



Exploring the Use of Global Positioning System (GPS) for Identifying Customer Location in M-Commerce Adoption in Developing Countries

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Abstract. M-commerce in Kenya has seen tremendous growth over the last few years due to the availability of mobile payments, mobile internet access, and expansion of mobile banking systems. A critical factor to the success of m-commerce is timely delivery of purchased items to the customers' premises. Timely delivery is highly dependent on the courier's ability to locate the buyer's physical location. To do this, the courier requires a reliable physical addressing system. However, like most developing countries, Kenya lacks a National Addressing System to provide properly registered physical identity of buildings, streets, and roads. The study explored the use of GPS in identifying customer's location as an alternative to named physical addresses. This paper describes the study design and discusses the findings concerning the use of GPS tracking application among six retailers and thirty customers. The study reveals that geolocation can substitute physical addresses in m-commerce home deliveries.

Keywords: M-commerce · Kenya · GPS · National Addressing System
Geolocation

1 Introduction

The Communications Authority of Kenya [1] indicates that during the fourth quarter of 2016/2017 (January–March, 2017) a total of 290.5 million mobile commerce transactions were completed, in which goods and services valued at Kenya Shillings 627.4 billion were merchandised. The success of m-commerce in Kenya could be attributed to the country's high mobile phone penetration level of 86.2% [1] and the availability of affordable mobile internet technologies for home users [2]. Kenya is also a world leader in mobile money, mobile payments, and other related mobile financial transactions. This has been attributed to “population demographic characteristics and the cultural practices of the Kenyan people which over the years demanded person-to-person money transmittals” [3, p. 15]. M-commerce is defined as any transaction involving the transfer of ownership or rights to use goods and services which is initiated and completed using mobile access to computer-mediated networks [4]. Other studies define mobile commerce as any transaction with a monetary value that is conducted via a mobile telecommunications network [5], while [6] describes mobile

commerce as buying and selling of goods and services, using wireless hand-held devices. There are many mobile commerce services and applications which include mobile banking, mobile marketing, mobile entertainment, mobile information services and mobile shopping [5]. This study focus is on physical delivery of customer's purchases from the business premises or collection point to the buyer's premises or selected drop-off point. Therefore, the study's mobile commerce application is mobile shopping [5].

A critical factor to the success of m-commerce is the timely delivery of the purchased items to the buyer's residence rather than the retailer's drop-off points. Timely delivery is highly dependent on the courier's ability to locate the buyer's physical location. To do this, the courier requires a reliable physical addressing system. However, like most developing countries, Kenya lacks a National Addressing System to provide properly registered physical identity of buildings (homes or business), streets and roads. One of the major benefits of using mobile commerce is the greater convenience [3] the user enjoys including fast on-demand delivery services, cheaper prices, and instant gratification. Thus, the customer expects the items ordered to be delivered immediately to the address they have specified without having to step out of their home or office. Most m-commerce firms do not hire in-house couriers but engage courier services from an external courier company. The Last mile delivery in Kenya is hampered by lack of registered physical addresses of the customers' physical location. Lack of registered physical addresses negatively affects the on-demand delivery services particularly with the popular food and groceries deliveries.

The main purpose of this study is to evaluate the viability of using GPS to provide an m-commerce customer geolocation as a substitute to a physical address for the last mile home deliveries. The study used an open-source GPS tracking application for identification of a customer's physical location as an addressing system for quick delivery of Liquefied Petroleum Gas (LPG). Specifically, the study was guided by the following objectives:

- (a) Analyze the impact of lack of physical addressing systems on the last mile mobile commerce on-demand deliveries;
- (b) Analyze the use of GPS based geolocation as an alternative to physical addressing systems in facilitating the last mile mobile commerce on-demand deliveries.
- (c) Compare mobile GPS based geolocation with desktop computer IP based geolocation as an alternative to physical addressing systems in facilitating the last mile mobile commerce on-demand deliveries.

The paper explores how the use of GPS based geolocation services as an addressing system in environments where physical addressing system is not in place and how these services can be applied to enhance the m-commerce customer shopping delivery experience. The next section has the study background. Section 3 describes the study research approach; Sect. 4 gives the analysis and findings while Sect. 5 has the discussions and conclusions of the study. Section 5 also gives a reflection on the success of the study, the study conclusion and directions for further research.

2 Background

M-commerce is the extension of e-commerce to wireless mediums. There are many different examples of m-commerce services in Kenya today which includes ticketing, gaming, banking, retailing and payments. Many e-commerce retailers are still struggling with the best way to approach m-commerce as a medium of their business transactions. Use of mobile websites and mobile apps continue to compete with the traditional good old websites. The retailers' main objective is to provide the customer who is using a mobile device to make their purchases a good mobile experience, as though they were in a physical shop. To make shopping experiences hassle-free for their customers' convenience and the choice of shopping anytime, anywhere, some online retailers such as Jumia [7] use a combination of the three (mobile app, mobile website and a traditional desktop website). Jumia [7] indicates that over the last one year (2015/2016) 32% of their customers used the tradition desktop website, 17% accessed their services using a downloaded Jumia mobile app while 51% used their mobile responsive website. In the African continent, KPMG [8] and Jumia [7] ranks South Africa, Egypt and Morocco higher than Kenya in their use of m-commerce services. However, Kenya is ranked highly globally in the adoption of mobile money transfers. Kenya's poor ranking on the adoption of m-commerce could be attributed to the absence of reliable, low-cost delivery services, coupled with the lack of a National Addressing System to provide properly registered physical identity of the customers' premises or selected drop-off points. These two factors are significant for reliable, timely and profitable m-commerce deliveries.

Some challenges associated with the fruitful use of m-commerce by individuals have been highlighted in literature to include complicated checkout and payment process, the high cost of delivery, security concerns and small phone screens. For the challenges relating to small phone screens, the checkout and payment processes can easily be solved through better application designs and dynamically designed sites and specialist apps to support the users' shopping experiences. Security concerns are a multifaceted problem which includes users' experience, application and device security and devices' operation environment. The problems associated with high cost of delivery have been mitigated through the use of third-party courier services, and E-tail focused logistics service providers globally [9, 10]. In contrast, little has been written regarding alternatives to identifying an m-commerce customer's physical location in developing countries where there are no formal physical addressing systems.

The challenge of identifying physical location of the customer in the absence of a standard named physical address is very exhausting particularly in areas which are densely populated and with no house numbers or even street names. Studies have shown that delivery challenges related to inadequate physical addressing systems are a significant barrier to the uptake of online shopping [11, 12]. The Communications Authority of Kenya [1] has identified the absence of reliable, low-cost delivery services as one of the key factors hindering the development of online shopping in Kenya. A local courier company YUM, which offers a food delivery service in Nairobi, has indicated that lack of physical addressing systems is an obstacle to making deliveries to their new customers within the promised time [13]. YUM's director of operations

indicated that their couriers have challenges in “navigating the less familiar neighborhoods of Nairobi” [13]. To alleviate the last mile courier delivery service, the Chairman of the Kenya Courier Industry Association suggested the government to “roll out a national and regional physical addressing system” [14]. The Chairman also indicated that appropriation and use of the “Google Maps may help, but they are not precise” [14]. The online shoppers desire faster deliveries and the retailers are also keen on having a frictionless delivery process. Therefore, this study posits that lack of low-cost last mile delivery services is attributable to the absence of a reliable physical addressing system for stress-free identification of the customers’ premises or selected drop-off points.

The Chairman of the Kenya Courier Industry Association opined that a combination of the physical addressing and mobile applications that provide an online shopper’s geolocation make a perfect recipe to solve the problem associated with lack of a physical address system [14]. To help in increasing efficiency in deliveries and to decrease the delivery time, geolocation services can be used in determining the geographical location of an m-commerce shopper. There are two types of geolocation techniques, one based on the user handset and the other based on the network. The mobile phone handset based geolocation technique uses the GPS system to determine a user’s location. The second technique uses the replicas of signals from the same handset at different base stations which are then combined to determine a user’s location [15]. GPS-based positioning is reliable and accurate for outdoor situations [15] which is a requirement in successful m-commerce home and office deliveries. With GPS assisted geolocation identification, it would be easy to identify a customer’s physical location much easier and with good accuracy. Another advantage of using GPS is that it allows tracking by both the customer and the retailer. The tracking feature allows the customer to know the location of the purchased items during the delivery process.

Geolocation refers to the determination of the geographical position of an object using Global Positioning System-based systems [16]. It is a technology which utilizes data obtained from an individual’s computing device to describe the user’s actual physical location [17]. GPS can be used on any modern mobile phones which is GPS-capable as well as on GPS-specific devices [16]. Information obtained using geolocation technology could be utilized for Georeferencing, Geocoding or Geotagging [17]. These three technologies are essential to facilitating identification of a customer’s home address. Geocoding is the process of converting addresses (like “Soweto, Kayole Mwisho, Bus Terminus”) into geographic coordinates while reverse geocoding is the process of converting geographic coordinates into a human-readable address. Geotagging is the process of adding geographical identification metadata to an object while georeferencing is the determining of objects physical location in relation to a coordinate system [17].

To assist in identification and tracking of an m-commerce delivery, use of user-device geolocation technique would be the most appropriate. User-device geolocation technique is also referred as the “Active geolocation.” Active geolocation uses technologies such as GPS, Wi-Fi positioning, and mobile applications and can be used for real-time tracking and provide high levels of accuracy [16, 18]. User-device geolocation technique raises privacy and security issues as a compromised active geolocation system can lead to people being tracked in real time. Location data can also

be analyzed for patterns or other variables to reveal private information [16]. A GPS enabled device can obtain location-based information in real time over the internet with a relatively high degree of accuracy. GPS works through the use of satellites. Groups of GPS satellites commonly referred to as arrays transmit information to GPS enabled devices. The information can be broadly described as information pertaining to the location of the satellite in orbit and the time the transmission was sent. The receiver then calculates its position by timing the various signals sent by any of the satellites in the array [16, 18].

Similar to the Kenyan case, United Arab Emirates (UAE) lacks a national physical address system. The country has over the years tried some technologies in addressing this problem with the first successful attempt being the completion of phase one of Dubai Municipality's Geo Address System (Gas) in 2013. However, the UAE based Fetchr [19] uses its proprietary Fetchr App which utilizes the GPS coordinates from a consumer's phone to allow local retailers and e-commerce firms to more accurately track down customers for easier home and office deliveries. Successful use of the Fetchr App is an indication that it is possible to use customers' mobile phones to identify their location and to achieve m-commerce deliveries successfully.

OkHi [20] a Nairobi based startup is hoping to solve Kenya's problem of not having a physical addressing system by facilitating people to log the details of where they live using their phones and combining a GPS data point with a photo of their house's front door. The OkHi App works by allowing users to upload an image of their exterior front door or home and locating it on the GPS system. The company then uses the OkHi App to make an OkHi address. OkHi users can then share their OkHi address using WhatsApp, SMS or email so that other users can use the addresses to locate their friends or families or even markets and physical landmarks.

Cost is a significant factor influencing adoption of ICT among micro and small enterprises [21, 22]. The study participants are small-scale retailers operating within marginalized communities. This means that the retailers may not be in a position to invest in a commercial GPS tracking application such as Fetchr. Their businesses are also categorized as Jua Kali or informal businesses. The informal nature of these business makes it hard for retailers to borrow or save enough money for them to acquire commercially available GPS applications. Thus, the study proposes to evaluate the use of an open-source GPS tracking app among the retailers and customers from marginalized communities where there are no named roads or notable landmarks which can be used to guide an m-commerce delivery courier.

3 Research Approach

The study utilized mixed methods theoretical premise in two phases. The first phase was a qualitative study using semi-structured interviews while the second phase was an experiment using an open-source GPS tracking application. A mixed method design was considered most appropriate as the study focus was exploring whether GPS could facilitate physical delivery of customer's purchases from the retailer's premises, even when the customer's residence has no known physical address.

The study population was purposely selected based on the study objectives. Three areas were chosen as the study sites. The study sites selected were residential areas within Nairobi Embakasi area and included Kayole, Mihang'o and Mowlem. The study areas were purposely selected because they lack registered physical identity of either the homes, businesses or the streets.

The study sample was the LPG retailers within the selected study sites and their customers. The retailers selected were expected to be offering the “*Cooking GAS Sales and Delivery Service,*” as usually advertised in some of the retailers’ outlets. This is usually an indication that a retailer is providing courier services to deliver the LPG to their customers’ doorstep within a specified duration after the customer requests a refill. From each of the study site, two retailers were randomly selected and tasked with the task of assisting the study with five of their customers. The customers were expected to be willing to participate in the study voluntarily. Thirty customers were randomly selected.

This being an exploratory study, qualitative data was collected through open-ended face-to-face semi-structured interviews and supported by observations during the initial phase. Patton’s [23] qualitative interviewing strategies was used in developing the structure of the open-ended interview and the interview guide. Although all the participants were asked the same basic questions which were prepared in advance, the exact wordings and sequence of questions were determined in the course of the interviews. Participants were also assured that any data collected for the study would be anonymized. The interviews lasted between 10–15 min. The interviews were conducted mainly to identify the participants’ characteristics and to ensure the homogeneity of the study sample. The participants were expected to be using a GPS enabled phone and had to have some basic digital and media literacy skills.

During the second phase of the study, the participants’ phones were installed with the open-source GPS tracking application. The customers and the retailers were offered basic training on how to use the application and on issues relating to information systems’ security and ethical use of the application. The data were collected over a period of two months with the defined objective of testing whether the retailer or the courier, with the assistance of the GPS tracking application, was able to reach the customer’s doorstep within a specified duration after the customer sends an SMS text requesting a refill.

4 Analysis and Findings

The study had six participating retailers, two from each study site. Each retailer was to work with five of their clients. Hence the study had thirty-six participants. All the participants were randomly selected.

A total of seventy-eight LPG refill requests were made by the study participants as presented in Fig. 1. The LPG refill requests were distributed unevenly among the study sites.

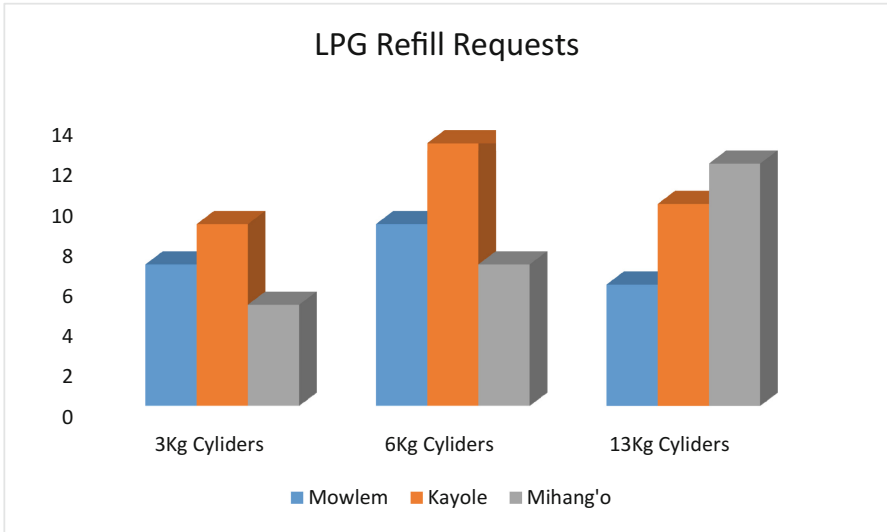


Fig. 1. Successful LPG refill requests

4.1 Without GPS Tracking

The customer would call for a refill give directions to their residence using some existing physical features. The courier would then try to navigate the residential area to find the desired location. In some instances, the courier took a long time to trace the location and sometimes would even be forced to call the customer for further guidance. The customer could also be waiting at a particular location to escort the courier the rest of the distance to their home.

One retailer had such experience and gave this example, *“I was given a call to deliver a 13 kg LPG cylinder one morning, the caller gave direction as, ‘**kuja Kayole mwisho, shukua chochoro nyuma ya Paradise Pub, tembea kindogo, upande wako wa kushoto kunja nahio njia, kuna mahali utaona plot ya green, nitakuwa na kungoja hapo nnje.**’* (come to Kayole bus terminus, take the path behind the Paradise Pub, take a few steps, take a left turn and follow the path, you should find an apartment painted in green color, I will be waiting for you outside the building) *When I went there, I saw that there were several apartments painted in green color. When I called the customer, I realized that I had walked for a longer distance before taking the left turn and had to go back as I had taken to the wrong direction. Sometimes the customers do not give me the instructions that are explicit enough”*. Though with good intentions, the retailer was not able to deliver the LPG and the customer was forced to meet him and to walk with him half of the journey. All the six study participating retailers had such similar experiences.

For most of the customers from Mihang'o, there was no specific land mark to use when giving directions and most of them were forced to walk to the LPG store and then take a motorbike ride back to their residence with the courier. A number of customers

who had this experience explained that “*it is faster for me to come here, and guide the courier to my home, rather than having him waste time trying to locate my residence*”.

Waiting for a refill at home when the courier has nothing to direct him to the specific residence may result to delayed deliveries and could also be expensive as the courier may keep on calling for direction and distance clarifications in order to make sure that they are heading to the right location. The selected study sites are characterized by unplanned and informal developments, narrow and unmarked streets and no major landmarks.

4.2 With GPS Tracking

Two parameters were essential to the study. Identification of a client’s physical location (residence) and the customer is in a position to track the delivery by monitoring the courier’s movement. A few considerations were put in place during the selection of the GPS tracking application. The application should allow the participants to:

- i. Decide when to share their location and with whom by opting when to switch on and off the localization function.
- ii. Receive automatic notifications when the courier departs the LPG stall and when he arrives at a customer’s residence.
- iii. Share their location continuously with the couriers and see the courier’s movement in real-time.
- iv. Only use a username and a phone number to connect to the application. This is to ensure that the application does not connect to the participants’ social networking sites such as the Facebook or Google accounts automatically.
- v. To broadcast their location to the courier while appearing offline to other contacts.

When the customer needed a refill, they would initialize the GPS enhanced LPG delivery procedure and successful delivery should be accomplished efficiently and in a timely manner.

- i. The customer makes sure that the GPS tracking application is running.
- ii. Chooses to share their location.
- iii. Sends an SMS text to the retailer for a refill.
- iv. The retailer receives the request and prepares for the delivery.
- v. The retailer using the application identifies the location of the customer and departs to deliver the refill to the customer’s residence.
- vi. The customer is notified of the courier departure.
- vii. The customer could opt to monitor the courier’s movement real-time.
- viii. The customer is notified when the courier arrives at their residence.
- ix. The customer collects the refill, pays the retailer and can stop broadcasting their location or just chose to appear offline to the retailer.

The GPS tracking App was able to detect the customer’s location, and to generate complete and accurate addresses of the customer. Using the application GPS functionalities, the GPS tracking facilitated accurate and efficient deliveries. This resulted in greater customer and retailer satisfaction. One customer indicated that “*mimi ni lituma tu ujumbe mfupi kwa muuzaji wa gesi ya kupikia, baada ya muda mfupi alikuwa*

mlangoni” (I just sent an SMS to the LPG retailer, in a short while, he was at my door). Therefore, all that the customer needed was to send an SMS text, and he did not need to give directions or fear that the courier will not deliver the refill in time. One of the studies participating retailer who did not have the means to offer the delivery services but relied on hiring the motorcycle operators commonly known as *boda boda* indicated that “*it is now possible to track in real-time the bodaboda rider movement to the customer’s premises*”.

The study participants had positive feedback on the success of using the GPS to facilitate their m-commerce transactions while using their mobile GPS application. The research study tested the use of the GPS geolocation using desktop applications.

4.3 Using IP Based Geolocation

Grounded on the study results, geolocation is a viable and versatile solution to facilitate last mile on-demand deliveries. It eliminates the problems encountered by the couriers during the m-commerce deliveries by offering an alternative to physical addressing systems. The study third objective was to compare mobile GPS based geolocation with desktop computer IP based geolocation as an alternative to physical addressing systems in facilitating the last mile mobile commerce on-demand deliveries. The goal of doing this comparison is because GPS based geolocation is normally accurate while IP based geolocation of most of the desktop devices is mostly an approximation location of the host and it is depending on which database is being used. The accuracy for IP based geolocation for a particular location in a city range between from 50% to 75% [24].

Using the experimental design, the study designed and implemented by integrating geolocation capabilities to a food delivery e-commerce application. The geolocation capabilities were supported by use of the Google Maps API. The application had the capabilities to automatically and dynamically generate users’ physical address and multi-device compatibility. The application was expected to work on both the desktop and mobile devices. The Google Maps API proved invaluable to the application as it was used in the translation of customer location information into address information through reverse geocoding as well as distance and route calculations through the Google Maps API distance and route services respectively. The e-commerce application required constant internet connection and the users’ devices had to have location services enabled.

4.4 Comparing Mobile GPS Geolocation to the IP Based Geolocation

To compare the accuracy of the two geolocation services, a total of 80 online transactions were carried out using the study’s e-commerce application. Forty transactions were completed using mobile device while the other forty transactions were placed at the exact same location using desktop device. A predetermined address within the location provided the control data which was used to evaluate the accuracy of the address generated. The desktop device shared location information through IP geolocation and the mobile device shared location information through GPS geolocation.

The geolocation address generated by the two distinct devices was then compared to the predetermined control addresses to determine their accuracy. Identification of the customer location was considered to be accurate when the physical location address was the same as the application generated location. The distance between the two points was recorded as the distance offset.

The results showed that only 45% of the IP Geolocation generated location addresses were within ten meters of the physical location, while 25% of the IP generated addresses were more than one kilometer away from the actual physical location. Results for the orders placed using mobile GPS, 92.5% of the geolocation addresses generated were within ten meters of the physical location, while 5% of the generated addresses were more than one fifty meters away from the actual physical location.

5 Discussions and Conclusions

Today's m-commerce shoppers expect more from their package delivery experience. For there to be successful adoption of mobile commerce in Kenya, reliable, timely and cost-effective delivery of any m-commerce purchases is paramount. Studies have suggested that reliable, safe and timely delivery is important to online buyers [25–27]. A study by the European Commission [28] indicates that problems associated with the delivery services prevent people from buying online. The study participating retailers stated that, in the past, they have relied on phone conversations to make their deliveries. The retailers' motorbike couriers are usually paid per the number of kilometers to and from the customer's premises. This has always resulted in increased delivery complexities and costs if the courier is not able to find the customer's residence. The GPS tracking application introduced to the retailers and their customers in the study facilitated accurate and efficient LPG home deliveries. This resulted in greater m-commerce transactions user satisfaction. In many developing countries, lack of a National Addressing System to provide properly registered physical identity of residential and business premises, roads and streets and postal regions acts as a barrier to adoption of m-commerce. From the study, use of GPS tracking application eliminated the problem by helping in the identification of the desired delivery location. Therefore, integrating GPS platforms in the m-commerce applications could enhance successful delivery of customers' items to their premises and hence improve the uptake of m-commerce in developing countries. The experiment helps to make a case for GPS integration into the m-commerce delivery processes. The customer location data could also be used for other m-commerce strategies in today's age of the big data. The study also shows that there are opportunities to leverage the GPS to facilitate m-commerce where there are no defined physical addresses.

There are security issues [29], privacy risks [30] and ethical concerns [31] linked to the use of the GPS Tracking Applications. However, most manufacturers of GPS systems are employing encryption technologies to make GPS tracking safer. For successful m-commerce adoption, [32] strongly suggest that businesses should address the users' security and privacy concerns. As opposed to trust which has a direct positive

effect on intention to use m-commerce, perceived risk has a negative effect [33]. Over the years, the retailers seemed to have built a strong business relationship with their customers. This made it possible for the customers to trust the retailers and to participate in the study. During the entire study period, the participants were willing to share their location information using the open source GPS tracking application. Therefore, measures had to be taken to protect the participants' privacy. This was achieved by ensuring that the study team adhered to research ethics and regulations provided by the study team's University. Other measures taken included limiting data access to only appropriate parties and offering digital literacy skills on responsible use of GPS, cyber-safety, and cyber-ethics.

The study wanted to find out the impact of lack of physical addressing systems on the last mile m-commerce on-demand deliveries. Park and Regan [34] indicate that one significant factor that draws customers towards online shopping is the ability to shop online and have goods delivered to their door step. The study results indicate that lack of physical addressing system negatively impacts the development of m-commerce in Kenya. Online shoppers expect timely and reliable deliveries [25]. The study established that without a well-defined method of identifying the m-commerce customer's location, the time taken to deliver an item is increased. This results in high costs and unpredictability in the last mile delivery services. The study participants associated these challenges with the lack of a physical addressing system for their neighborhood.

The study shows that GPS based geolocation could be used as an alternative to physical addressing systems in facilitating the last mile mobile commerce on-demand deliveries in Kenya. Suggestions have been made by the Communication Authority of Kenya [35], that considerations should be given to the use of mobile devices, and specifically the GPS technology to form the basis of an address system. The study affirms this suggestion and posits that GPS should be used as an alternative to the physical address system. From the study, the results have shown that GPS applications can be used to accurately detect a customer's location and to generate the customer's address. The GPS based geolocation produced more accurate and consistent customer location address compared to the IP based geolocation. This suggests that there is a need for the developers of desktop hardware to consider integrating the GPS hardware in the desktop devices for the platforms to offer better geolocation services.

Even though the study sites represent classical urban areas in developing and the experiment was successfully conducted, the study has some limitations. One limitation of this study is the comparatively small number of retailers and customers used in the study investigation. The second limitation is the use of an open-source GPS tracking application whose parameters the study did not have the power to contextualize.

To establish the trustworthiness of this study's results, respondent validation was done using a retailer and a consumer from each of the three study sites for member checking [36] as recommended when doing qualitative studies.

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