

AI-POWERED UNDERSTANDING OF FAMILY PLANNING BEHAVIOURAL CHANGE USING THE FOGG MODEL

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ABSTRACT

In this work, we share our methodology and findings from applying named entity recognition (NER) using machine learning, to identify behavioural patterns in transcribed family planning client call centre data in Nigeria based on the Fogg’s model. The Fogg Behaviour Model (FBM) describes the interaction of three key elements Motivation (M), Ability (A), and a Prompt (P) and their interaction to produce behavioural change. This work is part of a larger project that is focused on practical application of artificial intelligence to analyse and derive insight from large scale data call centre data. The entity recognition model called Fogg Model Entity Recognition (FMER) was trained using spaCy, an open source software library for advanced natural language processing on a total of 11510 words and F1 score of 98.5

1 BACKGROUND

1.1 FAMILY PLANNING AND SOCIAL BEHAVIOURAL CHANGE

Family planning programs are guided by the principle of informed choice as well as the goal of providing a wide range of contraceptive options to clients (Solo & Festin, 2019). Family planning programs have been adopted in several developing countries with the purpose of increasing contraceptive use, improving reproductive health, lowering fertility, and reducing rates of population growth (Desai, 2011). Whereas in places where adoption of family planning lags, it has been found that social and behavioural barriers continue to prevent potential clients from demanding, accessing, and using modern contraceptives. For instance, an analysis of Demographic and Health Survey data from 51 surveys found that concerns about side effects and the inconvenience of methods were a primary reason for non-use among 35% of married women in Latin America and the Caribbean, 28% in Africa, and 23% in Asia (Skinner, 2021). The success of family planning is dependent on changes in social activities and behaviour.

After five decades of implementing and evaluating Social Behavioural Change (SBC) strategies in the health sector, robust evidence demonstrates that at-scale SBC programs play a crucial role in improving health outcomes. The SBC strategy includes engaging men and working with couples to challenge inequitable gender norms and power relationships and improve couple communication (Doyle et al., 2018)(Lemani et al., 2017)](Subramanian et al., 2018), promoting role models and demonstrating pathways to change through mass media (Jah et al., 2014), and engaging communities through dialogues, communication, and empowerment (Wegs et al., 2016). Also, the impact of SBC programs on family planning is to establish a supportive environment in which women, men ,girls and boys can make their own reproductive decisions and use contemporary contraception.(Glanz et al., 2008).The evidence has shown that SBC programs can effectively influence family planning-related behaviour and even reach those not directly exposed to the intervention (Boulay et al., 2002).

A study by DKT Nigeria¹ indicated that family planning experts might have to adopt persuasive strategies to improve contraceptive use amid the interruptions of healthcare services caused by the pandemic. The use of the Fogg Behaviour Model (FBM) has been found to be a useful model to think through program design to influence behavioural change with regard to family planning.

1.2 FOGG BEHAVIOUR MODEL AND FAMILY PLANNING

(Fogg, 2009) proposed the Fogg Behaviour Model (FBM), which demonstrates that three elements interact to produce a behaviour change. These elements are Motivation (M), Ability (A), and Prompt (P). The model is commonly depicted as

$$B=MAP$$

where B, M, A, and P connote human behaviour, motivation, ability, and prompt, respectively. Figure 1 is a graphical representation of how these psychological entities relate to human behaviour. The behaviour of an individual towards family planning does not depend only on how motivated s/he is to use family planning but also her/his ability to use it, and a prompt. The action line is a curve that shows a trade-off between motivation and ability. It would be extremely difficult to get someone's behaviour to change towards a thing if they find doing so hard and have a low motivation to do so. Conversely, a little motivation is needed to achieve a target behaviour if it can be easily done. Understanding how these elements influence behaviour makes achieving any target behavioural change easier.

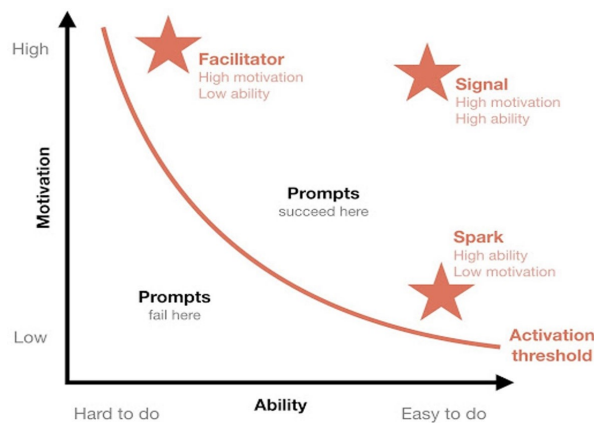


Figure 1: FMER

(Fogg, 2009) established that there are three core motivators, each of which is two-sided, as shown in Table 1. The motivators are central to human experiences and define the level of motivation a person has towards a target behaviour. For instance, to establish a high motivation to practice family planning and other healthy practises, the process should not be painful to engage and also, the person should have no fear of permanently losing her fertility.

Table 1: Core FBM Motivators

Motivators	Positive side	Negative side
Sensation	Pleasure	Pain
Anticipation	Hope	Fear
Belonging	Acceptance	Rejection

The second element, Ability, mainly refers to the ease of reaching a target behaviour; the ease of practising family planning as in our case study. One of the recommended paths to increased ability is to provide tools that either take away or reasonably reduce the difficulty in attaining a target objective. Attempts to make the process simple are very advantageous such that despite limited resources, the objective is achieved. According to the design of the Fogg model, the level

¹<https://www.dktnigeria.org/>

of availability of resources defines the human ability to achieve the target behaviour. The resources include time, money, physical effort, mental effort, and routine. In this aspect, we see that to ensure high ability to engage in family planning, the practice should be cheap and require minimal effort, to mention a few. To ensure minimal physical effort, an essential factor is the presence of medical stores, pharmacies, clinics, and hospitals in every residential neighbourhood.

The third element of the Fogg model is Prompt (P), which plays a vital role in causing a behavioural change. Prompt is any situation that influences motivation or increased ability and therefore leads to a push above the action line Figure 1. Prompt can be a call to action, cue, request, trigger, etc. For instance, in a situation where an individual tries to get more information about an emergency contraceptive because of occurrences such as condom breakage or an unplanned pregnancy with a friend. The Fogg Behaviour Model recognises these types of prompt: the facilitators, signal, and spark. Therefore, there is a need to understand the kind of prompt to engage to ensure a behavioural change Figure 1.

1.3 NAMED ENTITY RECOGNITION AND MACHINE LEARNING

Named Entity Recognition (NER) in text processing is where certain occurrences of words or expressions are identified and classified as categories of Named entities. It's range of application is wide in text mining, information extraction, information retrieval, relation extraction, semantic labelling, automated document forwarding etc. Named entity recognition depends on annotation (tagging), while the most common gazetteers (list of entities) are person, location, place, time and organisation. Named entity is context specific and the tags are dependent on the specific use cases (Carlson et al., 2009), (Mikheev et al., 1999).

A Named entity recognition system can be categorised into three classes, namely, Hand-made Rule-based NER, Machine Learning-based NER and Hybrid NER. Our focus here is Machine Learning based NER (ML-NER), which focuses on the fundamentals of machine learning. A model learns patterns and relationships from training data and then makes predictions on previously unseen data. The ML-NER approach converts entity identification into a classification problem in text and then uses a statistical model to solve it (Mansouri et al., 2008). The efficiency of NER is measured by F1 Score, Precision and Recall like standard classification tasks.

In this study, we aim at harnessing the power of NER to identify the entities belonging to the Fogg Model elements. A useful model that can recognize words and sentences that accurately express Motivation, Ability, and Prompt in order to learn conversational patterns for optimal engagements and the effectiveness of a given text to reinforce positive family planning behavioural changes.

2 METHODOLOGY

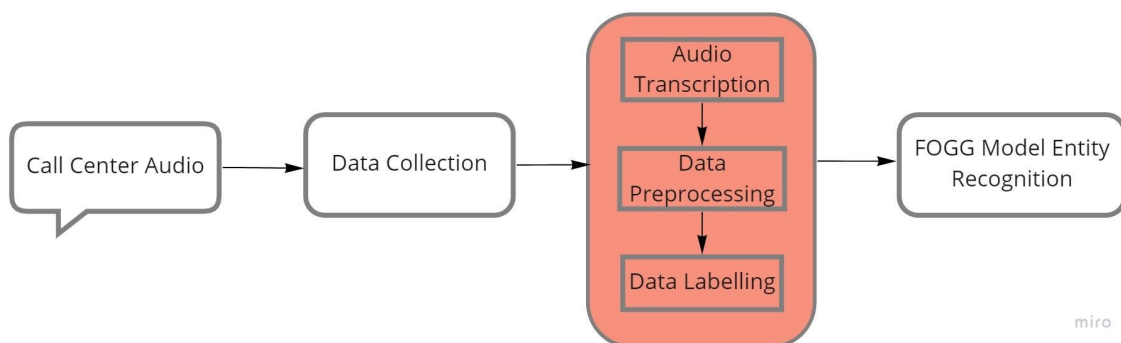


Figure 2: Methodology for creating a Fogg Model Entity Recognition (FMER) model

2.1 DATA DESCRIPTION

The dataset used in this study is from the call centre data of a top supplier of family planning products in Nigeria. About 101 audio files were transcribed, due to data sensitivity, all data used were transcribed by in house researchers. All personal identifiable information was also removed before model training.

2.2 DATA LABELLING

The three elements (Motivation, Ability and Prompt) of the FOGG model in the transcribed text were labelled using spaCy TagEditor software (v.2.3.2), an open-source annotation tool. Table 2 illustrates how the FOGG model’s elements were annotated in the transcribed conversational text.

Table 2: Label Guide for the FOGG model elements on the call center conversation.

Conversation	Motivation	Ability	Prompt
” Please I want to ask you of something? Please go ahead under what i saw here on your pamphlet according to two years pregnancy prevention okay.”	saw here on your pamphlet	two years pregnancy prevention	-
”what we do on this helpline we tell people on how to prevent pregnancy and child facing and how to prevent hiv aids but since the person already have hiv i will suggest the person should visit a medical doctor on that please, i will suggest the person should use our fiesta condom in case the person is going through”	-	-	visit a medical doctor, use our fiesta condom
”how may i assist you? I saw a post online and let me call to know what i don’t understand .Please visit our website www.honeyandbanana.com to learn more about our contraceptive methods and services”	saw a post online call to know	-	visit our website www.honeyandbanana.com

2.3 FOGG MODEL ENTITY RECOGNITION (FMER) MODEL TRAINING USING SPACY

An open source software library, spaCy², for advanced natural language processing was used as the framework of choice for FMER training. The annotated data was formatted from json files to the spacy gold standard. Then the data was split into training /test sets (80/20). As recommended in the official framework documentation, entities in each class had at least 50 representative expressions. Then the model was trained in 30 iterations, the best model was saved.

3 RESULT

Table 3-4 shows the evaluation metrics based on the FMER model trained using the spaCy framework

Table 3: General performance metrics for the FMER model

	Total number of words	F1 Score	Precision	Recall
FMER	11510	98.5	98.9	98.1

²<https://spacy.io/>

Table 4: Individual entity performance metrics for the FMER model

Entity	No of Exam- ples per en- tity	F1 Score	Precision	Recall
Motivation	≥ 50	98.2	98.2	98.2
Ability	≥ 50	98.4	100	96.0
Prompt	≥ 50	98.8	97.6	100

4 DISCUSSION

To assess the performance of the FMER model which is a classification model, F1 score, Precision and Recall were the metrics of choice. Table 3 shows the metrics of the general model and Table 4 shows a more granular entity based scoring. The general intuition is that there is general model performance and then performance per entity type.

Welcome to Honey and Banana connect good afternoon my name is dami may i know your name how may i assist you sir okay well actually uhm i just when i saw the advert that you know call for pregnancy prevention tips so i will like to know more about the product and services you know all the things that are that's why i called okay you are actually calling the right channel this is dkt nigeria what we do is **promote family planning MOTIVATION** and **prevention of HIV and AIDS MOTIVATION** and we have different contraceptive methods for you and your partner we have what is called Lydia IUD which is just a c or y shaped device that is like a small flexible plastic and it is inserted in the uterus for contraception and your partner can get this for around **three thousand naira ABILITY** it can last her for between 5 or 10 years depending on **how long ABILITY** she wants to sit **how long ABILITY** she wants to stay and the one she decides to go for we have Levofem as well which is a safe low dose pill taken daily to **prevent pregnancy MOTIVATION** and it contains **twenty eight pills ABILITY** so **your partner takes one everyday PROMPT** so as to get protected for a month she can get that for between fifty to hundred naira in pharmacies in chemist and mating stores but for a first time user we will always **suggest PROMPT** that she get to see her doctor so that they can actually **recommend her recommend PROMPT** it for her aside this we have what we call implant and the implant we have our DKT include implant on nrx and this is just like a small flexible rod which is just placed under the skin of the upper arm to **prevent pregnancy MOTIVATION** and it is as small as a match stick and can **prevent pregnancy MOTIVATION** up to **three years ABILITY** and for our implant nrx your partner can get that around **three thousand in clinics ABILITY** and hospitals around you but aside this we have our postpill which is an emergency pill and it is a one dose after sex pill which your partner can always get in pharmacies chemist and mating stores in your neighborhood for around two hundred and fifty naira and we always say postpill is your last chance to **prevent pregnancy MOTIVATION** however post pill should not be used more than four times in a month aside these we have our Sayana press injection which is a low dose contraceptive injection that is given every **three months ABILITY** and it comes with a very small needle in a prefilled ready to use syringe and its injected into the skin of the thigh or the stomach which is less painful and your partner can get the Sayana press for around **three fifty to four hundred naira ABILITY** in pharmacies in clinics and hospitals around you but aside this we have the fiesta condoms for

Figure 3: Prediction view of FMER on test data

The use of a postpill which is called the emergency contraceptive pill that **needs to be taken PROMPT** immediately after unprotected intercourse it **is a ABILITY** single dose that **needs to be taken PROMPT** After unprotected intercourse and can still be taken **within 5 days ABILITY** After the unprotected intercourse and we also **advise PROMPT** Our customer not use more than 4 post pills **in a month ABILITY** Use of our daily pill which is called levofem The levofem is a daily contraceptive pill that **prevent pregnancy MOTIVATION** it contains 28 pill if taken accurately you will be prevented from **a month ABILITY** You can get it for **50 naira ABILITY** to And we also **advise PROMPT** Of the daily pill should always speak to your healthcare provider before they will be able to We also have Our injection that **prevents pregnancy MOTIVATION** for the period of **three months ABILITY** It's call sayana press injection you can get it for **350 to 500 ABILITY** Depending on the area you are buying it from We also have our implants Which **prevent pregnancy MOTIVATION** for the period of 3 You can get it for **3000 ABILITY** And also our IUD which is called Lydia IUD It **prevents pregnancy MOTIVATION** for the period of 5 to 10 years it all depends on **how long ABILITY** you Choose to **prevent pregnancy MOTIVATION** ma And all our **contraceptive method they are reversible ABILITY** Reversible in the sense that one you are ready to get pregnant and you stop any of the method Your body will turn back to normal and fertility can take place within a short Our product is not postinor so our product here is postpill And the postpill is not for Abortion. What is for is just to **prevent pregnancy MOTIVATION** Ok after unprotected intercourse So that is why we **advise PROMPT** our customers to always **use it immediately PROMPT** after unprotected intercourse Most especially if a woman is on her ovulation and he had unprotected intercourse That is what the postpill is for Please ma I will **suggest PROMPT** you **consult with your medical health doctor PROMPT** on that ma What we do one this help line we only **Sanitize people on pregnancy prevention PROMPT** and child spacing That is what this helpline is all about Please you can feel free to call us whenever you have any enquires to make Our helpline is open from **Monday to Saturday ABILITY** **8am to 8pm ABILITY** We would be here to assist you Before you go ma I like to ask you a few questions will that be okay by you Or you heard it from a clinic or from a poster Please kindly **log on to our website on www.honeyandbanana.com PROMPT**

Figure 4: Prediction view of FMER on test data

Figure (3-4) shows a prediction view of the FMER model on test data. Each entity class predictions are represented by unique colours; Yellow as Motivation, Purple as ability then Red as prompts. Human eyeballing of predictions also showed a reasonable performance of the FMER model. In this work we explored the use of machine learning as a tool for information extraction in an interesting use case of language and healthcare, with a small dataset, a working proof of concept for phrasal extraction of key entities. One of the next steps is further finetuning of the labelling guide to be more specific to family planning and not general Fogg's model.

5 CONCLUSION

In this work we shared the process design and a proof of concept for the practical application of artificial intelligence as a tool for information extraction on family planning related call center data, based on the Fogg behavioural model in a low resourced health system. The general performance of the bespoke model called the Fogg Model Entity Recognition (FMER) model had an F1 score of 98.5. This is part of an ongoing project and the authors hope to share future findings.

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