Prediction of the ability and motivation to adopt Reproductive Health Behavioural change using anonymized customer center audio data

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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 behavioral 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 [12]. 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 [3]. 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 [11]. 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 [4, 8, 13], promoting role models and demonstrating pathways to change through mass media [7], and engaging communities through dialogues, communication, and empowerment [14]. 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 [6].The evidence has shown that SBC programs can effectively influence family planning-related behaviour and even reach those not directly exposed to the intervention [1].

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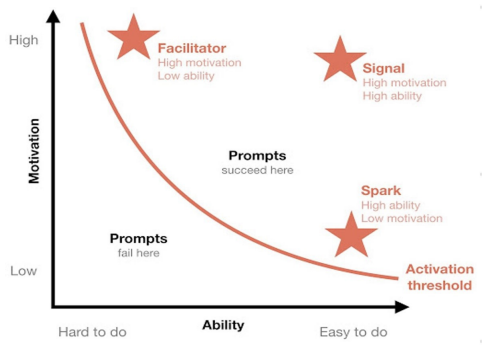

Figure 1: FMER

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

Table 1: Core FBM motivators

A study by DKT Nigeria[1] 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 [5] 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

@@@ MISSING FIGURE @@@

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.

Fogg [5] 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.

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 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.

[1] `https://www.dktnigeria.org`

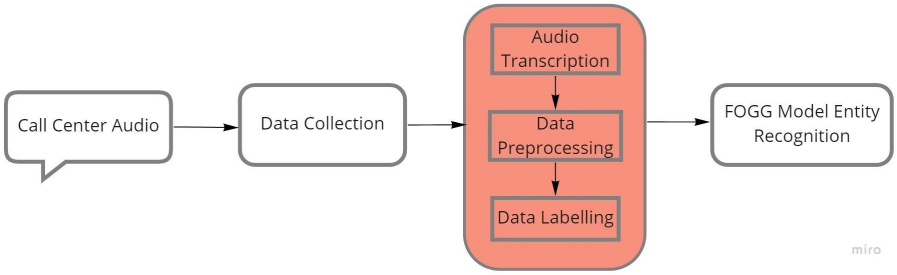

Figure 2: Methodology for creating a Fogg Model Entity Recognition(FMER) model

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.

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. Its 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 [2, 10]. Named entity recognition systems 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 [9]. The efficiency of NER is measured by F1 Score, Precision and Recall like standard classification tasks.

In this study, we aim to harness 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

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.

2.1 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.

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

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

	F1 score	Precision	Recall
FMER	98.5	98.9	98.1
Motivation	98.2	98.2	98.2
Ability	98.4	100	96.0
Prompt	98.8	97.6	100

Table 3: Performance metrics for the FMER model (row 1) and broken down by entity type (rows 2-4). The FMER model used 11,510 words, and each category (Motivation, Ability, Prompt) had ≥ 50 examples per type.

2.2 Data labeling

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. Table2 illustrates how the FOGG model's elements were annotated in the transcribed conversational text.

2.3 Fogg model entity recognition (FMER) training using spaCy

An open source software library, spaCy[2], 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 Results

Table 3 shows the evaluation metrics based on the FMER model trained using the spaCy framework. We obtained F1 scores above 98 within each category, with 98.5 F1 overall.

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 along with a more granular entity based scoring. The general intuition is that there is general model performance and then performance per entity type.

Figure 3 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.

[2] `https://spacy.io/`

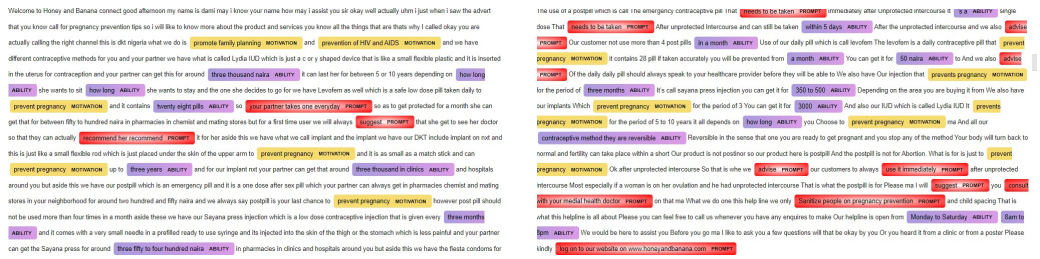

Figure 3: Prediction view of FMER on test data.

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-resource health system. The general performance of the be- spoke 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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