Online Social Networks for Personal Informatics to Promote Positive Health Behavior

Noreen Kamal
University of British Columbia
Media and Graphics Interdisciplinary Centre
FSC 3640 – 2424 Main Mall; Vancouver, BC
+1-604-822-2761

noreenk@ece.ubc.ca

Sidney Fels
University of British Columbia
Dept. of Electrical and Computer Engineering
2332 Main Mall; Vancouver, BC
+1-604-822-5338

ssfels@ece.ubc.ca

Kendall Ho
University of British Columbia
eHealth Strategy Office
855 West 10th Ave; Vancouver, BC

kendall.ho@ubc.ca

ABSTRACT

Social network services are becoming increasingly popular, and people are using these networks to obtain and share information. The application of social network and social media to the collection, storage and review of personal information presents opportunities for improved personal health management. This paper presents a survey of the literature on the models for the use of online social networks and models for health behavior change. These are then combined to present a framework for health behavior change through social media. This framework is then used to develop a prototype for the system design.

Categories and Subject Descriptors

H.5.2 [**Information Interfaces and Presentation**]: User Interfaces – *prototyping, theory and methods, user-centered design.*

General Terms

Design, Human Factors, Theory.

Keywords

Personal informatics, life logging, personal health management, personal health informatics, health behavior change.

1. INTRODUCTION

Today, the explosion of on-line social network services has demonstrated that individuals are willing to share a multitude of information with close and distant social connections [7, 9]. Recent advances in web technologies and in particular Web 2.0 and mobile applications offer tremendous opportunities for user created information through a rich interface using social media [17, 31].

Additionally, it has been widely accepted that personal health management or self-management is an effective way of managing chronic disease and avoiding illness in healthy people [5]. Social

networks and on-line communities are known to be a critical motivator in helping individuals to achieve positive health outcomes [16, 22, 10]. However, technical interventions are typically geared towards one chronic disease such are diabetes and hypertension and they are rarely aimed for healthy people.

By combining online social networks with personal health informatics system, a novel framework for self-management of personal health can emerge. This framework can then inform the design of the system, which will involve the logging of personal information, where the critical motivator of its use is the social networks that it supports for an individual. Personal health information will then be extracted and presented to the user to promote personal health management.

This paper will first present related work in the area of logging of personal information and personal health information. The next section (Section 3) will present a literature review of the models related to on-line communities and social networks. This will be followed by models or health behavior change. These two bodies of work will be combined to present a framework for an online social network system to promote health behavior change through life information logging (Section 5). Section 6 will present an initial prototype for this system. This will be followed by future work and conclusions.

2. RELATED WORK

There has been significant work done in the area of life logging, and the management of personal information. Understanding personal information especially those that do not fit into existing personal information management systems has been explored, and it was found that the information often is stored in temporary and dispersed locations such as notepad, Post-it notes and temporary text files [4]. Similar work has been done to understand how mobile applications can better support note-taking [6].

The concept of developing a system to log one's entire life was done through MyLifeBits [11]. This project allows us to think of the manner that life logging information would be linked together and organized.

The move beyond simply logging of personal information into personal informatics was modeled through a stage-based model [15]. This study proposed a 5-stage model for the life-cycle of personal informatics: *preparation* stage is where people motivate to collect data about themselves; *collection* stage is where data is collected; *integration* stage is where information is prepared, combined and transformed; *reflection* stage is where the user

reflects on their personal information; and *action* stage is where people choose what they are going to do with the information.

From these previously mentioned studies it is evident that there are numerous amounts of personal information that are stored in ad-hoc areas and they do not fit into existing personal information management systems. Furthermore, the life logging systems that have been developed require a high level of motivation to use, which further exasperates the usefulness of the system, as it can only be fully useful if they are used continuously. None of these studies has combined online social networks. Social network can provide a methodology to gain information from others, promote continuous use and increase the overall usefulness of the system.

Other related works also include personal informatics and life logging applied to the health domain. The challenge of managing personal health information has been explored from the perspective of managing diverse types of information such as information from various clinics, insurance information, and home information [20]. Further work was done to understand the types of "unanchored" information that needed to be managed by cancer patients [13], which found the large diversity in the information that was required to be handled from various locations, cognitive capacities and comprehension limitations. Additionally, the visualization of clinical medical information was explored using a horizontal timeline to review personal histories [19, 3].

These health related studies of personal informatics reveals some of the challenges with storing and retrieving information. The studies again did not take the dimension of social network into consideration; however, it was found that connection with social ties was a key component of managing their disease [13].

3. ONLINE SOCIAL NETWORKS
Before online social networks can be implemented, motivation to participate in online communities and social networks need to be understood. There are many theoretical models that have emerged from various disciplines that aim to understand an individual's motivation to participation in communities and groups, which have been extended to the participation in online social networks and online communities. These theories include: *Uses and Gratification* (U&G) theory, which looks at the reasons that individuals use a particular kind of media product and the gratification they receive from its use; *Common Identity and Common Bond* theory, which looks at what relationship ties an individual to a community; *Theory of Social Identity*, which attempts to explain the psychological processes by which a person perceives themselves as a group member and how they interact with the group; *Organizational Commitment*, which is a model of the sense of attachment that that members have with the brand or identity of the organization, which they belong to [14]. These models will be discussed in detail.

3.1 Uses and Gratification (U&G)
The U&G is a social science theory that has been emerging since the 1970's, and the theory has found new focus in light of telecommunications, computer-mediated-communication, and the internet. The foundations are based on understanding why people use a specific media and the gratification that they receive from it. U&G research categorizes motivations for media use by the following: diversions, social utility, personal identity, and

surveillance [27]. Table 1 summarizes the key motivators based on U&G that have been identified in the literature.

Table 1. Grouping of motivators from 4 studies into 6 categories based on U&G

General Term	Corresponding Motivator Identified from each Study
Entertainment	Diversions [27]; Pass time [18]; Entertainment [18, 8, 14]
Social Enhancement	Social utility [27]; Interpersonal utility [18]; Social Enhancement [8, 14]
Maintaining Interpersonal Connectivity	Social utility [27]; Interpersonal utility [18]; Maintaining Interpersonal Connectivity [8, 14]
Self-discovery	Personal identity [27]; Self-discovery [8,14]
Get Information	Surveillance [27]; Information seeking [18]; Purposive value [8]; Get Information [14]
Provide Information	Purposive value [8]; Provide information [14]
Convenience	Convenience [18]

3.2 Common Identity and Common Bond Theory
The common identity and common bond theory has been applied to design online communities. The premise of common identity is that an individual feels an attachment to a group as a whole. The other side of the coin is common bond, where an individual feels an attachment to individuals within a group. Table 2 lists the antecedents of both the common identity and common bond theories. [24]

Table 2. Antecedents for common bond and common identity theories [24]

Common Identity Theory Antecedents	Common Bond Theory Antecedents
Social Categorization	Social Interaction with others
Interdependence	Personal knowledge of others
Intergroup comparisons	Personal attraction to others through similarities

3.3 Organizational Commitment Theory
Organizational commitment theory is derived from occupational psychology literature and it has been applied to online communities [14]. The three main components to organizational commitment are the following: *affective attachments*, which are emotional and identifying reasons why one *wants* to stay in an organization; *continuance attachments*, which are the perceived cost of staying or the perceived need to stay in an organization; and *normative or obligation attachments*, which are reasons to stay based on obligation [2]. Table 3 shows these three components and their antecedents.

Table 3. Components of organizational commitments and their associated antecedents [2]

Component	Antecedent
Affective attachment	- Personal characteristics - Job characteristics - Work experiences - Structural characteristics

Continuance attachment	- The magnitude and number of investments that are made - Perceived lack of alternatives
Normative attachment	- Influenced by both prior to (cultural) and following (organizational) entry into the organization

3.4 Social Identity Theory

Social Identity theory is rooted in psychology, and it is based on the psychological process by which individuals perceive themselves as part of a group and how they interact with a group. The 4 key concepts of social identity are social categorization, social identity, social comparison and psychological distinction [29]. Social identity has been broken down into three psychological states by Dholakia et al. [8], which are *cognitive social identity*, *affective social identity* (or emotional social identity), and *evaluative social identity*. Table 4 defines the key components of social identity.

Table 4. Key components of social identity with definitions

Component	Definition	State
Social Categorization	The ordering of social environment in groupings of persons in a manner that is meaningful to the subject	Cognitive
Social Identity	Part of an individual's self-concept which derives from his knowledge of his membership of a social group(s) together with the emotional significance attached to that membership	Affective
Social Comparison	Ability to define one's self and one's group by measuring it against another group	Cognitive
Psychological Distinction	Ability to separate one's own group from another by similarities	Cognitive
Sense of Belonging	The ability for one to have greater similarities with others in the group	Evaluative

3.5 Social Network Threshold

The concept of influence of personal social network on the adoption of innovations has also been studied. Social network threshold can be explained by the percentage or amount of people in a person's social network that needs to have adopted an innovation before that individual will adopt the innovation. This strongly correlates to adopter categories as is shown in Table 5. [29]

Table 5. Matched adapter category to social network threshold

Adapter Category	Social Network Threshold Category
Early Adopter	Very low network threshold
Early Majority	Low network threshold
Late Majority	High network threshold
Laggard	Very high network threshold

4. HEALTH BEHAVIOR CHANGE

There are several models that theorize on the factors that influence personal health management. These include the Transtheoretical Model, Health Belief Model, the Theory of Reasoned Action, Conditioning Theory, Decision-Making Theory, and the Diffusion of Innovation Model. These will be explored in detail in this section.

4.1 Transtheoretical Model

The Transtheoretical Model attempts to define health behaviour change by incorporated a temporal dimension, and its core construct are the stages of change. The Transtheoretical Model is a based on 5 stages of change [23].

As described by Prochaska et al. [23], the 5 stages of change are as follows: 1) pre-contemplation, where one does not intend on taking action in the foreseeable future; 2) contemplation, where one intends to change in the distant future; 3) preparation, where one prepares to take action in the immediate future; 4) action, where one makes specific overt modifications to their lifestyle; 5) maintenance, where one works to prevent relapse. At this stage, the person can relapse to previous stages. The final stage labelled termination is where a person is no longer tempted by unhealthy behaviour and has reached 100% self-efficacy.

4.2 Health Belief Model

The Health Belief Model was developed to understand disease prevention and uptake of screening tests by social psychologists in the 1950's. It has been the basis of numerous studies to understand health behaviour change from preventative health behaviour (e.g. screening tests and exercise) change and sick-role behaviours (e.g. hypertension and diabetes). The main dimensions of the Health Belief Model are perceived susceptibility, perceived severity, perceived benefits and perceived barriers. Another dimension to the Health Belief Model is the "Cues-to-Action", which has not been studied as rigorously as the other four dimensions so it does not have the same level of validity. Table 6 shows these dimensions and their definitions. [12].

Table 6. Health Belief Model Dimension [12]

Dimension	Definition
Perceived susceptibility	Personal feeling of vulnerability to a condition; an individual's perception of the risk of contracting a condition.
Perceived severity	Feelings concerning the seriousness of contracting an illness, which includes evaluations of both medical and possible social consequences
Perceived benefit	The effectiveness of various actions available in reducing the disease threat, so the willingness to accept the recommended health action only if it is perceived as feasible and efficacious.
Perceived barriers	The perceived "cost" of the treatment, which can include expense, danger, discomfort, inconvenience, time etc.
Cues-to-action	Stimulus to promote health behaviour change, which can be internal (symptoms) or external (media, reminder postcards).

4.3 Social Cognitive Theory

The social cognitive theory or social learning theory has been used for understanding health behaviour especially for those behaviour that require long-term change such as weight loss, diet changes, drinking and smoking. The theory holds that behaviour is determined through expectancies and incentives, and the key expectancies are environmental, outcomes and efficacy [26]. Table 7 lists these determinants along with the definition of each.

Table 7. Determinants of the Social Cognitive Theory [26]

Determinant	Definition
Expectation about environmental cues	Beliefs about how events are connected, or beliefs about the causes and effects
Expectations about outcomes	Opinions about how one's behaviour is likely to influence outcomes
Expectations about self-efficacy	Belief about one's own competence or ability to perform the behaviour needed to influence outcome
Incentives	The value of a particular object or outcome, which include health, appearance, approval, and economic gain

4.4 Theory of Reasoned Action

The Theory of Reasoned Action (also called Fishbein and Ajzen's model) is rooted in social psychology and it has been applied to health studies as well as consumer behaviour [1,28]. The key determinants or constructs of this theory are *behavioural intention*, *attitudes*, and *subjective norms*. Table 8 shows these determinants along with their definition.

Table 8. Determinants of the Theory of Reasoned Action

Determinant	Definition
Attitudes	The sum of belief about a behaviour weighted by evaluation of the beliefs
Subjective Norms	The influence of people in their social environment on his/her behavioral intentions; the beliefs of people will influence their behavioral intention
Behavioral intentions	A function of both attitude and subjective norm towards a behavior, which predict the actual behavior

4.5 Diffusion of Innovation Model

The Diffusion of Innovation Model [25] was developed to be applied across domains, but it has been applied to the health domain from the perspective of translating new evidence into practice [21]. The diffusion of innovation model uses temporal bases for the stages in the innovation to decision process. The stages in temporal order described in this model are knowledge, persuasion, decision, implementation and confirmation. In some ways this can be likened to the transtheoretical model; however, the definition of each stage is different.

5. FRAMEWORK

By looking at the theories and models that provide an understanding of the motivations for using online communities and social networks and the motivations for health behavior change, a framework for an online social network to promote

positive health behavior change through personal informatics can emerge. This framework has the following components:

1. *Perceived Value to the user*: This includes getting information, providing information, convenience, entertainment, maintaining interpersonal connectivity, social enhancement and self discovery
2. *Social aspects*: These include social categorization, sense of belonging, social connection, social identity, and social comparison
3. *Organizational commitment*: This speaks to the reason that an individual would decide to stay part of the network or group based on the following attachments: affective, continuance and normative
4. *Temporal nature of health behavior change*: Before behavior can change there are several stages that occur, which is enhanced by gaining information and social norms, and the behavior needs to be maintained or an individual can revert to an earlier stage
5. *Social determinants:* These include subjective norms, environmental cues, and cues-to-action
6. *Individual determinants:* These include their perceived beliefs, their perceptions of self-efficacy and perceptions about the outcomes

6. PRELIMINARY PROTOTYPE

Based on the framework that emerged from the literature survey, a preliminary prototype was developed for a personal informatics online system. The primary concepts used to build an initial prototype was to use an online social network to increase motivation to use the system that will log and share one's personal information. At the same time, this system will be able to ramp up to include health informatics that will be of use in other contexts, such as, diagnosis, treatment and monitoring of chronic diseases.

Figure 1 shows an initial prototype for the entire system. The main design paradigm for this initial prototype is based on facebook style "newsfeeds". In the main center area, all of the social "newsfeeds" from all the social networks that this individual is part of are available. These include microblogs, picture sharing, recipe sharing, and event invitations. This speaks to the described framework's *perceived value to the user* by providing information and social connections, which also connects to the framework's *social aspect* category. The left pane includes the personal information management area with applications such as a calendar, to-do list and contact list. The calendar is interactive so that one can click on a date to see details of the events occurring on that day, add events and delete events. The to-do list includes both events and tasks, and again this box is interactive, where one can add, delete and share tasks as needed. The contact list or friends list is also interactive. The right-side of the screen contains the individual's entertainment box, and it includes movies, music, photos and recipes.

Of key importance is the **My Stats** link at the top of the page. This is where the entered information such as health information is mined from the data and presented to the user. This information feedback to the user provides key aspect of the framework such as self-efficacy and perceived outcomes (*individual determinants*). The *temporal aspect of change* (from the framework) can also be promoted by visualizing the changes that had occurred in the past.
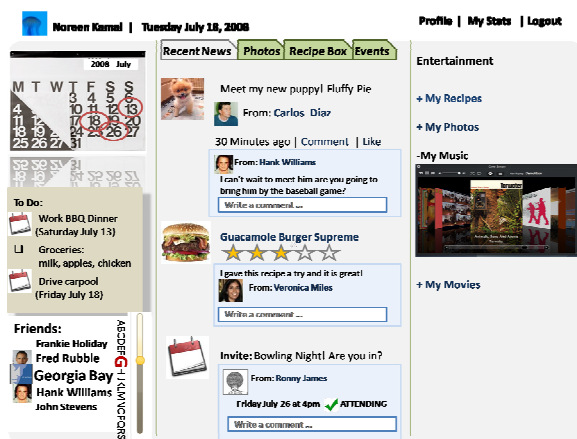
Figure 1. Preliminary prototype for an online social network for personal informatics

By looking at one of these applications in more detail, we can start to form how this system will work. The Recipe Box application's main page is shown in figure 2. This application was prototyped using HTML with AJAX controls. This figures shows the sharing of recipes with people within the social network. The user's own recipes (originals), recipes that she/he has reviewed, and her/his favorites are listed in the right panel.

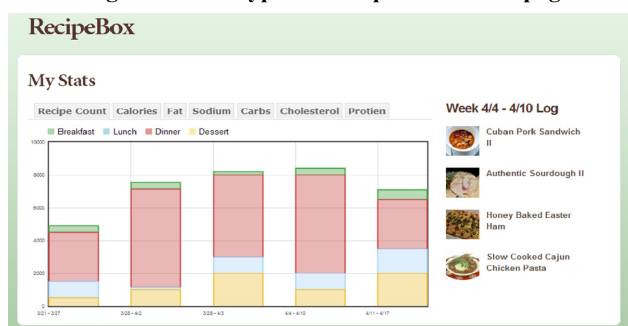**Figure 2. Prototype for Recipe Box's main page**

Figure 3. My Statistics page includes information about calories, fat and other nutrients consumed

The Recipe Box application is envisioned to contain recipes for common meals such as roast beef sandwich. This would allow the user to easily choose meals that they have on regular basis. Additionally, the RecipeBox can be extended to link in with restaurant websites (www.urbanspoon.com & www.yelp.com), where the user can select what they ate at the restaurant. This would allow for more accurate information about meal

consumption to be collected rather than inferred from the information that is provided at limited intervals. Figure 3 shows the prototype for the statistics pages.

7. FUTURE WORK

These prototypes need to be fully developed along with some alternate prototypes. These alternates can include a geographical visual display to provide the ability to share where one is currently and also plan their events and annotate their day on a geographical map; another option is to build a visual display that uses a calendar type system or temporal basis to visualize events. These prototypes need to be discussed with users through unstructured and semi-structured interviews to better understand how users' understand the system, and which system they are most likely to use.

This research will focus on allowing individuals to control how information is shared with their social network connection. This brings up the idea of having multiple truths; for example, a person may wish to share their personal information with specific people differently. The privacy interface needs to be easy to interpret and understand to ensure that the users feel comfortable in using it, and in sharing the information in the manner that they have full control over it. This includes the amount of information, the actual values (whether truthful or not) and with whom they share this information. This aspect of the system will also need to be user tested. Once a comprehensive understanding of user needs, likes and dislikes are understood, high-fidelity prototypes can be developed to conduct controlled usability studies to fully understand the design of the system.

8. CONCLUSIONS

By surveying the literature, motivations for using online communities and social networks and motivations for health behavior change can be understood. This provides a framework for designing an online social network system to influence health behavior. This framework includes the following dimensions: perceived value to the user, social aspects, organizational (or in this case community) commitment, temporal nature of health behavior change, and social and individual determinant for behavior change. Based on these dimensions a prototype was built for personal information management through online social networks. The vision for this system is that it would promote positive health behavior change.

9. ACKNOWLEDGMENTS

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