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Investigating the Feasibility of Crowdsourcing Current Events Information in Kenya

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ABSTRACT

This thesis explores the viability of crowdsourcing as a method for gathering current events information in Kenya, aiming to address the challenges posed by misinformation and the lack of reliable, local news sources. With a focus on Kenya's unique socio-technological landscape, categorized by high smart phone penetration but limited access to trustworthy traditional media, the research assesses crowdsourcing's potential to provide timely, hyperlocal, and trustworthy information. The study examines factors affecting the feasibility of crowdsourcing, including population density, technological accessibility, intrinsic motivation, and the impact of information. The analysis extends to comparing crowdsourcing's applicability in various geographic settings, emphasizing the contrast between urban, suburban, and rural areas within Kenya and other countries. The findings suggest that secondary cities in Kenya and similar contexts in Africa and Asia present the most favorable conditions for effective crowdsourcing. The study contributes to the understanding of crowdsourcing's role in enhancing information dissemination and combating misinformation, proposing a model for implementing crowdsourced news platforms in regions with high economic need and political fragility. The thesis highlights the importance of tailored approaches to technology deployment in developing countries, advocating for the strategic targeting of secondary cities to maximize the impact of crowdsourced information systems.

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Chapter 1 Background

“Knowledge is power,” is one of the most clichéd and highly referenced quotes of all time [1]. It’s also a quote that resonates in every corner of life. Whether knowledge is a tertiary degree used to receive a high paying job, or the whereabouts of a foreign entities nuclear arsenal used to maintain international peace, knowledge truly is power. For thousands of years, the civilizations and countries that have had the most knowledge have had the advantage. In the earliest days of civilization, battles were won and lost by the speed with which a messenger could report back to the commander about where the enemy was last spotted. As technology enabled the travel of information to increase in both speed and frequency, the world became much more knowledgeable about the events going on around them. Reading the morning newspaper, listening to the radio, or watching television all became consistent streams of timely information. The advent of the internet broke every rule in the book as information could be posted by anyone and seen by everyone who had an interest. A small house fire in Bangalore could be on the phone screen of a complete stranger from Los Angeles before the fire department in Bangalore is even on the scene.

Today, the adage "knowledge is power" holds true as ever, yet the challenge has shifted. In an era overflowing with information, the difficulty lies not in gathering knowledge, but in sourcing information that is hyperlocal, timely, and trustworthy — the kind of information that truly impacts daily lives. Each country has vastly different experiences with the pursuit of knowledge and each country’s unique information landscape sets the scene for varied impacts by misinformation. Kenya is an example of a country that faces serious concerns with everyday

misinformation. Kenya is the geographic focus of this thesis and a place with great global importance. Along with understanding the context of Kenya, it is also important to understand misinformation, where it manifests, and how harmful it can be. Only then can the necessity of crowdsourcing be realized.

1.1. Kenya and its Oppression

The development of each country around the globe has impacted the way that information travels and is shared. Kenya is an interesting example of a country that leap frogged the world technologically after its severe oppression by the British empire.

Kenya is a medium-sized country in East Africa that became independent from its oppressor in 1963, after 68 years. It's been one of the most fortunate on the continent in that it's been able to develop a strong GDP of 110 billion in its 60 years of freedom [2]. Under British rule there was significant censorship of information and one of the most severe attempts at censorship condoned the shut-down of various newspapers throughout Kenya. In the time before mass media, the lack of newspapers was a serious concern for information travel and safety. Britain was able to effectively oppress the Kenyan population with the limitation of information sharing. In 1963, when the British rule was squashed, information was once again free to travel. The economy in Kenya began to pick up and within the next couple decades there was significant technological improvement [3]. The Kenyan economy truly began to boom in the 2010's as mobile phone and smart phone usage became widespread. Although personal computers were not commonly found in the household, mobile phones and smart phones were.

The Kenyan mobile phone penetration is very high at 130% and smart phone penetration is roughly 65% which lags the rest of the world but is rising at a very fast rate internationally [4].

The fact that Kenya's technological boom occurred at the advent of the mobile phone and not at the advent of the radio or the television means that, as compared to other countries around the world, their percentage of infrastructure dedicated to traditional forms of media is quite small [5]. This leapfrog in technology places Kenya in a unique position. Kenya is uniquely poised for rapid and highly interconnected communication. There is a smart phone in most households, there is relatively weak television infrastructure, and there is a community that relied so heavily on interpersonal communication throughout their period of oppression that the idea of leaning on and learning from your neighbor is inherent to the Kenyan psyche. The vast majority of information that is shared throughout the country is communicated through social media and mobile phones. This means that WhatsApp and Facebook are the most common forms of communicating information to those that you don't see on a daily basis [6]. Misinformation runs rampant on social media platforms, like WhatsApp and Facebook, and while there are many benefits to social media, the downsides can be severe.

1.2. Misinformation and its Effects

There are many benefits to information sharing being done over social media like Facebook and WhatsApp. The speed with which information can be shared is much higher. The information also has the opportunity to come directly from the source which has the potential to add increased trustworthiness to the information that is being shared. Unfortunately, this potential is hardly ever realized. Information coming directly from the source is a double-edged

sword. Those with malicious intent have the ability to significantly alter or even fabricate information in order to promote personal or political agendas, gain power and funds, or simply cause chaos.

The inherent speed with which information is posted or sent through social media has its own issues. There is a classic kid's game called telephone. There is a line of people, and the first person in the line is given a message by the moderator. This message is then whispered in the ear of the child next in line, just once. The process is repeated until the last child has heard the message. At the end of the line the message is said aloud. The final message is often completely different than the initial message. The issues in correctly identifying the correct message arise from a few sources. The first is that the child is only allowed to say the message one time. If they misspeak there is no fixing their mistake. The second is that you may only receive information from the person directly before you in line, there is no way to verify with anyone that appeared earlier in the line. Third, the children must whisper the message, the communication is not clear. This game of telephone is done constantly on social media and just like telephone, social media has many inherent features that allow the initial message to be very different from the final message. Just like telephone, once something is said, it is permanent. Even if a mistake is corrected, there is no guarantee that every reader will see the correction or care that the correction was made. Additionally, with a few exceptions, there is no trail of where the information came from. Information reposted or copied from another source very rarely has the attribution that should rightfully be associated with it. Even if the attribution is available there is significant time and effort associated with tracking down an original source just to see if the initial message is the same as the final message. Similar to the speech handicap of whispering, there are handicaps in social media as well. Tone cannot be conveyed through simple text,

context can be easily removed, and pictures can be doctored. The game of telephone and the reality of social media show how easily misinformation can form.

It is clear that there are concerns with the trustworthiness of information found on social media. Misinformation is a global issue but one that is quite often thwarted by the presence of trustworthy news sources. Some of the most trustworthy news sources around the world include the Public Broadcasting Service (PBS) and British Broadcasting Corporation (BBC) [7]. These sources are great for the select few that have access to them and have value in their content. The initial barrier to entry is that many of the most trusted news sources have subscription fees which are necessary to keep the verified news feasible. Additionally, this news is only ever going to be pertinent at a very high level, news for an entire country or city is as detailed as these sources can get. In summary, for the small percentage of the world's population that has access to highly trustworthy news sources, there is low likelihood that the information presented can be applicable to your daily life.

The issue remains that there is a lack of access to information that is timely, hyperlocal, and trustworthy, all in one. Social media is often timely and hyperlocal. Highly trusted news sources are, naturally, highly trustworthy, but they are often not timely, and they are not nearly as hyperlocal as they need to be to provide value to readers.

As stated previously, Kenya's information sharing infrastructure was drastically impacted by the British colonial rule. The country's economic and technological progress was delayed and for that reason there is little highly trustworthy news infrastructure throughout the country. The Kenyan people are a great example of a population that must rely on social media for their information, a very untrustworthy source.

1.2.1. Examples of Misinformation

The United States is a country that struggles with immense amounts of misinformation, particularly political. The robust news infrastructure is often able to contain false information, but there are significant exceptions to this generality. One recent and incredibly dangerous example of misinformation in the United States came during the COVID-19 pandemic. The pandemic was wrought with misinformation, but one of the most impactful was the discourse regarding vaccines. As companies like Pfizer, Moderna, and Johnson & Johnson came out with vaccines there was massive uproar from sects within the country [8]. Rumors were started that the side effects, both short and long term, of the vaccine were egregious. The vaccine, which had been through clinical trials and all of the appropriate pathways towards public use, was being labeled as dangerous by people with one specific agenda – stop the use of vaccines. The lies that were widespread about the “dangers” of the COVID vaccines caused millions of people to refrain from receiving the potentially lifesaving vaccination. Ultimately, thousands died from COVID-19 because they chose to forego the vaccine [9]. Misinformation killed thousands, and this is just one example of the power of knowledge.

Similarly to the United States, Kenya has had to learn to deal with consistent and highly effective misinformation. Their issues come to fruition most impactfully with politics. The political landscape in Kenya has been highly controversial ever since their independence from Britain. There have been accusations of rigged elections, lies between the feuding parties, and much more. The 2007 election, in particular, was tumultuous. Violence during this election period caused over 1,000 deaths [10]. The misinformation began before the election as each political group spread rumors and exaggerated claims about their opponents. Once the election

was decided, there were allegations of vote-rigging and electoral fraud. Both sides were accusing each other of said acts. The violence that ensued due to this misinformation was further fueled by false or exaggerated reports of attacks by various ethnic groups. These messages were often sent through WhatsApp or by word of mouth and typically in tribal languages, not Swahili or English [11]. These poor communication channels led to even more confusion. No matter where in the world misinformation is spread, it can have a serious impact on those involved.

1.2.2. Impact of Misinformation

Misinformation means a lot more to the population of Kenya in comparison to the population of the United States. This is due to many issues regarding economic and political stability but most simply because of the average income. The average income in the United States is roughly \$60,000 per year and the average income in Kenya is roughly \$2,000 [12]. Misinformation undoubtedly disrupts lives, but the impact can be much greater on someone who, on average, earns 84% less.

Here is an example of the impact of misinformation for an average Kenyan. If a road is reported as closed by the local news agency, a Kenyan must take a different route to work. This may add hours to their travel time and decrease their daily wage by 30%. This means that instead of a meal consisting of lentils, rice, and greens, there is only ugali, a cheap dish made with corn flour and water. What if that road had been reopened just moments after the news reported it closed, but there was no way to know that was the case. The cost of information is quite high when you consider the diminished income that is caused by a lack of timely and accurate information.

The negative impacts of misinformation can rattle a family, a city, or a country, and the current information infrastructure is not effective in stopping the spread of misinformation. There is still no perfect solution. Many social media sites are beginning to incorporate trustworthiness algorithms and human moderation into their platforms, but with the sheer amount of information to comb through and the complexity of each piece of information, algorithms and moderation teams stand no chance against the power of misinformation [13]. One solution that shows high potential is crowdsourcing.

1.3. A Promising Solution to Misinformation: Crowdsourcing

Crowdsourcing involves obtaining information or assistance from the crowd in order to assist with an objective. Crowdsourcing is based on the idea that the wisdom of the crowd is stronger than the wisdom of an individual expert. In the case of crowdsourcing current events information, the 250 people that watched a car accident occur, in theory, collectively know the situation better than the news station that reported the car accident [14]. While the news station is not actually an expert on car accidents, it does claim to be due to the journalism process that it undertakes. Crowdsourcing finds a way to harness the individuals that make up the crowd. It allows information to become stronger than just the sum of its parts and provides value that wouldn't otherwise be possible.

Some of the best in class in the category of crowdsourcing include Uber, Wikipedia, and Netflix. Uber relies heavily on their users to rate the quality of their drivers. Uber understands that any evaluation techniques they were to implement would not be as accurate as the millions of riders in their cars every day.

Wikipedia is an example of a company that effectively uses crowdsourcing as a fundamental function of its platform and one that relies heavily on the wisdom of the crowd in its purest form. Wikipedia is an encyclopedia that is written by its users with information about almost anything a user can think of. Wikipedia demonstrates how the larger the crowd is, the more trustworthy the information is. In Wikipedia's early days, there was turmoil among the academic community that the information on its database could not be cited as fact and couldn't be trusted. This wasn't an unfair sentiment, and it was due to the small number of users that contributed to the database. In its current state, Wikipedia has over 46 million editors and due to the size of the crowd, provides valuable information on millions of topics that can be fully trusted [15].

Netflix is an interesting example because they used crowdsourcing to develop an algorithm that could predict user ratings of their movies. They created a competition with prize money for the most accurate algorithm [16]. Not only did the crowdsourcing technique used provide a more accurate algorithm than Netflix currently employed, but the winning algorithm actually accessed the other teams' algorithms to combine them into one. The wisdom of the crowd can be taken to truly any extreme.

The idea behind crowdsourcing current events information is not unlike any of the listed examples. In theory, users could report events that are going on around them. Whether the event is a house fire or a community event, there is value in the information. This report could then be labeled as true or false by anywhere from dozens to thousands of people who can discern the accuracy of the information based on eyewitness accounts. This information would be considered more trustworthy than news source by the theory of the wisdom of the crowd.

Crowdsourcing is great in theory and there are plenty of examples of it being used highly effectively, but in the realm of reporting current events information, there is currently no solution that effectively brings timely, hyperlocal, and trustworthy information effectively to its users. An analysis must be done to determine what makes crowdsourcing feasible and why the current platforms that attempt to crowdsource current events information are falling short.

1.4. Purpose of Thesis

This thesis seeks to answer the question: is Kenya a feasible place to crowdsource current events information. The question itself is quite specific and there is very little research done into the feasibility of crowdsourcing. For that reason, a method of determining feasibility is introduced throughout this thesis and applied to various countries and cities around the world in order to allow the reader to determine the efficacy of this analysis for themselves. The vast majority of this analysis is novel and based on experience working with the development of a crowdsourced network for Kenya over the past three years. While this analysis is focused largely on Kenya and secondarily on the United States, it is designed in such a way that it could be applied to every country and every city around the globe. In order to determine the feasibility of crowdsourcing current events information, feasibility must be broken down into its parts and studied, this is the focus of Chapter 2.

Chapter 2 Geographic Feasibility of Crowdsourcing

The feasibility of crowdsourcing is an area of study that has not received widespread academic attention. Feasibility has only been extensively tested by the markets. The companies that were previously mentioned, like Uber and Wikipedia, thrive off of crowdsourcing and prove its feasibility through viable business models. Crowdsourcing has been proven many times in highly developed nations, but there is a lack of effective crowdsourcing in developing countries. This lack of effective crowdsourcing is often due to a lack of effort in expanding into developing countries. When companies consider entering the African, Asian, or South American market, they make a tough decision involving accepting lower margins, difficult supply chain, and increased complexity. These reasons are often too great to surmount, and the developing economies of the world are often neglected. Proving the feasibility of crowdsourcing in developing countries has the potential to open the world's eyes to the opportunities that lie within developing economies. These countries are worth the business challenges that they present, and in the coming decades, as Africa, Asia, and South America become major economic players, every company will be scrambling to enter the market.

The feasibility of crowdsourcing must be studied in order to understand where and when crowdsourcing can be effective and provide maximum impact. This chapter dives into the factors that determine whether an area of the world is fit for crowdsourcing. Population density, intrinsic motivation, and potential for impact are the three geographically and culturally motivated feasibility factors.

Geographic feasibility factors are those that rely on the area of the world that information is being crowdsourced in. While location is important, the physical geography is not. The

important pieces are the geographical classification and the culture of the people that live there. These factors include details regarding how close together people live, how technologically advanced their population is, how inherently collectivist are their ideologies, and is there a potential for impact in their communities. One of the more straightforward factors that will be analyzed is effective crowd size.

2.1. Effective crowd size

One of the most important factors when discussing crowdsourcing is effective crowd size. Effective crowd size determines whether certain areas of the world have enough effective people passing by a current event to make the wisdom of the crowd valuable. There are two components that are used to determine the effective crowd size: population density and effective percentage.

$$\textit{population density} * \textit{effective percentage} = \textit{effective population size}$$

The first component in determining effective crowd size is population density. It's found by first determining an area of land and the population that lives on it. That area of land can be as small as a neighborhood or larger than a country. The population density is the population divided by the area.

$$\frac{\textit{population}}{\textit{area}} = \textit{population density}$$

The effective percentage is made up of three terms. In urban areas, it is estimated that at any given time 20% of the population is commuting around the city, whether by vehicle or on foot. This 20% of the cities' population are those who would be privy to current events occurring around them, they are able to contribute to the theoretical crowdsourcing of current events. In a city like Manhattan, this makes up the majority of the people outside at any given time. When you shift your view to a city like Kisumu, Kenya, this is no longer the case. Informal business that occurs on the streets is very common, and the percentage of people outside is likely higher than 20%. In order to perform conservative estimates, the percentage will remain at 20% for the duration of this analysis. The second term, 0.126 km², is 200 square meters around a point. This value was chosen because someone can only really have accurate eyewitness knowledge and be a part of a wise crowd if they are within 200 meters of an event. One final factor that highly impacts the availability of a person to report information happening around them is access to a smart phone, since a crowdsourced platform would likely need to be administered through a smart phone.

$$20\% * 0.126 \text{ km}^2 * \text{smart phone penetration} = \text{effective percentage}$$

In terms of the wisdom of the crowd, the larger the crowd the wiser the crowd can be. The largest increase in wisdom comes from the increase from 1 to 2 people. The incremental increase in wisdom from that point forward shrinks and the curve is logarithmic in nature. It has been determined that a crowd size of 20 is enough to provide accurate information. Incremental increases from this point follow the law of diminishing marginal utility, and while a larger crowd

size is always better, it is not a necessity for accurate information [17]. Assuming that 20 people viewing a current event is the minimum number required to accurately recall the facts correctly, a general equation can be applied to all areas of the world. Thus, the equation that a city or any arbitrary area must fulfill is as follows:

$$\frac{\text{population}}{\text{area}} * 20\% * 0.126 \text{ km}^2 * \text{smart phone penetration} > 20$$

Manhattan, for example, fulfills this inequality with flying colors. Their crowd would be roughly 560 individuals. Bucks County, a rural and suburban county outside of Philadelphia, would not exceed the minimum viable crowd size for accurate information. Bucks County's crowd is only 8 people. It is important to note that there were significant estimates made in this equation and while the thought exercise is quite valuable, the actual comparison of 8 to 20 may not have high precision. The next factor, intrinsic motivation, is not nearly as quantifiable as effective crowd size, nonetheless, it's important to analyze.

2.2. Intrinsic Motivation

Intrinsic motivation is motivation that comes from within. In the context of crowdsourcing current event information, it's the idea that people are compelled to crowdsource information because they know it is helpful to their community. Those intrinsically motivated individuals help their community expecting nothing in return. This trait has been identified around the globe at varying levels. It is important to note that certain areas of the world report a

greater willingness to help those around them expecting nothing in return. Through a survey performed with 77 Kenyans it was found that 82% of them would be willing to do something for their neighbor expecting nothing in return [6]. These results show that the Kenyan community as a whole is very willing to help each other. At risk of painting with a broad stroke, the Kenyan people, particularly in the Kisumu region, have maintained strong community ties since their oppression by Great Britain. They make up a collectivist community who care for one another and help each other whenever possible. Intrinsic motivation has the ability to multiply the power of a crowdsourced platform and supplement a potential lack of extrinsic motivation created by the platforms themselves. The final geographic factor, potential for impact, is closely related to intrinsic motivation.

2.3. Potential for Impact

One final geographic factor that should be considered when determining the feasibility of crowdsourcing current events information is the impact that the information can have on its users. This factor is tied heavily to the next section that will discuss the type of information being reported. The impact of misinformation is hard to quantify at the individual level. Research groups have quantified the effects of misinformation in dollars, but that means nothing to the individual. There is currently no publicly available way to quantify the effects of misinformation on the individual. Some factors that would be important to consider when determining impact could be reliance on word of mouth for information, severity of information being spread, urgency of information being spread, economic fragility of community, and political fragility of community. These are just a few factors that would seem to provide an overview of the potential

impact that crowdsourcing current events information could have on an individual or a community. Further research by a crowdsourced platform would be recommended in order to determine the nuances of an algorithm that could discern the impact of their platform. Now that the geographic factors that determine the feasibility of crowdsourcing current events have been identified, they can be applied to various areas of the world in order to determine where crowdsourced networks should focus their efforts. In the next chapter, countries will be analyzed for their feasibility.

Chapter 3 Analyzing the Feasibility of Countries

Understanding the ways in which a geographic location can be effective for crowdsourcing is an important first step in the analysis of feasibility. Throughout this chapter, two countries will be analyzed. The initial exigence of this paper regards Kenya and thus it will be analyzed first. Kenya will be followed by the United States in order to show juxtaposition between the two countries. The factors that are geographically or culturally tied are population density, intrinsic motivation, and potential for impact. These factors will be judged for each country of interest.

3.1. Feasibility of Kenya

Effective crowd size will be judged by the equation introduced earlier in this thesis. The equation is repeated here:

$$\frac{\text{population}}{\text{area}} * 20\% * 0.126 \text{ km}^2 * \text{smart phone penetration} > 20$$

The population of Kenya is 54.03 million [18] people in an area of 582,646 km² [19]. The country wide smart phone penetration is roughly 65% [20]. Utilizing the equation, Kenya's effective crowd size, roughly 1.5 individuals, does not meet the minimum effective crowd size of 20 individuals. That being said, Kenya is a country that is highly intrinsically motivated to help one another. Their previous oppression by the British baked into the Kenyan culture a necessity to help their neighbor. Just like intrinsic motivation, the impact of information would be high

because of the British oppression of Kenya. As discussed previously, the lack of news infrastructure and the leapfrog in technology that Kenya performed in the last few decades caused the vast majority of their information to be shared through word of mouth or social media. In a global context, Kenya would be considered economically and politically fragile. Their average earner makes 26 USD per day and there is typically only one source of income per family [21]. Politically, Kenya has been incredibly divisive since their freedom. Recent elections have seen large outbursts of political violence and bribes are common. Below is a summary of the feasibility of Kenya for crowdsourcing.

Table 1. Feasibility in Kenya

Effective crowd size	Intrinsic Motivation	Potential for Impact
Low	High	High

It can be determined that Kenya, treated as a homogenous country, is moderately feasible for crowdsourcing current events information. Next, the United States will be analyzed with the expectation that the feasibility will likely differ due to the vast geographic and cultural differences between the two countries.

3.2. Feasibility of United States

The population of the United States is 336 million people in an area of 9,147,420 km² [22][23]. The smart phone penetration in the United States is very high at roughly 90% [24]. The United States, maybe surprisingly, has a crowd size of 0.8 individuals due to the vast amounts of

land that are sparsely inhabited. The intrinsic motivation to help one another is noticeably lower in the United States and is likely decreased by the intense individualistic attitude that so many Americans hold. The potential for impact is also low because of the economic strength of the country, relative political safety, and large presence of trustworthy news sources.

Table 2. Feasibility in the United States

Effective crowd size	Intrinsic Motivation	Potential for Impact
Low	Low	Low

It can be determined that the United States, treated as a homogeneous country created by its average population density and values, is not at all feasible for crowdsourcing current events information. While this analysis makes sense at first glance, it is clear that there are issues with counting a massive country as one homogeneous unit.

3.3. Analyzing Countries as Homogeneous Units

Determining that the United States is infeasible for crowdsourcing current events information is interesting because there are already a few platforms in the United States, like Citizen, that many would argue effectively fulfill the current events needs of the communities they support. This introduces a fairly obvious conclusion that countries cannot and should not be treated like a homogeneous unit. Unless the country is as small as Singapore or Vatican City, homogeneity is a lazy assumption. Countries are too varied in population density, cultural norms, and economic levels. Countries cannot be holistically analyzed accurately. The reason that a

country like Kenya is not seen as highly feasible for crowdsourcing is because of their low effective crowd size. This is due to the large expanses where population density is very low. Seen in Figure 1, the population density of Kenya surrounds three cities: Nairobi in central Kenya, Mombasa on the East Coast, and Kisumu on the shores of Lake Victoria. The entire northeastern portion of the country is very sparsely populated.

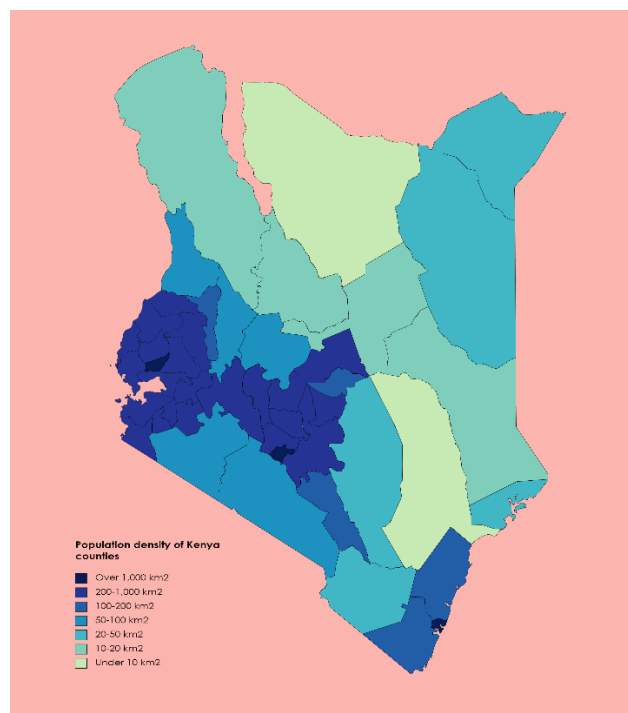


Figure 1. Population Density of Kenya [25]

This analysis of Kenya's population density shows that the feasibility of crowdsourcing could be much more valuable if applied more granularly, to cities. While subjective factors such as intrinsic motivation are harder to determine at a highly granular level, there are theories to help make these decisions easier.

As introduced previously, collectivist communities see increased intrinsic motivation. Collectivist ideologies are those that encourage community, interdependence, and group goals. Therefore, collectivist ideologies go hand in hand with intrinsic motivation to help others. Collectivist ideologies are, of course, not homogeneous to continents, but they are strongest in Africa and Asia. Individualistic ideologies are the opposite of collectivist ideologies. Individualistic ideologies are strongest in North America and Europe [26]. On a more detailed city level, the larger the city, the more individualistic the ideals of that community are. This is likely due to the increased economic opportunities, higher diversity, and increased exposure to global ideas [27]. This analysis of intrinsic motivation posits that some of the highest motivated areas of the world would be small towns in Africa and Asia. Some of the centrally motivated areas of the world are larger cities in Africa and Asia as well as smaller towns on individualistic continents. Some of the least intrinsically motivated areas, generally, are some of the largest cities in North America and Europe. With the knowledge of effective crowd size, intrinsic motivation, and potential for impact, an analysis of cities can and should be completed. Kenya and the United States are simply too large and too diverse to blanket analyses over their entire borders. Cities provide a relatively small geographical area with a high population density: the best conditions for crowdsourcing.

Chapter 4 Analyzing the Feasibility of Cities

As previously determined, countries are too large and too heterogeneous to analyze as a whole. Cities are a much more digestible area of land with a group of people that interact with each other on a daily basis. This chapter will look much more in depth into the three geographic factors that determine crowdsourcing feasibility. 20 cities were chosen in order to see a wide array of geographic locations. They are all either large or medium sized cities which are prominent in their region. An emphasis was placed on Kenyan cities due to its importance to the thesis question. An emphasis was also placed on United States cities because of the familiarity of most readers with the region.

When looking at cities for feasibility, it is important to know the effective crowd size of the city, the location, the size, the economic need, and the political turmoil present. These factors are all important in discerning the effective crowd size, the intrinsic motivation, and the potential for impact of a city.

First, taking a look at the effective crowd size, the effective crowd size equation was implemented at the city level. It is important to note that smart phone penetration values are not available at the city level and must be taken at the country level. The effective crowd size is the output of the equation, and the table is sorted from largest to smallest. Qualitative values were attached to the output in order to standardize this table with the other two geographic feasibility factors.

Table 3. Effective Crowd Size of Various Cities

City	Population [28]	Size (km²)	Population Density	Smart Phone Penetration	Effective Crowd Size	Effective Crowd
Sao Paulo	22,806,704	1,520 [29]	15,004	60 [30]	230	Very High
New York City	7,931,147	1,213 [31]	6,538	90 [24]	227	Very High
Cartagena	1,096,463	83 [32]	13,210	69 [33]	148	Very High
Seville	700,513	141 [34]	4,968	88 [35]	130	Very High
Nairobi	5,541,172	696 [36]	7,961	65 [20]	110	Very High
Shanghai	29,867,918	6,340 [37]	4,711	72 [38]	95	Very High
Mombasa	1,495,223	259 [39]	5,773	65 [20]	95	Very High
Philadelphia	1,533,916	367 [40]	4,180	90 [24]	94	Very High
Washington DC	672,738	177 [41]	3,801	90 [24]	87	Very High
Berlin	3,645,000	892 [42]	4,086	91 [43]	86	Very High
Karachi	17,648,555	3,530 [44]	5,000	51 [45]	64	Very High
Pittsburgh	303,034	151 [46]	2,007	90 [24]	46	High
Nakuru	436,990	450 [47]	971	65 [20]	31	High
Kisumu	406,684	297 [48]	1,369	65 [20]	31	High
Eldoret	464,570	248 [49]	1,873	65 [20]	22	Average
Tucson	550,472	587 [50]	938	90 [24]	21	Average
Jakarta	11,436,004	6,392 [51]	1,789	68 [52]	16	Low
Kinshasa	17,032,322	9,965 [53]	1,709	38 [54]	16	Low
Nashville	677,519	1,360 [55]	498	90 [24]	11	Low
Oklahoma City	706,576	1,610 [56]	439	90 [24]	10	Low

It can be seen in Table 3 that in order to have a large effective crowd size a city must be both dense and technologically advanced. While having a high smart phone penetration is necessary to have a high effective crowd size, it is not enough on its own. Population density is the most important factor to consider. In Figure 2, the population density is graphed against the smart phone penetration for each of the 20 cities. The curve that decays across the graph is formed by an effective crowd size equal to 20. Any city above the line meets the requirement and any city below the line does not. It is important to note that São Paulo, Nairobi, and Cartagena had population densities higher than that of New York City, but they were equalized for visual reasons.

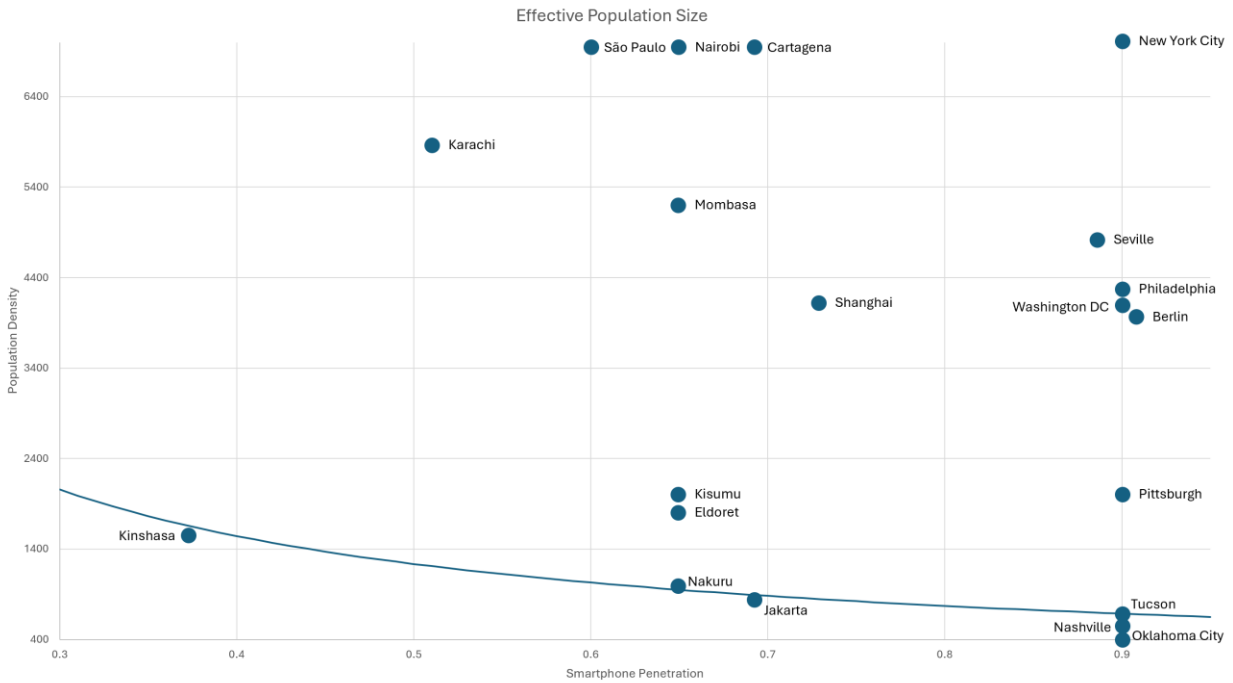


Figure 2. Effective Crowd Size with Feasibility Curve

The next factor to look into further is intrinsic motivation. As mentioned previously, Africa and Asia have some of the highest levels of collectivist attitudes and North America and Europe have some of the lowest. Large population cities tend to lead to lower levels of collectivism and vice versa. The intrinsic motivation assigned to each city was a balance of both location and population and it is certainly not an exact science. There are likely hundreds of factors that affect the intrinsic motivation of a group of people and to even consider an entire city as a homogeneous person is a gross generalization, alas this is the best that can be done until more research is done into the field. From the list of cities that were studied, the African cities tend to rank the highest in terms of intrinsic motivation, followed by very small cities in North America. Low intrinsic motivation can be found mostly in large cities throughout North America, Asia, and Europe. Note that the cities chosen from Asia were both very large in size and this dropped their score significantly.

Table 4. Intrinsic Motivation of Various Cities

City	Continent	Population	Intrinsic Motivation
Eldoret	Africa	464,570	Very High
Nakuru	Africa	436,990	Very High
Kisumu	Africa	406,684	Very High
Mombasa	Africa	1,495,223	High
Pittsburgh	North America	303,034	Average
Tucson	North America	550,472	Average
Cartagena	South America	1,096,463	Average
Nairobi	Africa	5,541,172	Average
Sao Paulo	South America	22,806,704	Average
Kinshasa	Africa	17,032,322	Average
Oklahoma City	North America	706,576	Low
Seville	Europe	700,513	Low
Nashville	North America	677,519	Low
Washington DC	North America	672,738	Low
Philadelphia	North America	1,533,916	Low
Jakarta	Oceania/Australia	11,436,004	Low
Karachi	Asia	17,648,555	Low
Shanghai	Asia	29,867,918	Low
Berlin	Europe	3,645,000	Very Low
New York City	North America	7,931,147	Very Low

The last factor to consider is the potential impact that crowdsourcing current events information could have on a city. To determine this, the economic need was determined through comparing the average income in that city to the average income globally. The global average income is 9,733 USD per year [57]. For political stability, The Global Economy has a ranking system that they use to rank each country globally [58]. 1 being the most politically stable and 193 being the least politically stable. This is likely a good indicator of the presence of both political pressure and violence that occur in a country and subsequently a city. As it turns out, economic need and political turmoil tend to go hand in hand. Where there is high economic need there are also high levels of political turmoil. As seen in Table 5 these cities have a very high potential for impact from crowdsourcing current events information. Of the 20 selected cities, the African and South American cities tend to have the most potential for impact.

Table 5. Potential for Impact on Various Cities

City	Economic Need	Political Stability Ranking [58]	Political Turmoil	Potential for Impact
Kinshasa	Very High	181	Very High	Very High
Mombasa	Very High	162	Very High	Very High
Eldoret	Very High	162	Very High	Very High
Nakuru	Very High	162	Very High	Very High
Kisumu	Very High	162	Very High	Very High
Nairobi	Very High	162	Very High	Very High
Karachi	High	180	Very High	Very High
Jakarta	Average	134	High	High
Cartagena	Average	145	Very High	High
Sao Paulo	Low	122	High	Average
Shanghai	Low	132	High	Average
Philadelphia	Low	100	Average	Average
Pittsburgh	Low	100	Average	Average
Oklahoma City	Low	100	Average	Average
Seville	Very Low	83	Average	Low
Tucson	Very Low	100	Average	Low
Berlin	Very Low	58	Low	Low
Nashville	Very Low	100	Average	Low
Washington DC	Very Low	100	Average	Low
New York City	Very Low	100	Average	Low

Combining all three factors together separates the 20 cities into five categories, ranging from very high feasibility to very low feasibility. It can be seen in Table 6 that the African cities have the highest feasibility for crowdsourcing current events information and North American and European cities have the lowest feasibility. While this analysis is by no means exhaustive or highly precise, it is a valuable thought exercise in what factors can determine feasibility when it comes to crowdsourcing and where crowdsourced platforms could potentially focus their efforts in order to create high impact, high buy-in services.

Table 6. Feasibility for Crowdsourcing Current Events Information in Various Cities

City	Potential for Impact	Intrinsic Motivation	Effective Crowd	Feasibility
Mombasa	Very High	High	Very High	Very High
Kisumu	Very High	Very High	High	Very High
Nakuru	Very High	Very High	High	Very High
Eldoret	Very High	Very High	Average	Very High
Nairobi	Very High	Average	Very High	Very High
Karachi	Very High	Low	Very High	High
Cartagena	High	Average	Very High	High
Sao Paulo	Average	Average	Very High	High
Kinshasa	Very High	Average	Low	High
Shanghai	Average	Low	Very High	High
Philadelphia	Average	Low	Very High	High
Pittsburgh	Average	Average	High	High
Seville	Low	Low	Very High	Average
Washington DC	Low	Low	Very High	Average
Jakarta	High	Low	Low	Average
Tucson	Low	Average	Average	Average
Berlin	Low	Very Low	Very High	Average
New York City	Low	Very Low	Very High	Average
Oklahoma City	Average	Low	Low	Average
Nashville	Low	Low	Low	Low

4.1. Secondary Cities

The majority of cities that scored highly in the feasibility matrix have one thing in common, they are classified as secondary cities. Secondary cities have a very loose definition. They are known as cities that are typically 10-50% of the population of the country's largest city. They are cities that have economic, cultural, and political significance and an identity unique from their largest city. Secondary cities are growing quickly and currently in Africa, secondary cities are experiencing the majority of the continent's urban growth. Potentially surprisingly, almost two-thirds of all secondary cities in the world are found in Africa or Asia [59].

Secondary cities are likely the most feasible areas of the world for crowdsourcing. They tend to be highly intrinsically motivated due to their collectivist attitudes in Africa and Asia. They are smaller cities in population, so the large city influence of individualism is less severe. These areas of the world have high enough population density and smartphone usage to be considered viable. The analysis completed throughout this chapter included a handful of secondary cities in Kenya. The secondary cities include Mombasa, Kisumu, Nakuru, and Eldoret. The four cities with the highest feasibility for crowdsourcing current events information.

It is important to understand that there are two sides to effective crowdsourcing of current events information. The location is quite important, as has been proven, but the location doesn't matter if the platform itself is not effective. The design of a crowdsourced current events platform that in theory could be effectively implemented in secondary cities across Africa and Asia is both challenging and yet to be created.

Chapter 5 Developing an Effective Crowdsourced Platform

As mentioned previously, there are feasibility factors that have nothing to do with the area of the world that a crowdsourced platform is used in. Some factors solely rely on the crowdsourced platform itself to be fulfilled. It is the job of these platforms to recognize the importance of the role they fill in ensuring that information is valuable and trustworthy. It is a difficult task and there isn't a perfect solution or else it would've been done already. Throughout this chapter an analysis will be done of the platform feasibility factors: information type, gamification, and malicious actors. Final commentary will be provided regarding feasible platform design as a whole.

5.1. Platform Feasibility Factors

Platform feasibility factors are those that do not rely on the area of the world that they are found in. The factors must be fulfilled by the platform that is allowing users to crowdsource and it is a pivotal step in the creation of effective crowdsourcing because without effective platforms there cannot be effective crowdsourcing. While these factors don't directly answer the question: is crowdsourcing current events information feasible in Kenya, it is important to understand the full picture. Whether Kenya is geographically and culturally feasible does not matter if there are not effective platforms to utilize the prime conditions. One of the most basic platform factors is the type of information that is presented to users.

5.1.1. Information Type

The first factor in regard to the platform feasibility of crowdsourcing current events information is what kind of information is being crowdsourced and shared. The content must be interesting enough or hold enough value that users are willing to report what's going on around them, validate each other's reports, and read each other's content even when someone is not an eyewitness. Current events are inherently a wide-ranging topic and there are areas of current events that cater to each group of people in a community. Depending on the culture, economic status, and geography of a community, the proportions of people interested in certain pieces of information change greatly. For example, a highly religious community, like a town in the Bible Belt, would be eager to learn about a church event occurring. An area of the world that is plagued by monsoon season, like India, would be looking to learn about the most up to date road closures due to flash flooding. California, a region that faces dangerous wildfires, would most likely prefer up-to-date knowledge on the location of fires. It is very important to ensure that the community that is attempting to implement crowdsourcing is focused on pertinent information for the community. The proper information can be augmented using gamification techniques, highlighted in the next section.

5.1.2. Gamification

Yu-kai Chou, a Taiwanese American entrepreneur and author, was one of the pioneers of gamification. Gamification is the idea that using typical game elements, like competition and scoring, increase engagement in non-game platforms. He determined that there are eight core drives of gamification. The drives are as follows: 1) Epic Meaning & Calling 2) Development &

Accomplishment 3) Empowerment of Creativity & Feedback 4) Ownership & Possession 5) Social Influence & Relatedness 6) Scarcity & Impatience 7) Unpredictability & Curiosity 8) Loss & Avoidance [60]. Gamification can and should be applied to crowdsourcing in order to increase buy-in and allow users to find enjoyment in the process. The core drives that are of importance to gamifying crowdsourcing are 1, 2, 4, 5, and 8.

Epic Meaning & Calling is the drive when people are motivated by the fact that they are participating in something bigger than themselves. This is inherently the case with crowdsourcing. One user can only provide a very small piece of the puzzle, but the sum of all the individual pieces to the puzzle is much greater than just the addition of its pieces.

2, Development & Accomplishment, has the potential to be effectively implemented into a crowdsourcing platform. This core drive is derived from the idea that humans like to work towards goals and achieve things. If a crowdsourced platform is able to effectively implement positive reinforcement for effective and accurate crowdsourcing, then core drive number 2 has high potential to motivate users, particularly if their accolades are publicly available.

Number 4, Ownership & Possession, plays on the sense of ownership that residents of a community feel over their community. It is within our human nature to protect and improve the things we own. If people feel as though they have some form of ownership over their community, and crowdsourcing current events information will either protect or improve the community, they may feel motivated to crowdsource.

Social Influence & Relatedness surrounds ideas of competition, but also of group quests. Crowdsourcing is innately a group quest. Can the crowd come together as one to complete a goal. In this case, the goal is accurate, timely, and hyperlocal current events information. The

competition aspect can relate back to core drive number 2, if accolades are public, then there is now a competitive nature to those accolades. Each user wants the most accolades.

Last is core drive 8, Loss & Avoidance. Motivation can occur from the fear of bad events occurring. In many cases, the current events pertinent to users could be public safety related: political violence, flash floods, fires, etc. If a user can report these dangerous events to warn other users to avoid the area, lives can be saved, and suffering can be avoided.

Gamification is a great way to get users engaged and maintain buy-in throughout an extended period of time. Users that enjoy the process of crowdsourcing are likely to take the process seriously and share the process with their friends and family. Those positively affected by gamification are some of the best users a platform can ask for. Unfortunately for the efficacy of crowdsourced platforms, not every user is ideal. Some users can even be outright malicious.

5.1.3. Malicious Actors and How to Stop Them

No matter how intrinsically motivated a group of people can be, there will always be a small percentage of the population that has malicious intentions. Whether someone is trying to gain power, information, or money, people will be selfish. The issue with malicious intentions in regard to crowdsourcing is that if there is a small enough sample size or a large enough group of malicious actors, then there can be serious consequences in terms of the effectiveness of crowdsourcing. That being said, it is important to ensure that there is either a lack of malicious actors or a way to stop malicious actors from swaying the mathematics of crowdsourcing. Both of these solutions fall onto the shoulders of the crowdsourcing platform.

In order to decrease the number of malicious actors it is important for platforms to include verification in their sign-up process and only allow each email or phone number to make one account. Additionally, and potentially more effectively, there can be algorithms in place within the crowdsourced platform in order to discern malicious accounts and behavior and stifle them before they make a large impact on the trustworthiness of information.

A trustworthiness algorithm would need to include the factors that determine malicious intent. One factor could be how long the account has been actively used for. This would stop malicious actors from using bots to create hundreds of accounts and immediately swaying the trustworthiness of an event that was reported. Another factor is the previous accuracy that a user has had when validating events. If a user has correctly validated 96 out of 100 events, their opinion should matter more than someone who only correctly validated 7 out of 100 events. Lastly, crowdsourcing of current events should likely include a location-based component because of the nature of local information. Users that are closest to the event that was reported should hold more weight than users that are far away. A user that is validating a fire that is 200 meters away is more likely to be correct than a user that is 10 kilometers away. These three factors could be scaled according to mathematically accurate equations found through machine learning. There are currently no publicly available data sets that would allow a model to be trained to create this equation, but if a crowdsourced platform were to collect large amounts of data from its users this algorithm could become a reality in the near future. There are likely other factors to be considered that are less obvious and the more data that is collected from crowdsourced networks, the more likely it is that an accurate algorithm can be developed. Utilizing an effective algorithm will allow for the creation of an effective platform.

5.2. Feasible Platform Design

Based on the three platform feasibility factors, a theoretical design for a crowdsourced platform can be conceptualized. This platform would likely be an app used on smart phones due to the widespread use of technology. This platform should cater to the needs of each community that it's present in. The information should be pertinent to those viewing it to ensure that the platform receives buy-in and enthusiasm. This platform should use gamification techniques to keep users excited and involved. This platform should incorporate sign-in techniques and a trustworthiness algorithm that thwarts malicious actors.

A platform used to crowdsource current events information must follow three facets. The information must be trustworthy, timely, and hyperlocal. Information is only valuable if it is available when you need it, pertinent to your situation, and can be taken as fact. The difficult part of designing a crowdsourced network is how to ensure that the three facets are met. To make information trustworthy, users must report what is going on around them in real time. This report would then be made publicly available on a map or feed interface for all other users to see. The other users would then be able to either validate or invalidate the initial report based on the information they are privy to. A trustworthiness algorithm, like the one mentioned in the previous section, would be a viable method to ensure that information is as safe as possible from malintent. It is important to ensure that reports are made transparently, and the inner workings of the platform are publicly available. The transparency of the platform and the information on the platform is paramount to the success of it.

When a crowdsourced platform is able to bring timely, hyperlocal, and trustworthy current events information into the hands of the people that need it the most, the potential for

impact is limitless. Secondary cities should see an increase in crowdsourcing in the coming years and hopefully they will be a model for how communities can come together, collectively, to achieve something amazing.

Chapter 6 Conclusions

Kenya, located in East Africa, is an area of the world that relies heavily on social media and word of mouth for current events information. The British oppression of the region squandered news infrastructure and caused a technological leapfrog with the advent of smart phones. Misinformation runs rampant on social media and the game of telephone is notorious when information is passed along by word of mouth.

When misinformation is brought into fragile areas of the world, whether that be from a political or economic standpoint, there are serious impacts. Crowdsourcing has been identified as a viable way to stop the spread of misinformation by ensuring trustworthy information is readily available. This potential for impact was the exigence of this thesis. The feasibility of crowdsourcing current events information is complex. There are many factors to consider when determining feasibility and there is no exact science on how these factors should be calculated, weighted, and analyzed. This thesis made an effort to put forth a way to analyze feasibility and apply it to Kenya and the world. While Kenya was deemed only moderately feasible for crowdsourcing current events information, it was determined that analyzing feasibility at the country level is painting with too broad of a stroke. An analysis of cities was carried out and produced intriguing results. The results highlighted the opportunity space to crowdsource in Africa and more broadly, secondary cities around the world. Secondary cities, those with population between 10 and 50% of a country's largest city are those that seem to house the best conditions for crowdsourcing current events information.

The information that secondary cities are the best place to implement crowdsourced networks is very important. Currently, crowdsourcing is often seen as a cutting-edge technology

that can only be applied to areas of the world that have highly developed economies. The United States and Europe have seen their fair share of crowdsourced platforms, but the success of most platforms is limited. This thesis puts forth that the reason crowdsourcing isn't reaching its full potential in the Western world is due to a generally low feasibility for crowdsourcing in those regions due to the geographic and cultural reasons like intrinsic motivation and the potential for impact.

If crowdsourced platforms are able to target secondary cities throughout Africa, Asia, and South America, the platforms will see high growth as well as high impact. As it turns out, the communities around the world that need crowdsourcing the most are also the communities where crowdsourcing current events is most feasible. Genuine desire is a strong contributor to feasibility as has been proven in Chapter 4.

“Knowledge is power.” For countries whose knowledge was withheld, and communication channels demolished, knowledge transfer can be difficult, even today. Crowdsourcing current events information is a viable solution to the challenges of knowledge transfer. The areas of the world that need crowdsourcing the most are those most primed to accept it and allow it to thrive. Crowdsourced platforms need to focus their efforts on secondary cities in Africa, Asia, and South America. There is truly so much potential for positive impact.

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