The Operational Problems of Cash Transfers in Kenya

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Executive Summary

In 2005, Safaricom, the leading Kenyan mobile network operator, launched a mobile phone-based payment service called M-PESA. Utilizing simple SMS technology on Safaricom's data network, M-PESA is cheaper, faster and more secure than the previously existing alternatives. Based on an already existing mobile network, M-PESA grew rapidly to register almost 6 million users by March 2009, with an average of 7 million transfers per month. By comparison, the country's formal banks only have 750 banking outlets and 3,000,000 bank accounts countrywide. For a country with limited access to electronic banking and extensive need for cash transfers from urban to rural, M-PESA has filled a great need and greatly reduced the costs and risks of money transfers for ordinary Kenyans. M-PESA's chief contribution is to reduce the problem of cash management for ordinary Kenyans. However, as this paper demonstrates, the problem has been shifted onto third-party agents. While this is a more efficient solution than what previously existed, it is still sub-optimal. Rural agents in particular are forced to go to the bank to restock cash far too frequently. Using the Economic Order Quantity (EOQ) model, this paper suggests three solutions that would better optimize M-PESA cash management. The first is for Safaricom to loan agents money so they can operate more efficiently. The second is to reduce the costs and risk of refilling inventory. Finally, the third is to look for partnerships with companies that have to bring cash from the rural areas back to the city, contracting with them to deliver excess cash from their retail points to M-PESA agents who need cash in exchange for virtual transfers plus additional incentives. Coca-Cola is the obvious candidate for this third solution, since they have a well-established distribution network in rural Kenya. In sum, although M-PESA has greatly improved payment and cash transfers in Kenya, it has not eliminated the fundamental problem of managing and transferring cash inventory from places that have surplus to places with deficit.

Introduction

For years, Timothy Arunga would diligently make the trip from Nairobi Kenya to his parents' home near the border with Uganda. His trips served an important economic function: bringing money home to his family. As a reporter for a major paper in Kenya, Arunga's salary generated cash for his family that their primarily livestock-based livelihood could not match. Sending money was an economic necessity. The difficulty was that the trips were long and difficult and there were few good options for sending the money home. Although Arunga had a bank account, his parents did not, and in fact there was no bank branch within miles of their home. He could send the money through a bus operator, or a friend, but this was risky and Arunga had lost money through both channels in the past. The only reliable option was Western Union, but the fees were too high to justify Arunga was the ideal customer for a mobile phone cash transaction service like M-PESA.

Access to financial services

Access to credit, savings and electronic transaction services is taken for granted by many, but in developing countries, only small minorities enjoy these services (Exhibit 1). In Kenya, only 27% of the adult population participates in the formal banking system.[1] Some people simply see little utility to banking. However, for many others, they cannot access banking services because banks are too far away or because bank fees are too expensive. Operating a bank is expensive in any context, but particularly in a developing country like Kenya, where the risk is often higher. Not having access to formal banking means that people cannot access financial credit and are vulnerable to risk.[2] [3]In the Kenyan context, access to financial services is highly variable by region of the country (Exhibit 2). In the capital Nairobi, access is close to 50%, while in western Kenya, it's less than 15%. These measures include both formal banks and savings and credit co-operatives (Saccos).

[1] finaccess, 2009
[2] The World Bank, 2007, *Finance for All? Polices and Pitfalls in Expanding Access*
[3] Stijn Claessens, 2006

Cash transfers in Kenya

Kenya's urban population is about 6 million, out of a total of around 34 million. Most of those in rural areas depend on agriculture for their livelihood, while in the city people work in a modern service-based economy. Migrant workers in particular maintain strong ties to their rural homes, including regular visits and remittances.[4] As a result, cash transfers are a significant part of the Kenyan economy. According to one survey, 33% of respondents had sent or received money from persons within Kenya in the past 12 months.[5] Most commonly this is from urban workers to their families in the rural areas. Since most of this money is sent informally, there are no good estimates of the amount of cash transferred within the country, but it is certainly substantial. In addition, 3.5% of survey respondents had received money from Kenyans working overseas[6], worth a total of $1.3 billion in 2007, equivalent to 4.4% of total GDP.[7]

Before M-PESA, money was already transferred within Kenya. Since this was typically done through informal channels, it is difficult to compare whether transfers have increased since M-PESA began. However, it is certain that the costs of these transfers have decreased substantially. As Exhibit 3, 4 and 5 show,[8] the various transaction methods before M-PESA all had major problems. The most commonly used, sending money through a friend, had no set cost, but it was very risky, as the money often did not make it to its destination.[9] Another popular method for sending money was via bus companies or group taxis known as matatus. However, this method was also seen as risky, particularly for larger sums. The post office offered money transfer services, but service was slow and unreliable. Bank transfers were limited to those who had bank accounts and were generally confined to urban areas. The fees were too high for low and middle income users. Finally, Western Union offered a reliable service, but transaction

[4] Morawczynski, 2008
5 finaccess, 2009
[6] Ibid.
[7] The World Bank, 2007, *2007 Development Indicators*
[8] Safaricom, 2009
[9] finaccess, 2009

costs could be as high as 50% for a small transaction. As a result, money transfers were often delivered personally by the sender. However, in addition to the cost in time and transportation expenses, the method also carried significant risks because of robbery. Thus there were considerable inefficiencies and unmet demand for cash transfer services, particularly for the low-income segment of the population, setting the stage for a breakthrough product.

Mobile Phones

Until recently, access to telephones was even more limited than access to financial services. Even in 2007, there were only 265,000 fixed line phones in the country, or one for every 132 people. However, by this time, over 11 million mobile phones were in use.[10] The rapid spread of mobile phones across developing countries is well-known.[11] Mobile phones have enabled ordinary people in developing countries to keep in touch with family, check on prices at market, arrange transportation and a host of other simple things that could not be done nearly so quickly and cheaply before. The spread of mobile phones has been particularly rapid in sub-Saharan Africa, increasing from 0 mobile subscribers in 1994 to 82 million in 2004, according to one estimate.[12] In Kenya the spread of mobile phones has been even more swift, with 31% of the population owning mobile phones in 2007, and many more having access to them through friends and family.

The spread of mobile phones in Kenya and elsewhere in Africa has been a triumph of the private sector. In contrast to the state-owned fixed line telecom company Telkom, whose infrastructure is limited and who service is generally poor, companies like Safaricom and Zain have rapidly developed effective infrastructure and services nationwide (Exhibit 6).[13] This infrastructure includes not only signal towers, but also a network of agents and vendors to sell mobile phone products. Indeed, it is difficult to go

[10] Ibid.
[11] The Economist, 2008
[12] Mbarika & Mbarika, 2006. This estimate excludes South Africa.
[13] Data for Figure 4 from WCIS Insight: Global Mobile Market Outlook 2009, quoted by Safaricom.

anywhere in Kenya without seeing advertisements for Safaricom and its competitors, as well as small shops selling air time. In contrast to banks, post offices and even roads, mobile phones are everywhere in Kenya, including the rural countryside and impoverished areas. As a result, this infrastructure can serve as a foundation for the developing of banking, even without traditional banks.

M-PESA Origin and Growth

In 2005, Safaricom, with backing from its parent company Vodafone, launched a pilot mobile-based payment service in Kenya. With no joining fee, monthly charge or minimum balance required, the 'pay as you go' service required significant upfront investment. Vodafone was successful in winning funds from the Financial Deepening Challenge Fund competition established by the UK Department for International Development (DFID) to encourage private sector investment in extending access to financial services in developing countries.[14] DFID's £1 million investment matched Vodafone's investment and spurred the start of M-PESA. After a successful pilot, the full commercial product was launched in March 2007.

Since its launch, M-PESA has experienced remarkable growth. According to Safaricom, it had almost 6 million registered users by March 2009 and monthly transactions of over 14.5 billion Kenyan shillings (roughly $180 million dollars) (Exhibits 7, 8 and 9).[15] Given the fact that most transactions are between low-income Kenyans transferring an average of 2000 Ksh ($25) per transaction, this translates to about 7 million transactions per month, or more than 1 per registered user. Furthermore, the number of agent outlets increased to more than 7,500 by March 2009, a network that spanned the entire country. By comparison, the country's formal banks only have 750 banking outlets and 3,000,000 bank accounts between them countrywide.

M-PESA's Operating System

[14] Department for International Development, 2008
[15] Safaricom, 2009

M-PESA's tremendous growth has been facilitated by the mobile phone network already developed by Safaricom in Kenya. Phone distribution was already widespread, the data network already functioned well, the SMS technology was already established, and a network of already existing Safaricom vendors was in place. As a result, the operating system is very simple. Safaricom developed a software application that uses SMS technology to transfer secure funds from phone to phone. M-PESA users must first register with an agent, who installs the application on the SIM card of the phone and creates an electronic account linked to the phone number. Users can then deposit money (or "pesa" in Swahili) with an agent, so the money is credited to their phone account. This money can then be used to purchase airtime or to transfer to another mobile phone. When money is transferred using M-PESA, an SMS is sent to the recipient. The recipient can add this to their M-PESA balance, or redeem it at an agent outlet by showing photo identification (Exhibit 10).

Agents are independent businesses licensed by Safaricom to act as M-PESA agents. Many are small mobile phone shops that sell phones, Safaricom airtime and M-PESA. When M-PESA was first launched, Safaricom utilized its already existing network of vendors. Since that time, the number of agents has expanded to other retail businesses. Safaricom has a formal application process for agents, whereby they verify that they meet Safaricom's size, cash float, permit and technology requirements.[16] Safaricom's principal concern is that agents will have enough cash to meet customer demand and will serve as reputable Safaricom representatives.

Impact of M-PESA

The rapid growth of M-PESA is evidence of its utility in the Kenyan context. The primary use for M-PESA has been for transfers between family members and friends. M-PESA transfers are faster, cheaper and more secure than any previously available method. A common practice is to deposit cash through M-

[16] M-PESA, "M-PESA agents," *Safaricom*, 1 1, 2009, http://www.safaricom.co.ke/index.php?id=28 (accessed 3 19, 2009).

PESA before travelling, and then withdrawing the cash upon arrival.[17] This is less risky than carrying cash, since the M-PESA cash cannot be withdrawn by anyone but the phone owner. M-PESA also makes ordinary transactions much easier. Trucking companies have begun using M-PESA to transfer money to drivers who need cash for repairs or for refueling. Since these transfers are almost instantaneous, considerable lag time is avoided.

It is too early to evaluate whether M-PESA has also helped extend financial access to low-income Kenyans. Although mobile phone usage is more widespread than access to banks, usage is heavily concentrated within people who already participate in the formal banking system.[18] As of 2006, according to the FinAcess survey, only 20% of unbanked people owned a mobile phone. However, it should be noted that mobile phone access has since expanded, and many people who do not own a phone have access to one through friends or family. Nevertheless, M-PESA's primary impact has been to make the current money transfer system more efficient.

Key Operations Problem: Cash Flow to Rural Areas

M-PESA has greatly eased the ability of Kenyans to transfer money, most significantly from urban areas to rural areas. However, the recipients of M-PESA transfers still have need for real, paper money. This is particularly true in the Kenyan context where limited formal bank access means that most economic transactions require cash. The recipients of the transfers must go to an M-PESA agent to get their cash. M-PESA has made the transfer of ownership of money much cleaner, faster and more secure, but the actual cash itself still must be moved. Before M-PESA the risks and costs of moving money to rural areas were bourn by the owners of the money. They had to pay for the cost of delivery whether it be through their time, paying for a courier, or sending the funds by Western Union. They also had to bear the risks of

[17] Kisimir, 2009
[18] finaccess, 2009.

loss or theft in the transfer of the paper bills. Since the virtual cash transfer in M-PESA does not in itself move the paper money, this responsibility has shifted to the M-PESA's agents.

Theoretically this should not be a problem. Individuals must meet a set of requirements in order for M-PESA to have them as agents. These include a proven amount of cash available in potential agents' bank accounts, retaining an e-money float (money in agents' bank accounts) of Kshs 100,000-200,000, and an unspecified cash float (paper money on hand).[19] [20] Additionally, they might not have to move cash at all since they already run businesses that deal in cash. The M-PESA website suggests that agents should not have to increase the stock cash that they hold.[21]

However, maintaining an adequate amount of cash float is a significant problem for agents and their employees. For many agents, the amount of cash that they used for their other business does not sufficiently cover the demands for withdrawals from M-PESA. Rural agents now "face a preponderance of cash withdrawals and are located farther away from bank branches" than urban agents.[22] By allowing people to securely transfer ownership of money cheaply and quickly from urban areas to rural areas, M-PESA has increased the demand for paper money in the countryside.[23] Though M-PESA agents manage cash businesses, the increase in demand for cash by M-PESA customers frequently overwhelms the stocks that agents keep on hand.

The agents now must pay for the time, travel and security costs of acquiring and moving paper bills. One agent in western Kenya complained about these issues,

[19] M-PESA. (2009, 1 1). *M-PESA agents.* Retrieved 3 19, 2009, from Safaricom: http://www.safaricom.co.ke/index.php?id=28
[20] Consultative Group to Assist the Poor, 2009
[21] M-Pesa. (2009, 1 1). *M-PESA agents*. Retrieved 3 19, 2009, from Safaricom: http://www.safaricom.co.ke/index.php?id=763
[22] Consultative Group to Assist the Poor, 2009
[23] Ibid.

> "Almost every day I ride my bicycle to Kakamega to top-up my float. This takes me almost three hours. I have to leave at 6am because I want to be there when the bank opens. I must then come back again and serve my customers."[24]

The agent added that there were no other ways to make the trip and that he could not afford the price of the shared taxi.[25] For at least one agent, being able to securely move cash is her primary problem.[26] These problems with the movement of cash can cause M-PESA to be unprofitable for rural agents.[27] The difficulties that M-PESA removed from average people trying to move money to rural areas have been shifted to rural agents. While this is an improvement on the old system, it fails to remove the problem entirely. If M-PESA can effectively address this problem, M-PESA will be able to improve its overall service.

The Economic Order Quantity Model

Economic order quantity (EOQ) models are used to improve inventory systems. These models address situations where orders to replenish inventories are based on an event, not on time. Usually, the event in question is a specific quantity of inventory. As a business operates, inventory is used up. In an EOQ system, an order is placed when inventories are reduced to a certain level by the operations of the business.

The basic EOQ model is set up as an equation that defines the total costs of the inventory. This equation leads to two formulas that define the optimal level of inventory to order as well as the quantity of inventory that should trigger a new order. Total costs in this model are defined by the annual demand for the inventory (D), the price per unit of the inventory (P), the quantity that is ordered (Q), fixed costs of placing an order (C), and the holding and storage costs of the inventory (H). The EOQ model defines the total costs (TC) of inventory as:

[24] Rosenberg, 2008
[25] Ibid
[26] Muthoni, 2009
[27] Consultative Group to Assist the Poor, 2009

$$TC = PD + \frac{CD}{Q} + \frac{HQ}{2}$$

The minimum total costs are found by taking the derivative. Doing this reveals an optimal quantity (Q^*) that produces the lowest total costs and is defined by this formula:

$$Q^* = \sqrt{\frac{2CD}{H}}$$

Additionally, assuming that demand does not change dramatically day-to-day, the daily demand (d) and the lead-time in days that it takes to place a new order (L) can define the quantity at which more inventory should be ordered (R):

$$R = dL$$

For inventory systems that re-order inventory based upon a specific level of inventory on hand, the basic EOQ model can provide a good idea of most cost reducing amount of inventory that should be ordered at a time as well as the quantity of inventory on hand that defines when a new order is placed.

Application of the EOQ Model to M-PESA

In order to understand how the basic EOQ model can be applied to M-PESA, it will be useful to describe how a rural agent currently gets the cash to serve his or her customers. This process is illustrated in exhibit 11. The rural agent conducts the other parts of his or her business receiving cash from customers and paying cash out to the suppliers. M-PESA customers might deposit some cash but the majority of the agent's business with them is withdrawals. The withdrawals overwhelm the amount of cash that the agent

has on hand. Once the cash float reaches a specific level, the agent must go to the bank to withdraw money from his or her e-money float and bring that cash back to the place of business. As described above, the transfer of cash is costly in terms of time spent and transportation costs as well as the risks associated with carrying large sums of money. When the agent returns, he or she continues to conduct business, but must also face costs and risks associated with having additional cash on had in order to supply M-PESA withdrawals. The system associated with cash for agents is quite simple in that paper money leaves the agent through withdrawals until the agent replenishes the cash float by way of a trip to the bank.

In many ways, the system used by M-PESA agents to retain their cash float is similar to the EOQ inventories. For an M-PESA agent, the inventory in question is the physical cash that is reduced through withdrawals. Demand for cash (D) from the agent can be defined by the amount of cash coming in from customers minus the amount that is taken out from M-PESA withdrawals and payments to suppliers. Unlike most businesses that receive more cash than they send out, rural M-PESA agents will experience demand for cash from their customers. The price per unit of inventory (P) is simply one because the price of Ksh 1 is simply Ksh 1. Since the inventory in this case is paper money, the price of one unit is just Ksh 1. The costs of travel and time as well as the risks associated with going to the bank to get the cash make up the fixed costs of placing an order (C). The costs of having the money at the place of business, in terms of space, security, and opportunity costs, make up the holding costs of inventory (H). The cash management problem that rural M-PESA agents have can be described using a simple EOQ model.

Exhibit 12 shows the estimates for the amount of cash that rural agents should get on each trip to the bank, the quantity of cash in inventory that should trigger an order, and the number of days between cash orders. Yearly demand per agent was calculated using estimates about the amount of cash withdrawn in

rural areas, which was based on M-PESA's September 2008 transfers.[28] Additionally, demand per agent was calculated across 7,000 M-PESA agents .[29] A 15% holding cost was assumed based upon Kenyan bank interests rates and inflation rates as well as security risks associated with holding cash. The range of fixed costs was based on the low and high costs for going to banks reported by agents .[30] The exhibit illustrates that as the costs of going to the bank increase the optimal amount that the agent should withdraw increases. The quantity that defines when the next order should be placed does not change because it is independent of the fixed costs. For rural agents who face particularly high costs in going to the bank, the length of time between trips is longer. This makes sense because the costs to the agent are on a per trip basis. Due to the lack of good information concerning M-PESA rural withdrawals and security risks in Kenya, the estimates presented are far from perfect. However, they present a suggestion of how M-PESA agents might optimally order their cash.

Potential Solutions to the Cash Flow Problem

Safaricom seems to be aware of the cash flow problems and is apparently working on a solution.[31] Several potential solutions exist to M-PESA agents' cash flow problem. Two use the EOQ model as a basis for limiting the costs to agents. The motivation behind these suggestions is that the entire cash flow system might not need be changed. Perhaps only small changes by way of M-PESA supplementing agents' e-money floats or finding ways to reduce fixed and holding costs for agents could address the operational issue. Other solutions present more drastic change. M-PESA might take the responsibility for all of the physical cash flows. The firm may do this by developing an effective multi-echelon inventory system and take control of delivering money to its agents. The last potential solution seeks to limit the movement of paper money by finding M-PESA a partner that has the opposite problem form the agents: the problem of moving cash from the countryside to urban areas. This solution will be referred to as the Coca-Cola

[28] Consultative Group to Assist the Poor, 2009
[29] Mwangi, 2009
[30] Consultative Group to Assist the Poor, 2007
[31] Consultative Group to Assist the Poor, 2007

Solution because that company could potentially be M-PESA's partner in this scheme. Addressing this cash flow problem would improve M-PESA's financial system as well as provide a model for other rural banking systems.

EOQ: M-PESA Supplements to Agents Bank Accounts

The EOQ model demonstrates a clear way for agents to determine how much cash to withdraw from the bank in order to minimize their costs. If agents are able to determine their fixed and holding costs, the lead-time needed to get the cash and their cash demand from customers, then they can determine the optimal level of cash to withdraw. Based on these calculations, agents are currently not taking out enough cash to minimize their trips to the bank. Some agents report that they must go to the banks daily.[32] [33] According to the estimations in exhibit 12, agents with very high fixed costs should only be going to the bank every two weeks. Those with lower costs should make the trip weekly.

The likely reason for this is that agents do not have enough money available in their accounts to withdraw the optimal amount of cash. The EOQ model shows the amount that should be taken out by the agent, whether or not it is actually available to the agent. Agents must make the frequent trips to the bank because the cash must be available to M-PESA customers. When a customer comes to the agent for a withdrawal, the funds that the customer wishes to withdraw are taken out of his or her virtual account and moved into the agent's e-money float. This is the customer's payment for the cash that he or she is receiving. However, the order of this transaction means that the agent must have the cash on hand when the customer comes for a withdrawal. The agent must have already removed those cash funds from the bank where the e-money float resides. The agent must take cash out of the bank and then wait for customers' withdrawals to replenish it virtually. The cash that the agent can remove from the bank is

[32] Consultative Group to Assist the Poor, 2009
[33] Muthoni, 2009

limited by withdrawals of earlier M-PESA clients. Agents are unable to withdraw the adequate level of cash because not enough is available in their accounts.

The simplest manner in which this problem might be resolved is by Safaricom supplementing agents' e-money floats. The cash process flow for this type of solution is illustrated in exhibit 13. This system would work through Safaricom loaning enough money to agents' e-money floats so that they could withdraw the optimal amount of cash as determined by each agent's EOQ model for his or her business. This would reduce the costs for agents and reduce situations where M-PESA clients must go to several agents in order to withdraw cash.[34] While in the earlier system, clients' cash withdrawals were matched by virtual transfers to agents' accounts, in this system, as clients withdraw cash from the M-PESA agent, the funds go to repay the e-money supplement. This system shifts the repayment of the cash withdrawal away from the agents with their limited resources to M-PESA with much greater reserves.

A possible objection to this type of system is that the money will be less secure. Safaricom will have to supply a considerable amount of funds to its agents. Though the system will not change drastically, M-PESA is open to greater risks. More of the money in M-PESA will be turned into cash in the hands of agents, which is much less secure.

Safaricom does seem to be willing to attempt such a model. They currently employ Super Agents who are able to transfer virtual and physical cash.[35] This option might partially address the issue of limited funds in agents' e-money floats. However, for agents to fully utilize the optimal solution from the EOQ model, their accounts must be supplemented to the degree that they can withdraw the full amount of cash. If M-PESA is willing to make this type of cash commitment to its agents, then costs for the agents will be reduced and clients will be served more smoothly.

[34] Mwangi, 2009
[35] Muthoni, 2009

EOQ: M-PESA Reducing the Costs of M-PESA Cash Flow

A significant weakness of the EOQ model is that the process of using the model often treats the costs as unchangeable. The fixed and holding costs are simply used in order to find the optimal quantity to order. This is a very limiting way to use the model. Attempts should always be made to reduce costs.

Attention to the costs associated with the EOQ model is very important to M-PESA agents. Reducing the costs will improve the profitability of being an M-PESA agent. Under the current system, many agents complain that a variety of costs, but especially those associated with getting cash, severely cut into the money that might be made as an M-PESA agent.[36] Additionally, being an M-PESA agent does not supplement the rest of the business as much as many agents believed that it would.[37] The EOQ optimization minimizes total costs principally by decreasing the frequency with which the fixed costs mush be borne and optimizing them in relation to the holding costs. Fixed cost reductions would also reduce the amount of cash that must be withdrawn by agents on each visit to the bank. This is another way of addressing the limited funds available to agents in their e-money floats. If fixed costs are reduced, agents will be more able to take out the optimal level of cash. Safaricom could help reduce costs by paying for agents' travel expenses insuring agents' cash against the loss or theft or by providing agents with safes or other security devices. These suggests could all reduce the costs on agents and further ease the transfer of paper money from urban areas to rural.

A problem with the cost reduction solution is that the costs are really just transferred from the agents to Safaricom. The costs are currently all borne by the agents and the firm does not need to worry about them too much. But agents are crucial to the M-PESA system and it is the rural agents that provide the most significant of M-PESA's services. The mobile phone allows people to connect to a virtual banking

[36] Rosenberg, 2008
[37] Muthoni, 2009

system, but it is the agents that give the system it strength by giving rural people a place to deposit and withdraw cash. In the long-run, agents may abandon M-PESA if they are not able to turn a profit by being part of the system. The best way for Safaricom to retain its agents within an EOQ system is to reduce their costs of acquiring and holding cash.

Multi-Echelon Inventory and the Traveling Salesman

To this point in the analysis, the EOQ model has continued to be the system that M-PESA agents would use in order to get cash. However, it is possible that the system and the model that it represents are not the right ones for physical cash transfers from cities to the countryside. Perhaps, the agents are the wrong members of the M-PESA system to be deciding how paper bills are moved. It was shown above that agents are only aware of the demand for cash when client come to their business to make withdrawals. Other parts of the M-PESA system are already aware the money has changed ownership in a transfer from city to country. This knowledge could help predict what the demand for cash in rural areas would be and when the cash would be needed.

A possible solution to agent's cash flow problem is to give the responsibility of cash movement to the larger organization of Safaricom. The firm might be able to do this through holding cash in a multi-echelon inventory system and delivering cash to agents. The cash process flow for this type system is demonstrated in exhibit 14. Safaricom would have to create a system of cash inventories throughout M-PESA's areas of operation. The inventory spaces might be new centers built by Safaricom or could be banks with which the firm already has relationships. Agents also might be able to serves as inventory points for cash in the wider system. In addition to the creation of an inventory system, Safaricom would have to organize the secure delivery of cash to and between different points in the system. Safaricom has shown evidence that it might support such an idea by the existence of the Super Agents mentioned above. By taking on a multi-echelon inventory system and delivery, Safaricom would greatly increase its liability in moving cash but would probably create a less costly system.

In a couple of ways, the M-PESA organization is well suited for developing such a system. The electronic transfers provide Safaricom with excellent information about where cash is likely to be needed. The inability to anticipate client demand is one of the key and costly weaknesses of agents. Were they able to predict the level of withdrawals, they may be able to plan the use of cash to limit the trips to banks. Safaricom has all of the information about where the money is moving and could strategically move cash to places where more demand is likely. Additionally, since banks are the crucial inventory junctions for agents now, banks may continue to be used with Safaricom in more direct control. The firm would not necessarily want to create new locations to hold cash inventory because M-PESA can transfer virtually from bank to bank without moving paper money. The more that Safaricom can rely on virtual transfers, the cheaper the system will be. In this way, Safaricom can avoid some of the costs of physically moving cash by using the pre-existing banking system. In these ways, the existing systems of M-PESA are would be able to use a multi-echelon inventory to great effect.

Even though this system has considerable benefits and seems well suited to M-PESA business, two weaknesses are apparent. The most prominent is that Safaricom would incur large costs to develop such a system. As mentioned earlier, currently the costs of physical cash transfer is left to agents. Safaricom would have to understand that taking on the costs of such a system would greatly reduce the overall costs to the system as well as provide clients of M-PESA with better service.

Another weakness is that by taking on the responsibility of delivering the cash, Safaricom would have to embrace the traveling salesman problem. This is the very common operations problem that tries to determine what is the best route for a travelling salesman to take. It seems to be an unsolvable problem, though many algorithms exist that address aspects of the problem. As a company that does not deal with deliveries as such, this problem may cause considerable problems for Safaricom, especially in light of the significant security concerns that persist in Kenya.

The Coca-Cola Solution

The last solution to be examined is the "Coca-Cola solution." This solution is illustrated in exhibit 15. Since M-PESA has drastically increased the demand for cash in rural areas for its agents, the Coca-Cola solution considers whether any firms experience the opposite problem. One such firm is Coca-Cola. Coke delivers product to many rural areas in Kenya and is generally paid in cash for its product. Coke truck drivers must then take the cash out of rural areas to cities to be deposited. Coke has the opposite problem of M-PESA.

The beauty of the Coca-Cola solution is that it eliminates much of the actual movement of physical cash. Imagine two situations: one where the Coke supplier deals with an M-PESA agent whose other business sells Coke and another where the Coke retailer is not an M-PESA agent. In the first situation, the Coke supplier would normally be taking the cash as payment and taking it back to the city. This is unfortunate for the agent because it will mean that he or she must return to the bank more frequently to replenish the cash float. Under the Coca-Cola solution, the Coke supplier would be able to accept payment from the agents e-money float. In this way, the agent would be able to keep the cash and the driver would not have to deal with the security issues of transporting bills to the city.

In the second situation, the rural storeowner pays for the Coke products with cash. The supplier does not however immediately return to the city with the cash. Instead, the Coke supplier takes the paper cash to nearby M-PESA agents who take the paper money and use M-PESA to electronically transfers funds into Coke's accounts. As presented in these possibilities, money would be transferred electronically, but paper money would not have to make the long trek between urban and rural areas.

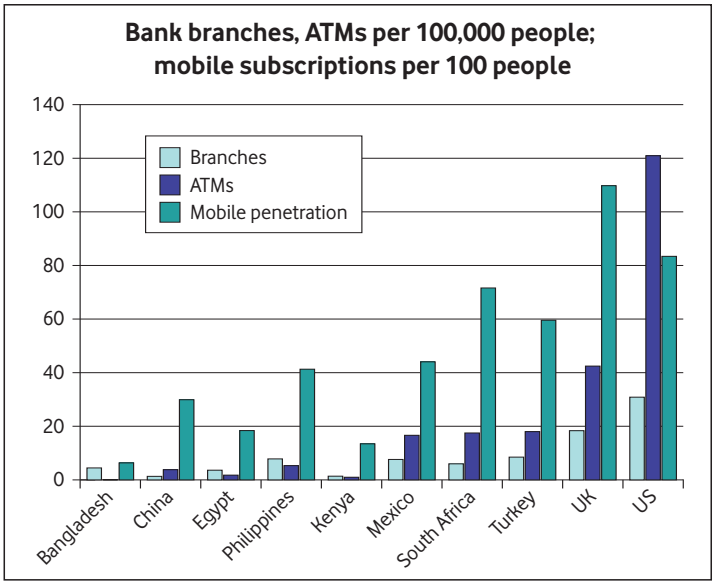
This system matches the incentives of two firms in order to make them both better off. Nonetheless, there are some weaknesses to this system. Even though M-PESA and Coke would both be providing services to

each other, Coke may need to be additionally incentivized to participate. Coke drivers would after all be doing the bulk of the cash moving and may have to go out of their way to deliver money to M-PESA agents. Additionally, it seems that organizing and timing such a system properly would be very difficult. M-PESA may have to develop an intermediate inventory step between Coke supplier and agent in order to centralize the transfer of cash from one firm to the other.

Conclusion

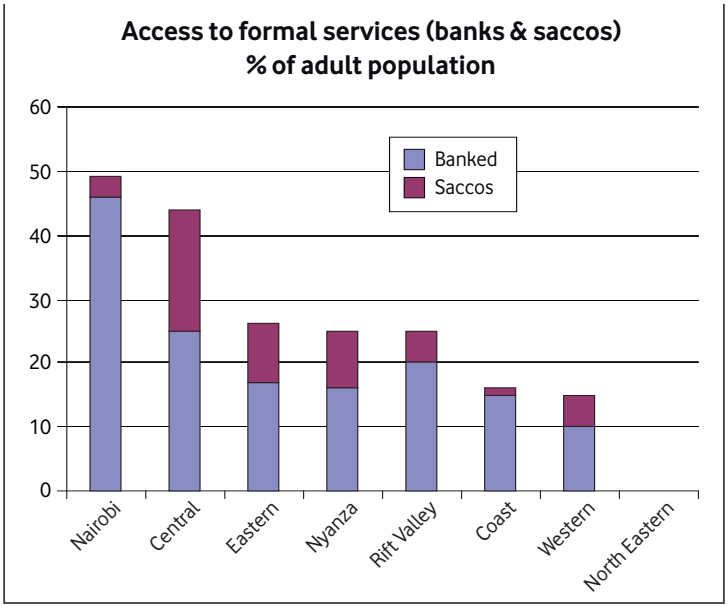
Although M-PESA has greatly improved payment and cash transfers in Kenya, it has not eliminated the fundamental problem of managing and transferring cash inventory from places that have surplus to places with deficit. As M-PESA and other systems like it grow in Kenya and elsewhere in Africa, this fundamental problem will only increase. Since Kenya is still a cash-dominated economy, the M-PESA system depends on agents who can sustainably exchange virtual funds for cash. Given the transportation and security challenges in rural Kenya and elsewhere, it is unclear whether the current system is sustainable. Certainly it can be improved, and this paper has set out a framework for further consideration. More complete data would be needed to determine the best solution and fully optimize the system, but this framework highlights the key factors needed to do so.

Exhibit 1



Source: World Bank

Exhibit 2



Source: FinAccess Survey 2006

Exhibit 3

Means of Transfer	Users	Risks	Problems
Bank transfer	Government departments, companies, NGOs and international agencies, business people	Fraud and forgery	Delays in clearing banker's cheques, long queues, network limitations, insolvency of branches, high cost for non-account holders, insolvency of branches; banks are suspicious of large amounts due to control policies concerning money laundering and terrorist financing
Dedicated money transfer services, e.g. Western Union	Relatives working oversees, parents and guardians	Leakage of password	High costs of service; misspelled names; when there are differences in expected amounts; cash-flow problems of agents; problems with communication or data lines
Postal services	Employees in urban centers, relatives and guardians, parents and students	Theft by staff	Liquidity problems of offices and agencies; reputation as a government facility; unreliable communication network; old equipment and facilities; competition from the private sector; weakness in marketing; poor services; limited amounts that can be transferred through the system
Courier companies	Business people, parents and guardians, students, small-scale traders	Money taken from parcels; highway robberies; misdirected parcels or delays	None reported
Bus companies	Traders, parents, guardians, employees in urban centers,	Loss of money, accidents, misdirected parcels and delays	None reported
Physical transfer	Traders, NGOs, individuals	Highway robberies, accidents and thefts	Time spent in transferring money physically and cost of transport is high; trivial expenditures on unplanned items
Relatives and friends	Individuals, parents, guardians, employees in urban centers	Misuse of money sent by relatives, dishonesty	Delays in sending the money to its destination, diversion of money for personal use
Matatu drivers and bus conductors	Individuals in urban centers, students, traders, workers and employees in urban centers	Highway robbery and thefts	Delays in case of accidents or mechanical problems; diversion of money to self use and repayment in small installments or not at all
Prominent businessmen	Relatives, friends and businesspeople locally and abroad	Transaction not honoured; business contact no longer available (e.g. closed)	Loss on forex rates; delays in receiving money due to cashflow problems

Exhibit 4

Service	Providers	Fees (KShs.)
Formal System	Commercial Banks	**Domestic Transfer** Electronic Funds Transfers (EFTs) 0-500 Telegraphic Transfers (TTs) 0.2%-0.5% or minimum 1,000 and maximum 5,000 Mail Transfers 650 Bank cheques per cheque 600 - 650 (for customers), and 1,250-1,500 (for non-customers) for amounts below 500,000. Beyond 500,000 the charges are a constant 0.3% of the value or 0.3%min Ordinary Cheques 350-370 Direct debit 165-450 **International Transfers** Telegraphic transfers 0 .25%- 0. 3% of value subject minimum of 1200 maximum of 6,500 Traveler's cheques 50 per leaf 1% of value 250 minimum Swift charges 0. 2% - 0.3% of value - min 1,500, max 7,500
	Post Office	Ordinary money order 42 for amounts below 500 And 657 for amounts of 30,000 -35,000 ExpressMoney Order charges are 57 for amounts less than 500 and 662 for amount up to 30,000 POSTA Speed Cash 125 for amounts below 600 and 925 for amounts between 25,001- 30,000.
	Western Union	minimum 1,150 for amounts up to 7,000
	MoneyGram	minimum 924 for amounts up to 7,700
	Tumaleo Dalsan/Kaah	Tumaleo 10% of value Dalsan/Kaah Express commission of 5 to7%
	Forex Bureau	$10 fee
Semi-formal System	Securicor Courier Akamba Bus-Star Scandinavian Matatu SACCOs (e.g. 2NK)	Securicor Courier a minimum of 105 per letter Akamba letters and parcels below 10kg: 100 and 180 respectively BusStar 30 for every Ksh. 1,000 Scandinavian 400 for every Ksh. 10,000 Matatu SACCOs the prices are negotiable but range from Ksh.50 – 100 per Ksh. 1000
Informal System	Individual bus/mini bus conductors Friends and relatives Business people / informal networks (e.g. Hawala) Self	Individual bus/mini bus operators have no system and no standard charges; fees are all negotiable and service based on personal trust/relationship Friends/relatives/businessmen no fee, no standard system; token of appreciation or future reciprocity informal networks typically earn their revenue on forex, some charge additional fees at a low percentage cost Self main cost is transport

Exhibit 5

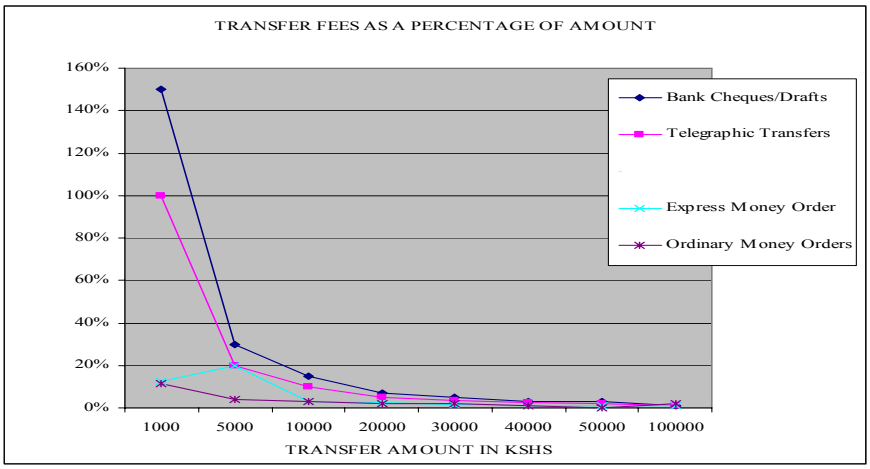


Exhibit 6

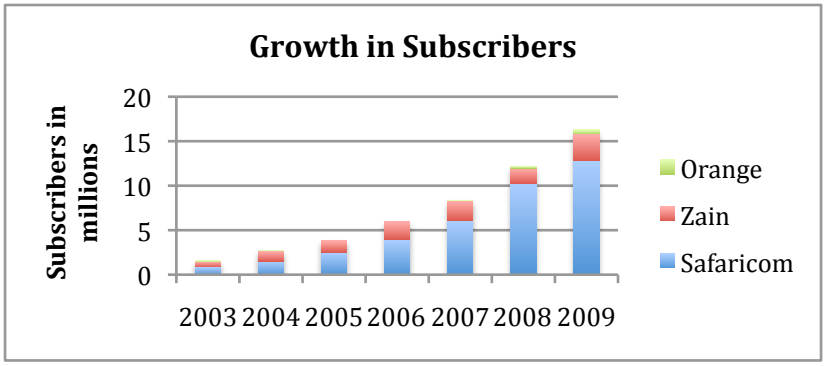


Exhibit 7

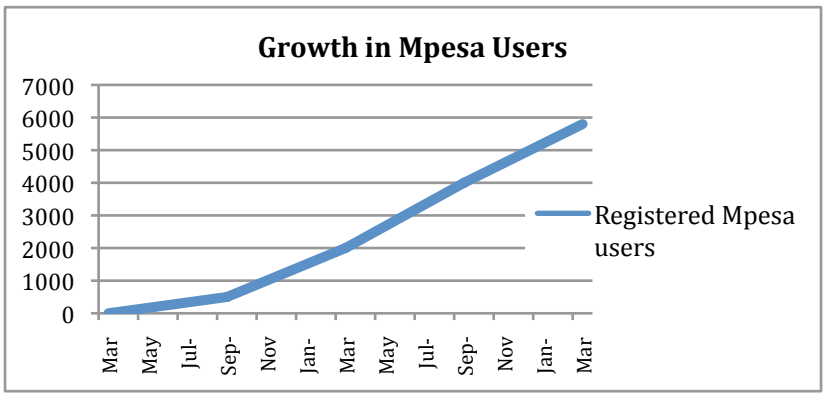


Exhibit 8

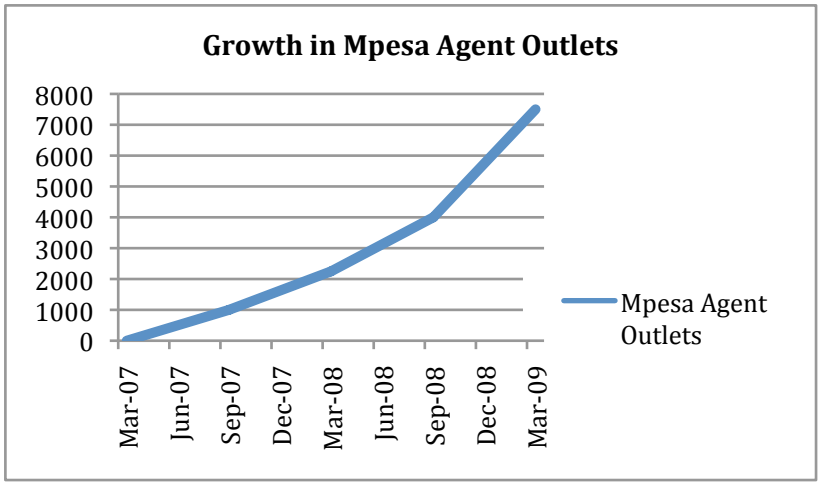


Exhibit 9

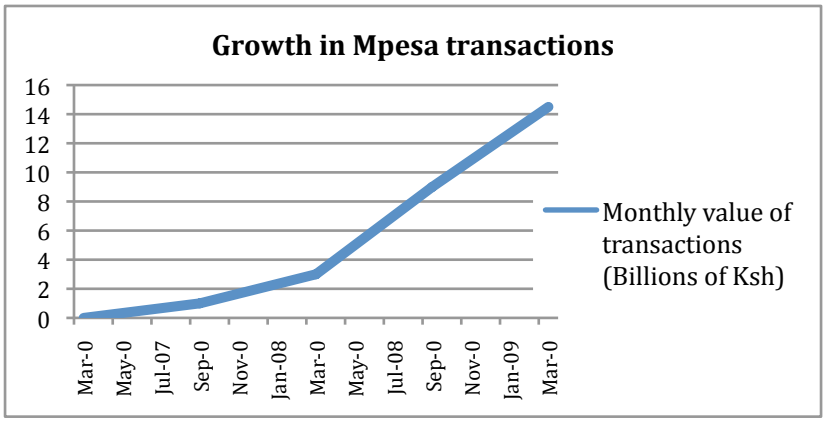
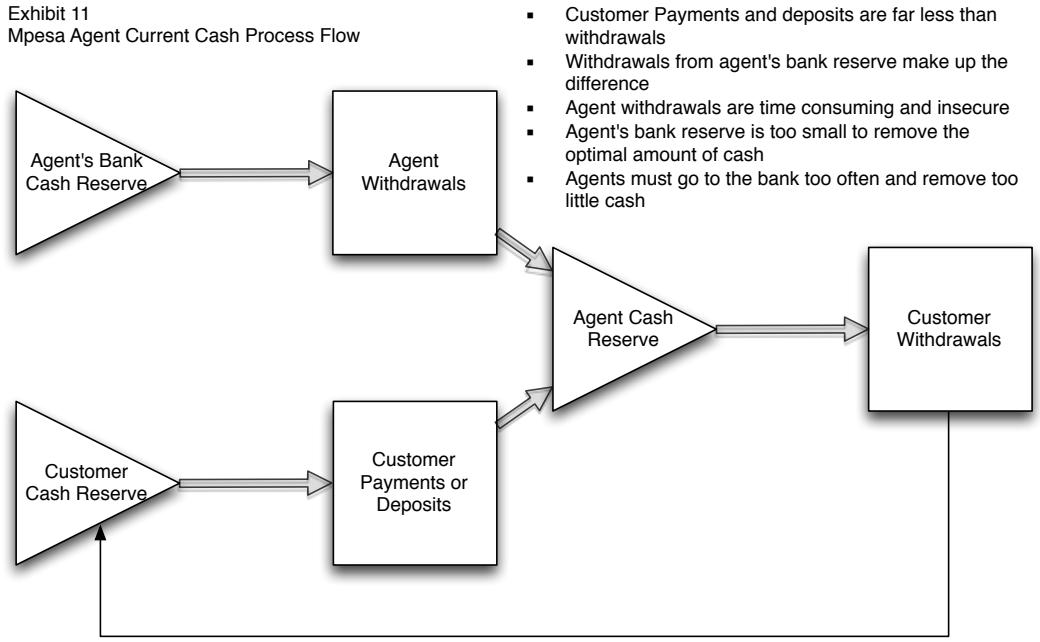


Exhibit 10

Exhibit 11
Mpesa Agent Current Cash Process Flow

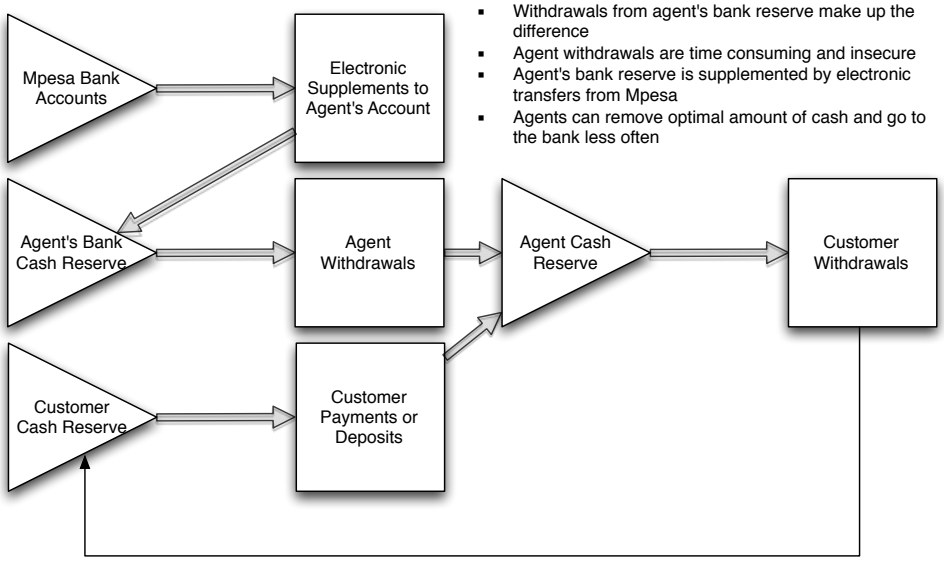


- Customer Payments and deposits are far less than withdrawals
- Withdrawals from agent's bank reserve make up the difference
- Agent withdrawals are time consuming and insecure
- Agent's bank reserve is too small to remove the optimal amount of cash
- Agents must go to the bank too often and remove too little cash

Exhibit 12

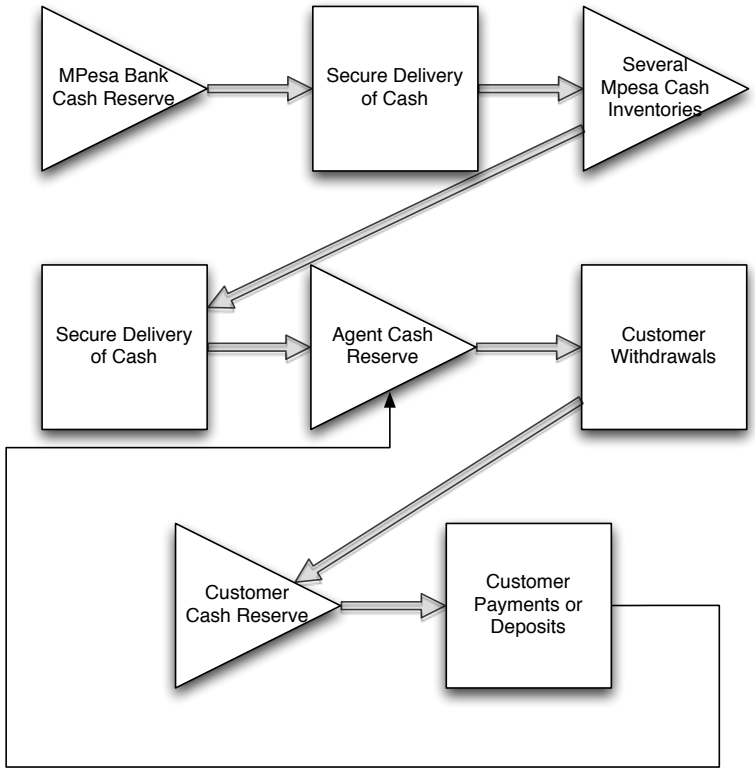
EOQ Optimization values for estimations of fixed costs						
Costs of Going to Get Cash (Ksh)	Optimal Order Amount (Ksh)	Re-order Quantity of Cash (Ksh)	Costs of Going to Get Cash (US$)	Optimal Order Amount (US$)	Re-order Quantity of Cash (US$)	Days Between Orders
100.00	185,040.54	46,904.11	1.19	2,203.83	558.63	6
150.00	226,627.45	46,904.11	1.79	2,699.13	558.63	8
200.00	261,686.84	46,904.11	2.38	3,116.69	558.63	9
250.00	292,574.78	46,904.11	2.98	3,484.57	558.63	10
300.00	320,499.61	46,904.11	3.57	3,817.15	558.63	12
350.00	346,179.14	46,904.11	4.17	4,122.99	558.63	13
400.00	370,081.07	46,904.11	4.76	4,407.67	558.63	14
Assuming 15% holding cost, yearly demand of Ksh 8,560,000 (≈$102,000) and 2 days of lead time to acquire cash						

Exhibit 13:
Mpesa Agent Cash Process Flow with Supplement



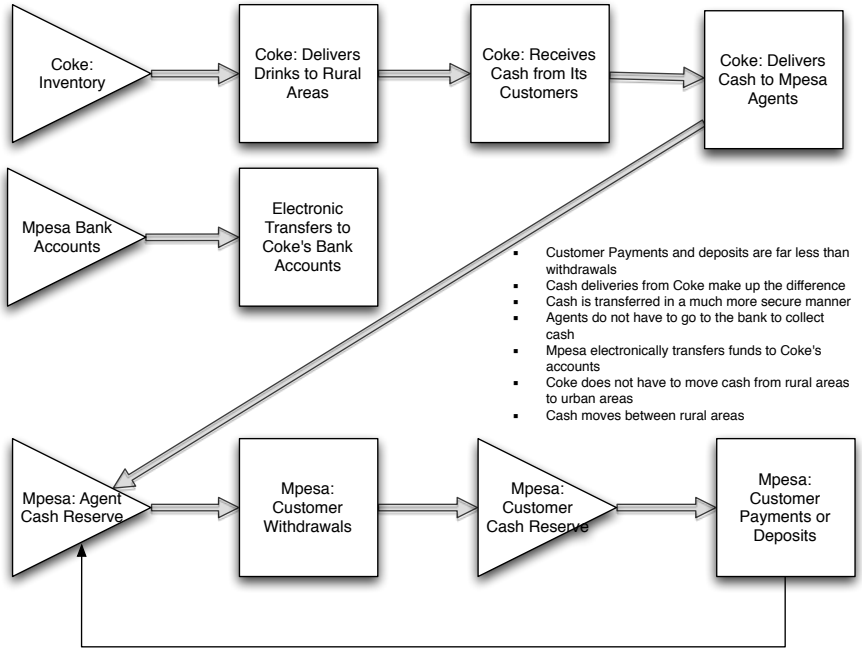
- Customer Payments and deposits are far less than withdrawals
- Withdrawals from agent's bank reserve make up the difference
- Agent withdrawals are time consuming and insecure
- Agent's bank reserve is supplemented by electronic transfers from Mpesa
- Agents can remove optimal amount of cash and go to the bank less often

Exhibit 14:
Mpesa Agent Cash Process Flow with Mpesa Inventory and Delivery



- Customer Payments and deposits are far less than withdrawals
- Cash deliveries from Mpesa make up the difference
- Cash is transferred in a much more secure manner
- Agents do not have to go to the bank to collect cash
- Cash may move between agents or from inventories to agents

Exhibit 15:
Mpesa Agent Cash Process Flow: The Coke Solution



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