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Fighting Obesity: A Proposed Formula for Calculating Gamified Airtime Rewards for Using Public Exercise Equipment

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Abstract: Health agencies around the world are documenting a growing obesity crisis with the world's population becoming more and more overweight. There have been a number of attempts to tackle the growing obesity problem using smart devices such as walking apps on GPS enabled devices and wearable devices. Such suggested solutions, however, require enough internal motivation on the part of the overweight person to download the app or purchase a wearable device. Another possible solution is to give real world rewards on public exercise equipment. This would provide opportunities to *impulse exercise* (as opposed to *impulse buy*). One of the difficulties here, however, is how to price these real world rewards. This paper proposes a generalised formula or algorithm for providing real world rewards on public exercise.

Keywords: Exercise, obesity, health

1 Introduction

The population of the world is becoming more and more obese. According to the World Health Organisation (WHO), in 2014 1.9 billion adults over the age of 18 years were overweight or obese. This amounts to 39% of the world population. In addition, nearly 42 million children under the age of five were considered to be obese. The majority of the world population now lives in countries where more people die of problems relating to obesity than die of problems relating to malnutrition [1].

Other health researchers, including the Harvard TH Chan School of Public Health, have shown that obesity contributes to a wide variety of health issues including heart disease, stroke, diabetes, high blood pressure, unhealthy cholesterol, asthma, sleep apnea, gall stones, kidney stones, infertility and as many as eleven different types of cancers including leukemia, breast cancer and colon cancer [2].

This growing scourge of obesity is not just a First World problem. Studies in sub-Saharan Africa have shown that the region is not immune to obesity related issues even while it is battling malnutrition. 2010 data from South Africa put the estimated overweight and obesity rate at 41.3% for men and 68.5% for women. Only one African country had higher obesity rates than South Africa. Seychelles' overweight and obesity rate for men was 63.8% and for women 73.8% during that same period [3]. There is evidence of the overweight and obesity rate constantly increasing in all of sub-Saharan Africa.

There is a growing number of smart phone applications and wearable devices which are attempting to tackle this problem. Smart phone apps such as JogTracker [4] encourage participants to log the distance that they run, jog, or walk and upload these values to social media. Apps such as Zombies, Run! [5] provide a more gamified approach by placing the participants in an artificial world populated by Zombies and the participants must run to escape the zombie hordes. Wearable devices such as Fitbits [6] measure exercise throughout the entire day and also measure exercise where a GPS might not be accessible (such as climbing stairs inside an office block).

However, the use of smart phone apps and wearable devices require a certain internal motivation on the part of the user and also impose a certain financial barrier to entry. The potential user must be able to afford a smart phone or wearable device. In the case of the smart phone, the user must also take the initiative to download specific apps to the smart device and/or buy additional devices such as wearables.

External motivation is another possible way to tackle the growing level of obesity. The term *impulse-buying* is used to describe the situation where some external stimulus is used to motivate a consumer to unexpectedly buy a product. By a similar argument, the term *impulse-exercise* could be used to describe a situation where some external stimulus is used to motivate a person to immediately exercise with no required preparation.

This paper will first provide a number of examples of smart devices and apps that rely on internal motivation. The paper will then provide a number of examples where impulse-exercise is motivated by external stimulus. Finally, the AirCycle project will be described which created a prototype device and associated software which could be placed on public exercise equipment to provide low barriers to entry for public exercise in a gamified manner. The AirCycle provided cell phone airtime rewards for public exercise.

Unanswered questions, however, regarding the size of the airtime reward were not answered by the AirCycle project. This paper investigates a configurable formula for airtime rewards in such situations.

2 Internal Motivation

For people who are intrinsically motivated to exercise, there are a wide variety of apps and devices available that can be purchased and/or downloaded. These apps and devices offer a variety of rewards for successful exercise. Some of the rewards are simply virtual rewards. Apps such as JogTracker and Zombies Run (mentioned in Section 1) merely offer points on a leaderboard with possible additional badges and levels. Other apps and devices offer real world value in their rewards.

Bitwalking Dollars [7, 8] is a crypto-currency, which encourages people to *mine* Bitwalking Dollars by walking. It is necessary for participants to have both a smart phone with an onboard GPS as well as the Bitwalking app. The Bitwalking Dollars are verified through an algorithm, which matches the GPS track with Wi-Fi connections along the route. One Bitwalking Dollar is currently equivalent to approximately 30,000 steps. The Bitwalking Dollars can be redeemed through partner organisations.

Good Coins [9] is Candadian based reward system, which rewards good behaviour in society. This includes walking, bicycling, etc, but also includes actions such as volunteering and recycling. The GoodCoins which are earned can be redeemed at partner organisations and stores. Research by [10] shows that people are most willing to complete tasks if the rewards are between 200 and 300 GoodCoins.

FeatApp [11] is an Italian based reward system, which encourages people to both exercise and eat in a more healthy manner. As with other exercise tracking apps, FeatApp tracks the user while walking, running, and bicycling. The points which are earned can then be redeemed for healthy foods. One coin is the equivalent of 500 steps. According to the FeatApp website, the partner food outlets “...are passionate about their store and their products... [They] pay attention to ingredient's and promote good, healthy food choices through seasonality and local procurement.” [12].

Although these apps and devices appear to encourage exercise, they have motivational and financial barriers to entry. Besides requiring the intrinsic motivation to download the app, in the case of Bitwalking and GoodCoins, the facility is open only by invitation. At the time of writing this paper (March, 2016), the FeatApp facility is only available on iPhones and is not yet available on lowercost Android devices [12].

Another major disincentive for lower income users is the fact that in the case of GoodCoins and FeatApp, the "coins" can only be redeemed at partner stores against further purchases. In Malawi, however, Bitwalking Dollars can be redeemed through the third party partner, Skyband, for Internet connectivity without requiring additional purchases. Skyband provides Internet service options, including numerous WiFi hotspots across Malawi [13].

3 External Motivation

Programs that provide external motivation to exercise often use in-your-face marketing. A prime example of this would be motivational messages on the risers of stairs (the vertical portions of stairs) as can be seen in Illustration 1.

Illustration 1: Banners on stair risers (image credit www.birmingham.ac.uk)

Research has shown that in low pedestrian volume areas, advertisements on stair risers are effective, but in high volume areas (such as train stations), the pedestrians obscure the message from the pedestrians behind them. In such cases, wall posters are more effective than stair risers [14]. Another approach, which has been taken to make climbing stairs more fun and engaging, is the use of piano stairs [15, 16]. In the case of piano stairs, the entire stairway is turned into a piano keyboard and notes are played as a person walks up and down. One of the first implementations of piano stairs was at the Odenplan metro station in Stockholm. Both of these examples, however, provided no tangible reward to the participant other than a bit of healthy exercise and some enjoyment and music. These implementations, even though not providing a tangible reward, were successful in motivating some of the commuters to rather take the stairs than the escalator.

The Moscow subway system, however, implemented a program entitled "Squat a 30, Ride for Free" which allowed participants to do 30 squat exercises and then receive a free ride on the Moscow subway system [17] as can be seen in Illustration 2. A similar project was initiated in the Mexico City subway system [18]. Commuters were given the option of doing ten squat exercises in exchange for tickets to the subway. These projects were successful in their respective countries in motivating impulse exercise in commuters. This provided proof that people could be motivated to do short bursts of exercise for some form of real world reward.

Illustration 2: Squat a 30 (image credit: BrandingMagazine)

At Amsterdam's Schiphol airport, stationary bicycles, provided by WeWatt [20], are set up that charge electronic devices whilst the user is cycling. This system is depicted in Illustration 3. The users are provided with a free means of exercise, which allows them to stretch their legs between flights, and are rewarded with a significantly charged phone after half an hour of cycling.

Illustration 3: Amsterdam airport (image credit WeWatt)

These five examples showed how *impulse-exercise* with very low (or even non-existent) barriers to entry can be used to encourage exercise. The stair-risers simply provided motivational messages to encourage people to exercise. The piano stairs offered fun and music in exchange for exercise. Both the Moscow and Mexico City subway systems offer tangible real word value in the form of subway rides in exchange for exercise. The Amsterdam bicycles offer electricity in exchange for exercise.

These types of projects inspired the underlying project described in this paper. It is important to just compare the Moscow "Squat a 30, Ride for Free" project with the similar project in Mexico City which only required 10 squats in order to ride the subway. At the time of drafting this paper, there appears to be no published reasons on why 30 squats were required in one city and 10 squats were required in the other city. This difference forms the basis of this paper.

The next section of this paper describes the AirCycle project which encouraged participants to ride on a public exercise bicycle in order to received cell phone airtime rewards. The section will describe the project from a technical point of view. The subsequent section proposes a formula for calculating airtime rewards in exchange for exercise.

4 AirCycle

The AirCycle Project was a Design Science Research project to develop a prototype physical device and associated software to enable public exercise devices to dispense airtime awards. The physical device would be attached to a public exercise device. A low cost Android tablet with a bluetooth printer could be positioned nearby in a secure enclosure. This would provide low barriers to public exercise. The participants would not have to purchase smart devices and would not have to download any apps.

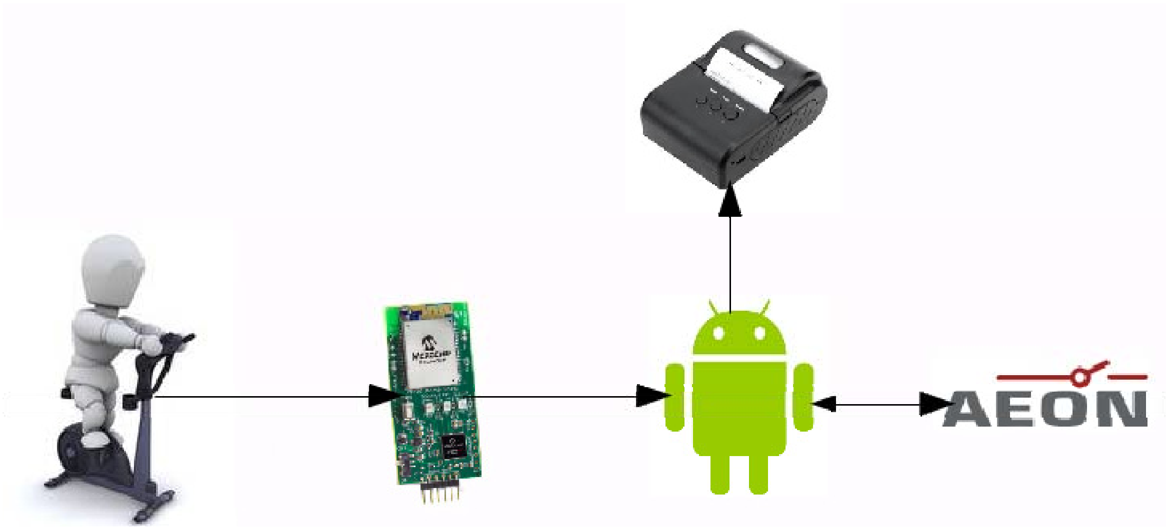

Illustration 4: High level architecture

This project was fully reported at [19]; however a short description of the prototype is outlined here. The AirCycle prototype showed how low cost exercise equipment can be augmented with a lowcost device and associated software to encourage the public to exercise in exchange for airtime rewards. The prototype consisted of three major sections:

1. A Wi-fi G demo board manufactured by Microchip was used to determine if the exercise bike was in use. The board consisted of a PIC32MX695F512H 32-bit microcontroller and a MRF24WG0MA IEEE 802.11 Wi-Fi Transceiver Module. The board generates its own wifi-hotspot and hosts a small webserver. A sensor on the microcontroller detects whether a revolution has been made and updates a webpage. The board and sensors are powered by AAA batteries. This can be seen in Illustration 5.
2. An Android app was developed that monitored the web page hosted by the board described in Paragraph 1 above. When the Android app determined that an award must be given, the app communicated with the test version AEON commercial platform as will be described in Paragraph 3. A voucher for airtime was obtained and printed on a lowcost bluetooth printer.
3. The airtime rewards were obtained through the AEON commercial service which is a proprietary platform of Blue Label Telecoms based in Johannesburg. The AirCycle

project was able to communicate with the AEON test platform which then forwarded requests to associated test platforms of four major cell phone carriers in South Africa: MTN, Vodacom, Cell C, and Telkom Mobile. A voucher for cell phone airtime was obtained and was sent back to the Android app described in Paragraph 2 above for printing. It is important to note that the AEON platform itself is a commercial platform and not actually part of this research.

A high level overview of the architecture of the prototype can be seen in Illustration 4 and a photo of the device and sensor in operation can be seen in Illustration 5. Two evaluations were done of the project. The evaluations showed that there was not a consensus among the evaluators to a number of questions. This lack of consensus forms the basis of this paper.

Illustration5: AirCycle Prototype

5 Previous Unanswered Questions

The volunteers who helped evaluate the AirCycle prototype included university students and professionals employed in the Information Technology industry. The questions which had the greatest diversity in answers which appeared in the evaluations provided by those volunteers and in verbal conversations with them included:

1. Should airtime be awarded on distance covered? On speed? Or on time?
2. What value should the airtime award be?

Although it was nearly unanimous that the airtime award should be based on distance covered, no suggestions were made by the participants as to the effective radius of the wheels of the bicycle or the gearing. In other words, an exercise bicycle does not actually move. One rotation of the pedals is converted to distance by emulating a physical bicycle with specific gearing and wheel radius.

In addition, the participants' suggestions for the value of the airtime reward per kilometer ranged from R1.00 to R20.00 per kilometer travelled. In retrospect, this was probably to be expected because the participants in the evaluation included unemployed students and well employed IT professionals.

However if the device was connected to an exercise device such as a weight lifting machine, the concept of distance is not applicable. A more general solution of awarding airtime based on the number of light pulses would be necessary.

One suggestion from a university commerce student also suggested that the amount of the award should also be based on the amount of funding available to the AirCycle, on the number of people expected to use the AirCycle during a specific period of time, and on the location of the AirCyle. His example was that an AirCycle placed in the hostel of a rural highschool could give different airtime awards than an AirCycle based outside of a commercial gym in an urban area.

Other unanswered questions included whether or not there should be an upper limit in time, distance (pulses), or value that a person could be awarded.

These unanswered questions form the basis of this research.

6 Research Methodology

The research question for this project was:

> What is the best configurable method for calculating airtime rewards for reciprocating (going back and forth) or rotary (such as a bicycle) exercise equipment?

It is important to note that this research is not about the actual value of the end reward. This research is about generating a method or formula for calculating the end reward taking a number of factors into account. The method or formula must be usable for a wide range of exercise equipment. That would mean, for example, that one revolution of an exercise bicycle may not have the same value as one lift on a weight machine.

Any solution would need to cater for a wide variety of public exercise equipment. Examples of these varied public exercise equipment can be seen in Illustrations 6.

Illustration 6: Sample public exercise equipment at Walter Sisulu Botanical Gardens, Johannesburg

It is important to note that in these three example photos, each pass of the photo diode past the Wi-fi G board represents different things. For example, on the equipment in the far left of Illustration 6, each pass would represent one step of some length; on the equipment in the bottom right, each pass would represent a pull on a row boat which propelled the boat some distance; and in Illustration 5, each pass would represent the distance travelled by the bicycle with a given radius wheel and a given gearing.

7 Proposed Formula

The formula to cater for the wide variety of exercise equipment and a wide variety of locations is

$$A = f_1 a \frac{(f_2 c + f_3 t + f_4 s)}{n}$$

where

A	Amount of the airtime reward
a	Amount of the funding available for a given time period
c	Number of “clicks” or cycles of the photo diode past the Wifi G board
t	Number of seconds (time) the user was exercising
s	Speed measured in clicks/second
n	Number of people expected to use the equipment during a given time period

The four factors f_1 through f_4 allow the owner of the installation to configure specifically for what is considered important and for the economic environment. For example one installation may consider speed to be more important than distance while a different installation may wish to reward for time exercised.

f_1	General factor to bring the resulting value within the economic environment of the physical area. That would mean that an installation outside of a gym in an urban area could give different award sizes compare to a high school residence in a rural area.
f_2	Adjustment factor for number of clicks. This value needs to cater for the assumed radius of the wheel in the case of a bicycle, or cater for the step length, or cater for the assumed distance rowed in a rowing machine. This factor could be zero if the installation was not awarding “distance.”
f_3	Adjustment factor for the time exercised. This factor could be zero if the installation was not awarding “time” exercised.
f_4	Adjustment factor for the average speed attained. This factor could be zero if the installation was not awarding “speed.”

This algorithm would allow the owner of a specific installation to reward the type of desired exercise. The amount of the award could be scaled to cater for the amount of funding for the equipment and for the estimated number of people who would use the equipment.

This algorithm itself does not limit the size of the award. Limitations such as being awarded a maximum of ten Rand would have to be implemented in addition to the algorithm.

It should also be noted that the user group would alter depending on the location and the reward value of the system. The formula is set up in such a way that the installation can be adjusted to accommodate the most likely user of the location. This allows for a variable target market.

8 Results

The aim of the AirCycle was to provide impulse exercise with a real world reward in order to inspire people to exercise. The real world reward needs to have a high enough value that the system would encourage people to use it. The proposed algorithm allows for adjustments to be made depending on the location of the system, the type of people who will use the system, and the amount of airtime available to the supplier.

The algorithm is tested by adjusting the factors suitable to the situation and determining whether or not the system inspires enough users to exercise. It should also be determined that if there are many users, does the system provide too much airtime for the supplier to sustain.

The adjustable nature of the algorithm makes it ideal for mounting the system on various types of exercise equipment without having to change the core of the system.

The volunteers who tested the AirCycle prototype all agreed that the system would be successful in inspiring impulse exercise, and they concur that the amount of airtime rewarded needs to be adjustable depending on demographic.

Even though the system is designed in a way that encourages a variable target market, provides impulse exercise, and a real world reward, there will always be those who would not consider using the system. These people would most likely be those who need the system the most. There is only so much external motivation can do. Some form of internal motivation is still needed from the user to actually start exercising. However, due to the monetary reward, this system would be more successful than devices which have rewards that are only virtual, such as the previously mentioned JogTracker.

9 Conclusions

The world is experiencing an obesity epidemic. This growing problem is not just a first world problem. Obesity is also becoming a greater and greater health issue in the developing world. Obesity contributes to a wide variety of health issues including heart disease, stroke, diabetes, high blood pressure, unhealthy cholesterol, asthma, sleep apnea, gall stones, kidney stones, infertility and a number of cancers.

By implementing systems that provide free, impulse exercise, the health of the user would be improved, significantly or not, leading to societal benefits. By improving the health of the user, economic benefits are also brought about as studies have shown that having a healthy population leads to a productive population.

There have been a number of projects, which use smart devices to monitor and encourage people to exercise. These types of interventions require an amount of internal motivation on the part of the overweight person to buy a device or install an app. Other interventions depended on the in-you-face presence of devices or equipment in public places to inspire participants to exercise. Such interventions can give participants real world awards.

One of the problems encountered with giving real world awards is the calculation of the award value. This paper proposed a configuration algorithm to calculate these award values taking in to account a number of factors including the funding available to the device, the number of people expected to use the device during the time period, etc. This formula has been theoretically tested through simulation. If more funding could be obtained, the formula could be tested on actual exercise devices.

Future work could be done by implementing the system on a variety of exercise devices and determining the effect of the formula, whether or not the variability of the formula makes it possible to incite impulse exercise in various types of people. Due to the rise in obesity in sub-Saharan Africa, implementing this system at various locations and studying the effects, more solutions to combating this epidemic are likely to arise.

References

[1] World Health Organisation, "Obesity and overweight, fact sheet no 311," WHO, Tech. Rep. 311, January 2015. 2015.
[2] *Obesity Consequences*. Available: http://www.hsph.harvard.edu/obesity-prevention-source/obesity-consequences/
[3] Agyemang, Charles, et al. "Obesity in sub-Saharan Africa." *Metabolic Syndrome: A Comprehensive Textbook* (2016): 41-53.
[4] (2011). *Jogtracker website*. Available: http://www.jogtracker.com/.
[5] (2015). *Zombies, Run! Websit*e. Available: https://www.zombiesrungame.com/.
[6] *Fitbit Corporate Websit*e. Available: https://www.fitbit.com/uk/product/corporate-solutions
[7] *Bitwalking Websit*e. Available: http://www.bitwalking.com.
[8] *Bitwalking dollars: Digital currency pays people to wal*k. Available: http://www.bbc.com/news/technology-34872563.
[9] (2016). *Good Coins websit*e. Available: https://www.goodcoins.ca/.
[10] T. van Mierlo, D. Hyatt, A. T. Ching, R. Fournier and R. S. Dembo. Behavioral economics, wearable devices, and cooperative games: Results from a population-based intervention to increase physical activity. *JMIR Serious Games 4(1),* pp. e1. 2016.
[11] H. Garrison. Using mindfulness to explore the future of food.
[12] (2016). *FeatApp websit*e. Available: http://featapp.com.
[13] (January 12, 2016). *Bitwalking and Skyband introduce new plans for Malaw*i. Available: http://www.bitwalking.com/press/2016/1/12/bitwalking-and-skyband-introduce-new-plans-for-malawi.
[14] E. K. Olander, F. F. Eves and A. Puig-Ribera. Promoting stair climbing: Stair-riser banners are better than posters… sometimes. *Prev. Med. 46(4),* pp. 308-310. 2008.
[15] M. Peeters, C. Megens, E. van den Hoven, C. Hummels and A. Brombacher. "Social stairs: Taking the piano staircase towards long-term behavioral change," in *Persuasive Technolog*yAnonymous 2013, .
[16] D. Graham-Rowe. Public planning: Designs fit for purpose. *Nature 493(7434),* pp. S4-S5. 2013.
[17] V. Bojovic. Squat a 30, ride for free. 2013.
[18] *Mexico's latest way to beat the obesity epidemic: make commuters do squats for free subway ticket*s. Available: http://www.theguardian.com/society/shortcuts/2015/jan/27/ mexico-beat-obesity-make-commuters-do-squats-for-free-subway-tickets
[19] L. Butgereit and L. J. Martinus, "AirCycle proof-of-concept: Work towards using gamification and IoT to fight the global obesity crisis," in *3rd International Confernce on Advances in Computting, Communication & Engineering (ICACCE 2016) 28-29 Nov, 2016,* Durban, South Africa, 2016, .
[20] *WeWatt Websit*e. Available: http://www.wewatt.com.