature allowed us to assert the validity of the data collected instrument we are going to design. Hence, the questionnaire prepared for this study is more than a simple list of questions. It is an efficient instrument of primary data acquisition based on various items relating to the research topic. The instrument consisted of two parts. The first part is designed to identify demographic attributes of the respondents. It contained demographic indicators such as gender, academic years, experience, background, workplace, studies and perspectives. The questions in the second part are not only made based on Davis's prior studies with modifications to fit the specific context of FOSS adoption but also mainly adapted from TOE and SIT for the objectives of the study. Finally, 48 questions (items) included in the second part of the survey are subdivided in a total of eighteen (18) single sub-constructs and organized in turn of the three (03) related models. The measurement scales[3] of each item and coding[4] are provided (see Appendix 1b). That is, all items are measured on five-point Likert-type scales, from point one (1) '*not useful or strongly disagree*' to point five (5) '*very useful or strongly agree*'.
To definitively complete the data collection instrument, various researchers and professors specialists in social sciences research methodology reviewed the survey structure. That is, the indications in each part of the questionnaire, the question length as well as its explanatory capability, and other specific points are reviewed. For instance, contents definitions and clarity of some questions are suggested; negative questions in the survey are recommended to be modified and reformulated in a positive sense because the existence of both positive and negative sentences in a questionnaire sometimes mislead or induce to different orientation of the questions and this could make the data analysis difficult. Before sending off the questionnaire to the sample population, a pre-test is also carried out by considering the feedback in order to permit the participants of the survey to participate in the investigation without any comprehension difficulty.

3.3.4 Sample selection process

According to Roztocki et al., (2016), and Walsham, (2017), research in ICT4D involves the interaction of policy makers, practitioners and researchers to understand the effects of ICTs on development outcomes. Walsham, (2017) proposes that researchers should engage with users, practitioners, and policy-makers through communities of practice on particular themes and issues. Based on these valuable arguments, target population in this study is consisted of IT users in Ghanaians SMEs; software developers/technicians; IT manager or chief executive officer (CEO); 3rd year bachelor and 2nd year master alumni of graduate schools of technology and business of some Ghanaian universities who have completed or are still completing their national service[5] within a company as national duty to the

[3] A measurement scale is a tool with a predetermined number of closed-ended responses that can be used to obtain an answer to a question.

[4] Coding is referred to the assignment of numbers to categories in a manner that facilitates measurement.

[5] Ghanaian students who graduate from accredited tertiary institutions are required under law to do a one-year national service to the country.

country.
The selection of this target population was possible thanks to the collaboration of several university lecturers, IT researchers and some personal contacts and research on-line. As the survey is a web survey, a questionnaire link (www.surveyosserp.com) is sent to the electronic mail of each participant after receiving their own authorization or the permission from their respective organizations, schools and universities. Some printed questionnaire booklets are also administered in person to interviewees during the fieldwork. The data is collected in the period between September 2016 – February 2017 in different regions of Ghana. Approximately, total of 1280 questionnaires are distributed (by web, e-mail, fax and self-administered) to the selected population. Finally, 306 filled questionnaires are received from the selected and a total of 260 questionnaires are considered complete. The few responses to the questionnaires from participants and the long time periods spent for data collection (due to the non-respect of appointments and the deadlines by some participants) revealed a lack of interest in the proceeding. Moreover, this is accentuated by problems of communication; internet access difficulties in some areas; sometimes bad results and impressions; etc. Even though the 10 regions of Ghana are involved, only areas easily accessible by transport and telecommunications (where internet, jobs and businesses, higher education institutions and other centres of socio-economic life are present) are considered. At this point, obtaining a representative sample that reflects the views of the general population is quite impossible or is a real challenging and requires a great deal of time and effort. However, credible responses are obtained from few effective population that reflect the characteristics of the population from which they are selected.

3.3.5 Data analysis process

Descriptive statistics

In the descriptive statistics, the demographic profile of the sample population is analyzed by using some spreadsheets programs. The goal is to compare proportions or totals of the occurrences of categories. Descriptive statistical analyses such as frequency, percentage and cross-tabulation are implemented from data gleaned from the first part of the questionnaire (Appendix 1a), where respondents were asked to indicate their age, gender, type of company, location, educational qualification, experience and others related information about IT. Table 3.1 presents the demographic profile of the sample.

TABLE 3.1: Demographic details of the respondents.

Demographic characteristics	Frequency	Percentage
Gender		
Male	238	91.5
Female	22	8.5
Age		
24 - 29	68	26.1
30 - 35	137	52.7
36 - 41	48	18.5
> 41	7	2.7
Software awareness		
open source software (OSS)	43	16.5
proprietary software (PS)	115	44.2
both PS & OSS	102	39.3
Type of SMEs		
Services	101	38.8
ICT office/training center	85	32.7
Education institutions	31	11.9
Finance institutions	24	9.3
Manufacturing & Industry	11	4.2
Agriculture	8	3.1
Education		
graduate	131	50.4
post graduate	112	43.1
doctorate	13	5
others	4	1.5

From the results displayed in Table 3.1, male respondents are far more prevalent. Out of the 260 responses that are obtained and considered for this study, the most important percentage of the respondents are in the age group of 30 to 35. Education qualification of the respondents is relevant. All of them are involved in IT sector and are working in different SMEs composed by services, ICT office/center, educational, manufacturing, industry, agriculture and financial sectors.

Inferential statistics

In inferential statistics, the study tests the hypotheses and addresses the level of statistical significance of the results. The study specifically uses an advanced multivariate statistical technique analysis of Structural Equation Modelling (SEM) to infer, from data gleaned from the second part of the questionnaire (Appendix 1a), information that can be applied to larger population with similar characteristics. Multivariate data analysis involves the

application of statistical methods that simultaneously analyze multiple variables representing measurements associated with individuals, companies, events, activities, situations and so forth. SEM is used to explore or confirm theory. Indeed, several considerations are necessary in deciding to use multivariate analysis particularly SEM. Among the most important, elements such as measurement, composite measure of the variable, measurement scales, coding, and data distributions are validated in this study. Moreover, it is important to note that there are two types of SEM: '*covariance-based SEM*' (CB-SEM) and '*partial least squares SEM*' (PLS-SEM). According to Hair, et al (2017), CB-SEM is primarily used to confirm or reject theories (i.e., a set of systematic relationships between multiple variables that can be tested empirically). It does this by determining how well a proposed theoretical model can estimate the covariance matrix for a sample data set. In contrast, PLS-SEM is primarily used to develop theories in exploratory research. It does this by focusing on explaining the variance in the dependent variables when examining the model. Usually, when running a regression analysis, researchers select the dependent and independent variables based on a priori established theories and concepts. The aim of the regression analysis is then to test these theories and concepts. Nevertheless, according to Mateos-Aparicio, (2011); Sarstedt et al., (2014); Hair, et al., (2017) and others scholars, the technique can also be used to explore whether additional independent variables prove valuable for extending the concept being tested, which is a similar case in this study. Based on this affirmation and the above definitions, PLS-SEM is considered as an appropriate multivariate analysis method for this quantitative approach. The selection of this technique can, moreover, be justified by the fact that the goal in this research is identifying key driver constructs; there are many constructs and many indicators or items (so the proposed model is complex); there are no identification issues with small sample (i.e., even if the sample population is small, as in this case study, PLS-SEM can achieve high levels of statistical power), and the technique is not affected by data inadequacies.
Besides having these key characteristics of PLS-SEM as advantages there are, however, several limitations of PLS-SEM. In its basic form, the technique cannot be applied when structural models contain causal loops or circular relationships between the latent variables. Furthermore, even though the recent research of Henleser et al., (2014) introduced the standardized root mean square residual (SRMR)[6] as a fit measure to validate the model, PLS-SEM does not have an established global goodness-of-fit measure. In fact, its use for theory testing and confirmation is generally limited.

In general, in the data analysis process, some indications is deemed necessary to note:

- Where the answers are discrete in nature (i.e., respondent position), bar charts and pie charts are used. These diagrams are used interchangeably, depending on what the researcher find best illustrated the data.

- Where the questions require Likert scales responses and the researcher want to use non-parametric[7] tools (i.e., histograms) to present data distribution, item responses are combined to create a score for the group items, in order to make easier the interpretation.

In summary, to test the various hypotheses in this study, first, the researcher finds that it is nevertheless worthwhile to consider data distribution (even though, a non-parametric statistical technique PLS-SEM does not require the data to be normally distributed). Second,

[6]SRMR measures the squared discrepancy between the observed correlations and the model-implied correlations.

[7]Non-parametric statistics refer to a statistical method in which the data is not required to fit a normal distribution.

the data consistency and validity are assessed. And finally, advanced PLS-SEM analysis are developed. The results are provided with deep details in the following chapter (chapter Four).

QUALITATIVE METHOD

3.3.6 Techniques definitions

In addition to the quantitative approach presented above, a form of social investigation is also provided. It is an approach that focuses on the way people interpret and make sense of their practices and the world in which they live. In fact, a social inquiry such as Delphi technique and a SWOT matrix analysis are also used as tools for this research objectives. SWOT analysis can help to set the context for strategy development, and decision-making can be provided through the Delphi consensus approach. In general, the goal is to increase stakeholders' ability to understand present situation and forecast future internal and external environments conditions of SMEs regard FOSS adoption. This cannot only help to add value in Research and Development (R&D) efforts for FOSS adoption in LDCs, but also it can provide suggestions for future engagement in Ghana in order to achieve the information technology innovation goals fixed by the government.

What is a Delphi technique?
Delphi is an adaptable research technique as it is used to conduct future research or research into areas where knowledge is partial. The Delphi method is a type of group interview, using in the collective opinion of knowledgeable experts. In general, the method is typified in five main characteristics:

1. First, its focus on researching the future or things about which little is known. According to Steward, Shamdasani, (1990) it used for developing forecasts of future events; for conceptualizing and inventing the future. It is also useful where there is a "lack of agreement or incomplete state of knowledge concerning either the nature of the problem or the components which must be included in successful solution" (Delbecq et al., 1975).

2. Secondly, it is characterized by the use of a group format in the form of panels of knowledgeable experts (Stewart et al., 1990; Denzin et al., 1994). That is, it is also characterized by the reliance on the use of expert opinion.

3. Thirdly, the technique can use a remote group communication (Jeffery et al., 2000). It does not require face-to-face contact and is particularly useful for involving experts who cannot come together physically (Delbecq et al., 1975). In short, e-mail or fax can be used to distribute the questionnaires (Saint-Germain et al., 2000).

4. Fourthly, the technique is characterized by the typical adoption of an iterative research process called rounds.

5. A fifth characteristic of the technique is the creation of a consensus opinion. Consensus is observed through the convergence of variances or the decrease of the standard deviations in subsequent iterations (Linstone et al., 1975).

What is a SWOT analysis?
SWOT analysis is a technique for identifying strengths and weaknesses, and for examining the opportunities and threats, a group or individual face in a given situation or process. This powerful technique enables group or individual to move from everyday problems

and strategies to a fresh prospective. It is always used as framework for organizing and using data and information gained from situation analysis of internal and external environment. In this study, SWOT analysis is considered as a useful tool for characterizing the helpful (strengths and opportunities) and the harmful (weaknesses and threats) components of FOSS adoption in Ghana. Table 3.2 displays a basic framework of SWOT analysis.

TABLE 3.2: SWOT analysis framework.

	Helpful to achieving the aim	Harmful to achieving the aim
Internal factors (attributes of internal environment)	STRENGTHS	WEAKNESSES
External factors (attributes of external environment)	OPPORTUNITIES	THREATS

In summary, the two techniques (Delphi and SWOT) are combined in a powerful tool that helped to deeply explore potential influencing factors in FOSS adoption and its impact on development in Ghana.

3.3.7 Survey participants and methods procedures

In this study, the Delphi technique makes use of three rounds of data collection and feedback to create a consensus of opinion (Trevor Amos and Noel Pearse, 2008). Before developing the different phases of this survey processes, it is important to describe the group of experts who have participated to the survey and define the questionnaire which are attributed to them.

Delphi survey: participants, questionnaire and procedures

Delphi survey participants: In general, the number of participants is always a critical and challenging issue in Delphi surveys since no statistical guides exist for the optimal number of survey participants (Gordon, 1999). Worst cases are in most LDCs, where weak monitoring and evaluation capacity and lack of statistical data for a baseline are major challenges. Thus, determinate an optimal and representative sample on the number and qualifications of local professionals in software industry would be almost impossible (Yildirim et al., 2005). Aware of this critical concern, the researcher found relevant to consider the number of respondents who have rated excellent or average their experience with FOSS and those who have rated excellent their experience in both FOSS and proprietary software (PS) in the quantitative approach survey questionnaire (Appendix 1a). Indeed, a total of 30 respondents who rated excellent or average their experience exclusively with FOSS, and number of 10 respondents of a total of 29 who rated excellent their experience both with FOSS and PS, are contacted. The groups of participants are thus consisting of 40 experts or professionals such as, computer technicians (developers/researchers on software); IT managers (industry representatives, project leaders, CEO); and students with very good experience in IT.
Delphi survey questionnaire and procedures: As stressed above the survey is carried out in three rounds. Based on the information that was provided from the quantitative analysis results, a Delphi questionnaire (Appendix 3) is designed for the first round. In the first round, the questionnaire is sent by e-mail (3rd characteristic of Delphi technique listed

above) to the knowledgeable expert groups of industry representatives, developers and students. In the second round and the third round, the participants also received questionnaires (Appendix 4 & Appendix 5) by e-mail, but most of them are also met in Ghana or contacted by phone. The aim of this iterative research process – rounds (4th characteristic of Delphi technique listed above) would be first to reiterate or confirm the evident validated factors that influence FOSS adoption. In addition, they can also help to deeply understand and define how these factors impact the adoption of FOSS for business practices and management in Ghanaian SMEs. The results should be classified in order to provide high audit circumstance that can allow experts to think about any valuable suggestions for strategies development (1rst characteristic of Delphi technique listed above).

Delphi survey phases with conceptual SWOT framework

First round
The aim of the first round is assessed in two-fold questions as follow:

1. In the first round questionnaire (Appendix 3), precisely in question (a.), the participants are asked to rate the importance of the mentioned factors on a 5-points Lykert scale varying from point one (1) '*not important*' to point five (5) '*very important*'. Factors that are rated important, that is, factors which received 3 points and above in average, should be considered as '*validated factors*'. The other factors are dismissed from the development of a consensus in the second round survey (4th characteristic of Delphi technique listed above). The 'validated factors' are, therefore, used to prepare a new questionnaire for the second round.

2. In the question (b.), the participants are also asked to identify through the mentioned factors the internal and the external strategic factors of their companies. Obviously, the internal factors are defined as strategic factors within the internal environment of SMEs industry and the external factors are considered as factors covering its external level inhibitors.

The related results of the two-fold are presented and discussed in the chapter Four.

Second round
The aim of the second round survey is assessed in three-fold points:

1. In fact, in the second round questionnaire (Appendix 4), to validate results of the first round and promote convergence, the findings of the first round are resent to the group of experts. The 1^{st} point of the second round questionnaire (question (1.)) has led experts to revise and reflect again their responses accordingly.

2. In the 2^{nd} point (question (2.)), a SWOT analysis has been carried out on the basis of the previous findings (internal and external rated factors) in order to derive a good understanding and functioning of these factors through their strengths, weaknesses, opportunities, and threats. Hence, to determine the strengths and the weaknesses, Delphi survey participants are asked in the second point of the second round questionnaire to rate the position of the Ghanaian SMEs in relation to the validated internal factors in order to determine the strengths and the weaknesses of its internal environment. Additionally, the participants are also asked to rate the possible effects of external factors on Ghanaian SMEs in order to determine the opportunities and the threats of its external environment. This path is justified since we agreed that strengths and weaknesses mainly refer to internal factors of internal environment, and, opportunities and threats refer to external factors of external environment in

SWOT matrix analysis.
To achieve the results, mentioned factors are also asked to be rated on a 5 points Lykert Scale: 1 as "*very weak*"; 2 as "*weak*"; 3 as "*moderate*"; 4 as "*strong*"; and 5 as "*very strong*". Factors that are rated as 4 "*strong*" or 5 "*very strong*" should be recognized as "*strengths*" for internal factors and as "*opportunities*" for external factors, and factors that are rated as 1 "very weak" or 2 "*weak*" should be considered as "*weaknesses*" for internal factors and as "*threats*" for external factors. Factors that are rated as 3 "*moderate*" should be acknowledged as neutral and thus will be dismissed in SWOT analyses. The factors perceived as neutral will be dismissed for both the external and the internal factors. This because, since a factor (external - rated as neutral) do not create an opportunity to be profited from or a threat to be avoided in an eventual policy design, or, since a factor (internal - rated as neutral) do not constitute a weakness to be strengthened or a strength to be used as useful guidance that could help to develop the necessary recommendations to support a strategic open source IT development, there is no need to keep these factors in the analysis (see Table 3.2).

3. In the 3^{rd} point (question (3.)), the revealed factors on the basis of the strength, weakness, opportunity and threat are asked to be numerically ranked in order of importance and priority, starting from one (1) as the most important factor.

Third round
In the final iteration, the results obtained from the 3^{rd} point (question (3.)) of the second round survey are resent to the respondents for final validating (Appendix 5). In fact, the participants are asked to list again the ranked factors in order of priority. This is not only to ensure that the most relevant factors are obtained within the approved consensus of the experts but also, to raise up the most needed concerns and suggestions from the prioritized factors (5th characteristic of Delphi technique listed above).
The related results of the second and the third round survey are also presented and discussed in the chapter Four.

3.3.8 CONCLUSION

In this chapter, the theoretical and philosophical concepts underlying the research methodology in information technologies field are reviewed. A relevant debate of research designs and methods are conducted. As result of this debate, the researcher's choice for given methodology is selected and key steps and procedures are outlined for both quantitative and qualitative approaches. Results gained from the study are presented in the following chapter.

Chapter 4

PRESENTATION AND INTERPRETATION OF THE RESULTS

4.1 Introduction

The chapter presents the results of quantitative and qualitative analysis. The analysis pursues two goals:

1. Identifying the potential influencing adoption factors of FOSS in Ghanaian SMEs industry.
2. Understanding how these factors are likely to affect the deployment of effective FOSS ICT for development in Ghana.

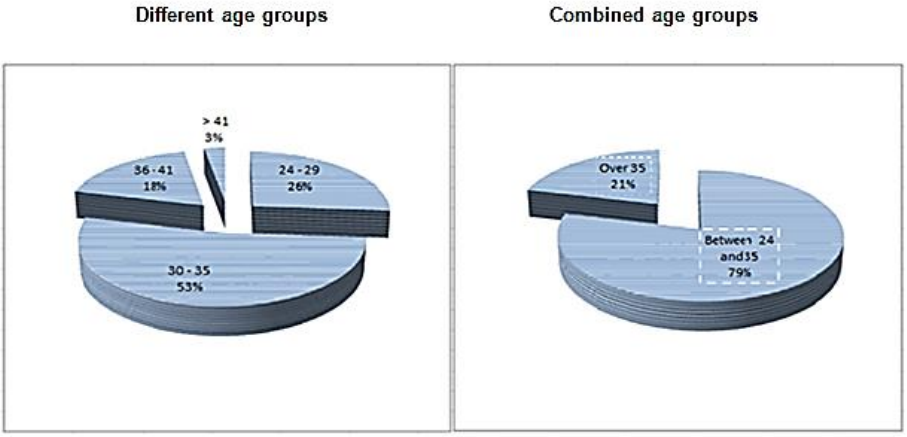
Section One of this chapter presents and interprets statistical analysis of the data obtained from the questionnaires (Appendix 1a). The purpose of these statistical paths is to identify the potential influencing adoption factors of FOSS (goal (1.)). Spreadsheets programs such as Microsoft Excel program and Statistical Analysis System are used to generate graphs, charts and tables, while SmartPLS 3 statistical program (Ringle, C. M., Wende, S., and Becker, J.-M. (2015), is used to estimate the model.
Section Two is basically focused on the understanding of the second goal (goal (2.)). Delphi iteration process combined with a SWOT analysis are techniques used.

4.2 Section One - Quantitative Method

4.2.1 Descriptive Statistics

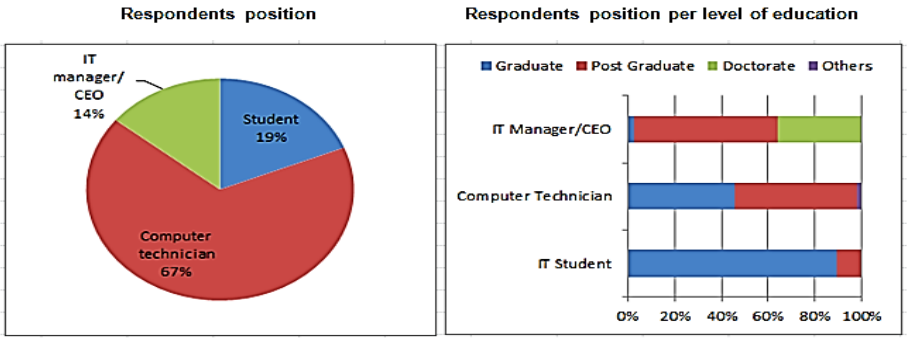
Before proceeding to identify the strategic factors influencing FOSS adoption in Ghanaian SMEs, frequencies distribution, cross-tabulations, means and variations of the data are generated.
In order to facilitate interpretation of results, age range of the respondents are generated in table 3.1 (see Table 3.1 in Chapter Three). That is, the age group of 24 to 29 and that of 30 to 35 are combined in one group age (age group of 24 to 35), and the age group of 36 to 41 and that of over 41 are combined in the second group age (group of respondents older than 35).

FIGURE 4.1: Age of the respondents.



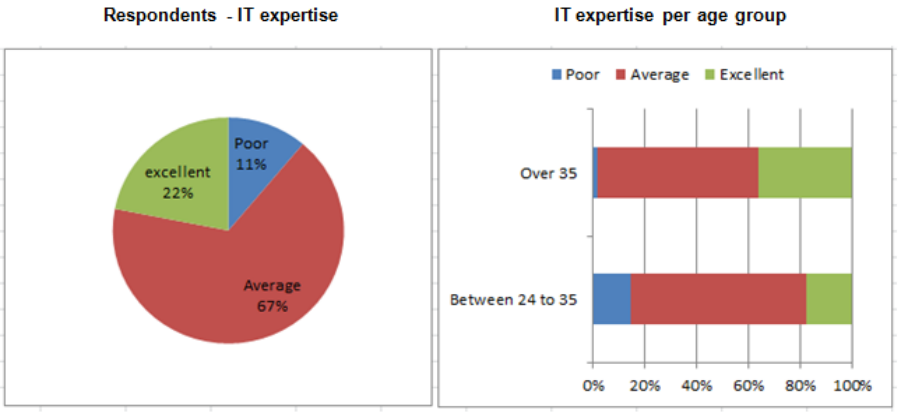
The combined age groups in Figure 4.1 shows that the largest demographic group is still young, ranging between 24 and 35 years of age.
Cross-tabulations used to analyze the joint and relative frequencies of some selected variables are presented in the figures below.

FIGURE 4.2: Respondents position & Cross-tabulation: position per level of education.



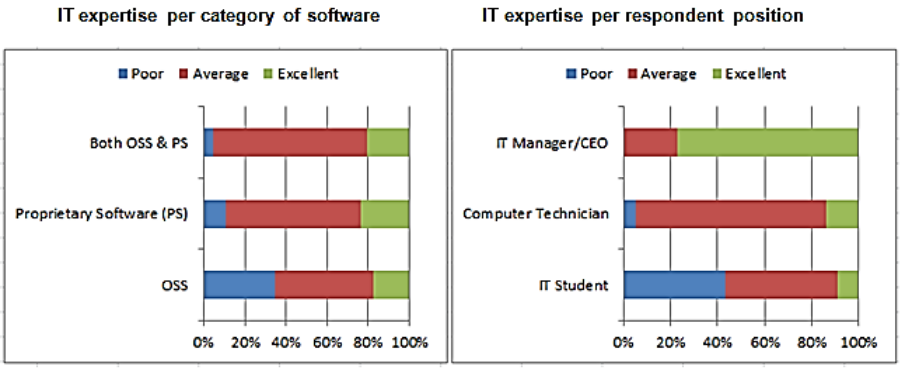
From the figure above, about 67% of the respondents are computer technicians who attained either graduate or post graduate level of education. Doctorate degrees are only attained by Chief Executif Officer (CEO) and IT manager groups. The computer technician position is the only category where more than two percent (2.16%) of the respondents rated their grade obtained from other educational certificates (training, technical and vocational education).

FIGURE 4.3: Respondents IT expertise & Cross-tabulation: IT expertise per age group.



Most of the respondents (67%) rated their level of IT expertise as average. Those who are excellent represented 22%. Only 11% of the respondents rated their level of IT expertise as poor. Age did not properly reveal a significant role in the level of IT expertise, but a higher percentage of respondents over the age of 35 considers their level of IT expertise to be excellent as compared to younger respondents below the age of 35. Respondents with 35 years and above indicates 1.82% of poor IT expertise as compared to the percentage (14.54%) of respondents with ages below 35.

FIGURE 4.4: Crosstab: IT expertise per category of software & IT expertise per position.

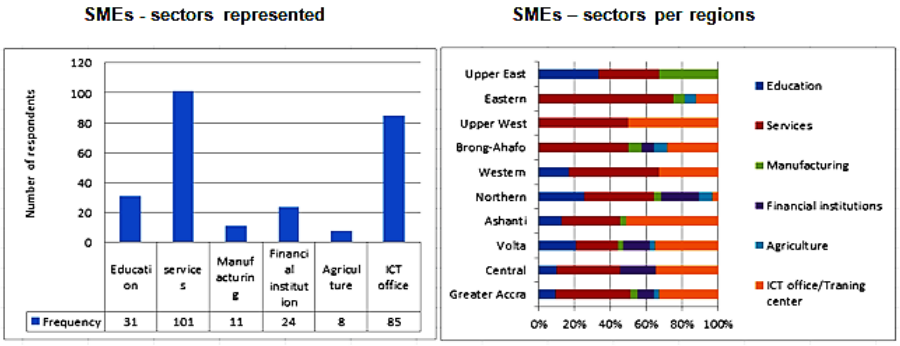


As depicted in Figure 4.4 above (IT expertise per category of software), most of the respondents rated their level of IT expertise as average and excellent with proprietary software (PS) and with both free open source software (F/OSS) and PS. Only about 17% of respondents rated their level of IT expertise as excellent exclusively with OSS systems. The second graph of the figure (IT expertise per respondent position) shows that most of the respondents (76.92%) from IT manager position rated their level of IT expertise as excellent, and about 82% of computer technicians rated their level of IT expertise as average. The highest percentage (43.10%) of poor IT expertise is indicated by the student position.

The small and medium enterprises represented are not very mature as few of them are older than 5 years. Also, the study focused prevalently on selected urban areas in each of the regions in Ghana. The companies represented by the respondents in this survey cover a broad spectrum of sectors such as services, ICT, educational, manufacturing and

industry, agriculture and financial sectors. As depicted in Figure 4.5 below (SMEs – sectors represented), the highest number of respondents is represented by the service sectors.

FIGURE 4.5: SMEs - sectors & Cross-tabulation: SMEs - sectors per regions.



In effect, the second graph of the figure (SMEs – sectors per regions) also shows that the services sector is widespread in each region of the country, from the southern border of Cape Coast to the northern area of Tamale.

4.2.2 Inferential Statistics

Before proceeding with the hypotheses test, a preliminary analysis is deemed necessary.

Preliminary analysis

As argued by Rensis Likert (1932), in an ordinal scale[1], responses can be rated or ranked, but the distance between responses is not measurable. An example is the typical Likert scale generally used by respondents to rate the degree to which they agree or disagree with a statement. Hence, descriptive statistics, such as means and standard deviations, have unclear meanings when applied to Likert scale responses. For instance, we can ask once more the question posed by Jamieson S., (2004) in the case of this survey responses analysis: what does the average of "*disagree*" and "*neutral agreement*" really mean? Does "*disagree*" and "*neutral* or *medium*" have a useful meaning? Moreover, if responses are clustered at the low and high extremes (strongly disagree and strongly agree) as in our case study, the mean may appear to be the neutral or the medium response, but this may not characterize the data fairly. This is in contrast to interval data [2] in which the difference between responses is measurable and so can be calculated. In fact, there has been a longstanding controversy regarding whether ordinal data, converted to numbers, can be treated as interval data (Carifio L., et al. 2008). However, the findings of several experts on this matter have revealed that if there is an adequate sample size (at least 5 –10 observations per group) and if the data are normally distributed (or nearly normal), parametric statistics[3] (include parameters such as means, standard deviation, etc.,) can be used with the Likert scale to analyse ordinal data (Jamieson S., 2004). Consistent with this, the researcher finds it appropriate to present in the following table (Table 4.1) a few indices such as (SD) referring to the standard deviation, (N) the number of responses, and the mean. To achieve this, the various responses (strongly disagree; disagree; neutral; agree; strongly

[1]Ordinal scale provides information about the order of our observations, but we cannot assume that the difference in this order are equally spaced.

[2]Interval data, is a data measured along a scale in which each position is equidistant from one another.

[3]Parametric statistics is a branch of statistics which assumes that sample data comes from a population that follows a probability distribution based on a fixed set of parameters (Geisser et al., 2006).

agree) collected from the respondents are converted to numerical values of respectively 1; 2; 3; 4 and 5.

TABLE 4.1: Summary of measurement scales.

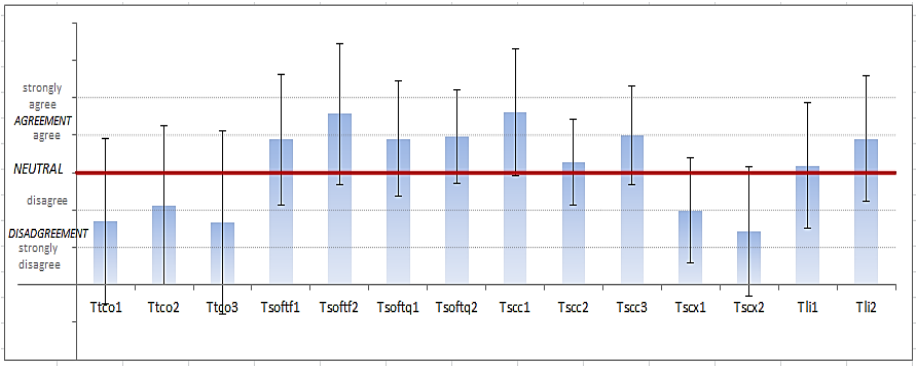
Items	N	Mean	SD	Items	N	Mean	SD	Items	N	Mean	SD
Ttco1	260	1,704	1,099	Os3	260	3,623	0,694	Ssi3	260	3,788	0,524
Ttco2	260	2,123	1,067	Otr1	260	3,900	0,700	Ssi4	260	4,708	0,744
Ttco3	260	1,662	1,219	Otr2	260	3,931	0,635	Pu1	260	3,923	0,449
Tsoftf1	260	3,885	0,874	Egsp1	260	2,296	0,713	Pu2	260	3,996	0,530
Tsoftf2	260	4,562	0,949	Egsp2	260	3,054	0,417	Pu3	260	3,023	0,247
Tsoftq1	260	3,904	0,771	Eedu1	260	3,115	0,450	Pu4	260	4,704	0,734
Tsoftq2	260	3,950	0,621	Eedu2	260	3,108	0,434	Peou1	260	3,088	0,367
Tscc1	260	4,608	0,855	Eawar1	260	2,050	0,342	Peou2	260	3,946	0,579
Tscc2	260	3,285	0,572	Eawar2	260	1,288	0,743	Peou3	260	3,958	0,616
Tscc3	260	3,985	0,662	Ppiit1	260	3,946	0,469	Peou4	260	4,019	0,617
Tscx1	260	1,988	0,699	Ppiit2	260	4,623	0,731	Ia1	260	3,931	0,616
Tscx2	260	1,423	0,858	Ppiit3	260	3,927	0,301	Ia2	260	4,112	0,701
Tli1	260	3,181	0,842	Scd1	260	3,012	0,434	Ia3	260	3,881	0,636
Tli2	260	3,892	0,839	Scd2	260	3,842	0,664	Ia4	260	4,681	0,730
Os1	260	2,312	1,119	Ssi1	260	3,965	0,736	Usb1	260	4,488	0,731
Os2	260	2,604	1,012	Ssi2	260	3,992	0,588	Usb2	260	4,523	0,670

Table 4.1 exposes the means (or averages) for each one of the items contained in each construct with the respective standard deviation (SD). The majority of the SD values are close to zero and ranged from 0.247 to 1.219. For all the items included in the study, a one hundred percentage (100%) response is rated for each item. This information led us to believe that the survey is easier to understand and that the respondents did not have any difficulty in responding to the questionnaire.
The Likert scales used in the survey allowed for some additional preliminary statistical analysis through the use of confidence intervals. Indeed, comparative plots of the mean and values are built for the statements that related to each construct. Specifically, the aim is to identify provisionally the possible influencing factors considered by the respondents through an '*agreement*' statement. The mean of each item is displayed in the plots in the form of vertical blue-sky bars. The value of each vertical blue-sky bar is accompanied by a 95% confidence interval, represented by a thin black line. The intervals show the standard deviation (SD) and the sample size, in which array the mean of the true population lies. To display useful information derived from the data, questions structured in five categories of responses are once again aggregated into three categories. That is, both point (1) and point (2) represent a "Disagreement" statement; both point (4) and point (5) are considered as an "Agreement" statement and point (3) is equal to a "*Neutral*" statement represented by a red line that allows us to identify the considered factors by separating or delimiting the range in which the mean of the true population lies. The plots are presented in the following figures (Figure - 4.6, 4.7, 4.8 & 4.9).

Technology – Organization – Environment (TOE)
The TOE dimensions (Technology,Organization and Environment) are presented and interpreted separately.

Technology

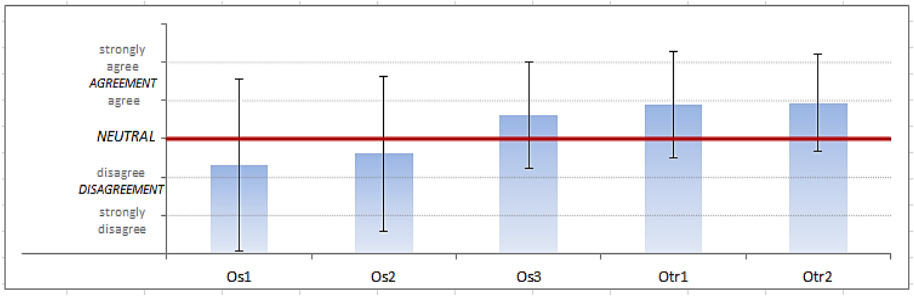
FIGURE 4.6: Mean rating for technology adoption factors.



Based on the results presented by the figure above (Figure 4.6), some indicators or items such as software flexibility (Tsoftf1 and Tsoftf2); software quality (Tsoftq1 and Tsoftq2) and training (Tr1 and Tr2) system compatibility and capabilities (Tscc1, Tscc2 and Tscc3); and legal issues (Tli1 and Tli2) are rating as possible influencing factors because their respective means are above the red line that separate the two statements (Agreement and Disagreement). That is, the respondents in general agree that these indicators are possible factors that influence FOSS adoption. The mean of each indicator, such as total cost ownership (Ttco1, Ttco2 and Ttco3) and system complexity (Tscx1 and Tscx2), is rated below the red line. However, they cannot be immediately dismissed as influencing factors because their interval of confidence cut the red line.

Organization

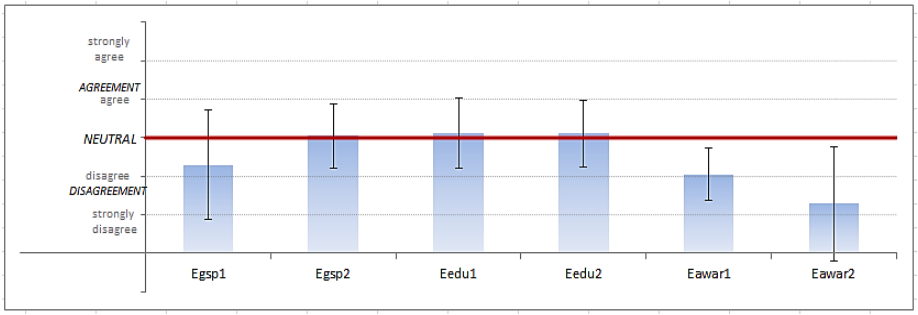
FIGURE 4.7: Mean rating for organization adoption factors.



Organisational support (Os3) and training (Otr1 and Otr2) are considered as possible influencing factors by the respondents. Despite the mean of the corresponding respondent statements on Os1 and Os2 being rated as "disagree", their confidence intervals cut the red line. Therefore, organisational support (Os1 and Os2) cannot be dismissed as influencing factors.

Environment

FIGURE 4.8: Mean rating for environment adoption factors.

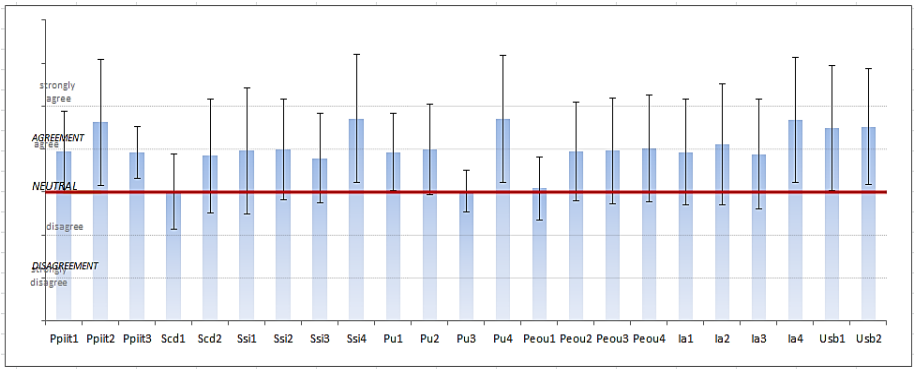


As shown in the figure above (Figure 4.8), government supports and policies (Egsp2) and education (Eedu1 and Eedu2) cannot be dismissed as influencing factors because the respective mean of Egsp2, Eedu1 and Eedu2 overlap with the red line and thus their confidence intervals cut the red line. Egsp1 can also be considered as a factor, because, even the mean rating goes to the bottom of the red line, the confidence interval cutting the line. Only awareness (Eawar1 and Eawar2) in the environmental characteristics could be dismissed as factors influencing FOSS adoption.

Individual characteristics: SIT and TAM

Personal, social and/or intentional dimensions which have taken concrete shape in the form of the two basic models (SIT and TAM) are shown in a unique graph in the figure below (Figure 4.9).

FIGURE 4.9: Mean rating for related individual characteristics adoption factors.



As can be noted in the figure above (Figure 4.9), the individual characteristics appeared to have much more of an underlying impact and stronger feedback in terms of adoption factors of FOSS than technology, organisation and environment characteristics.
Apart from the cultural dimension (Scd1), perceived usefulness (Pu3) and perceived ease of use (Peou1) which means overlap the red line, all the mentioned indicators are rated as influencing factors with a potential agreement.
In summary, the preliminary analysis of results revealed that all items could be considered as possible influencing factors except the 'awareness' indicators, where the average and interval of confidence fell short of the red line. However, it is important to remember that our data have an ordinal nature as highlighted above, and parametric statistics including parameters such as mean, standard deviation and confidence interval are used.

Again, we come back to the questions of Jamieson S., (2004) by asking ourselves what the average of a statement really means. In fact, these results cannot be relied upon as definitive influencing factors since sufficient statistical information or significance for indicators are not approved. It is therefore important for the data analysis to show more confident results. To do this, the consistency and validity of the data collected are assessed and various hypotheses are then tested.

Hypotheses testing

PLS-SEM simulation of the proposal model is carried out by using SmartPLS 3 software (Ringle, et al., 2015). The software made it possible to calculate and assess various parameters. In effect, item loading, reliability and validity are tested through the measurement model process and the coefficient of determination and the path coefficients are estimated through the structural model assessment (Vinzi et al., 2010). That is, the technique involved two principal stages: the measurement model evaluation and the structural model assessment.

Measurement model evaluation

The measurement model evaluation aimed to evaluate the consistency and validity of the variables that could be directly measured or observed (manifest variables).

Consistency evaluation

Consistency evaluations are tested through individual manifest and construct reliability.

1. **Individual manifest reliability**

The first parameter for consistency evaluation is calculated by the standardized outer loadings.

The standardized path loadings are indicators of the degree of association between the principal latent factor and each item. The coefficient should be greater than 0.7 and statistically significant (Gefen, Straub, & Boudreau, 2000). In fact, the manifest variables with outer loading of 0.7 or higher are considered highly satisfactory (Henseler et al., 2009 and Gotz et al., 2010). While a loading value of 0.5 is regarded as acceptable, the manifest variables with a loading value of less than 0.5 should be dropped (Chin et al. 1998, & Hair et al., 2010). A loading value of 0.4 should be also acceptable (Hulland, 1999), however, Henseler et al. (2009) recommended that a manifest variable with loading values between 0.4 and 0.7 should be reviewed before elimination. For the present analysis the cut-off value taken for outer loading is 0.5. Thus any item with outer loading of less than 0.5 would be deleted, as shown in Table 4.4 and Table 4.5 below.

2. **Construct reliability**

The second parameter for consistency evaluation is construct reliability. It is assessed by two measures: Cronbach's Alpha and Composite Reliability (CR).

Cronbach's alpha and CR describe how well a set of manifest variables appraises a single latent construct. Nonetheless, compared to Cronbach Alpha, CR is considered a better measure of internal consistency because it uses the standardised loadings of the manifest variables (Fornell and Larcker, 1981). Cronbach's Alpha coefficients analyse the internal consistency of each variable with all the other

variables in the same construct. In conclusion, the interpretation of the Composite Reliability score and Cronbach's Alpha is similar. The recommended value of Cronbach's Alpha should be higher than 0.7 (Litwin, 1995 and Nunally et al., 1995) and the CR must be larger than 0.7 (Hair et al., 1998; 2011).

Validity evaluation

As concerns the validity of the variable, the variables are tested on convergent and discriminant validities.

1. **Convergent validity**

The first parameter for validity evaluation is the convergent validity. It is carried out by estimating the Average Variance Extracted (AVE) test on variables (Fornell and Larcker, 1981).

AVE determines the amount of variance captured by the latent variable from its relative manifest variables due to measurement errors. According to Barclay et al., (1995) and Hair et al., (1998), a minimum 50% of the variance from manifest variables should be captured by latent variables. That is, the AVE value of the construct should be greater than 0.5.

2. **Discriminant validity**

The second parameter for validity evaluation is the discriminant validity. It is carried out by estimating the square root of the AVE test on variables (Fornell and Larcker, 1981). According to Hulland (1999), discriminant validity indicates that a construct should share more variance with its measures than it shares with other constructs in a given model. The discriminant validity assessment has the goal of ensuring that a reflective construct has the strongest relationships with its own indicators (i.e. in comparison with than any other construct) in the PLS path model (Hair et al., 2017).

In effect, two approaches are usually used to evaluate discriminant validity. With the first approach, discriminant validity can be demonstrated if item loadings are high on their intended constructs and cross loadings with other constructs are lower (Henseler et al., 2009). With the second approach, it can be demonstrated if the square root of AVE is larger than the absolute value of the standardised correlations (Chin et al. 1998).

Based on the parameters developed above, the measurement model is evaluated by means of an iterative process. The iterative process is adopted for elimination of the manifest variables falling under the recommended thresholds. A total of two iterations are involved in this analysis where each of the iterations is evaluated based on consistency and validity parameters. The following tables (Table 4.2; Table 4.3) present the first and the second (final) iterations.

TABLE 4.2: First iteration of factor loading and indices of Reliability and Validity.

Main construct	Sub construct	Items	Loading	Alpha	CR	AVE	DV
Technological characteristics	Total cost ownership	Ttco1	0.934	0.924	0.952	0.868	0.932
		Ttco2	0.929				
		Ttco3	0.932				
	Software flexibility	Tsoftf1	0.960	0.915	0.959	0.922	0.960
		Tsoftf2	0.961				
	software quality	Tsoftq1	0.939	0.859	0.934	0.876	0.936
		Tsoftq2	0.933				
	System compatibility & capabilities	Tscc1	0.917	0.707	0.833	0.637	0.798
		Tscc2	0.518				
		Tscc3	0.896				
	system complexity	Tscx1	0.916	0.824	0.919	0.850	0.922
		Tscx2	0.928				
	Legal issues	Tli1	0.878	0.766	0.894	0.809	0.899
		Tli2	0.920				
Organizational characteristics	Supports	Os1	0.885	0.599	0.777	0.560	0.748
		Os2	0.854				
		Os3	0.409				
	Training	Otr1	0.947	0.877	0.942	0.890	0.943
		Otr2	0.940				
Environmental characteristics	Government supports & policies	Egsp1	0.939	0.839	0.925	0.860	0.927
		Egsp2	0.917				
	Education	Eedu1	0.967	0.926	0.964	0.931	0.965
		Eedu2	0.963				
	Awareness (e-readiness)	Eawar1	0.916	0.845	0.927	0.865	0.930
		Eawar2	0.944				
Personal characteristics (innovativeness in technology)		Ppiit1	0.764	0.797	0.880	0.710	0.843
		Ppiit2	0.901				
		Ppiit3	0.857				
Social influence characteristics	Cultural dimensions	Scd1	0.855	0.756	0.888	0.799	0.894
		Scd2	0.931				
	Social identification	Ssi1	0.889	0.920	0.943	0.806	0.898
		Ssi2	0.871				
		Ssi3	0.903				
		Ssi4	0.928				
Perceived usefulness (Pu)		Pu1	0.906	0.743	0.837	0.602	0.776
		Pu2	0.827				
		Pu3	0.199				
		Pu4	0.929				
Perceived ease of use (Peou)		Peou1	0.397	0.798	0.869	0.641	0.801
		Peou2	0.892				
		Peou3	0.907				
		Peou4	0.886				
Intention to adopt/use (Ia)		Ia1	0.841	0.883	0.920	0.741	0.861
		Ia2	0.834				
		Ia3	0.866				
		Ia4	0.901				
Usage behaviour (Usb)		Usb1	0.915	0.781	0.901	0.820	0.906
		Usb2	0.896				

CR = Composite Reliability, AVE = Average Variance Extracted (Convergent Validity), DV = Discriminant Validity, Alpha = Cronbach's Alpha.

TABLE 4.3: Final iteration of factor loading and indices of Reliability and Validity.

Main construct	Sub construct	Items	Loading	Alpha	CR	AVE	DV
Technological characteristics	Total cost ownership	Ttco1	0.930	0.924	0.952	0.868	0.932
		Ttco2	0.932				
		Ttco3	0.933				
	Software flexibility	Tsoftf1	0.960	0.915	0.959	0.922	0.960
		Tsoftf2	0.961				
	software quality	Tsoftq1	0.939	0.859	0.934	0.876	0.936
		Tsoftq2	0.933				
	System compatibility & capabilities	Tscc1	0.917	0.707	0.833	0.637	0.798
		Tscc2	0.517				
		Tscc3	0.896				
	system complexity	Tscx1	0.916	0.824	0.919	0.850	0.922
		Tscx2	0.928				
	Legal issues	Tli1	0.877	0.766	0.894	0.809	0.899
		Tli2	0.921				
Organizational characteristics	Supports	Os1	0.900	0.716	0.875	0.778	0.882
		Os2	0.864				
		Os3	omitted				
	Training	Otr1	0.947	0.877	0.942	0.890	0.943
		Otr2	0.940				
Environmental characteristics	Government supports & policies	Egsp1	0.938	0.839	0.925	0.860	0.927
		Egsp2	0.917				
	Education	Eedu1	0.967	0.926	0.964	0.931	0.965
		Eedu2	0.963				
	Awareness (e-readiness)	Eawar1	0.916	0.845	0.927	0.865	0.930
		Eawar2	0.944				
Personal characteristics (innovativeness in technology)		Ppiit1	0.765	0.797	0.880	0.710	0.843
		Ppiit2	0.901				
		Ppiit3	0.857				
Social influence characteristics	Cultural dimensions	Scd1	0.854	0.756	0.888	0.799	0.894
		Scd2	0.932				
	Social identification	Ssi1	0.889	0.920	0.943	0.806	0.898
		Ssi2	0.871				
		Ssi3	0.903				
		Ssi4	0.928				
Perceived usefulness (Pu)		Pu1	0.907	0.866	0.918	0.790	0.889
		Pu2	0.824				
		Pu3	omitted				
		Pu4	0.932				
Perceived ease of use (Peou)		Peou1	omitted	0.881	0.927	0.808	0.899
		Peou2	0.872				
		Peou3	0.924				
		Peou4	0.901				
Intention to adopt/use (Ia)		Ia1	0.841	0.883	0.920	0.741	0.861
		Ia2	0.834				
		Ia3	0.866				
		Ia4	0.901				
Usage behaviour (Usb)		Usb1	0.915	0.781	0.901	0.820	0.906
		Usb2	0.896				

CR = Composite Reliability, AVE = Average Variance Extracted (Convergent Validity), DV = Discriminant Validity, Alpha = Cronbach's Alpha.

In the first iteration table (Table 4.2), the majority of the loadings are significant except for one item of System compatibility and capabilities (Tscc2); one item of Organisational support (Os3); one item of Perceived usefulness (Pu3) and one item of Perceived ease of use (Peou1) which are less than 0.7. But since the cut-off value taken for outer loading considered in this study is 0.5, the item Tscc2 whose loading value is equal to 5.18, is maintained. Hence, a total of three weak manifest variables are identified in the first iteration. In the second iteration (Table 4.3), the three weak manifest variables are discarded from the respective sub-construct in order to allow Cronbach's Alpha to reflect a very high reliability. In fact, all Cronbach's Alpha are now above 0.7. The CR values ranged from 0.833 to 0.964. This meant that all are above the recommended level of 0.7 for a reliable construct. Additionally, all the AVE values of the sub-constructs are over the recommended threshold of 0.5. Thus, the convergent validity is established.
Once the iteration process is completed, the final model is checked for discriminant validity based on cross loading values generated from the final iteration. Indeed, the technique advocated by Henseler et al. (2009) is adopted and the results of item loadings and cross loadings are presented in the following table (Table 4.4).

TABLE 4.4: Item loadings and cross loading.

	Eawar	Eedu	Egsp	Is	Os	Otr	Peou	Pplit	Pu	Sod	Ssl	Tll	Tsoo	Tsox	Tsoftf	Tsoftq	Tbo	Usb
Eawar1	**0,918**	0,437	0,699	-0,711	0,606	-0,677	-0,678	-0,686	-0,724	-0,739	-0,691	-0,657	-0,690	0,692	-0,706	-0,655	0,033	-0,604
Eawar2	**0,944**	0,506	0,845	-0,863	0,787	-0,836	-0,826	-0,836	-0,881	-0,851	-0,846	-0,822	-0,846	0,853	-0,865	-0,824	0,018	-0,742
Eedu1	0,514	**0,867**	0,494	-0,525	0,453	-0,461	-0,514	-0,502	-0,506	-0,523	-0,459	-0,476	-0,538	0,558	-0,535	-0,476	0,061	-0,434
Eedu2	0,470	**0,883**	0,449	-0,502	0,430	-0,480	-0,485	-0,434	-0,490	-0,489	-0,478	-0,442	-0,502	0,513	-0,468	-0,435	0,042	-0,421
Egsp1	0,841	0,492	**0,933**	-0,840	0,770	-0,826	-0,806	-0,794	-0,855	-0,803	-0,837	-0,792	-0,833	0,821	-0,840	-0,820	0,045	-0,718
Egsp2	0,703	0,410	**0,917**	-0,727	0,649	-0,699	-0,695	-0,708	-0,738	-0,687	-0,719	-0,689	-0,700	0,706	-0,655	-0,655	-0,033	-0,619
Is1	-0,695	-0,424	-0,662	**0,941**	-0,686	0,718	0,685	0,679	0,685	0,675	0,699	0,726	0,683	-0,676	0,657	0,666	-0,059	0,616
Is2	-0,687	-0,454	-0,689	**0,934**	-0,615	0,700	0,715	0,673	0,684	0,681	0,736	0,668	0,716	-0,699	0,687	0,643	-0,067	0,638
Is3	-0,749	-0,454	-0,748	**0,888**	-0,693	0,728	0,702	0,760	0,746	0,721	0,770	0,728	0,723	-0,736	0,722	0,702	-0,035	0,668
Is4	-0,801	-0,497	-0,813	**0,901**	-0,746	0,820	0,816	0,811	0,824	0,778	0,833	0,810	0,829	-0,816	0,831	0,839	-0,115	0,689
Os1	0,718	0,403	0,719	-0,753	**0,900**	-0,701	-0,721	-0,726	-0,713	-0,703	-0,739	-0,722	-0,726	0,718	-0,729	-0,696	0,047	-0,633
Os2	0,611	0,406	0,633	-0,647	**0,884**	-0,632	-0,596	-0,624	-0,648	-0,609	-0,634	-0,658	-0,663	0,658	-0,640	-0,624	-0,006	-0,536
Otr1	-0,802	-0,465	-0,810	0,840	-0,726	**0,947**	0,818	0,802	0,808	0,775	0,851	0,773	0,829	-0,815	0,799	0,832	-0,060	0,729
Otr2	-0,744	-0,455	-0,748	0,787	-0,704	**0,940**	0,759	0,723	0,771	0,728	0,803	0,740	0,767	-0,739	0,741	0,768	-0,068	0,674
Peou2	-0,747	-0,482	-0,728	0,780	-0,689	0,762	**0,872**	0,732	0,790	0,735	0,779	0,716	0,777	-0,750	0,748	0,750	-0,053	0,681
Peou3	-0,738	-0,473	-0,746	0,781	-0,705	0,784	**0,924**	0,750	0,767	0,746	0,769	0,713	0,760	-0,770	0,750	0,784	-0,069	0,655
Peou4	-0,712	-0,440	-0,717	0,727	-0,627	0,707	**0,901**	0,701	0,730	0,690	0,722	0,695	0,712	-0,689	0,705	0,715	-0,085	0,619
Pplit1	-0,538	-0,316	-0,519	0,552	-0,503	0,537	0,537	**0,785**	0,526	0,495	0,540	0,526	0,518	-0,551	0,569	0,507	-0,057	0,408
Pplit2	-0,700	-0,396	-0,709	0,753	-0,675	0,686	0,704	**0,901**	0,735	0,654	0,715	0,678	0,733	-0,698	0,721	0,715	-0,020	0,630
Pplit3	-0,808	-0,491	-0,784	0,809	-0,731	0,788	0,773	**0,857**	0,821	0,760	0,809	0,804	0,815	-0,828	0,813	0,792	-0,090	0,676
Pu1	-0,792	-0,467	-0,806	0,790	-0,718	0,738	0,777	0,755	**0,907**	0,742	0,784	0,745	0,784	-0,789	0,763	0,754	-0,017	0,676
Pu2	-0,637	-0,390	-0,646	0,639	-0,552	0,639	0,644	0,651	**0,824**	0,642	0,640	0,624	0,681	-0,654	0,644	0,638	-0,055	0,578
Pu4	-0,869	-0,509	-0,831	0,836	-0,770	0,839	0,828	0,825	**0,932**	0,826	0,835	0,792	0,840	-0,844	0,844	0,824	-0,016	0,742
Sod1	-0,657	-0,381	-0,607	0,591	-0,551	0,566	0,595	0,529	0,589	**0,864**	0,575	0,588	0,582	-0,557	0,560	0,520	-0,008	0,517
Sod2	-0,855	-0,536	-0,810	0,857	-0,757	0,823	0,816	0,808	0,864	**0,932**	0,821	0,812	0,853	-0,818	0,828	0,790	-0,044	0,733
Ssl1	-0,712	-0,441	-0,718	0,782	-0,681	0,778	0,732	0,734	0,732	0,710	**0,889**	0,736	0,754	-0,731	0,741	0,767	-0,052	0,660
Ssl2	-0,680	-0,372	-0,701	0,736	-0,655	0,751	0,724	0,682	0,708	0,630	**0,871**	0,675	0,697	-0,710	0,691	0,718	-0,108	0,659
Ssl3	-0,748	-0,437	-0,779	0,804	-0,710	0,785	0,749	0,755	0,777	0,715	**0,903**	0,745	0,794	-0,744	0,766	0,769	-0,045	0,652
Ssl4	-0,843	-0,486	-0,822	0,849	-0,755	0,833	0,817	0,810	0,841	0,808	**0,928**	0,810	0,839	-0,822	0,833	0,800	-0,026	0,725
Tll1	-0,614	-0,410	-0,635	0,679	-0,627	0,609	0,625	0,643	0,657	0,648	0,658	**0,877**	0,689	-0,652	0,627	0,633	-0,049	0,545
Tll2	-0,813	-0,445	-0,793	0,842	-0,771	0,816	0,779	0,801	0,799	0,780	0,818	**0,921**	0,796	-0,795	0,797	0,794	-0,093	0,705
Tsoo1	-0,808	-0,508	-0,814	0,850	-0,762	0,827	0,819	0,817	0,848	0,788	0,847	0,821	**0,917**	-0,807	0,830	0,809	-0,082	0,731
Tsoo2	-0,302	-0,288	-0,292	0,348	-0,278	0,313	0,319	0,335	0,349	0,318	0,330	0,316	**0,617**	-0,300	0,353	0,317	-0,134	0,282
Tsoo3	-0,754	-0,464	-0,748	0,745	-0,721	0,757	0,739	0,734	0,767	0,751	0,758	0,727	**0,898**	-0,751	0,765	0,729	-0,050	0,655
Tsox1	0,735	0,501	0,725	-0,756	0,693	-0,736	-0,733	-0,772	-0,760	-0,712	-0,736	-0,729	-0,726	**0,918**	-0,729	-0,727	0,090	-0,616
Tsox2	0,809	0,523	0,798	-0,814	0,747	-0,784	-0,779	-0,771	-0,832	-0,743	-0,809	-0,766	-0,803	**0,928**	-0,820	-0,796	0,044	-0,718
Tsoftf1	-0,808	-0,497	-0,786	0,815	-0,739	0,778	0,797	0,823	0,796	0,747	0,811	0,769	0,815	-0,815	**0,960**	0,805	-0,030	0,678
Tsoftf2	-0,828	-0,502	-0,774	0,806	-0,756	0,790	0,774	0,800	0,837	0,784	0,813	0,766	0,836	-0,801	**0,961**	0,829	-0,056	0,704
Tsoftq1	-0,784	-0,447	-0,780	0,820	-0,709	0,818	0,795	0,796	0,806	0,714	0,823	0,756	0,812	-0,792	0,818	**0,939**	-0,088	0,716
Tsoftq2	-0,718	-0,436	-0,718	0,734	-0,695	0,770	0,769	0,726	0,761	0,698	0,769	0,744	0,730	-0,755	0,774	**0,933**	-0,136	0,620
Tbo1	0,010	0,021	-0,014	-0,063	0,011	-0,056	-0,065	-0,040	-0,035	-0,008	-0,056	-0,045	-0,054	0,042	-0,031	-0,112	**0,930**	-0,003
Tbo2	0,050	0,071	0,009	-0,096	0,019	-0,076	-0,077	-0,072	-0,030	-0,059	-0,060	-0,102	-0,110	0,079	-0,050	-0,117	**0,932**	-0,038
Tbo3	0,012	0,054	0,031	-0,064	0,042	-0,055	-0,070	-0,074	-0,020	-0,021	-0,059	-0,076	-0,095	0,077	-0,044	-0,103	**0,933**	0,000
Usb1	-0,700	-0,452	-0,690	0,720	-0,656	0,703	0,705	0,682	0,720	0,702	0,714	0,664	0,713	-0,709	0,698	0,684	-0,002	**0,915**
Usb2	-0,620	-0,345	-0,618	0,652	-0,545	0,642	0,605	0,573	0,642	0,589	0,644	0,606	0,627	-0,600	0,601	0,608	-0,028	**0,898**

Bold values indicate loadings for the items most associated with each latent variable.

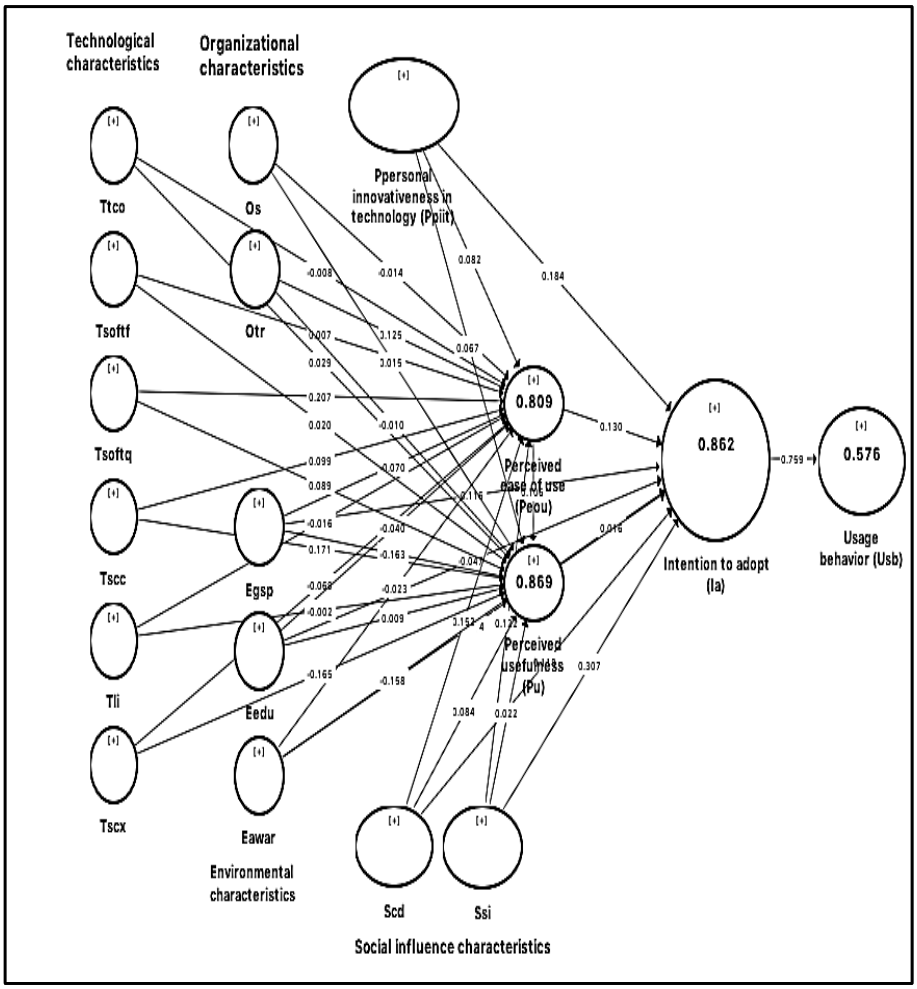
For each of the items, the results reveal high loadings on their intended constructs and lower cross loadings with other constructs. This validates the fact that the manifest variables in each construct represent the assigned latent variable, and thus confirms sufficient discriminant validity of the model.

Structural model assessment

The structural model is examined to finally test the hypotheses. In fact, the model assesses the relationship between exogenous and endogenous latent variables through evaluating R-square (R^2) value, that is, the coefficient of determination (Hair et al., 2012) and also the β value, that is, the path coefficients of the model (Chin, 1998).

- R^2*:* generated for each regression equation, indicates the explanatory power or variance explained of the latent endogenous variables, that is, the degree of explained variance of endogenous latent variables (Akter et al., 2011). It can be taken as indicator for the quality of the model.
- β*:* indicates the strength of an effect from variables to endogenous latent variables (Lleras et al., 2005).

FIGURE 4.10: Structural Equation Model.



As shown by Figure 4.10, the number inside circle is the R^2 and the number on the line is the direct effect (Path Coefficient).

- R^2*:* the percent of variance of the dependent variable which has been explained by the independent variables ranging between (0 -1). According to Cohen (1988) and Cohen et al. (2003), when the value of R^2 of the endogenous latent variable is more than 0.26, the model could be considered as good. In effect, R^2 value in this model is equal to 0.576 for usage behaviour (*Usb*); 0.862 for intention to adopt (*Ia*); 0.809 for perceived ease of use (*Peou*) and 0.869 for perceived usefulness (*Pu*), which are higher than the suggested value. As a result, the model is considered to have a substantial degree of explained variance of endogenous latent variables.

- β*:* as concerns the strength of effect from variables to endogenous latent variables, the path coefficients have standardised values between -1 and + 1. When the estimated path coefficient is close to 0, the relationship is weak (very low values close to 0 are usually non-significant). For example, Hair et al., (2014), claims that path coefficients with standardised values below 0.10 are usually not significant. The estimated path coefficient value close to +1 symbolises a strong positive relationship (and vice versa for negative value close to -1) that are almost always statistically significant. This reiterates the statement by Aibinu and Al-Lawati (2010) that argued that the highest β value represents the strongest effect of the predictor (exogenous) latent variable towards the dependent (endogenous) latent variable. The model estimated in this study shows the highest direct effect value equal to 0.759 for intention to adopt related factors. This implies that intention to adopt (*Ia*) is the most significant construct that critically influences and affects users' behaviour in FOSS adoption.

To provide a more comprehensive overview of the relationships between the exogenous and endogenous latent variables, the total effect that is the sum of direct and indirect effects is computed and their significance for the structural model are presented in Table 4.5.

TABLE 4.5: Direct and Indirect effects and its significant for the structural model.

Direction of effect	Direct effects		Indirect effects		Total effects	
	B	P Values	B	P Values	B	P Values
Eawar -> Ia	-0.104	0.115	-0.006	0.761	-0.109	**0.083**
Eawar -> Peou	0.023	0.781			-0.023	0.781
Eawar -> Pu	**-0.158**	**0.027**	-0.002	0.819	**-0.160**	**0.029**
Eawar -> Usb			**-0.083**	**0.081**	-0.083	**0.081**
Eedu -> Ia	**-0.047**	**0.029**	-0.005	0.355	**-0.052**	**0.019**
Eedu -> Peou	-0.040	0.193			-0.040	0.193
Eedu -> Pu	0.009	0.743	-0.004	0.376	0.005	0.870
Eedu -> Usb			**-0.040**	**0.017**	**-0.040**	**0.017**
Egsp -> Ia	**-0.116**	**0.046**	-0.012	0.476	**-0.127**	**0.024**
Egsp -> Peou	-0.070	0.359			-0.070	0.359
Egsp -> Pu	**-0.163**	**0.011**	-0.007	0.509	**-0.171**	**0.006**
Egsp -> Usb			**-0.097**	**0.026**	**-0.097**	**0.026**
Ia -> Usb	**0.759**	**0.000**			**0.759**	**0.000**
Os -> Ia			-0.002	0.851	-0.002	0.851
Os -> Peou	-0.014	0.812			-0.014	0.812
Os -> Pu	0.015	0.702	0.002	0.850	0.014	0.731
Os -> Usb			-0.001	0.851	-0.001	0.851
Otr -> Ia			0.016	0.255	0.016	0.255
Otr -> Peou	0.125	0.109			0.125	0.109
Otr -> Pu	0.010	0.901	0.013	0.278	0.004	0.965
Otr -> Usb			0.012	0.261	0.012	0.261
Peou -> Ia	**0.130**	**0.035**	0.002	0.850	**0.132**	**0.031**
Peou -> Pu	**0.106**	**0.098**			0.106	**0.098**
Peou -> Usb			**0.100**	**0.034**	**0.100**	**0.034**
Pu -> Ia	0.016	0.824			0.016	0.824
Pu -> Usb			0.012	0.824	0.012	0.824
Ppiit -> Ia	**0.184**	**0.011**	0.012	0.320	**0.195**	**0.007**
Ppiit -> Peou	0.082	0.263			0.082	0.263
Ppiit -> Pu	0.067	0.212	0.009	0.431	0.076	0.167
Ppiit -> Usb			**0.148**	**0.006**	**0.148**	**0.006**
Scd -> Ia	**0.118**	**0.042**	0.021	0.137	**0.140**	**0.014**
Scd -> Peou	**0.152**	**0.027**			**0.152**	**0.027**
Scd -> Pu	0.084	0.164	0.016	0.215	0.100	**0.082**
Scd -> Usb			**0.106**	**0.013**	**0.106**	**0.013**
Ssi -> Ia	**0.307**	**0.000**	0.016	0.281	**0.323**	**0.000**
Ssi -> Peou	0.122	0.160			0.122	0.160
Ssi -> Pu	0.022	0.722	0.013	0.338	0.035	0.569
Ssi -> Usb			**0.246**	**0.000**	**0.246**	**0.000**
Tli -> Ia			-0.002	0.790	-0.002	0.790
Tli -> Peou	-0.016	0.766			-0.016	0.766
Tli -> Pu	-0.002	0.966	0.002	0.804	-0.004	0.937
Tli -> Usb			-0.002	0.790	-0.002	0.790
Tscc -> Ia			0.016	0.341	0.016	0.341
Tscc -> Peou	0.099	0.147			0.099	0.147
Tscc -> Pu	**0.171**	**0.027**	0.010	0.348	**0.182**	**0.016**
Tscc -> Usb			0.012	0.345	0.012	0.345
Tscx -> Ia			-0.012	0.431	-0.012	0.431
Tscx -> Peou	-0.069	0.344			-0.069	0.344
Tscx -> Pu	**-0.165**	**0.006**	-0.007	0.529	**-0.172**	**0.004**
Tscx -> Usb			-0.009	0.432	-0.009	0.432
Tsoftf -> Ia			0.001	0.924	0.001	0.924
Tsoftf -> Peou	0.007	0.938			0.007	0.938
Tsoftf -> Pu	0.020	0.804	0.001	0.947	0.021	0.800
Tsoftf -> Usb			0.001	0.924	0.001	0.924
Tsoftq -> Ia			**0.029**	**0.093**	0.029	**0.093**
Tsoftq -> Peou	**0.207**	**0.007**			**0.207**	**0.007**
Tsoftq -> Pu	0.089	0.110	0.022	0.161	**0.111**	**0.043**
Tsoftq -> Usb			**0.022**	**0.098**	0.022	**0.098**
Ttco -> Ia			-0.001	0.900	-0.001	0.900
Ttco -> Peou	-0.008	0.760			-0.008	0.760
Ttco -> Pu	0.029	0.268	-0.001	0.809	0.028	0.282
Ttco -> Usb			0.000	0.898	0.000	0.898

Bold font indicates significant effect at 0.01, 0.05 or 0.10 level.

From the table above (Table 4.5), with a significant effect at 0.05 we can note for example that intention to adopt has only a positive direct significant effect on user behaviour (direct effect: β = 0.759, and P-value = 0.000); cultural dimension has a positive direct significant effect and positive indirect insignificant effect on intention to adopt (direct effect: β = 0.118, and P-value = 0.042; indirect effect: β = 0.021, and P-value = 0.137); the social identification variable has a positive indirect significant effect on user behaviour (indirect effect: β = 0.246, and P-value = 0.000); software quality has only a positive direct significant effect on perceived ease of use (direct effect: β = 0.207, and P-value = 0.007); etc.
Based on what the general structural equation model reveals for direct and indirect relationships between latent variables (Table 4.5), hypothesis acceptance or rejection outcomes are reported in the following table (Table 4.6).

TABLE 4.6: Hypotheses acceptance or rejection results.

Hypotheses	Decision	B	P
Hypothesis H1 (ia→usb)	**Accept**	**0.759**	**0.000**
Hypothesis H2 (peou→ia)	**Accept**	**0.132**	**0.031**
Hypothesis H2 (pu→ia)	Reject	0.016	0.824
Hypothesis H2 (Egsp→ia)	**Accept**	**-0.127**	**0.024**
Hypothesis H2 (Eedu→ia)	**Accept**	**-0.052**	**0.019**
Hypothesis H2 (Eswar→ia)	**Accept**	**-0.109**	**0.083**
Hypothesis H2 (Scd→ia)	**Accept**	**0.140**	**0.014**
Hypothesis H2 (Ssi→ia)	**Accept**	**0.323**	**0.000**
Hypothesis H2 (Ppiit→ia)	**Accept**	**0.195**	**0.007**
Hypothesis H3 (peou→pu)	**Accept**	**0.106**	**0.098**
Hypothesis H3 (Ttco→pu)	Reject	0.028	0.282
Hypothesis H3 (Tsoftq→pu)	**Accept**	**0.111**	**0.043**
Hypothesis H3 (Tscc→pu)	**Accept**	**0.182**	**0.016**
Hypothesis H3 (Tscx→pu)	**Accept**	**-0.172**	**0.004**
Hypothesis H3 (Tli→pu)	Reject	-0.004	0.937
Hypothesis H3 (Os→pu)	Reject	0.014	0.731
Hypothesis H3 (Otr→pu)	Reject	0.004	0.965
Hypothesis H3 (Egsp→pu)	**Accept**	**-0.171**	**0.006**
Hypothesis H3 (Eedu→pu)	Reject	0.005	0.870
Hypothesis H3 (Eswar→pu)	**Accept**	**-0.160**	**0.029**
Hypothesis H3 (Scd→pu)	**Accept**	**0.100**	**0.082**
Hypothesis H3 (Ssi→pu)	Reject	0.035	0.569
Hypothesis H3 (Ppiit→pu)	Reject	0.076	0.167
Hypothesis H4 (Tscc→peou)	Reject	0.099	0.147
Hypothesis H4 (Tscx→peou)	Reject	-0.069	0.344
Hypothesis H4 (Os→peou)	Reject	-0.014	0.812
Hypothesis H4 (Otr→peou)	Reject	0.125	0.109
Hypothesis H4 (Egsp→peou)	Reject	-0.070	0.359
Hypothesis H4 (Eedu→peou)	Reject	-0.040	0.193
Hypothesis H4 (Eswar→peou)	Reject	-0.023	0.781
Hypothesis H4 (Scd→peou)	**Accept**	**0.152**	**0.027**
Hypothesis H4 (Ssi→peou)	Reject	0.122	0.160
Hypothesis H4 (Ppiit→peou)	Reject	0.082	0.263

In statistics and in many researches, standard level of significance of 0.05 is used for statistical comparison purposes. Thus, to make a decision in the above table (Table 4.6), we generally compared our probability value with 0.05. The interpretation of the results are presented as follows:

- Under the technological characteristics, the relationship between the external variables such as FOSS *quality*; *system compatibility and capabilities*; *system complexity*, are

found to be significant related to perceived usefulness. FOSS quality, compatibility and capabilities are positively related to perceived usefulness. System compatibility and capabilities is one of the major determinant of perceived usefulness. Users of technology are more fulfilled with the use of a technology if they believe that its technological characteristics will help them to improve their job performance and productivity. This has been also confirmed by several studies (Mawhinney & Lederer,1990; Vlahos et al., 1995). Moreover, system compatibility and capabilities is more evident when it is come to introduce new system to existing systems. In fact, Ghanaian users found FOSS compatibility with the existing systems very important to them. Conversely, *system complexity* had a negative and significant effect on perceived usefulness. FOSS is considered as complex system, difficult to learn and to use as reveal by Dedrick et al., 2004; Goode, 2005; and Gwebu, 2010 in the literature review. However, since users in a sector (IT, services, manufacturing, etc.,) find themselves become more familiar (good practical skills) with proprietary software, consider a new software (FOSS) as complex can be justified as a stereotypical assumption.

- Under organizational characteristics, the relationships between the organizational constructs and the endogenous variables are not properly supported.

- Under the environmental characteristics, *education* had a negative and significant effect on intention to adopt. The related hypothesis is then supported. This can be explained by the fact that national education has not sufficiently integrate FOSS system in Ghanaian teaching programs and this can negatively affect user intention to adopt the system. *Awareness* had a negative effect on perceived usefulness and intention to adopt, supporting the related hypotheses. This can be explained by the fact that current awareness or a well-known brands of FOSS systems is generally weak. Consequently, these affects negatively the degree to which a user perceives FOSS usage would enhance his or her job performance. In other words, lack of awareness can result in poorly adoption of the software. Idem reasoning for *government supports and policies* that indicates a significantly negative relationship with perceived usefulness and intention to adopt.

- Under the social influence characteristics, *social identification* is positively and significantly related to intention to adopt (β= 0.323 and P = 0.000), confirming the related hypothesis. That is, social identification with FOSS community positively affects FOSS adoption intention. Consistent with what argue Gwebu et al., (2011) in the literature review, this finding can be explained by the fact that joining FOSS social network groups as members or individuals who, simply or psychologically identify themselves with FOSS community is found to reinforce individuals' identification with the community and their intention to adopt this particular software. Likewise, *power distance cultural dimension* is positively related to perceived ease of use and intention to adopt (at 0.05 level of significance) and also positively related to perceived usefulness (at 0.10 level of significance). This denotes that national culture (power distance) had a significant effect on FOSS technology acceptance. The interpretation is that this relationship is significant with favorable perception that the power exerted by a leader or manager influence users' perceived ease of use and intention to adopt. In addition, at 0.10 level of significance, users' perceived usefulness is also influenced when an authority figure recommends or exercises power over the use of the system. However, at 0.05 level this relationship is not supported. That is, even if users have favorable perception for the system perceived ease of use (through the

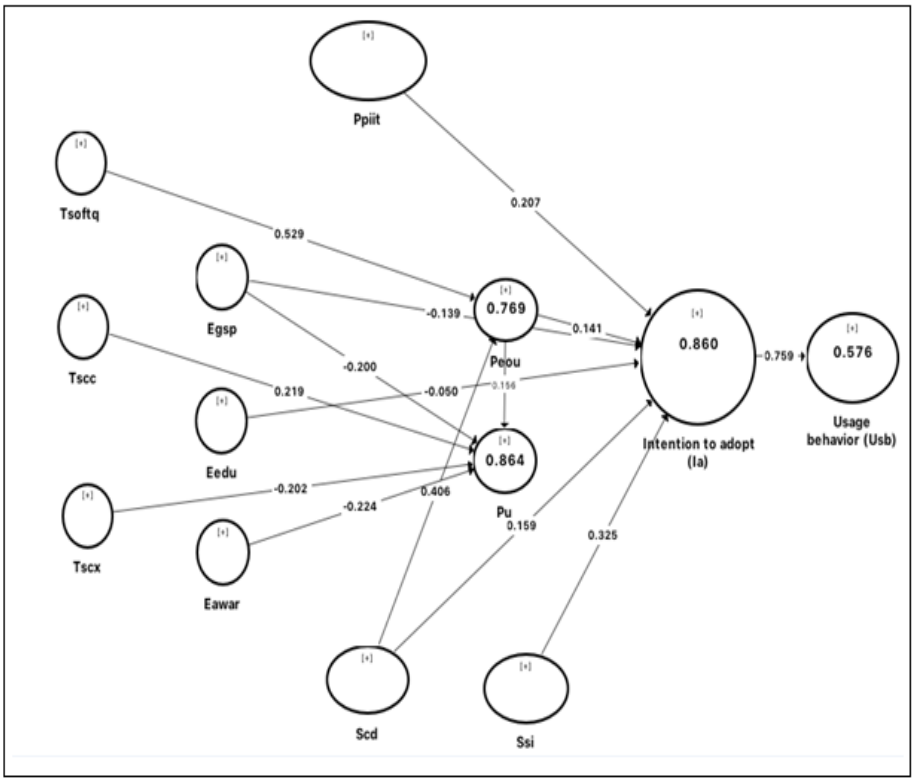
power exerted by a leader or a manager), there is a need for awareness and added attraction or motivation for the system perceived usefulness.

- Under the personal innovativeness characteristics, *personal innovativeness in information technology* had a positive effect only with intention to adopt, but no significant relationship with perceived usefulness and perceived ease of use. One possible explanation can be state on the fact that users demonstrate a full tendency to try out and accept new technologies and innovations (FOSS). Conversely, the no significant relationship with perceived usefulness and perceived ease of use can possibly be explained by the fact that some characteristics of the software such as the multitude FOSS licenses available; or users lack of educational training; lack of software diffusion on national level; etc., impose restrictions or present challenges to users and reduce in general their favorable motivations towards the software adoption.

- Under the technology acceptance model some relationships between endogenous variables are restated in this study with FOSS technology. Indeed, intention to adopt affects strongly and positively usage behavior. Perceived ease of use had a significant effect on intention to adopt at 0.05 level of significance and a significant effect on perceived usefulness only at 0.10 level of significance. We found perceived usefulness not to be significant with adoption intention. This is also consistent with the findings of Gwebu et al., (2011). In fact, Davis' TAM characteristics relationship is partially confirmed here, when perceived usefulness has no effect on users' intention to adopt. A possible interpretation can be that the majority of the software users may have already perceived current proprietary software solutions to be useful enough in serving their needs (Bonaccorsi et al., 2003). Therefore, it might be difficult to migrate from proprietary software to FOSS even though users may perceive FOSS applications to a certain degree more advantageous than the proprietary ones. This is due to the fact the proprietary software market presence vis-à-vis of FOSS is significantly dominant in the sectors. At 0.05 level of significance, perceived ease of use is not found to impact perceived usefulness. This can be explained by the fact that the degree to which respondents who are old-users of FOSS believe that using the software would be free of effort becomes less important overall in determining perceived usefulness after the actual use. Likewise, the rationale behind the proprietary software reliance is also confirmed in this case.

Generally, it is standard practice to use the coefficient p-values to decide whether to include variables in the final model. For the results of Table 4.6 above, we would consider removing variables that are not statistically significant because keeping them can reduce the model's precision. In fact, the result of the re-estimated model is presented in the following figure.

FIGURE 4.11: Structural Equation Model (re-estimated)



The results of the PLS-SEM show that R-square of perceived usefulness is (R^2= 0.864) meaning that independent variables related to perceived usefulness explain 86.4% of variance of perceived usefulness. R-square of perceived ease of use is (R^2= 0.769) which means that independent variables related to perceived ease of use explain 76.9% of variance of perceived ease of use. R-square of intention to adopt is (R^2= 0.860), meaning that independent variables related to intention to adopt explain 86% of variance of intention to adopt. Likewise, regarding usage behaviour, R-square is 0.576, hence intention to adopt explains 57.6% of the variance of usage behaviour. To check the quality of the model we determine, the mean of R-square which is equal to 0.767, the mean of CR is equal to 0.917, the mean of AVE is equal to 0.82 and the mean of Cronbach's Alpha is equal to 0.838. All of these criteria indicate that the quality of the structural model is high.

4.3 Section Two - Qualitative Method

4.3.1 Delphi and SWOT matrix analysis

Studying outcomes '*usage*' cannot be seen as a measure working in isolation (Sun et al., 2009), otherwise there is no way of knowing if the system investments are successful or not. Therefore, outcomes of the usage of FOSS (for instance its productivity; usefulness; success and satisfaction; performance; empowerment in organization; local initiatives; quality improvements; etc.) should be investigated from different viewpoints. Agree upon the fact that to allow FOSS promotes innovation processes and creates an exclusive opportunity for local needs solutions it is fundamental to identify the potential factors influencing its adoption, the quantitative analysis in Section One has revealed specific results. Hereby, the researcher has found that understanding how these factors are likely to affect the deployement of an effective FOSS ICT for growth in Ghana (goal (2.)) should not be

overlooked. In effect, deep analysis is developed through a qualitative approach including a combination of the Delphi technique and a SWOT matrix analysis for this purpose.

4.3.2 Presentation of analysis

First round analysis

The aim of the 1^{rst} round questionnaire (Appendix 3) is assessed in two main questions, principally based on questions related to the validation of FOSS adoption factors features. In effect, the first round questionnaires are sent to a group of 40 experts. A return rate of 93% of responses is recorded:

- In the first question, participants are asked to rate various adoption factors grouped into thirteen (13) themes. Factors which received 3 points and above on average according to the Likert scale (1 to 5 points) are considered as *validated factors*. The other factors which received low than 3 points are dismissed from the list of the following iterative questionnaire.
- In the second question, SMEs' internal factors and external factors related to FOSS adoption are well-defined by the same group of respondents. The results lead us to group into eight (8) themes the various internal adoption factors and into five (5) themes the external adoption factors.

The results of the two main questions are presented in the following tables (Table 4.7 & 4.8).

TABLE 4.7: Internal factors rating.

Internal factors	Validated/dismissed
a. Total costs ownerships standpoints	
Financial resources for bearing switching costs	validated
b. Technical specifications of OSS	
OSS for business provide flexible user guidance	validated
OSS functionality enhanced job activities	validated
OSS systems for business are compatible with the others software being used in our organization	validated
c. Supports services and training on OSS	
Availability of OSS consultancy, training, supporting services	validated
d. Individual/personal innovativeness in information technology	
Individual determination to try out new information technologies	validated
Intention to use as often as needed the OSS applications for performing my job-related work	validated
e. Social and cultural pressures using OSS	
Mainstreaming of gender considerations in decision making at workplace	(dismissed)
Equality, mutual respect and collaboration in team work (between employers and employees)	validated
f. User ability in OSS applications Usage	
Ability to use OSS applications assuming that we have access to the system	validated
g. Individual performance	
Using OSS is a valuable aid to me in the performance of my job	validated
h. Employees empowerment	
OSS systems provide very accurate, complete and comprehensive information about how well or badly I have done my work	validated
OSS systems provide very reliable information about my work, and it gives me considerable autonomy in deciding how to carry out my work	validated
OSS make us ensure proper operation or processing	validated

TABLE 4.8: External factors rating.

External factors	Validated/dismissed
a. Legal concerns – software copyrights and licensing system	
Existing of multitude of OSS licenses	validated
New models for restructuring licensing systems	validated
Number of knowledgeable lawyers that could help to understand OSS licenses complexity	validated
b. Government supports and policies for OSS using	
Commitment/support of government or action plan for using OSS	validated
IT infrastructure of the country is based on OSS	validated
There is a public reaction against the monopoly of and unfair competition with Microsoft	validated
Improvement of hardware integration of OSS by the government	validated
Hardware integration of OSS in business practice	validated
c. National educational knowledge based on OSS	
Number and qualifications of national OSS developers	validated
Encouragement of academics/students towards OSS	validated
d. Open source diffusion processes/opportunities	
Preference for OSS in the system software market	validated
Preference of small and medium sized enterprises for OSS use	validated
Availability of broadband Internet	validated
Participation of software professionals in OSS community or global developer communities	validated
Willing to be a member of OSS community	validated
Maturity of local developer communities	validated
Facility in pratical use	validated
e. Local initiatives and quality improvements on OSS systems	
Improvement to the delivery of socioeconomic services to the local communities	validated
User collaboration-intervention in product improvement/development process	validated
Use of OSS for business practice in mobile systems	validated
Developments in local OSS business models which enable practical adaptation of OSS	validated

The above tables reveal that only one internal factor (i.e. mainstreaming of gender considerations in decision-making at the workplace) is dismissed. This means that experts did not properly consider the mainstreaming of gender considerations as a possible factor in decision-making as regards FOSS usage in the companies. The factors that received 3 points and above on average of the Likert scale are rated as potential factors. These factors are therefore used to prepare the new questionnaire for the second round.

Second round analysis

The 2^{nd} round questionnaire (Appendix 4) is based on questions that indicate the strength, weakness, opportunity and threat of the validated factors. The total of 37 effective respondents of the first round are contacted again and the return rate of responses are one hundred percent (100%). Addressing questions in the second round involved taking three points into consideration:

- In the first point, opportunity is given to the respondents to revise and reflect their previous responses. The results of the first round are once again confirmed by the experts. This means that there is a remarkable convergence of experts opinions concerning the factors rating.
- The second point provided the SWOT analysis. The matrix of this analysis is carried out on the basis of the validated results (internal and external factors). Indeed, Delphi survey participants are asked to rate the position of Ghanaian SMEs in relation to the validated internal and external factors by defining these factors through their strengths, weaknesses, opportunities, and threats.

Internal factors and external factors are therefore examined through the SWOT analysis framework:

Internal factors

Weaknesses and *strengths* with regard to the deployment of effective FOSS ICT in Ghanaian SMEs are assessed with internal factors. Internal factors that are rated as "*very strong*" (5 point) or "*strong*" (4 point) are considered as *strengths*, and the factors that are rated as "*very weak*" (1 point) or "*weak*" (2 point) are considered as *weaknesses*. Internal factors that are valued as "*moderate*" (3 point) are dismissed in the SWOT analyses as they did not constitute a weakness to be strengthened or a strength to be used in the revision or the design of policies. Table 4.9 displays the results of the internal factors analysis.

TABLE 4.9: SWOT analysis framework presentation (internal factors).

Internal factors	(S) / (W)
a. Total costs ownerships standpoints	
Financial resources for bearing switching costs	W1
b. Technical specifications of OSS	
OSS for business provide flexible user guidance	S1
OSS functionality enhanced job activities	S2
OSS systems for business are compatible with the others software being used in our organization	S3
c. Supports services and training on OSS	
Availability of OSS consultancy, training, supporting services	W2
d. Individual/personal innovativeness in information technology	
Individual determination to try out new information technologies	S4
Intention to use as often as needed the OSS applications for performing my job-related work	(dismissed)
e. Social and cultural pressures using OSS	
Equality, mutual respect and collaboration in team work (between employers and employees)	W3
f. User ability in OSS applications Usage	
Ability to use OSS applications assuming that we have access to the system	W4
g. Individual performance	
Using OSS is a valuable aid to me in the performance of my job	S5
h. Employees empowerment	
OSS systems provide very accurate, complete and comprehensive information about how well or badly I have done my work	S6
OSS systems provide very reliable information about my work, and it gives me considerable autonomy in deciding how to carry out my work	S7
OSS make us ensure proper operation or processing	S8

External factors

Opportunities and *threats* with regard to the deployment of effective FOSS ICT for growth in Ghana are assessed with external factors. The same rationale is applied on the basis of the 5-points Likert scales. To determine *threats* and *opportunities*, Delphi participants also evaluated SMEs' external adoption factors. Factors that are rated as "*very strong*" (5 point) or "*strong*" (4 point) are accepted as *opportunities*, and factors that are rated as "*very weak*" (1 point) or "*weak*" (2 point) are considered as *threats*. External factors that are rated as "*moderate*" (3 point) are dismissed in the analysis as they did not constitute an opportunity to be profited from or a threat to be avoided in the revision or the design of policy suggestions. Table 4.10 displays the results of external factors analysis:

TABLE 4.10: SWOT analysis framework presentation (external factors).

External factors	(O) / (T)
a. Legal concerns – software copyrights and licensing system	
Existing of multitude of OSS licenses	T1
New models for restructuring licensing systems	T2
Number of knowledgeable lawyers that could help to understand FOSS licenses complexity	T3
b. Government supports and policies for FOSS using	
Commitment/support of government or action plan for using FOSS	T4
IT infrastructure of the country is based on OSS	T5
There is a public reaction against the monopoly of and unfair competition with Microsoft	O1
Improvement of hardware integration of OSS by the government	T6
Hardware integration of OSS in business practice	O2
c. National educational knowledge based on FOSS	
Number and qualifications of national OSS developers	T7
Encouragement of academics/students towards OSS	T8
d. Open source diffusion processes/opportunities	
Preference for FOSS in the system software market	O3
Preference of small and medium sized enterprises for FOSS use	(dismissed)
Availability of broadband Internet	O4
Participation of software professionals in OSS community or global developer communities	T9
Willing to be a member of FOSS community	O5
Maturity of local developer communities	T10
FOSS practical use	T11
e. Local initiatives and quality improvements on OSS systems	
Improvement to the delivery of socioeconomic services to the local communities	O6
User collaboration-intervention in product improvement/development process	O7
Use of FOSS for business practice in mobile systems	O8
Developments in local FOSS business models which enable practical adaptation of OSS	T12

Table 4.9 and Table 4.10 set out the results of the SWOT analysis. The tables reveal that two factors such as "*Preference of SMEs for OSS use*" and "*Intention to use as often as needed FOSS applications for performing my job-related work*") are perceived as moderate/neutral factors and then are dismissed.

- In the third point of the 2^{nd} round questionnaire, factors are numerically ranked in order of importance and priority, starting from 1 as the most important factor.

The following table shows the results:

TABLE 4.11: Ranked list of factors.

Factors		Rank
j.	Government supports and policies for FOSS using	1
k.	National educational knowledge based on FOSS	2
e.	Social and cultural pressures using FOSS	3
m.	Individual/personal innovativeness in information technology	4
d.	Local initiatives and quality improvements on FOSS systems	5
f.	User ability in FOSS applications Usage	6
c.	Supports services and training on FOSS	7
b.	Technical specifications of OSS	8
a.	Total costs ownerships standpoints (switching costs)	9
l.	Open source diffusion processes/opportunities	10
i.	Legal concerns – software copyrights and licensing system	11
g.	Individual performance	12
h.	Employees empowerment	13

Third round analysis

In the 3^{rd} round analysis, the results of the third point of the 2^{nd} round survey (Table 4.11 - Ranked list of factors) are re-sent to respondents for final validation. Experts have ranked again the first ranked list of factors in order of priority. This second ranking is required not only to ensure that the relevant factors are obtained within the approved consensus, but also, to raise the most needed concerns and suggestions from the prioritized factors. Hence a consensus is reached by the expert group after the second ranking processes. The only difference between the first and the second ranking iterations is that the "*National educational knowledge on FOSS*" tied "*Social and cultural pressures using FOSS*" for first place, with the "*Government supports and policies for FOSS using*" being placed third (compare Table 4.11 and Table 4.12).
The adoption factors that would primarily be considered for possible solutions, suggestions or policy design, ranking by the panel of experts using Delphi method, are presented in the following table (Table 4.12).

TABLE 4.12: Ranked list of factors after second iteration .

Factors		Rank
k.	National educational knowledge based on FOSS	1
e.	Social and cultural pressures using FOSS	1
j.	Government supports and policies for FOSS using	3
m.	Individual/personal innovativeness in information technology	4
d.	Local initiatives and quality improvements on FOSS systems	5
f.	User ability in FOSS applications Usage	6
c.	Supports services and training on FOSS	7
b.	Technical specifications of FOSS	8
a.	Total costs ownerships standpoints (switching costs)	9
l.	Open source diffusion processes/opportunities	10
i.	Legal concerns – software copyrights and licensing system	11
g.	Individual performance	12
h.	Employees empowerment	13

4.3.3 Interpretation of the results

The results of the analysis are interpreted in this section. First, internal potential factors with the current deployment of FOSS adoption in Ghanaian SMEs are defined through strengths and weaknesses. Then, external potential factors with current deployment of FOSS adoption for growth in Ghana are defined through opportunities and threats.

Strenghs

b. Technical specifications of FOSS: FOSS for business provide flexible user guidance. Flexibility is the main point to check the value of a software. In fact, most of the Delphi participants have commented their responses by claiming that FOSS applications have scalability tendencies because they are open source , therefore their codes can be modified and used for other purposes. The possibility to change the code and to develop it to be used in other conditions and for other needs can enhance users' experiences and abilities and their creativity. For the majority of participants, FOSS functionality enhanced their job activities; satisfaction and security are highlighted. According to the participants, satisfaction could be achieved without any problems if the software was developed inside the company. By doing this, different solutions are accessible and supported by the community of users and SMEs should be able to develop their own systems and control their

quality during this time. Moreover, even though participants confirmed that the use of different systems packages to build new software solutions for different issues took time and seemed complex, FOSS systems are still compatible with the other software being used in their organizations.

d. Individual/personal innovativeness in information technology: Individual determination to try out new information technologies such as FOSS is approved by the participants. They have found that the software offers the best opportunity by increasing personal efficacy and efficiency in their respective job activities. Development of the software within the company brings innovation and improves employees technical capabilities. In fact, the willingness of individuals or employees to try out any new IT systems is emphasized as a strength for the SMEs' position. The employees or the staff became more profitable because they permitted to generate company growth without any costs.

g. Individual performance: Delphi participants underlined that using FOSS system in their job activities allowed them to achieve the desired performance results without restrictions. This is because the shared ideologies and values that shape FOSS development and the way users behave in a community reinforced a sense of duty and obligation, which in turn boost the individual performance.

h. Employees/community empowerment: The majority of participants go on to contend that FOSS provides very accurate, complete and comprehensive information about their works. This makes them ensure their proper operation or processing. In general, community empowerment refers to the process of enabling communities to increase control over their lives. FOSS community empowerment is not different in this respect. In effect, through its various benefits, FOSS in Ghanaian SMEs has brought about more widespread dissemination of information throughout the organization. This provides FOSS users more control over choosing software applications and components that suited their business needs. The possibility that users had to increase control over their own decisions or choices allowed them to not be empowered by others. Consequently, this allowed managers that seriously improve their potential to hold FOSS, to choose their budgets without a long-term commitment to a costly commercial IT system.

Weaknesses

a. Total costs ownerships standpoints: Low financial resources for bearing switching costs is considered as one of the main issue in adopting FOSS. In effect, training cost in companies increases switching cost; it is because there are few skilled FOSS in the market. Universities and other training institutions do not have adequate expertise in training more FOSS technologies.

c. Supports services and training on FOSS: Participants underlined that there is a growing preference for FOSS in general, but support services and training continued to lag behind.

e. Social and cultural pressures using FOSS: Most technicians and IT students have confirmed that equality, mutual respect and collaboration in team work are sometimes threatened. In fact, even though FOSS gives to users considerable autonomy in deciding how to carry out their job activities, power distance cultural dimension exerts pressure on individual choice. This often affects user behavior as regards FOSS usage, that is, the full enjoyment of the software freedoms. Hence, individual decisions and personal innovativeness in IT could be limited.

f. User ability in FOSS applications usage: People lack skills and ability to operate with FOSS because there are inadequate training facilities and expertise in the area.

Opportunities

b. Public support and policies for FOSS usage: Even though proprietary IT systems are

more readily available on the Ghanaian IT market, the result of the survey shows that there is a public reaction against the full presence of proprietary software and its operation systems on the market.

d. Open source diffusion processes/opportunities: Availability of broadband Internet promotes the dissemination of FOSS thereby increasing customer demand. Moreover, the growing awareness of FOSS benefits also increases the preference for FOSS in the software market. However, participants sustained that the preference for open source diffusion is from a general viewpoint, reason why the preference of SMEs (exclusively) for FOSS use is perceived as moderate or neutral factor and thus dismissed from the list of external factors.

e. Local initiatives and quality improvements of FOSS systems: According to the participants, ongoing initiatives for local development have started in some sectors. FOSS users have also expressed their wish to belong to the FOSS community and to cooperate. In effect, web communications initiatives based on FOSS applications use through mobile phone for example are developed for banking services. In fact, remittances from relatives living far away in rural areas are now largely conducted via mobile money transfer services that use open source software as platform. This may reduce money transfer problems for some indigenous people who are unable to open their own accounts with financial institutions or banks. IT systems based on FOSS applications not only offer opportunities for empowerment to their users, but they also prepare users to be a source of renewal and dynamism in the local area. That is, every user will be an asset that can be used for community building. With this capacity building, new projects could emerge in order to meet the wide range of needs that indigenous people are expected for their satisfaction. These projects are at times addressing optimal applicability for any size of firms in urban or rural communities. Moreover, FOSS usage through its collaborative and constructive approach, can be considered as a public good created by its own community which could provide a useful basis for sustainable development of the local community. As a public good, FOSS could strongly contribute to the strengthening of local ICT capacity development with particular emphasis on community needs that can actively support the conception of local research and development efforts, which in turn could drive prosperity and economic development in LDCs in the years ahead.

Threats

a. Legal concerns – software copyrights and licensing system: FOSS systems licensing are very complicated. Software systems licensing are not simple to use without understanding the different aspects of the license of everyone. It is not simple to look for a specialized lawyer in this sector in Ghana. FOSS licenses can pose major issues for companies if they do not follow the conditions for use. Nowadays there are a huge number of software patents that cause problems for free software; allowing the patenting of software may lead to reduced innovation in the technology world, as there may be dependencies and interdependencies for different software. Although, proprietary software owners can play in both sides, that is, they can use these licenses to produce their own products, FOSS for LDCs remains the only viable solution that help these countries SMEs to develop and use their products without high costs and external dependency.

b. Government supports and policies for FOSS usage: There is a lack of government supports and policies. This confirms what is revealed by the review of literature (CSIS, Report 2010). In general, a decision on the part of the public administration is the main starting point for the growth in every kind of development. In Ghana, public administration support and promotion of FOSS systems usage appears non-existent. According to the Delphi participants, the problem is that FOSS systems implementation is a long-term strategy, but usually public administrators are looking for a quick result and long-term

strategy decision-making for efficient solutions is avoided.
c. National educational knowledge based on FOSS: Schools and universities are considered to be the main player in terms of production of innovation and new ideas. In Ghana most production of innovative software are born inside higher education institutions and training centers. However, the national education sector is dominated by the use of proprietary IT systems as national educational software. This obviously limits the number of skilled developers or users in FOSS. Moreover, there is a lack of support in this regard. Since the focus on software education is not based on FOSS and supported, there is no hope that national education will make a major contribution to fostering the use of FOSS through education training programs.
d. Open source diffusion processes/opportunities: Delphi participants argued that there are problems with the practical use of FOSS in Ghana. This is due to the lack of methodological competencies on the national level. The lack of widespread quality expertise in FOSS limits the participation of software professionals in global developer communities and hence, limits the growth and the maturity of local developer communities. Even though some South and Eastern African countries such as South Africa, Botswana and Kenya are trying to support FOSS by introducing the software in different sectors, low practical use remains problematic in general on the continent (Reijswoud Victor, et al., 2008). The main issues are related to the lack of research centers, schools, public and private companies to support open source software production and the collaboration of regional goverments that provide back-up support to these projects.
e. Local initiatives and quality improvements in FOSS systems: Proper business model is one of the cause of inability to adapt FOSS to community needs. In addition, although user collaboration-intervention in the product development and improvement are confirmed, participants in the final concensus have suggested that FOSS users in different sectors in Ghana should be better informed about their products development through shared production and innovation model.

Overall, considering internal factors affecting FOSS adoption, the current deployment of FOSS within Ghanaian SMEs is not properly critical. This can be explained by the fact that factors such as users' efforts, personal innovativeness and FOSS technical functionalities are actually considerable strengths within Ghanaian SMEs. However, with the external factors results show that current deployment and future trends of FOSS present less opportunity for growth in Ghana. In fact, future trends for effective FOSS ICT use for development could be possibly threatened by restraining force if policy suggestions and actions are neglected.

4.4 Conclusion

In summary, the data analysis and its interpretation have been discussed in this chapter. The chapter has followed the data analysis methods described in the methodology chapter with reference to the literature review in chapter [2]. Findings related to the research questions are gathered and presented through two approaches (quantitative and qualitative). The chapter demonstrated the analysis tools used and the relevance of the findings. The main findings of the investigation are summarized in the following chapter [5]. The final chapter concludes the study by discussing its implications, designing solution-based approaches or a policy framework and making recommendations for further research.

Chapter 5

DISCUSSION, RECOMMENDATIONS AND CONCLUSION

5.1 Introduction

The final chapter [5] summarizes and re-emphasizes the main results obtained and presented in the chapter [4]. The significance of this research in the context of FOSS adoption for local ICT capacity building and development in Ghana is observed. In addition, policy recommendations are judged necessary to outline at the end of this work as the researcher is well aware from his experience and knowledge about the Ghanaian communities living in rural and urban areas and the government strategy for ICT for Accelerated Development (ICT4AD).

5.2 Summary of the main findings

The primary research question derived from the literature review is:*'What are the potential factors influencing FOSS adoption and the resulting impacts on local ICT capacity and development in Ghana?'*. This research question was broken down into two secondary questions:

1. *What are the potential factors influencing FOSS adoption in Ghanaian SMEs?*
2. *How can these factors influence the deployment of effective FOSS ICT for development in Ghana?*

To answer the first question, four main hypotheses are anticipated. Survey data gleaned from a sample population (prevalently represented by young male professionals, highly educated, and IT versed) are statistically analyzed. The results obtained through reliability and validity tests give more precision with statistical significance. In summary, the results lead us to claim that:

- **Result 1:** IT users' behavioral usage of FOSS is affected by their intention to adopt.
- **Result 2:** IT users' intention to adopt FOSS is affected by their perceived ease of use, personal innovativeness, social identification, power distance cultural dimension, *education*, and *government supports*.
- **Result 3:** IT users' perceived usefulness of FOSS is affected by their perceived ease of use, power distance cultural dimension, software quality, system compatibility and capabilities, *system complexity*, *awareness*, and *government supports*.

- **Result 4:** IT users' perceived ease of use of FOSS is affected by their software quality, and power distance cultural dimension.

In other words, the results suggest that *software complexity*, *government supports*, *education* and *awareness* have negative influence on users' perceived usefulness and/or on users' intention to adopt. Conversely, software quality, compatibility and capabilities, power distance, social identification and personal innovativeness in IT have positive effect on users' cognitive and affective responses (perceived usefulness, perceived ease of use and intention to adopt). Intention to adopt has a strongly significant and positive influence on behavioral usage of FOSS. Some of these factors such as personal innovativeness in IT, power distance and social identification are the most potential factors that determine users' intention to adopt and therefore their behavioral usage (see Appendix 2).

To answer the second question, various elements stemming from FOSS system usage are analyzed and for which some driving and restraining forces or positions are expressed both internally and externally from SMEs environments. In the internal environment, individual performance; employees empowerment; some technical specifications of FOSS such as flexibility, compatibility and functionality are considered as driving forces. Conversely, low financial resources, supports services and training on FOSS, cultural pressures using FOSS (i.e., power distance orientation) and user ability in FOSS applications usage are ranked as restraining forces. In the external environment, while public support of FOSS use (public reaction against the proprietary software market dominance) is boosting an optimal adoption tendency for FOSS, lack of governmental supports and effective policy for FOSS use threaten this advantage. Moreover, although the preference for FOSS, the willingness to be a member of FOSS community and the increasing availability of broadband Internet, some factors such as educational software based on FOSS, effective participation of software professionals in the community, maturity of local developer communities, and skills through practical use are lacking.
In summary, a point that shares fundamental concerns with this thesis when it comes to FOSS adoption is what revealed the individual and social characteristics results. In other words, as changes occurring in individual and social characteristics are evolved, IT users' behavioral adoption of FOSS also changes.

5.3 Research limitations, implications and contributions

Apart from the various problems encountered during the data collection phases (see chapter [3], page 39, section 3.3.4), one of the limitations of the present research work is that there is a lack of database system that adequately captures all SMEs and their locations in Ghana. This reduces the possibility to cover a representative sample of the relevant population in the area in question. The sample size should be increased by covering both the registered SMEs that are using IT or producing IT systems services based on FOSS and those that are not yet registered in order to obtain a high number of participants. In addition, the study is conducted with cross-sectional survey from respondents; some influential factors on the intention to adopt may vary at different stages in the implementation process. For this reason, future research could be recommended with a large sample using a longitudinal approach.
The second limitation is of the fact that, the study did not focus on specific FOSS application but relied general snapshot approach during the survey. In fact, future research could be recommended that surveys should be on specific FOSS application. This will help to support companies' internal operations and provide competitive opportunities.
Furthermore, as stated in the literature review, FOSS adoption can happen in voluntary

or mandatory situations (Venkatesk et al., 2000). The findings of Venkatesk et al., (2000) suggest that factors influencing IT adoption differ from mandatory to voluntary conditions. Though, software adoption process in this case study is largely based on voluntary decision, some particularities with FOSS use are due to cultural pressures. Indeed in sociology research, the effects of social influence on behavioral intention manifest through different routes – subjective norm and social identification (Bagozzi et al., 2002). The effect of subjective norm on intention is more likely to occur in mandatory settings due to the compliance and coercive power characteristics. The effect of social identification on adoption occurs in a voluntary setting due to the fact that there is a route of self-defining relationship with a group and its members. Agree with these statements, the results of this research cannot be spontaneously extended to the mandatory settings even though there is a cultural pressure that affect user' usage behavior. In fact, future research could be investigated in order to analyze the difference between the effect of social influence on FOSS use occurring in mandatory setting versus voluntary setting. In mandatory setting, authorities will have the coercive power to reward the adoption intention or to penalize non-adoption intention. In this regard, effect of subjective norm on intention to adopt FOSS could be an interesting field to explore. Moreover, as the results from this study reveals that there is a resistance to change from proprietary software to FOSS solutions (due to the fact that the proprietary software already meet some requirements of users), a different approach of FOSS adoption might be needed to overcome this challenge.
Aside from these limitations and their respective implications, we have managed to obtain satisfactory results of our model in this research (independent variables related to intention to adopt explain 86% of variance of intention to adopt; intention to adopt explain 58% of variance of usage behavior). However, the model does not explain 100% of the results, therefore, we must not overlook the existence of some characteristics or constructs that have not been included in the study.
Some contributions related to adoption of FOSS technologies at industrial and national levels are added to the existing body of knowledge. In addition to the potential factors identified, the results provide a solid interpretation that; quality is not a necessary criterion for lack of FOSS adoption, but its brand name awareness. This is because brand name capital investments in FOSS applications are weaker than that of proprietary software. From the study, there are increasing common consumer and contributors interest in FOSS solutions which could bring stability and innovation to FOSS products in future. However, the lack of clear corporate policies and responsibilities (who backs FOSS up) makes FOSS adoption in the corporate setting difficult.
Furthermore, the results provide more evidence indicating that power distance cultural dimension could have considerable effect on FOSS use and its acceptance decisions. This study demonstrates the importance of adding specific context of cultural dimension (as normative[1] social influence) to social identification (established as informational[2] social influence). In effect, power distance factored into the main construct (social influence characteristics) extends the predictive and explanatory utility of the construct. In other words, adding power distance cultural dimension to a synthesis of social influence characteristics allow us to explain a significant portion in behavioral intentions to adopt and use FOSS. Future studies on FOSS adoption should therefore include power distance where it is culturally appropriate. The validation with other subjects of a similar environment will boost our certainty and can also help to confirm that power distance has a consistent effect on FOSS adoption. A theoretical implication with regard to this specific result can lead us

[1]Normative social influence: it means going along with others in pursuit of social approval or belonging (avoid disapproval/rejection).

[2]Informational social influence: it means going along with others because their ideas and behavior make sense, the evidence in our social environment changes our minds.

to accept that, in indigenous entrepreneurship, particular attention should be paid to indigenous human environment relationships and associated cultural values. Indigenous communities that promote entrepreneurial endeavours with FOSS systems by embedding the use of this specific technology into pre-existing cultural values facilitate the adoption of the specific technology and have a higher chance of meeting local needs and interacting with the global economy on their own terms.

5.4 Policy recommendations

Considering the ranked list of factors examined (Table 4.12, Chapter 4) and as well as the results obtained from the statistical analysis, policy recommendations have been outlined with the main purpose of creating a resourceful FOSS ICT that boosts FOSS promising advantages of capacity development in Ghana. In fact, policy recommendations as concerns strengths and weaknesses in terms of internal strategic factors of FOSS deployment in Ghanaian SMEs, and also policy recommendations as concerns opportunities and threats in terms of external strategic factors of Ghanaian SMEs for effective FOSS ICT use for development in Ghana, are illustrated in a unique framework (Table 5.1). The combination of the relationships between strengths, weaknesses, opportunities, threats and their correspondent policy recommendations is drawn up base on the following criteria also used by Nihan Yildirim, and Hacer Ansal (2011):

1. Strengths that correspond to a policy recommendation are intended to be used by the implementation of a correspondent policy to reduce the impact of the related weaknesses, in order to benefit from opportunities and to avoid threats linked to the same policy;

2. Weaknesses that correspond to a policy recommendation are intended to be minimized for their negative impacts through the implementation of a correspondent policy that takes advantage of related strengths and opportunities;

3. Opportunities that correspond to a policy recommendation are intended to offer benefits for designing, implementing and improving the correspondent policy;

4. Threats that correspond to a policy recommendation are intended to be avoided for their negative impacts through the implementation of correspondent policy that takes advantage of related strengths and opportunities.

The results shown in Table 5.1 have only considered the first five factors listed in the ranking table (Table 4.12) in order to design five of the core correspondents policy suggestions that could be usefully implemented by the key players.

TABLE 5.1: Links between policy recommendations and SWOT.

Policy recommendations	Related Strength (S), Weakness (W), Opportunity (O) and Threat (T) of Table-13 and Table-14
1.Introducing and increasing the national software education knowledge on FOSS.	T4 T7 T8 T9 O1 O4 W2 W4
2. Increasing collaboration and equality among staff to deal with social and cultural diversity and pressures.	S1 S2 S4 S7 S8 W2 W4 W5 O4 O6
3. Stressing FOSS in national policies and using funds for supporting FOSS in small business infrastructure and in educational IT infrastructure.	W1 W3 W5 S4 T2 T4 T5 T6 T7 T8 T10 T11 T12 O1 O2 O3 O5 O6 O7 O8
4. Stimulating individual innovativeness in IT based on FOSS.	S1 S2 S4 W2 W5 T8 T9 T10 T11 O4 O5 O7
5. Supporting local initiatives and quality improvements on FOSS systems.	W3 S4 S8 T2 T4 T5 O1 O2 T6 T7 T8 O3 T9 T10 T11 T12 O5 O6 O7 O8

Based on the link between policy recommendations and SWOT results, some reasoning are taking into account. Indeed, any process of knowledge is based on education and this requires, among others things, existing infrastructures and adequate training programs. Since IT infrastructures based on a software technology becomes fundamental in any sector (education, business, services, health, etc.), it becomes ever more important to introduce and increase national software education knowledge on FOSS. Ghanaian universities IT strategies are expected to be revised by increasing the focus on FOSS education. Research in FOSS development matter should be a priority in academic research agendas and should benefit of financial supports granted by government and industry. This can allow students or users to have better preparation in order to increase number and quality of professional in FOSS and certainly reduce numbers of projects initiatives ended in failure. Perhaps to overdo, it would be better and more advantageous to integrate open source system in the education system from the lower level. This will enable the preparation of qualified and experienced people with FOSS operating system. Education institutions in LDCs like Ghana have to support their IT students in FOSS projects. One of the best example in Africa is Ubuntu[3] project support in South Africa campus. Other example is Ushahidi[4] project that is able to resolve different issues which became famous around the world. In addition, innovation should be incentivized using FOSS in Ghanaian education system and SMEs industry with financial supports from the government and international NGOs. This can probably change the conservative traditional IT educational system in adopting FOSS. Full access of the system source code fosters a real sense of belonging in FOSS-community, and also encourage more users to play a more active part in innovation and the support decisions of their companies. For this reason, policies with regard to technological innovativeness within local communities are fundamental. Government has to emphasize FOSS in national policies development. Generally, in most of LDCs (in Africa), improved governance has remained an optical illusion. Leadership have to focus on an advantageous stability and prosperity that fulfilling the real needs of the local community. Since open source technology solutions is unique and fundamental for poverty alleviation, income generation and empowerment, governmental bodies are expected to support and encourage projects and efforts aimed at developing national operating system that focusing and localizing FOSS systems. Admittedly, failure of leadership in this concern cannot

[3] Ubuntu translated as "humanity to others" from the African dialect "Nguni-bantu", started just from universities between different students, became the main support of different project in Africa with its contribution to the success of corporate management systems.

[4] Ushahidi, which translates to “testimony” in Swahili, was developed to map reports of violence in Kenya after the post-election violence in 2008. It is one of the most widely project used collaborative mapping programs in the world. It is a non-profit technology company with staff in nine countries whose mission is to help marginalized people raise their voice and those who serve them to listen and respond better.

be attributed to Ghanaian government since governmental bodies:

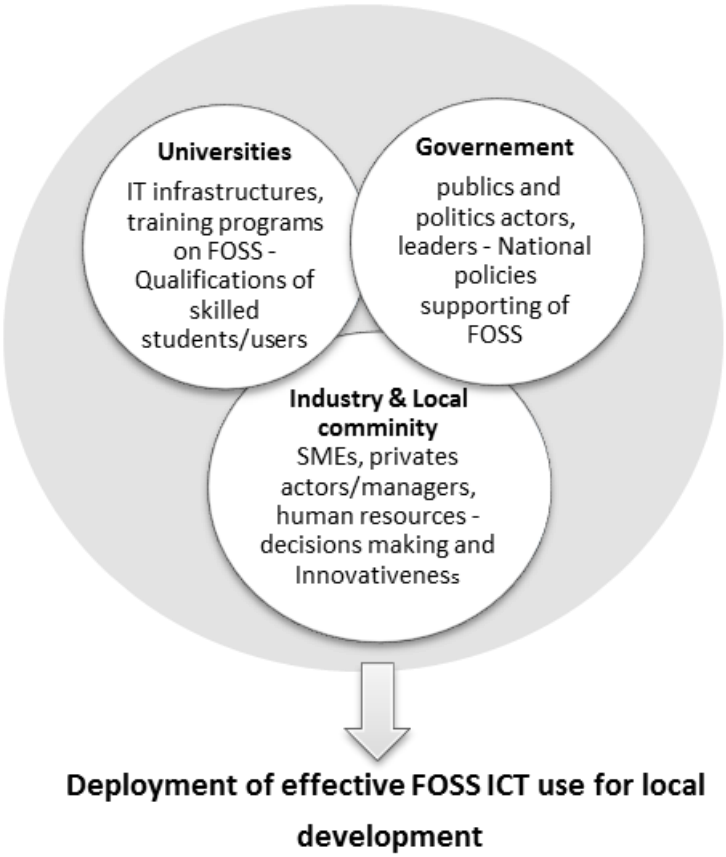
- in 2003 have already formulated an ICT policy dubbed, Information and Communication Technology for Accelerated Development (ICT4AD);
- in 2005 ratified at the World Summit on Information Society, their objective to ensure the availability of quality and affordable access to information and communications services to facilitate the transformation of Ghana into knowledge-based society and technological driven-economy.

However, the Ghanaian software development industry is still under-developed and mainly based on the proprietary software. To emerge from the quagmire of this subordination of proprietary software, an effort is still needed by creating a competitive software industry through the adaptation of effective national technology policies and industrial strategies. Specifically, Ghanaian government should revise its policy statement stipulating Ghana's ICT4AD, founded on 14 pillars that set the priority policy focus areas (principally based on proprietary software) and define the country's ICT-driven development agenda. An effective decision-making on FOSS integration and supports in different sectors in Ghana should be included in the pillars formulated in the ICT4AD policy. It is therefore indispensable for LDCs' governments to collaborate and take patience without claiming an immediate result of their investments but thinking for the future development and prosperity of the whole region through FOSS initiatives. This because, investing in FOSS calls for long-term project and it can be successful if LDCs' governments around the world can emulate use-case countries like Peru, Malaysia, Brazil, etc.
The results also offer practical suggestions for users and companies. Indeed, companies have to select FOSS which is useful and easy to use, in order to minimize system complexity issues. The conception that effective use of FOSS is complex, remains critical. Therefore, the support of practical training should be a solution to reinforce perceptions of the ease use of FOSS. Furthermore, this can significantly affect the effect of perceived usefulness on FOSS adoption intention. Companies should also consider criteria such as system compatibility and capabilities for selecting the most adequate FOSS. Brands of FOSS should be prepared to actively participate in software generation process and its awareness. In this regard, government role should not be overlooked since the presence of a government to define property rights and enforce contracts is an implicit assumption of the economic paradigm of market exchange (Benjamin Klein et al., 1981). This can help consumers to identify who supports the software and then be certain to adopt it. Additionally, companies have to find the way to motivate their employees to join FOSS social network groups in order to encourage FOSS ideology; they have to principally increase collaboration and equality among staff to deal with sociocultural diversity and pressures in order to facilitate FOSS adoption and its adaption to particular local needs or conditions.

In a broad spectrum, open source-oriented software development industry should be supported by governmental bodies and universities in order to coordinate FOSS oriented efforts of other industrial organizations and create collaboration. Moreover, government should also support FOSS applications use on national level through any entities in order to create a market oriented local FOSS supply. Local initiatives taken by citizens to promote the importance of FOSS systems adoption in small size activities should be funded and assisted. Society or environment in which users, communities and organizations operate and conduct their activities, should be involved in the development process with FOSS. Industry managers and academicians should also take the initiative in training software developers and create local FOSS developer communities. That is, professional training programs on FOSS and consulting services should be provided. This could obviously endorse individual innovativeness in IT based on FOSS.

The above suggestions mainly call for a tight collaboration, partnership and cooperation among governmental bodies, universities and industry. A proposed framework is therefore depicted in the following figure (Figure 5.1).

FIGURE 5.1: Key players for building national competitive industry.



In summary, the role of governments, universities or higher education institutions (HEIs), industries and communities in the promotion of a local capacity development through the creation of an efficient FOSS ICT industry should become a real engagement of all partners.

5.5 General conclusion

According to the report of the third World Forum of Local Economic Development (2015), a local economic development approach calls for improvements in the organisation of existing and new local production and consumption systems. This entails moving from a welfare-based and sectoral approach to a sustainable human development approach, thus horizontally integrating economic, social, institutional and environmental dimensions, according to the features and actors involved in each context and level. Furthermore, and in agreement with the research findings of A. Bonfatti, (2015), LDCs can only achieve sustainable development when they are able to guarantee the availability of quality services and connectivity infrastructure for their communities. This can be ensured by linking the entire technological, science and socioeconomic systems with local knowledge through implementing strategies. To design a solution to meet these needs, ICT integration into

different sectors of activities is absolutely fundamental. ICT use is a dynamic and evolving aspect and today, no sector can develop without appropriate IT infrastructure.
Since open source software ICT is recognised as a unique opportunity for LDCs, Ghana has no appropriate alternative solution if it wishes to close, or resolve, the problem of the digital divide. Although most Sub-Saharan African countries are '*latecomers*' in ICT sectors, creating a competitive software industry nowadays cannot be considered as an unattainable challenge, since FOSS freely allows the generation of an innovative capability in software technology.
African countries cannot be fully compared with advanced countries in ICT because the continent is still in the initial phase of IT development. To state it somewhat baldly, the African continent resembles a large company born after centuries of slavery and colonisation, and reborn 50 years ago since most of the countries achieved '*independence*' (in 1960). Hence, obvious political, social, economic and cultural challenges inevitably persist in these countries. However, to overcome such challenges, the introduction of FOSS in the software industry has been conceived to provide a major opportunity to build and create innovative societies in a context of strong local economic development. For this reason, the factors contributing to effective FOSS adoption and implementation in different national sectors should be carefully studied and continuously improved. This could clearly help to prevent LDCs from lagging behind as downstream users by promoting initiatives based on local software technology, thus reducing dependency on proprietary software.
The present case study, Ghana, reveals that individual and social factors are the most strategic ones influencing FOSS uptake on the part of SMEs.
Additional findings on current FOSS deployments and trends are translated into policy suggestions aimed at enabling SME decision-makers, users/citizens and government to take full advantage of it as a means of avoiding threats to sustainable development and minimising structural weaknesses in Ghana. In fact, Ghana should attach great significance to FOSS: policies on FOSS should be approved and supported by the government; priority should be given to an education system with national education software based on FOSS; serious consideration should also be given to encouraging individuals and creating social acceptance of FOSS, since users clearly tend to be resistant to change. Policy measures previously identified may be possible through strict collaboration of all partners responding to this wake-up call with determination, and serious decision making.
In summary, to create a competitive software industry as the mainstay of a future welfare economy, Ghanaian local leadership has to design and improve open source-oriented policies and adapt development to different decentralised communities if the latter agree to *go local and grow global*. In general, it is evident that each LDC presents different situations and needs shaped by the political situation and socio-economic and environmental conditions, etc. However, Sub-Saharan African customs and values remain familiar, and their common interests are to meet the challenges linked to the UN sustainable development goals at local level. Accordingly, the recommendations outlined in this research may also be applicable to these countries and can be considered as a roadmap.

APPENDIX

Appendix: Survey questionnaires; Measurements, Direction of effects & significance, 1^{rst}, 2^{nd} and 3^{rd} Rounds Delphi questionnaires.

The purpose of this survey is to understand the factors influencing F/OSS adoption and use in Ghanaian organizations (SMEs).

Appendix 1a: Survey Questionnaire

The purpose of this survey is to understand the factors influencing F/OSS for business practices adoption and use in Ghanaian organizations (SMEs).

SOME LITTLE DETAILS

1. Questionnaire responses were classified in 5 point Scale Likert (specific to each question) varying from:

1 strongly disagree	**2** disagree	**3** neither agree or disagree	**4** agree	**5** strongly agree
Disagreement		**Medium agreement or disagreement**	**agreement**	

(Mark down one with a sign in the survey).

2. The sample population include master or 3rd year IT students, IT professionals and managers from small and medium enterprises.

PLEASE START THE SURVEY HERE
First Part: Questions about your experience, background, workplace, studies and perspectives.

1. Gender: Male ☐ Female ☐
2. In the following scale, what is your age?
   24-29 years old ☐ **30-35 years** ☐ **36-41 years old** ☐ **More than 41** ☐
3. With which software do you have a good experience? (Mark down one of them)
   OSS ☐ Proprietary software ☐ OSS & Proprietary s..tware
4. How are your expertise in IT?
   Poor ☐ Average ☐ Excellent ☐
5. What is the name of your organization; the year of establishment; the size (small and medium or large enterprises); the location (region) and what position do you hold within?
   Name:_____Year:_____
   _____Size:_____Region:_____
   _____Your
   position_____
   ____
6. Please indicate your highest academic title and degree
   a) Undergraduate_____
   a) Masters_____
   b) PhD_____
   c) Others_____.

Second part: Questions about OSS adoption and use.

Technological characteristics	**T**	
Ttotal cost ownership	**T**tco1	The support cost of OSS systems for your business management are more expensive than that of proprietary systems. This affects its adoption in my company.
	Ttco2	The costs involved in switching to an OSS system is too high. This really influences its use in my small business.
	Ttco3	It is much more cost effective in the long run to maintain an OSS application for business activities. This affects its adoption for my job activities.
Tsoftware flexibility	**T**softf1	OSS for business is designed for all levels of users.
	Tsoftf2	OSS for business provides flexible user guidance.
Tsoftware quality	**T**softq1	I perceive OSS' performance to be strong relative to proprietary alternatives, so I use it for my business practices.
	Tsoftq2	OSS applications functionality enhanced my job activities
Tsystem compatibility &	**T**scc1	OSS for business matches my current processing procedure.

capabilities	**T**scc2	OSS systems for business are compatible with the others software being used in our organization.
	Tscc3	I believe OSS for business management is an efficient and a reliable system.
Tsystem complexity	**T**scx1	Working with OSS system is very easy, it is easy to understand what is going on.
	Tscx2	OSS system is much less complex to implement than the proprietary system, so it is easy to use it for my job activities.
Tlegal issues	**T**li1	The multitude of open source licenses available to developers creates a problem that must be handled with care.
	Tli2	There is a lack of knowledgeable lawyer that could help to understand OSS licenses complexity.
Organizational characteristics	**O**	
Osupports	**O**s1	OSS system-Top management supports are considerable problems in my organization.
	Os2	Limited supports and encouragement of the use of OSS is a real issue in my organization.
	Os3	Sometimes there are problems (*internet connectivity*, *electricity* and *phone lines*) due to weak infrastructure.
Otraining	**O**tr1	Training organize in or by my company improved my level of OSS systems understanding and use.
	Otr2	Training gave me confidence in the use of OSS system in business related activities.
Environmental characteristics	**E**	
Egovernment supports & policies	**E**gsp1	Local government supports for OSS projects enhance OSS applications use in my work sector.
	Egsp2	Government strategies on OSS adoption help to provide OSS practical use in my job sector.
Eeducation	**E**edu1	The kind of training gained from schooling was complete and can help me to easily use OSS applications.
	Eedu2	Educational training is just enough to ensure the minimum capacity to manipulate any IT system based on OSS programs.
Eawareness (e-read & brand awareness)	**E**awar1	There is a well-known brands of OSS systems in the market. This encourages OSS adoption and use in my job-related work.
	Eawar2	There is a full presence of OSS systems in the market. This motivates its adoption and use in my job sectors.
Personal characterristics	**P**	
Ppersonal innovativeness in technology	**P**piit1	Among my peers, I am usually the first to try out new IT based on OSS.
	Ppiit2	Often enough, I am determined to try out new information technology.
	Ppiit3	I am always curious too, to try out new information technologies.
Social influence characteristics	**S**	
Scultural dimensions	**S**cd1	Position at your workplace limits decision making and free use of OSS.
	Scd2	You believe that your supervisor has more power than you have and you go to pieces under pressure. This threatens your longing to freely try or adapt new IT to your job activities.

Ssocial identification	**S**si1	I am proud to think of myself as a member of the OSS community.
	Ssi2	I think about being an open source user often.
	Ssi3	I devote myself more often to the group team in my work.
	Ssi4	Being an open source user is an important part of my self-image.
Perceived usefulness (Pu)	Pu1	I find OSS to be useful in my work.
	Pu2	Using OSS would give me greater control over my tasks than using proprietary software.
	Pu3	I perform tasks more effectively and efficiently if I use OSS compared to if I use proprietary software.
	Pu4	The use of OSS can increase the effectiveness of my interaction with my computer.
Perceived ease of use (Peou)	Peou1	Generally, I find it easy to get OSS learning system to do what I want it to do.
	Peou2	It is easier to perform most tasks when using OSS than using proprietary software. So, interacting with OSS in my business practices does not require a lot mental effort.
	Peou3	It is easy for me to become skillful at using OSS.
	Peou4	Overall, OSS provides helpful guidance in performing tasks.
Intention to adopt/use (Ia)	Ia1	People in my area whose opinions I value think that I should use OSS applications in my work.
	Ia2	I intend to use the OSS system for performing my job as often as needed.
	Ia3	If I heard about a new information technology (such as OSS), I would look for ways to experiment with it in my work.
	Ia4	I think my interaction with the software will be effective, good and positive.
Usage behavior (Usb)	Usb1	How do you consider the extent of your current OSS use?
	Usb2	On average I frequently use OSS for job related work.

Thank you for your participation!

Please add here your email address or your phone number for further information regard your questionnaire response, in case of need:

If you have any comments you would like to make, please feel free to do so in the space provided here:

We appreciate the time and effort you committed to completing this questionnaire.
If you have any questions about this research, please contact Kudzo W. Parkoo at
parkoobienvenu@gmail.com/kudzowoezo.parkoo01@universitadipavia.it

Appendix 1b: Measures and operationalization

Models/ Constructs	Sub-constructs	Items	Question items used in the survey	Scale Likert 1 2 3 4 5
TOE TECHNOLOGY	**Total Cost Ownership**	Tco1	The support cost of OSS systems for your business management are more expensive than that of proprietary systems. This affects its adoption in my company.	
		Tco2	The costs involved in switching to an OSS for business practices is too high. This really influences its use in my small business.	
		Tco3	It is much more cost effective in the long run to maintain an OSS for business. This affects its adoption for my job activities.	
	Software flexibility	Tsoftf1	OSS for business is designed for all levels of users.	
		Tsoftf2	OSS for business provides flexible user guidance.	
	Software quality	Tsoftq1	I perceive OSS' performance to be strong relative to proprietary alternatives, so I use it for my business practices.	
		Tsoftq2	OSS applications functionality enhanced my job activities.	
	Syst. Compatibility & capabilities	Tscc1	OSS for business matches my current processing procedure.	
		Tscc2	OSS systems for business are compatible with the others software being used in our organization.	
		Tscc3	I believe OSS for business management is an efficient and a reliable system.	
	System Complexity	Tscx1	Working with OSS system is so complicated, it is difficult to understand what is going on.	
		Tscx2	OSS system is much less complex to implement than the proprietary system, so it's easy to use it for my job activities.	
	Legal Issues	Tli1	The multitude of open source licenses available to developers creates a problem that must be handled with care.	
		Tli2	There is a lack of knowledgeable lawyer that could help to understand OSS licenses complexity.	
ORGANIZATION	**Org. Supports**	Os1	OSS system-Top management supports are considerable problems in my organization.	
		Os2	Limited supports and encouragement of the use of OSS is a real issue in my organization.	
		Os3	Sometimes there are problems (internet connectivity, electricity and phone lines) due to weak infrastructure.	
	Training	Otr1	Training organize in or by my company improved my level of OSS systems understanding and use.	
		Otr2	Training gave me confidence in the use of OSS system in business related activities.	
ENVIRONMENT	**Government supports & policies**	Egsp1	Local government supports for OSS projects could enhance OSS applications use in my work sector.	
		Egsp2	Government implementation strategies on OSS adoption help to provide OSS practical use in my job sector.	
	Education	Eedu1	The kind of training gained from schooling was complete and can help me to easily use OSS applications.	
		Eedu2	Educational training is just enough to ensure the minimum capacity to manipulate any IT system based on OSS programs	

	Awareness (e-read & brand-awareness)	Eawar1	There is a well-known brands of OSS systems in the market. This encourages OSS adoption and use in my job-related work.
		Eawar2	There is a full presence of OSS systems in the market. This motivates its adoption and use in my job sectors.
SIT	**Personal innovativeness in technology**	Ppiit1	Among my peers, I am usually the first to try out new IT based on OSS
INDIVIDUAL		Ppiit2	Often enough, I am determined to try out a new information technology.
		Ppiit3	I am always curious too, to try out new information technologies.
SOCIAL INFLENCE	**Cultural dimensions**	Scd1	Position at your workplace limits decision making and free use of OSS.
		Scd2	You believe that your supervisor has more power than you have and you go to pieces under pressure. This threatens your longing to freely try or adapt new IT to your job activities.
	Social Identification	Ssi1	I am proud to think of myself as a member of the OSS community.
		Ssi2	I think about being an open source user often.
		Ssi3	I devote myself more often to the group team in my work.
		Ssi4	Being an open source user is an important part of my self-image.
TAM	**Perceived usefulness (PU)**	Pu1	I find OSS to be useful in my work.
		Pu2	Using OSS would give me greater control over my tasks than using proprietary software.
		Pu3	I perform tasks more effectively and efficiently if I use OSS compared to if I use proprietary software.
		Pu4	The use of OSS can increase the effectiveness of my interaction with my computer.
	Perceived ease of use (Peou)	Peou1	Generally, I find it easy to get OSS learning system to do what I want it to do.
		Peou2	It is easier to perform most tasks when using OSS than using proprietary software. So, interacting with OSS in my business practices does not require a lot mental effort.
		Peou3	It is easy for me to become skillful at using OSS.
		Peou4	Overall, OSS provides helpful guidance in performing tasks.
	Intention to adopt (Ia)	Ia1	People in my area whose opinions I value think that I should use OSS applications in my work
		Ia2	I intend to use the OSS system for performing my job as often as needed.
		Ia3	If I heard about a new information technology (such as OSS), I would look for ways to experiment with it in my work.
		Ia4	I think my interaction with the software will be effective, good and positive.
	Usage behavior (Usb)	Usb1	How do you consider the extent of your current OSS use?
		Usb2	On average I frequently use OSS for job related work.

Appendix 2: Direction of effects and SEM significance.

Direction of the effects	Direct effects		Indirect effects		Total effects	
	B	P Values	B	P Values	B	P Values
Eawar -> Pu	-0,224	**0,001**			-0,224	**0,001**
Eedu -> Intention to adopt (Ia)	-0,050	**0,024**			-0,050	**0,024**
Eedu -> Usage behavior (Usb)			***	***	-0,038	**0,024**
Egsp -> Intention to adopt (Ia)	-0,139	**0,011**			-0,139	**0,011**
Egsp -> Pu	-0,200	**0,001**			-0,200	**0,001**
Egsp -> Usage behavior (Usb)			***	***	-0,106	**0,013**
Intention to adopt (Ia) -> Usage behavior (Usb)	0,759	**0,000**			0,759	**0,000**
Peou -> Intention to adopt (Ia)	0,141	**0,010**			0,141	**0,010**
Peou -> Pu	0,156	**0,011**			0,156	**0,011**
Peou -> Usage behavior (Usb)			***	***	0,107	**0,011**
Ppiit -> Intention to adopt (Ia)	0,207	**0,003**			0,207	**0,003**
Ppiit -> Usage behavior (Usb)			***	***	0,157	**0,003**
Scd -> Intention to adopt (Ia)	0,159	**0,001**	***	***	0,217	**0,000**
Scd -> Peou	0,406	**0,000**			0,406	**0,000**
Scd -> Pu			***	***	0,063	**0,015**
Scd -> Usage behavior (Usb)			***	***	0,164	**0,000**
Ssi -> Intention to adopt (Ia)	0,325	**0,000**			0,325	**0,000**
Ssi -> Usage behavior (Usb)			***	***	0,247	**0,000**
Tscc -> Pu	0,219	**0,000**			0,219	**0,000**
Tscx -> Pu	-0,202	**0,000**			-0,202	**0,000**
Tsoftq -> Ia			***	***	0,074	**0,015**
Tsoftq -> Peou	0,529	**0,000**			0,529	**0,000**
Tsoftq -> Pu			***	***	0,082	**0,016**
Tsoftq -> Usage behavior (Usb)			***	***	0,056	**0,017**

Appendix 3: Delphi questionnaire - First round

a. According to the importance of the mentioned F/OSS (Free/Open Source Software) adoption factors characteristics, please, rate the list on the 5-point Lykert scale varying from 1 to 5: (1) ''not important or strongly disagree''; (2) ''slightly important''; (3) ''moderately important''; (4) ''important''; (5) ''very important''. (Write your comments on themes at the end of the questionnaire if necessary).
b. Please, identify through the mentioned factors, the internal (SMEs' internal environment) and the external (SMEs'

1) Total costs ownerships standpoints: 1 2 3 4 5 internal☐ external☐
(Financial resources for bearing switching costs).

2) Technical specifications of OSS: 1 2 3 4 5 internal☐ external☐
(OSS for business provides flexible user guidance; OSS functionality enhanced job activities; OSS systems for business are compatible with the others software being used in our organization; complexity problems in pratical use).

3) Legal concerns – software copyrights and licensing system: 1 2 3 4 5 internal☐ external☐
(The multitude of OSS licenses available to developers creates a problem that must be handled with care; Introduction of new models for restructuring licensing systems; There are currently fewer knowledgeable lawyer that could help to understand OSS licenses complexity).

4) Supports services and training on FOSS: 1 2 3 4 5 internal☐ external☐
(Availability of OSS consultancy, training, supporting services).

5) **Government supports and policies for OSS using: 1 2 3 4 5 internal☐ external☐**
(Commitment/support of government or action plan for using OSS; Present IT infrastructure of the country that is based on proprietary software; There is a public reaction against the monopoly of and unfair competition with Microsoft; Improvement of hardware integration of OSS; Hardware integration of OSS in business practice).

6) National educational knowledge based on FOSS: 1 2 3 4 5 internal☐ external☐
(Number and qualifications of national OSS developers; Encouragement of academics/students towards OSS).

7) Individual/personal innovativeness in information technology: 1 2 3 4 5 internal☐ external☐
(Individual determination to try out new information technologies; Intention to use as often as needed the OSS applications for performing my job-related work).

8) Social and cultural pressures using OSS: 1 2 3 4 5 internal☐ external☐
(Gender issues in decision making at workplace; Power distance pressures in team work - collaboration and communication).

9) **User ability in OSS applications Usage: 1 2 3 4 5 internal☐ external☐**
(Ability and frequent use of OSS applications assuming that we have access the system).

10) **Individual performance: 1 2 3 4 5 internal☐ external☐**
(Using OSS is a valuable aid to me in the performance of my job).

11) Employees empowerment: 1 2 3 4 5 internal☐ external☐
(OSS system provides very accurate, complete and comprehensive information about how well or badly I have done my work; OSS system provides very reliable information about my work, and it gives me considerable autonomy in deciding how to carry out my work; OSS make us ensure proper operation or processing).

12) **Open source diffusion processes/opportunities: 1 2 3 4 5 internal☐ external☐**
(Preference for OSS in the system software market; Preference of small and medium sized enterprises for OSS use; Availability of broadband Internet; Considerable use of OSS for business practice; Participation of software professionals in OSS community or global developer communities; Willing to be a member of OSS community; Maturity of local developer communities).

13) **Local initiatives and quality improvements on OSS systems: 1 2 3 4 5 internal☐ external☐**
(Improvement to the delivery of socioeconomic services to the local communities; User collaboration-intervention in product improvement/development process; Use of OSS for business practice in mobile systems; Developments in local OSS business models which enable practical adaptation of FOSS).

Appendix 4: Delphi questionnaire - Second round

1. Please write down your suggestions and comments if the grouping in the table below is not to your satisfaction (i.e., "Total costs ownerships standpoints" as **Internal factors**, or, "National educational knowledge based on OSS" as **External factors**):----------

Internal factors (**companies' internal factors - local factors)**	**External factors (global level strategic factors)**
a. Total costs ownerships standpoints b. Technical specifications of OSS c. Supports services and training on OSS d. Individual/personal innovativeness in information technology e. Social and cultural pressures using OSS f. User ability in OSS applications Usage g. Individual performance h. Employees empowerment	a. Legal concerns – software copyrights and licensing system b. Government supports and policies for OSS using c. National educational knowledge based on OSS d. Open source diffusion processes/opportunities e. Local initiatives and quality improvements on OSS systems

2. In the following table, rate on the 5-point Lykert scale varying from 1 to 5: (1) ''very weak''; (2) ''weak''; (3) ''moderate''; (4) ''strong''; (5) ''very strong'', the related items of each main factors.

Internal factors	**1 2 3 4 5**	**External factors**	**1 2 3 4 5**
a. Total costs ownerships standpoints		**a. Legal concerns – software copyrights and licensing system**	
Financial resources for bearing switching costs		The existing of multitude of OSS licenses is handled with care	
b. Technical specifications of OSS		Introduction of new models for restructuring licensing systems	
OSS for business provide flexible user guidance		There are currently knowledgeable lawyers that could help to understand OSS licenses complexity	
OSS functionality enhanced job activities		**b. Government supports and policies for OSS using**	
OSS systems for business are compatible with the others software being used in our organization		Commitment/support of government or action plan for using OSS	
		IT infrastructure of the country is based on OSS	
c. Supports services and training on OSS		There is a public reaction against the monopoly of and unfair competition with Microsoft	
Availability of OSS consultancy, training, supporting services		Improvement of hardware integration of OSS by the government	
d. Individual/personal innovativeness in information technology		Hardware integration of OSS in business practice	
Individual determination to try out new information technologies		**c. National educational knowledge based on OSS**	
Intention to use as often as needed the OSS applications for performing my job-related work		Number and qualifications of national OSS developers	
e. Social and cultural pressures using OSS		Encouragement of academics/students towards OSS	
Mainstreaming of gender considerations in decision making at workplace		**d. Open source diffusion processes/opportunities**	
Equality, mutual respect and collaboration in team work (between employers and employees)		Preference for OSS in the system software market	
f. User ability in OSS applications Usage		Preference of small and medium sized enterprises for OSS use	
Ability to use OSS applications assuming that we have access to the system		Availability of broadband Internet	
g. Individual performance		Considerable use of OSS for business practice	
Using OSS is a valuable aid to me in the performance of my job		Participation of software professionals in OSS community or global developer communities	
h. Employees empowerment		Willing to be a member of OSS community	
OSS systems provide very accurate, complete and comprehensive information about how well or badly I have done my work		Maturity of local developer communities	
		Facility in pratical use	
OSS systems provide very reliable information about my work, and it gives me considerable autonomy in deciding how to carry out my work		**e. Local initiatives and quality improvements on OSS systems**	
OSS make us ensure proper operation or processing		Improvement to the delivery of socioeconomic services to the local communities	
		User collaboration-intervention in product improvement/development process	
		Use of OSS for business practice in mobile systems	
		Developments in local OSS business models which enable practical adaptation of OSS	

3. Please rank the mentioned factors in order of importance and priority, starting from one (1) as the most important factor.

Factors		Rank
a.	Total costs ownerships standpoints	
b.	Technical specifications of OSS	
c.	Supports services and training on OSS	
d.	Individual/personal innovativeness in information technology	
e.	Social and cultural pressures using OSS	
f.	User ability in OSS applications Usage	
g.	Individual performance	
h.	Employees empowerment	
i.	Legal concerns – software copyrights and licensing system	
j.	Government supports and policies for OSS using	
k.	National educational knowledge based on OSS	
l.	Open source diffusion processes/opportunities	
m.	Local initiatives and quality improvements on OSS systems	

Appendix 5: Delphi questionnaire - Third round

1. Please rank again (second rank list) the mentioned factors in order of importance and priority, if you are not agree with the first ranked list. (Start with one (1) as the most important factor).

Factors		First ranked list	Rank list after first iteration
j.	Government supports and policies for FOSS using	1	
k.	National educational knowledge based on FOSS	2	
e.	Social and cultural pressures using FOSS	3	
m.	Individual/personal innovativeness in information technology	4	
d.	Local initiatives and quality improvements on FOSS systems	5	
f.	User ability in FOSS applications Usage	6	
c.	Supports services and training on FOSS	7	
b.	Technical specifications of OSS	8	
a.	Total costs ownerships standpoints (switching costs)	9	
l.	Open source diffusion processes/opportunities	10	
i.	Legal concerns – software copyrights and licensing system	11	
g.	Individual performance	12	
h.	Employees empowerment	13	

2. Write in the space provided any comments you would like to make regard your ranking.

Please add here your email address or your phone number for further information regard your questionnaire responses, in case of need:

Thank you very much!

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