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## ICT adoption in road freight transport in Nigeria – A case study of the petroleum downstream sector

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### ABSTRACT

This paper advances the ICT adoption discourse to explore ICT mechanism use, adaptation and contextual influences on management strategies in Africa. A polar-type multiple case studies approach is used to guide empirical data collection across 10 individual cases. 21 interviews were conducted with top executives and these were corroborated with over 30 h of non-participant observations and archival documentation from these cases. Using a tripartite coding frame, thematic and content analyses were performed to identify patterns and themes in the collected data. Findings of this study evidence ICT use at firm level with significant links to local contextual factors. Additionally, whilst affirming relationships between size and adoption, the findings also suggest an inverted parallel between both variables. The paper contributes by empirically highlighting the influence of contextual factors on ICT use in road freight transportation as well as highlighting the potential for ICT developers and OEMs to acquire innovative input from local adaptation practices within the industry.

### 1. Introduction

Information and communications technology (ICT) has been identified as a critical enabler of sustainable development (Kayisire and Wei, 2016). Mobile phones, internet of things (IoT), big data, radio frequency identification (RFID) and geographic information systems (GIS) are some examples of ICT tools that have been deployed to support sustainable development across a variety of contexts (Kyem, 2012; Koría et al., 2014; Wang et al., 2015). The application of ICT tools to promote sustainable travel is documented within the literature. For example, authors have identified time saving efficiencies from the application of ICT (barcoding, decision support systems) to haulier operations, improving the overall experience of the service providers and users (Sternberg et al., 2014). Other studies have linked competitiveness (Davies et al., 2007), safety (Harris et al., 2015; Wang et al., 2015), and wellbeing (Button et al., 2001) to the use of ICT tools like GIS navigation and on-board computers (OBCs) to support transportation. However, the evidence for this link between ICT and sustainable transport in Africa is absent, despite the importance of transportation as a key UN sustainable development indicator as well as the high socio-economic costs associated with transportation in Africa (UN, 2016).

Africa accounts for a disproportionately high percentage of externalities from road transport incidents with Nigeria identified as recording the second highest fatality figures in the world (UN Economic

and Social Council, 2009; International Transport Forum, 2016). By exploring the evidence for ICT adoption in road freight transport within Africa, this paper seeks to improve insight on how adoption of ICT is taking place in road freight transport operations as well as the key contextual factors that are influencing the adoption from a management perspective (Gallego et al., 2015; Osabutey et al., 2014; Wang et al., 2015).

Accordingly, this paper reports on ICT use by firms in the road freight transport sector of one of Africa's largest petroleum industries; the Nigerian downstream petroleum industry. It highlights evidence for ICT use, adoption, perceived socio-economic benefits and specific contextual factors that influence management. Our discussion is aligned with the technology adoption and freight transport literature to demonstrate how our findings inform policy as well as ICT developers and original equipment manufacturers (OEMs) in promoting sustainable transport within the continent.

The rest of this paper is structured as follows; in section 2, we review the literature and present the theoretical underpinning of the research; in section 3, we explain our research methodology and report our findings in section 4. Finally, in sections 5 and 6 we discuss the implications of the findings and advance some conclusions from our study.

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## 2. Literature review

ICT has been identified as promoting growth in developing and developed nations and several studies have explored ICT use in various contexts (Siegel, 1997; Kyem, 2012; Asongu and Le Roux, 2017). The use of the term ICT is expansive within the literature, incorporating mobile phones, decision support applications, IoT applications and technology hardware into the scope (Harris et al., 2015; Jean, 2007; Kayisire and Wei, 2016; Wang et al., 2015). In this study, we determined ICT as a multi-tier concept, incorporating hardware, software and information constructs of connectivity tool configurations that enable a variety of relationships, processes and networks. The emphasis is on information acquisition, processing, exchange and remote access capabilities that match the user's requirements. In the succeeding sections, we review the material on ICT adoption from a general perspective on developing countries as well as Africa. Subsequently, we explore the literature on road freight transport in Africa and identify the potential of ICT use to support road freight transport in African contexts before concluding with a theoretical framework and some key research questions.

### 2.1. ICT adoption and adaptation in developing countries

Adoption refers to the replicative uptake, incorporation or use of ICT for private, public or individual purposes whilst adaptation refers to the adjustment of ICT for uses other than the replicated use (Biagini et al., 2014). The literature uses the term interchangeably, however Biagini et al.'s (2014) paper offers a better understanding of adaptation as involving some modification of technology to suit the localised context requirements.

In exploring the influence of ICT adoption in developing countries, Gallego et al. (2015) studied 3759 Columbian manufacturing firms and established factors like human capital, size, innovation and international competitiveness as key drivers of ICT adoption. Other studies have advanced cultural, economic and infrastructural factors as influencing adoption at developing country levels (Erumban and De Jong, 2006; Kayisire and Wei, 2016; Roztocky and Weistroffer, 2016). The literature highlights differences in adoption drivers in different contexts. For example Erumban and De Jong (2006) found that cultural practices are key drivers of ICT adoption, whilst Caselli and Coleman (2001) attribute ICT adoption to market structures. Additionally, we know that adoption rates differ between countries, with a number of comparative studies highlighting differences in adoption rates at country levels, using factors like income per capita, legal quality, and infrastructure being advanced as construct measures of ICT adoption (Chinn and Fairlie, 2010; Weber and Kauffman, 2011).

At firm level, team-working and quality structures in firms have been highlighted as some unique factors that drive ICT adoption (Bayo-Moriones and Lera-López, 2007). Other authors have linked ICT adoption to increased capital productivity (Bharadwaj, 2000), operations efficiencies (Kohli and Devaraj, 2003; Melville et al., 2004) and national competitiveness (Gallego et al., 2015). These studies underline the importance of firm level investigations as instructive for understanding the role that businesses play in advancing sustainable development within developing regions like sub-Saharan Africa. Since most technology adoptions are driven by the actions of firms within a country, studies have highlighted industry level decomposition approaches as critical for understanding sustainable development challenges (Kveiborg and Fosgerau, 2007). The focus on a specific industry is also influenced by our understanding of industry specific factors responsible for technology adoption (Kayisire and Wei, 2016).

### 2.2. ICT adoption and adaptation in Africa

The literature on ICT adoption in Africa is continuing to emerge. Recent studies have identified adoption drivers like policy,

competitiveness, innovation and government spending as critical to ICT adoption in Kenya and Ghana (Koria et al., 2014; Osabutey et al., 2014), however the literature highlights gaps in terms of how policy in Africa is helping to scale up technological capacity and adoption at firm level (Amankwah-Amoah and Sarpong, 2016). More recently, Danquah and Amankwah-Amoah (2017) established positive correlations between human capital and technology adoption in sub-Saharan African (SSA) countries, extending the discourse on links between socio-demographic factors and technology adoption (See also Asongu and Le Roux, 2017). It is worth noting that whilst some other studies have reported on ICT adoption in African countries, their data sets have adopted regional aggregation models and as such these studies may not have reflected some unique nuances of the African countries they relate to (Erumban and De Jong, 2006; Kayisire and Wei, 2016). As such, these aggregated models are likely to omit context specific factors that are important for understanding African contexts.

Closely linked is the issue of ICT adaptation that may be better investigated by localising research? Whereas the literature has largely focused on adoption, i.e. the replicative uptake of ICT by African firms, it also highlights some inherent risks that accompany such adoptive transfers and replication that often lead to performance failures (Dadzie, 1990; Erumban and De Jong, 2006; Kayisire and Wei, 2016). This perhaps supports the arguments for adaptation, whereby local firms are going beyond replicative models to modify technology use to support specific requirements that are unique to their environments. Examples of these adaptations include the use of drones to deliver medical aid supplies to remote communities in Rwanda and the MellowCabs electric vehicles phenomenon in South Africa that are free for users but supported by revenue from advertising on ICT enabled platforms on the cab. The adaptation phenomena and its link to firm performance vis-à-vis drivers, processes and outcomes are increasingly areas of research interest (Weber and Kauffman, 2011; Biagini et al., 2014), yet we note that very few empirical studies have focused on African contexts, despite opportunities for learning and innovation by ICT developers and OEMs.

From a firm perspective, we view ICT as not only a critical resource but also suggest that its application and performance is best understood by identifying contractual factors that drive modification to suit firm objectives beyond the original intentions of the technology innovators (Jean, 2007). Our study contributes to the literature by extending insight on ICT adoption in Africa by adopting an industry decomposition approach to explore ICT adoption for sustainability performance from a strategic management perspective. We advance on the findings from previous studies to highlight the impact of contextual factors on management's adoption of ICT, linking sustainability and strategy in road freight operations (Erumban and De Jong, 2006; Aleke et al., 2011; Chinn and Fairlie, 2010; Gallego et al., 2015; Osabutey et al., 2014; Kayisire and Wei, 2016).

### 2.3. Road freight transport

Africa has the highest risks of road transport fatality with over 26% of road accidents occurring in Africa (UN Economic and Social Council, 2009; World Health Organisation, 2015). Porter (2014) highlights the unique nature of many African contexts where the consumption of human and freight mobility services occur simultaneously. Whilst the co-consumption of freight and people transport increases latent risks of fatalities within road freight in Africa, the risk is also significant in industry sectors like the petroleum products transport industry where co-consumption is very rare.

Most African economies rely heavily on petroleum products for industrial and domestic purposes fuelling high local demands for transportation. These transport operations often come with significant human, social, environmental and economic costs (UN Economic and Social Council, 2009). For example, in Nigeria and Ghana, there have been series of fuel tanker related deaths between 2008 and 2015. In the

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