Design and Implementation of Individual Sustainability Systems

Claris Yee Seung Chung
Department of Information Systems and Operations Management, University of Auckland
Auckland, New Zealand
64-9-373-7599
yee.chung@auckland.ac.nz

David Sundaram
Department of Information Systems and Operations Management, University of Auckland
Auckland, New Zealand
64-9-373-7599
d.sundaram@auckland.ac.nz

ABSTRACT
Sustainability is a topic that has matured and has evolved from organizational sustainability to societal sustainability and more recently to individual sustainability. As an individual is the core, basic component of society, and plays a critical role in societal transformation, there is growing interest and discussions on individual sustainability and wellbeing. Information systems can play a critical role in supporting sustainable transformation. However not many current systems have models to support an individual's sustainable transformation, based on a holistic understanding of the dynamics among multiple life dimensions. To address this lacuna we propose concepts, models and conceptual framework that are fundamental for the design of Individual Sustainability Systems (ISS). We then suggest a system framework for ISS. Finally we illustrate system views of prototypical systems that we are implementing in the real world context of an online supermarket and habit formation mobile apps.

Keywords
Individual sustainability, shopping, habit formation, behavioral changes, transformation, gamification, wellbeing, health, finance, environment.

1. INTRODUCTION
Sustainability concepts have matured dramatically from an initial focus on world sustainability to national sustainability to organizational sustainability to societal sustainability to more recently individual sustainability. [17] Many study disciplines have been interested in this particular topic and have tried to find answers for our life and society to be sustainable. Also the recent prevalence of mobile technologies have opened the doors wide for opportunities that enable individuals who want to transform their lives and be sustainable. An individual is the core, basic component of society and plays a critical role in societal transformation. Thus there are three crucial reasons for us to explore pathways towards individual sustainability: Firstly, individual sustainability is a pre-requisite for true sustainable societal transformation [14]; secondly, balancing life aspects and being well are long-cherished desires of people; thirdly, there is a burgeoning market in individual sustainability from a business perspective.

Information systems take naturally a critical role in supporting sustainability because sustainable transformation involves measurement and management of critical key performance indicators (KPIs). Yet there are not many information systems that fully support an individual's sustainable transformation. To address these problems and issues, this paper proposes Individual Sustainability Systems (ISS) as a pathway to individual sustainability.

This paper firstly reviews the literature and studies related to the concept of sustainability and individual sustainability. Secondly we propose concepts, models and conceptual frameworks that could become a foundation for the design of ISS. Thirdly we propose a system framework and architectural components of such systems. Finally we describe two prototypical implementations, namely: *Sustainable Social Shopping System* and *Lively Suite*.

2. SUSTAINABILITY, LEVELS OF SUSTAINABILITY AND LIFE DIMENSIONS
"Sustainability" concepts have been approached and developed by incorporating ecological and environmental issues at an organizational level. However, "sustainability" can hardly be achieved by focusing on one dimension, or only driven by organizational and/or societal stakeholders. Therefore to achieve true sustainability, researchers and policy makers had also recognized the importance of social and economic dimensions of sustainability and sustainable development [2, 11].

Along with social and organizational sustainability, there is growing interest and discussions on individual sustainability and wellbeing. When Starik and Rands discuss the concept of sustainability, they also identify multi-levels in sustainability [18]. Furthermore, the individual is at the heart of sustainability, surrounded by organizational, political-economic, social-cultural, and ecological levels (Figure 1). Interaction between adjacent levels influences input, processes, outputs, and feedbacks [16]. This means that an individual's sustainability is as important as any higher level's sustainability. In addition to this, ordinary individuals are the real decision makers for sustainable development. They are responsible for understanding and improving awareness of sustainability, and deciding whether to adapt their attitudes and behaviors for sustainable development within different roles of their lives -- for instance, as an individual or as a family member [17]. However individuals are often treated as secondary actors in traditional sustainability practices. Individuals are also well aware of the importance of sustainability.

Conference'10, Month 1–2, 2010, City, State, Country.

ICCASA 2014, October 15-16, Dubai, United Arab Emirates

DOI 10.4108/icst.iccasa.2014.257279

They tend to engage with right choices that contribute to positive changes, because people often derive personal happiness from these choices [20].

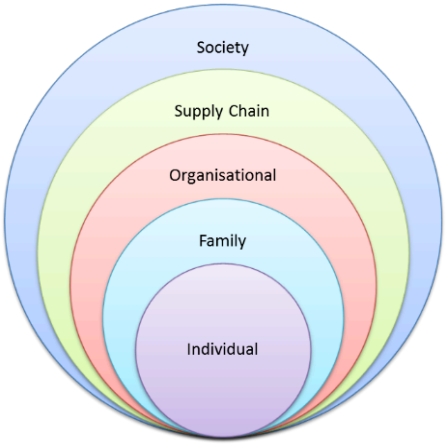

Figure 1. Sustainability Levels

Individuals interact with other levels by taking a certain role in each sustainability level. When individuals take a different role in each level, different life dimensions are involved and focused on. For sustaining an individual's life in a positive manner, it is important to understand their life dimensions. Pappas suggests that "Sustainable individuals are characterized by creating harmony, interconnection, and relatively high levels of self-awareness in their values, thoughts, behaviors and actions, as well as cultivating continued individual growth in their physical (health), emotional, social, philosophical, and intellectual abilities" [14]. In other words, the concept of individual sustainability is one that enables individuals to be well, or happy, while they are balancing various life aspects and challenges. This can be achieved through making life-affirming decisions and pursuing activities that are aligned with an individual's life values in various life dimensions (Figure 2). According to Tapia-Fonllem, Corral-Verdugo, Fraijo-Sing and Duron-Ramos, individuals are showing sustainable behaviors by taking pro-ecological, frugal, altruistic and equitable actions, and they perceive these actions as being closely related to their well-being [19].

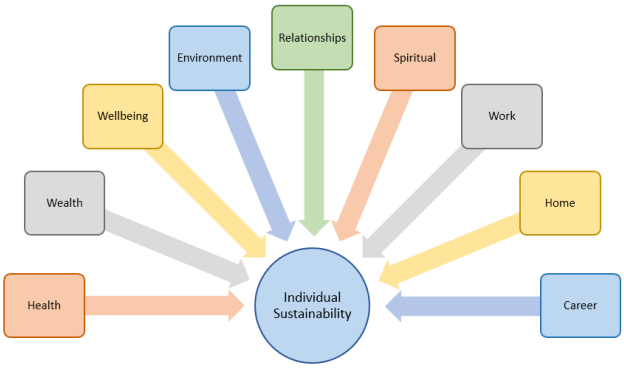

Figure 2. Life Dimensions

As not all of life aspects have a simple and positive relationship, a core challenge for sustainable life lies in understanding relationships between each dimension. For example, work dimension can have a positive relationship with wealth dimension, while health and home life dimensions may have negative relationships. Therefore understanding these dynamics among multi-dimensional life aspects is an important initial step to support an individual's sustainable life.

3. RESEARCH PROBLEMS AND PRACTICAL ISSUES

Information systems play a critical role in supporting sustainable transformation. Delivering commitments for sustainability involve a high level of cognitive load, and hence the careful design and development of information systems is vital to support sustainable transformation [21]. With the rise of mobile technologies, the self-management/quantified-self industry has mushroomed and it has become a multi-billion dollar market. However the efficacy of these solutions is in question [10], because most of these solutions are only focused on a single life aspect and provide insufficient means to address the root problem. For example, most smoking cessation mobile apps intervene in users' smoking habit by sending a series of text messages [1]. As behaviors are interrelated and some are habitual, interventions should be made on fundamental behaviors or habits. Unfortunately not many current systems have effective models to support understanding of these dynamics among multi-dimensional life aspects. Furthermore there is little support for motivating individuals to become more sustainable. Since most relationships among life aspects are wide, complex and dynamic, it is important to identify some fundamental activities that we do habitually, but which affect our lives in many ways. One of the key activities that humans undertake, and which has an overwhelming influence on their individual and family life, is shopping. Shopping is a fundamental household activity which is closely interconnected with multi-dimensional life values of an individual, such as financial, health, philosophical and environmental values, and is often carried out by the individual's habitual behaviors [19]. Hence it is worthwhile to provide holistic information to shoppers. This can improve shoppers' sustainability and ultimately bring about transformation in their, as well as their family members', lives, by enabling them to make quality, efficient, and sustainable purchase decisions.

Another issue with the current solutions is that these systems provide very simplistic motivational features (e.g. goal setting or feedback) which rely mostly on users' will power [6]. According to Conroy et al. [3], apps that offer well-established techniques for bridging user's intention to behavioral changes in physical activity are rare. Many users do not continue to use the behavioral change apps because they provide information and feedback merely based on users' data inputs. Hence, it is important that systems have well-established techniques for providing continuous persuasion and motivation. "Gamification" is another recent trend in persuasive technology and behavioral studies [8]. According to a literature review of empirical studies on gamification by Hamari et al. [9], majority of studies show positive effects and benefits of gamification on behavioral outcomes.

To address the lacunae identified above we propose concepts, models and conceptual frameworks that are fundamental for the design of Individual Sustainability Systems in the following section. We then suggest a system framework for ISS. Finally we illustrate system views of prototypical systems that we are

implementing in the real world context of an online supermarket and habit formation mobile apps.

4. INDIVIDUAL SUSTAINABILTY SYSTEMS

4.1 Concept, Model and Conceptual Framework

Individual sustainability systems consist of different systems that can connect together to support an individual's sustainable transformation. Sustainable Social Shopping System (SSSS) and Lively Suite are the initial development of ISS. In order to support an individual's sustainability, systems should work closely with their daily life patterns. A sustainable transformation process is often achieved by sequential behaviors within an individual's social context [5]: what you eat, and what exercise you do, often determine your health; how you spend money significantly impacts your financial status; what environmental values you have contribute to environmental issues.

According to Duhigg [5], habit is formed through iteration of a three-step loop: cue, routine and reward. Cue is the intrinsic or extrinsic stimuli, which make people to crave for rewards. Routine is the habitual activities to achieve rewards. Rewards are the desirable results of the loop that people crave for. Cue is an important initial step to let users discover and learn exactly what stimuli triggers routine actions, and to understand relationships between stimuli, routine actions and rewards. Not all of life facets are aligned in the same direction, but many of them actually have conflicting relationships in many situations. For example, positive human actions on environmental issues can have negative effects on financial situations and visa-versa [13]. Using routine steps, users can strategize and design appropriate actions for win-win rewards for their life. Routine is also the most important step to intervene to change habits, to bring about life-affirming transformation. As explained, rewards are closely interconnected with cue. People feel positive, and reinforce cues, by monitoring and controlling their transformation progress (Figure 3).

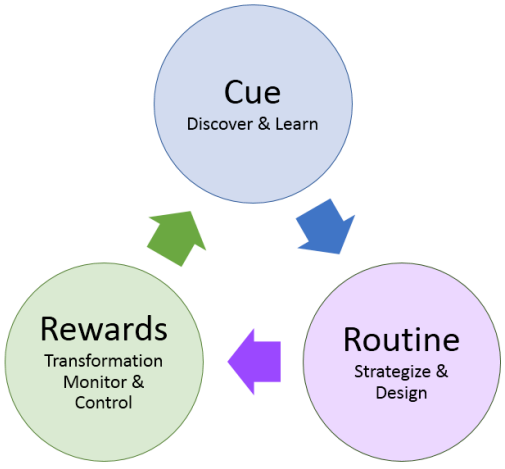

Figure 3. Habit Formation

While the concept is simple and flexible, it is also powerful in motivating people to be transformed via habit-forming activities. We use this concept as a foundation stone in the design of the ISS to support habit formation along with a variety of system features and functionalities.

ISS will be beneficial to anybody who wants to have a better life, but ISS will work more effectively on people who want sustainable transformation and who are ultimately pursuing well-being and happiness through various life changes. The systems will support individuals during the entire transformation period and work closely in guiding individuals to make life-affirming choices. To motivate people to utilize ISS for the whole, complete, transformation journey, education and motivation features should be facilitated in the systems. According to Mounson and Consolvo's experiment [12], one of the most motivating mobile app feature, for encouraging participants to achieve a 4-week physical activity, was information features like support in goal-setting and self-monitoring. Collaboration feature is also important. In many motivation studies, interactions and collaboration from family, friends or people who have similar interests can make significant contributions to individuals in achieving their goals. This is because people can share useful information and get the support they are looking for, and enjoy interactions with other people who have similar interests [15]. The benefits of entertainment features are recognized in many areas, such as education and health sectors. Entertainment features like gamification is a new trend in supporting user engagement and enhancing positive patterns. Hamari et al. [9] reviewed peer-reviewed empirical studies on gamification with the question "Does Gamification Work?". They found that majority of empirical studies show positive effects and benefits of gamification on motivational affordances, psychological and behavioral outcomes. Therefore ISS should facilitate information, collaboration and entertainment features to support a holistic sustainable transformation (Figure 4).

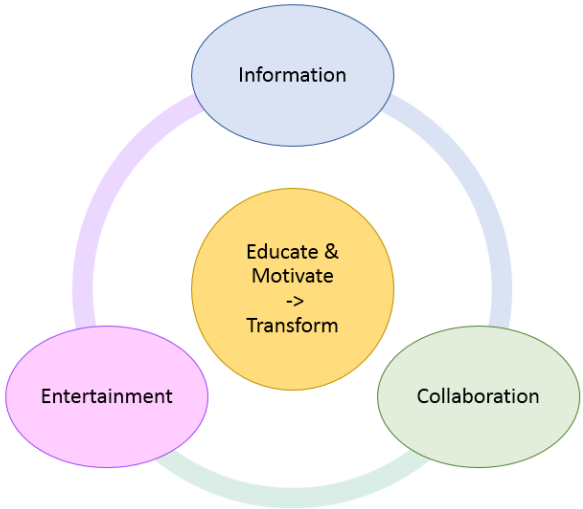

Figure 4. A conceptual framework for ISS

4.2 System Framework

In order to support an individual's sustainability, ISS should be able to provide insightful multi-dimensional information through the entire transformation process. Therefore the system should be developed based on a framework which enables systems to discover and understand multi-dimensional personal life aspects, and help an individual to be continuously motivated through benchmarking and entertainment. ISS's framework should embrace all these concepts, models and processes (e.g. decision making processes, transformation processes, habit formation

modeling, system dynamics, data and information integration modeling). This research therefore proposes a sustainable individual transformation system framework that integrates these concepts, models and processes together in developing ISS. The framework suggests that ISS needs to have the following elements to achieve individual transformation: measure, model, benchmark and entertain. As most individuals' current situations are strongly engaged with inputs, the first step of sustainable transformation is to "measure" these inputs. As input entry can be the major issue for the system usability, ISS should be able to handle and share data from different systems or wearable devices. For example, direct and indirect health related data from wearable devices' systems and financial data from banking or budgeting systems need to be collected and fed into ISS. This collection of data is transformed by a variety of "models", and the results reported back to users. Models for prediction, recommendation and behavioral changes can be implemented using solvers such as mathematical and recommendation algorithms, data mining techniques and system dynamics. The understanding of life aspects and their relationships, through models, allows individuals to understand the key variables, that they need to modify to achieve transformation. Furthermore various types of benchmarking (internal, external, historical, and theoretical) as well as historical trends, comparative and cause-effect analyses allows the individual to be motivated and transformed. We truly believe that we cannot transform what we cannot measure, model, and benchmark. We also believe that transformation need not be a hard and difficult path but it can be a path that can be made easier and fun through entertainment features (Figure 5).

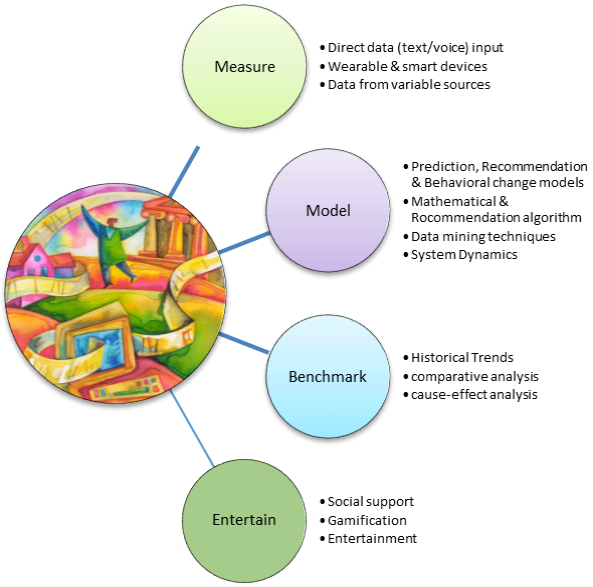

Figure 5. A system framework for ISS

While the process of measure, model, and benchmark may seem onerous, there is a possibility that transformation could also be approached, and achieved, through gamification, social, and ultimately entertainment features.

5. DESIGN AND IMPLEMENTATION OF PROTOTYPICAL SYSTEMS

Based on the proposed concepts, models, processes and framework, Individual Sustainability Systems (ISS) can be developed in different system forms to support various human activities or purposes. We believe that (a) shopping is one of the key activities that have an overwhelming influence on individual and/or family sustainability and (b) individuals can be transformed through habit formation. To support these aspects we have designed and developed the *Sustainable Social Shopping System* and *Lively Suite* as initial proof of concept of ISS.

5.1 Sustainable Social Shopping System

Unlike an ordinary online shopping cart system, the Sustainable Social Shopping System (SSSS) will provide information on at least three life dimensions (financial, health and environmental aspects) in an integrated manner. The system is a tablet-friendly application, which helps businesses to target not only PC users, but also mobile device users. Basically the system consists of 5 pages: Featured, Search, Stats, Shopping Confirmation, and Profile.

A product or a package appearing in the featured page (Figure 6) is a result of a process run by a recommendation engine. Featured page infrastructure is flexible, which means sections (like Top-Charts, Social Choice etc.) are easily altered and updated.

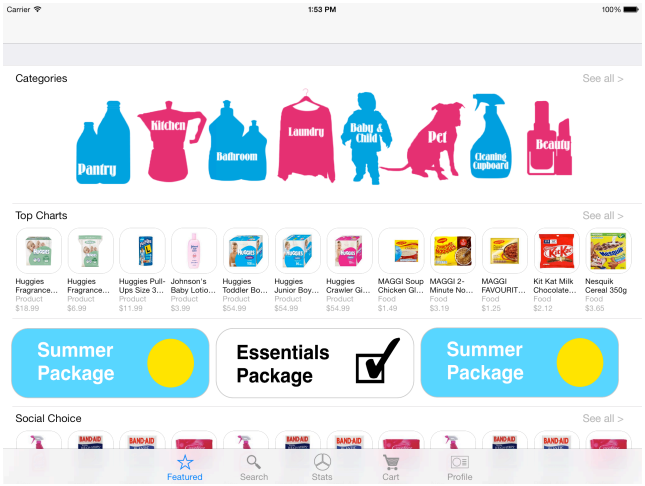

Figure 6. Featured Page

Within the Featured page, customers can click into a detailed product information page (Figure 7) and view multi-dimensional sustainability information. Information for each life dimension will be guided by either commonly adopted methods or government regulations. For example, information on the health dimension will be shown using traffic lights (green, amber and red) [4].

Figure 7. Sustainability of Product

The Search page provides basic search functionality for the user to be able to find products, categories of products or packages. The Stats page is responsible for aggregating transactional data, produced by the user, and presenting useful information acquired from this data to the user in three dimensions (Health, Finance, and Environmental Footprint). This page is designed to let the user understand his/her online shopping behavior as well as the level of personal sustainability. All chosen products will be shown in the Shopping Confirmation page (Figure 8).

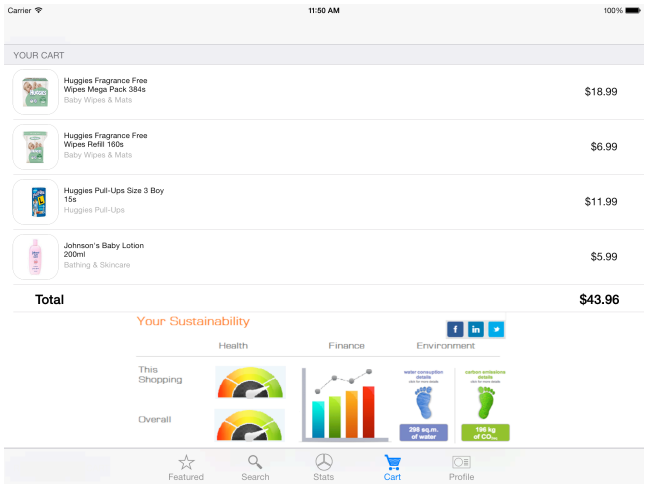

Figure 8. Shopping Cart with Aggregated Health, Finance, and Environmental Scores

As the prototype pages show, SSSS will show sustainability information and provide social shopping features. In the shopping confirmation page, the health meter will show the number of healthy and unhealthy products that the consumer purchased in current shopping, and overall shopping, for comparison purposes. The financial information dimension will provide information on whether a chosen product is cheaper than other options; and if it is, then the amount saved will be shown. Lastly environmental information will be shown based on ecological footprint standards (http://www.footprintnetwork.org/en/index.php/GFN/page/application_standards/). Having information on three vital life dimensions in one page, providing an intuitive graphical presentation while they are making a purchase decision, will enable consumers to have a holistic perspective on their decisions. The Profile page includes user's basic personal information. The user will be able to log in using existing social networks, or fitness social networks, which will later provide more useful information about the health dimension of the user's sustainability status.

5.2 Lively Suite

Lively Suite is a configurable mobile application that helps people to achieve their goals by strengthening positive habits but quitting negative ones. This prototypical system can consist of multiple logging apps. As every individual's situation is different, Lively Suite users can customize their logs and reconfigure app settings. Data can be directly entered through text or voice recognition, or captured by various measurement apps and wearable devices. The collection of data will be fed into the Lively Suite. Data related to each activity will produce insightful information and a progress report for users. Also each activity log can be combined together to provide an integrated and holistic view of relationships of life facets (Figure 9). These relationships can be better understood based on models such as system dynamics, recommendation and analytical hierarchy process.

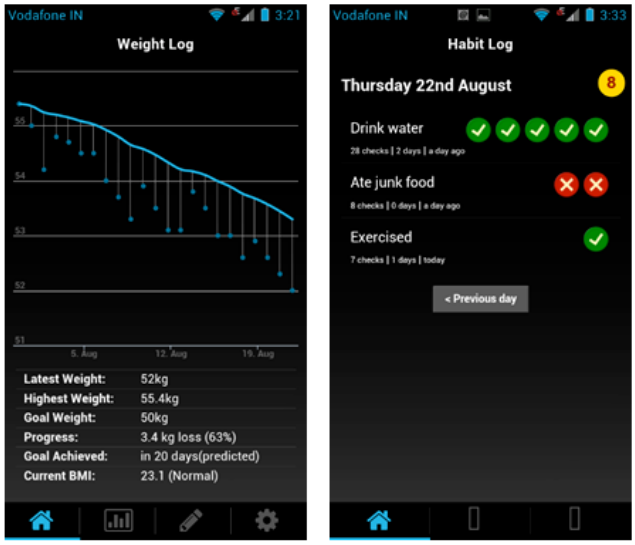

Figure 9. Weight & Habit Logs

The Lively Suite is evolving even as we write this. We plan on building customizable packs. Packs can be specific for an individual's goal or situation. For instance, if a user is suffering from diabetic disease, then he/she can use the "Diabetes pack" which is of particular relevance to those with diabetes such as (a) logging of weight, (b) sugar levels, (c) rest, (d) cholesterol, etc as well as motivating them (e) not to eat too much carbs, (f) lead a more active lifestyle, etc and ultimately sustaining their health and life. The beauty of packs is in helping users to build a unique data set for their own, and use these for benchmarking. Basic packs can be formed to support a micro activity, these micro activities could be aggregated to a meso level to support a good habit or overcome a bad habit and ultimately these meso level habits could be used to support life changing enhancing and transforming processes. We envisage that the Lively Suite will have entertainment motivational features like social networking

support, gamification, and exercise music formation. Thus the system can encourage users to continue their efforts for sustainability.

6. CONCLUSION

Sustainability is one of the most often discussed topics in our society. Although no one argues that individuals are the main players in changing society and the environment, individuals have always been treated as just actors and decision makers who transform the organizational, societal, national, and/or global sustainability practices. However our fundamental belief is that individual and personal sustainability is at the heart of organizational and societal sustainability. To be sustainable, integrated and balanced information should be offered to consumers. Therefore ISS can be a very attractive system, as it not only supports individual sustainability but also has the potential of becoming a promising business model. This research proposes concepts, models, and processes that have the potential to be the foundation for the formation of sustainable and life transforming habits. Furthermore we also propose a framework and architectural components that have been validated through the prototypical implementation of the Sustainable Social Shopping System and the Lively Suite to realize the aforementioned concepts, models, and processes. The Sustainable Social Shopping System enables customers to understand sustainable purchase choices for better quality of life, and aids them to transform sustainably through shopping experiences. The Lively Suite allows users to measure, monitor, and benchmark activities, and thus helps them to form desirable habits easily. The systems have design features based on traditional purchasing decision-making model, as well as habit-forming models. At this stage, the Sustainable Social Shopping System provides information on three life dimensions: health, finance and environment. The data is currently sourced from product suppliers, government regulations and studies from expert organizations. And the Lively Suite provides data logs and trend report for progress information. However in order to support a holistic individual sustainability, the systems need to be flexible to incorporate other aspects of life dimensions, and connect to a larger variety of data from outside sources.

7. REFERENCES

[1] Abroms, L.C. et al. 2011. iPhone apps for smoking cessation: a content analysis. *American journal of preventive medicine*. 40, 3 (Mar. 2011), 279–85.

[2] Ahmed, M.D. and Sundaram, D. 2012. Sustainability Modelling and Reporting: From Roadmap to Implementation. *Decision Support Systems*. 53, 3 (Jun. 2012), 611–624.

[3] Conroy, D.E. et al. 2014. Behavior change techniques in top-ranked mobile apps for physical activity. *American journal of preventive medicine*. 46, 6 (Jun. 2014), 649–52.

[4] Department of Health 2013. Guide to Creating a Front of Pack (FoP) Nutrition Label for Pre-packed Products Sold through Retail Outlets.

[5] Duhigg, C. 2012. *The Power of Habit. Why We Do What We Do and How to Change*. Random House LLC.

[6] Free, C. et al. 2013. The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: a systematic review. *PLoS medicine*. 10, 1 (Jan. 2013), e1001362.

[7] Gilg, A. et al. 2005. Green Consumption or Sustainable Lifestyles? Identifying the Sustainable Consumer. *Futures*. 37, 6 (Aug. 2005), 481–504.

[8] Groh, F. 2012. Gamification: State of the art definition and utilization. *Proceedings of the 4th seminar on Research Trends in Media Informatics* (2012), 39–46.

[9] Hamari, J. et al. 2014. Does Gamification Work? -- A Literature Review of Empirical Studies on Gamification. *2014 47th Hawaii International Conference on System Sciences*. (Jan. 2014), 3025–3034.

[10] iHealthBeat 2011. Mobile Health Apps Popular, but Efficacy in Question, Experts Say. *CALIFORNIA HEALTHCARE FOUNDATION*.

[11] Munro, D.A. 1995. *A Sustainable World: Defining and Measuring Sustainable Development*. IUCN - the World Conservation Union by the International Center for the Environment and Public Policy, California Institute of Public Affairs.

[12] Munson, S.A. and Consolvo, S. 2012. Exploring goal-setting, rewards, self-monitoring, and sharing to motivate physical activity. *Pervasive Computing Technologies for Healthcare (PervasiveHealth), 2012 6th International Conference on. IEEE, 2012.* (2012), 25–32.

[13] Newton, P. and Meyer, D. 2013. Exploring the Atitudes-Action Gap in Household Resource Consumption: Does "Environmental Lifestyle" Segmentation Align With Consumer Behaviour? *Sustainability*. 5, 3 (Mar. 2013), 1211–1233.

[14] Pappas, E.C. 2013. Individual Sustainability: Preliminary Research. *Frontiers in Education Conference, 2013 IEEE* (Oct. 2013), 1631–1636.

[15] Pfeiffer, J. and Benbasat, I. 2012. Social Influence in Recommendation Agents: Creating Synergies between Multiple Recommendation Sources for Online Purchase. *European Conference on Information Systems* (Barcelona, Spain, 2012).

[16] Reefke, H. 2012. *Sustainable Supply Chain Management: Concepts, Models and Roadmap*. The University of Auckland.

[17] Starik, M. 2004. Toward a Multi-level, Multi-Systems Approach to Sustainability Governance and Outcomes : An Essay. *Innovation: management, policy & practice*. 6, 2 (2004), 167–169.

[18] Starik, M. and Rands, G.P. 1995. Weaving an Integrated Web: Multilevel and Multisystem Perspectives of Ecologically Sustainable. *The Academy of Management Review*. 20, 4 (1995), 908–935.

[19] Tapia-Fonllem, C. et al. 2013. Assessing Sustainable Behavior and its Correlates: A Measure of Pro-Ecological, Frugal, Altruistic and Equitable Actions. *Sustainability*. 5, 2 (Feb. 2013), 711–723.

[20] Venhoeven, L. et al. 2013. Explaining the Paradox: How Pro-Environmental Behaviour can both Thwart and Foster Well-Being. *Sustainability*. 5, 4 (Mar. 2013), 1372–1386.

[21] Volkoff, O. et al. 2011. The Strategic Role of Information Systems in Supporting Sustainability Sustainability. *Proceedings of the 7th Americas Coference on informations Systems* (Detroit, 2011).

[22] Young, C.W. et al. 2000. Strategies for Sustainable shopping, Cooking and Eating for 2050 – Suitable for Europe. *International Sustainable Development Research Conference* (2000).

ACKNOWLEDGMENTS

The authors thank Roman Proskuriakov and Dr. Sarah Henderson who contributed to the design of the Sustainable Social Shopping System and Lively Suite respectively.