Analyzing the Prospects and Acceptance of Mobile-based Marine Debris Tracking

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Abstract. Marine litter has been considered as a growing concern within different coastal areas around the world and to address this issue, there have been apprehensions from various stakeholders including international regulatory bodies and governmental institutions, among others. Amongst the different technologies being promoted by key stakeholders, mobile-based marine debris tracking is being promoted due to the widespread utilization of mobile devices. However, although a few mobile based marine debris reporting, and tracking tools have emerged, limited research has been undertaken about the acceptance of such solution by end users. Assessment of acceptance of this technology is important in order to understand aspects that impact future adoption. To address this gap, this paper investigates and analyses the acceptance of mobile-based marine debris tracking. In order to achieve the purpose of this paper, an application called "Mau Marine-Litter Watch" was developed and assessed through application of the Technology Acceptance Model.

Keywords: Marine Debris Tracking, Technology Acceptance Model, Marine Litter, Mau Marine-Litter Watch, Mobile Application.

1 Introduction

Marine litter has been regarded as a problem of global dimensions that affect human beings, wildlife and the economic health of coastal communities to differing extents [1]. Marine debris has been defined as "*any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment*" [2], and recently, it was estimated that 5.75 Trillion pieces of marine debris were to be found in the ocean [3]. The most widely recognized materials that form marine debris include plastics, wood, fabric, rubber, and paper and these have severe impacts on the ecosystem [1]. For human beings, marine debris such as sharp glasses and broken fishing nets are considered hazardous since these materials are often the cause of multiple injuries [4]. Moreover, the biodegradation of certain debris release toxic gases in the sea and this adversely affects human beings principally through the food chain [5]. Furthermore, marine litter makes beaches unattractive and discourages beach users from performing activities and from visiting such areas [4]. On the other hand, marine litter also affects the marine environment and wildlife principally through entanglement

in fishnets and ingestion of plastic bags or bottle caps thus causing injury or death of such animals [6, 7]. In addition, debris is known to destroy habitats though wearing of the seabed due to accumulation of toxic waste in such areas [8].

Owing to the increasing concerns related to marine debris, the National Oceanic and Atmospheric Administration (NOAA) from America has set up a Marine Debris Program with the purpose to monitor, track and further explore polluted areas within their geographical location [9]. Different technologies are also being promoted in the process, and recently there has been the promotion of the mobile platform for litter tracking principally because of the widespread utilization of mobile devices, which has also exceeded the number of individuals around the world [10]. As such, there has been the emergence of different mobile-based marine litter tracking tools, having the key purpose to enable end users to report and track marine debris in different locations through a mobile application.

Even though such applications have been considered as useful, limited assessment has been conducted about whether this technology is accepted by the intended users or not. In other words, the assessment of this technology is essential so as to understand aspects that impact future adoptions of such tools [11]. Technology acceptance here relates to the way by which people accept and perceive the use of technology [12] and is important to study since it provides sound predictions of usage [13]. Taking cognizance of this gap, this paper investigates and analyses the acceptance of mobile-based marine debris tracking.

2 Related Works

The first development of mobile-based marine tracking tool originated in 2010 at the University of Georgia through a partnership of the NOAA Marine Debris Program and the Southeast Atlantic Marine Debris Initiative (SEA-MDI) [14]. From this partnership, the mobile-app called Marine Debris Tracker was developed. The application enables users to report marine litter in a simple manner in the U.S., where the tool can automatically capture the geographical location of the litter being reported to eventually upload the details when Wi-Fi connection is established. Once reported, the information is relayed to related American parastatal bodies and Non-Governmental Organizations (NGO). Similarly, the European Environment Agency (EEA) in collaboration with the Marine Conservation Society in the United Kingdom funded and developed a Marine Litter Watch mobile application [15]. The tool was launched in 2014, with the purpose to tackle the issues of marine debris within the European territory. It uses a different slightly different approach as compared to Marine Debris Tracker where collected data are uploaded to a public database and for use in a geographical information system (GIS) that allows web developers to embed interactive maps on their website in order to spread awareness.

Fig. 1 – Marine Debris Tracker

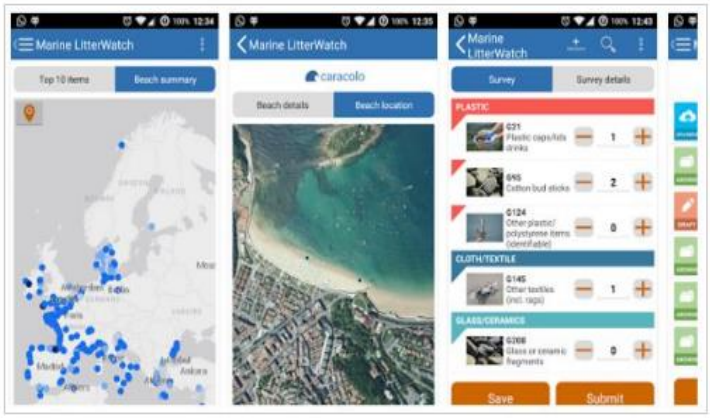

Fig. 2 – Marine Litter Watch

Although being useful, these tools have different limitations where the key ones include country or region specificity and that the tools are only linked to NGOs and parastatal bodies within the region addressed. Furthermore, the tools have limited options for reports and charts. In addition, limited work has been undertaken to assess the acceptance of such tools, as discussed earlier.

3 Proposed Application: Mau Marine-Litter Watch

In order to address the mentioned problems and to achieve the purpose of this paper, a mobile application named 'Mau Marine-Litter Watch' was designed and implemented for Mauritius island. This island was considered for the study since marine litter has been regarding as a growing potential threat that could affect marine life, the country's economy, tourism and coastal areas [1, 16]. Mau Marine-Litter Watch aims to help coastal users report and track marine debris in Mauritius in order to showcase the current severity of this issue within the island. To implement the application, the Xamarin technology along with .Net Framework was considered since it enables cross-platform integration where the codes can eventually be compiled to target key operating systems including Android, IOS and Windows executable files. Based on the crowd-sourcing model, reporting of marine debris can only be initiated by end users in Mau Marinelitter Watch and as such, registration is not required in order to reduce the number of processes in the application. The main feature of the tool is to allow users to add located marine debris by firstly, capturing a photo of the debris, selecting the size and type of debris (e.g. metal, plastic, glass, etc.), followed by providing a description of the latter. Furthermore, the latitude, longitude and region name of the debris is automatically retrieved with the use of Google API upon submission. Once a debris has been registered, a pointer is added on a Map to allow other users to clearly identify the location of reported marine debris as shown in the first image in Fig. 3. In addition, other users can use the interactive features in the tool to locate debris by different characteristics (e.g. type, size, location) as depicted in Fig. 3 and can also determine the route to be taken in order to collect the debris (shown in the right image in Fig. 3).

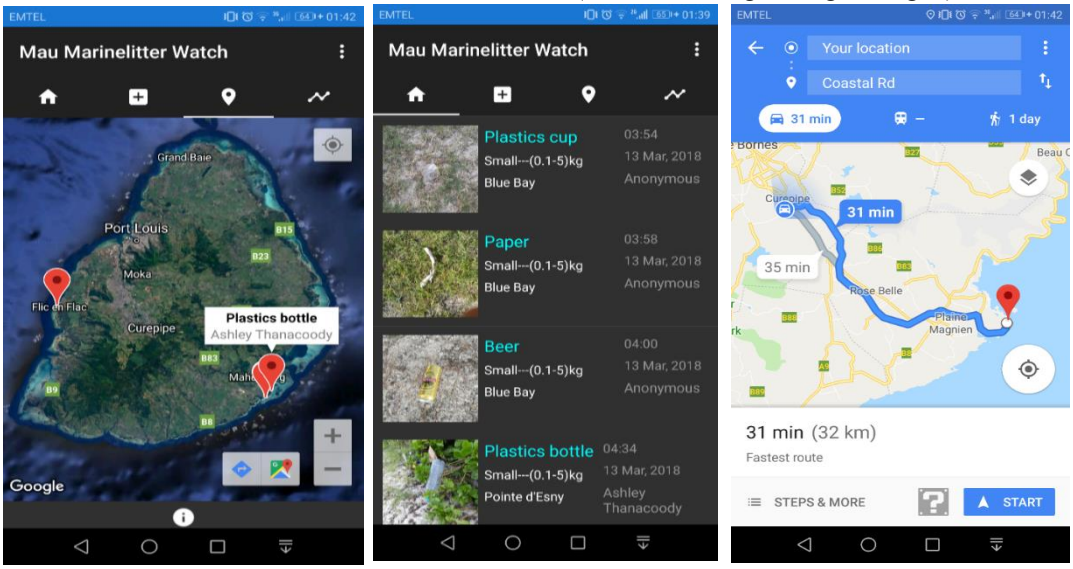

Fig. 3 – Key Features of Mau Marine-Litter Watch

Moreover, the mobile application also allows end users to generate different statistics, reports and charts including filtering by types of debris for a particular period

of time in addition to comparing debris in different regions as shown in Fig. 4. This can help NGOs or other organizations identify the most polluted coastal region as a benchmark to set priorities for beach cleaning activities. Also, energy saving design techniques were implemented in order to reduce energy consumptions of the application while also preventing it to heat-up the device [17].

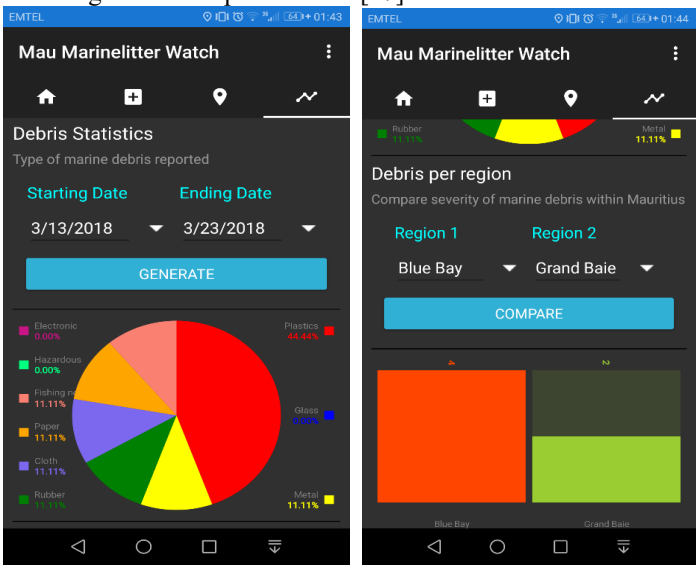

Fig. 4 – Charts and Reports in Mau Marine-Litter Watch

4 Evaluation Method

In order to evaluate the acceptance of mobile-based marine debris tracking, the Technology Acceptance Model was chosen since it is the most experimentally validated and widely used among acceptance assessment models including the Innovation Diffusion Theory [17]. TAM was proposed by Davis (1989) and Davis, et al. (1989) in order to investigate the reasons for users to accept or reject information technology [18, 19]. Furthermore, this model has been used in similar studies to assess technology acceptance of mobile commerce [20], wireless internet [21] and mobile learning [22], among others. According to TAM specifications, there are four main variables that are considered as major determinants of technology use, namely, Perceived Usefulness, Perceived Ease of Use, Behavioral Intention to Use [23]. Firstly, in the context of the assessment of technology acceptance of Mau Marine Litter Watch, Perceived Usefulness (PU) defines the degree to which an individual believes that using the application would be useful for the tracking marine debris. Furthermore, the Perceived Ease of Use (PEOU) determines the extent to which an individual acknowledges that using the mobile application would be free of cognitive effort. TAM suggests that the determinant factor for technology use depends also on the Behavioral Intention to Use (BTU), which co-relates to Attitude Towards Usage (ATU).

As procedures of the data collection process, a TAM questionnaire was prepared consisting of five sections, notably for the four variables described earlier in addition to the demographic details of participants. Each TAM variable has different questions or items assessed through Likert-5 scale (1 representing strongly disagree to 5 meaning strongly agree) and these questions were adapted from previous studies involving application of the model [24, 25, 26]. Following preparation of the questionnaire, data were collected in the coastal regions of Flic-en-Flac, Wolmar and Blue-Bay in Mauritius. As target audience, a total of thirty beach users were targeted for this study in order to meet the minimum number of test users required for such quantitative studies [27, 28]. Furthermore, beach users with different demographic details were targeted irrespective of age group, gender and country of origin so as to obtain opinions from all groups. To meet this target, 48 users were approached, where 18 were unable to participate principally due to unavailability of suitable phones, limited Internet access to install the application, language barriers, and amount of time needed for participation. With every participant, a brief of the research was first given and then ethical consent was sought using appropriate forms. Following ethical approval, Mau Marine-Litter Watch was installed on the mobile phone of the participant while also ensuring that the application is operational. Then, the participant was briefed on how to use the application while also providing explanations on the key features. After the briefing session, participants were given 1 hour to explore the beach area and utilize the application to report debris found, amongst other features explained earlier. After this duration, each participant was again met and was asked to fill-in the TAM questionnaire while also gathering some feedback on the application and evaluation process. The questionnaire was then collected and checked by the research team, in order to ensure its reliability and validity. The same process was repeated with every participant until the sample size of 30 participants was met. Finally, data collected from the questionnaire were input on SPSS for statistical analysis.

During the data collection process, different challenges were encountered. The first one involved the need for Internet connectivity for downloading the application from Google Play and many users did not readily have Internet access on their phone. As a solution, the application was shared through Bluetooth. Furthermore, a group of participants chose not to participate in the study as the group preferred to enjoy their time off on the beach. These challenges delayed the data collection process and it took a full week to be able to meet the targeted sample size.

4 Results and Discussions

As demographic details of participants, a slightly higher percentage of male respondents (notably 17 participants - 56.7%) took part in the study as compared to 13 (43.3%) female participants. Also, 23 local beach users (76.7 %) participated in the study as compared to 7 foreigners (23.3%). Furthermore, the majority of respondents were within the age group of 18-30 with a percentage of 53.5% as compared to 26.7% aged between 31-40 years and 20.0% aged above 41 years. Findings from the application of TAM are addressed as follows, starting by discussing each variable of the specifications.

4.1 Perceived Usefulness (PU)

As mentioned earlier, PU defines the degree to which an individual believes that using the application would be useful for the tracking marine debris. For this variable, findings showed that the mean for all the items investigated ranged between 4.00 and 4.73 as depicted in Table 1. For this variable, the highest mean obtained was for PU1 where most participants strongly agreed that the mobile application would enable the tracking of marine debris in Mauritius. This finding also highlights the prospects of marine debris trackers as an important tool in addressing the marine litter problem [1]. On the other hand, the least rated item for this variable was PU3 where 33.3% of respondents were neutral on the fact that using the mobile application improves consciousness about marine littering. This is because this group perceived that more features could be added to improve consciousness such as interactive learning and quiz to assess learning. Overall, high rating highlighted that participants perceived the usefulness of the marine tracking tool.

Table 1. Perceived Usefulness

ID	Description	Mean	Standard Deviation
PU1	Using the mobile application will enable the tracking of marine debris in Mauritius	4.73	0.52
PU2	Using the statistics report from the mobile app raises awareness against marine littering in Mauritius.	4.43	0.63
PU3	Using the mobile application makes you more conscious about marine littering.	4.00	0.83
PU4	Using the mobile application, you can identify the most and least polluted beaches in Mauritius.	4.57	0.57
PU5	I found using the Mau Marine litter Watch useful.	4.37	0.67

4.2 Perceived Ease of Use (PEOU)

PEOU quantifies the level of easiness that beach users undergo while reporting, tracking and analyzing marine debris with the mobile application. As shown in Table 2, the mean varied between 4.01 and 4.37 to demonstrate that irrespective of demographic details, participants accepted that the marine tracking tool is easy to use. Amongst the various items, the user interface was the easiest aspect to use (PEOU1). For the same criterion, 3.3% disagreed with this statement as this small group mentioned to rarely download and use mobile applications. The least rated item was for PEOU2 where 23.3% of participants were neutral that learning to use the Mau Marine Litter Watch was easy for me. The same group found the mobile application similar to many others with no interactive tutorials that explain how to use the application.

Table 2. Perceived Ease of Use

ID	Description	Mean	Standard Deviation
PEOU1	Overall, I found the Mau Marine litter Watch interface easy to use	4.33	0.76

PEOU2	Learning to use the Mau Marine litter Watch was easy for me.	4.07	0.74
PEOU3	I found it easy to access the main functionalities of the mobile application.	4.37	0.67
PEOU4	I found it easy to interact with the mobile application.	4.23	0.73
PEOU5	It is easy for me to become skillful at using the Mau Marine litter Watch mobile application.	4.10	0.80

4.3 Attitude Towards Usage (ATU)

The ATU variable attempted to quantify the way that beach users react with the use of the mobile application. Among the items, the highest mean obtained was for ATU2, as shown in Table 3, where most participants strongly agreed that it is a good idea to use the application to report, track and analyze marine debris in Mauritius. On the opposite, for ATU5, 16.7% of participants were neutral about enjoying using the application. This was particularly because of limited features to improve engagement in long-term use such as daily challenges, interactive videos and animations. Overall, a positive attitude was recorded for ATU with the items ranging between 4.20 and 4.70.

Table 3. Attitude towards Usage

ID	Description	Mean	Standard Deviation
ATU1	I have a generally favourable attitude towards the use of the Mau Marinelitter watch mobile application.	4.33	0.67
ATU2	I believe it is a good idea to use Mau Marinelitter watch to report, track and analyse marine debris in Mauritius.	4.70	0.47
ATU3	I like the idea of using the Mau Marinelitter watch.	4.53	0.51
ATU4	I feel being a more responsible citizen after using the mobile application.	4.23	0.86
ATU5	Overall, I enjoyed using the Mau Marinelitter Watch	4.20	0.71

4.4 Behavior Towards Usage (BTU)

These statistics quantify the likelihood that beach users would use the Mau Marinelitter watch mobile application. As shown in Table 4, mean score for all the items relating to this variable is between 3.70 and 4.20 hence showing that an important group of respondents agree to use the application in the future, as represented by BTU4 which was the highest rated item. On the other hand, the least rated item was BTU2 with 10% of participants disagreeing to continuously use this mobile application in the future. This was because the group claimed about not visiting the beach often so as to use the application continuously.

Table 4. Behavior towards Usage

ID	Description	Mean	Standard Deviation
BTU1	I intend to use the mobile application whenever I go to a coastal region	3.70	0.70
BTU2	I intend to use the Mau Marinelitter Watch on a frequently basis.	3.70	0.88
BTU3	I intend to use the Mau Marinelitter Watch as soon it is publicly available	3.93	0.83
BTU4	I plan to use the mobile application in the future.	4.20	0.96
BTU5	I expect to continuously use this mobile application in the future.	3.80	0.96

4.5 Technology Acceptance

Overall, mobile-based marine debris tracking has been positively accepted by end-users with an average rating of 4.22 for all the variables investigated. This high acceptance also highlights the prospect of such tools towards reporting and tracking debris in coastal regions. Amongst the variables, PU received the highest mean of 4.42 showing that end users perceived the usefulness of such a tool. On the other hand, BTU had the least overall rating (3.86) and this was mainly because the users do not visit the beach often thus reducing prospects of frequent use of the tool. The overall findings comparing the different variables are given in Fig. 5.

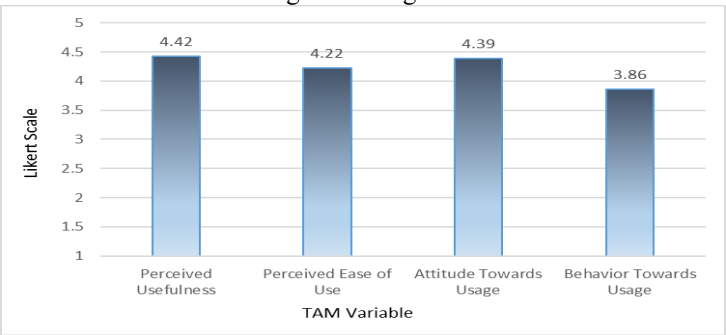

Fig. 5 – Comparison of Key TAM Variables

However, this study is also limited in different ways, where first of all, a larger sample size could have been targeted so as to assess acceptance on a larger scale of end-users. Furthermore, participants could have been given more time to use the application and provide ratings so as to be able to spend enough time on all the features of the application. Also, the proposed mobile application could be further evaluated against existing and more popular apps such as WhatsApp and Messenger. Even though the latter applications do not have the same functionality as the one implemented in this study, in the face of user community and reach, these mobile applications have already settled themselves as social apps that can highly influence and sensitize the population at large when it comes to the deterioration of the marine/coastal environment.

5 Concluding Remarks

This paper investigated and analyzed the acceptance of mobile-based marine debris tracking. For this, a mobile-based marine debris reporting and analysis tool called “Mau Marine-Litter Watch” was developed and tested. Technology acceptance was then evaluated through application of the Technology Acceptance Model within a study involving 30 end users. As key findings, all variables were able to obtain a mean score above 3.8 thus showing a high acceptance rate from the end users. Among the different TAM variables, PU registered the highest rating and BTU achieved the lowest rating. Overall, this high acceptance also highlights the prospect of such a tool towards reporting and tracking debris in different coastal regions as this could also potentially lead to the enforcement of new policies and legislation. However, a few limitations

were noted, especially regarding the sample size of participants involved in this study, in addition to duration of the experiment, and these limitations could be addressed as future works.

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