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Tracking the Environmental Footprint of Business Activities

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Abstract

The research reported in this paper is motivated by the concerns that have been raised for more than forty years for the deterioration of the environment associated with human activities. This paper concerns the design of a freely available online information system that would enable managers of Small and Medium Enterprise (SMEs) to determine and track the contributions to their Environmental Footprint of their various business 'activities'. There are many online 'carbon calculators' that can help people estimate the amount of Green House Gas (GHG) or carbon emissions associated with 'things' such as vehicles for transport, equipment of all kinds, and so on. These are either direct emissions (e.g. truck exhausts) or indirect emissions due to equipment which uses electric energy from non-renewable sources. Business can take steps to be more environmentally responsible by reducing their use of 'things' that pollute the environment or by choosing equipment that is more environmentally friendly; but this will only get you so far. Further gains need a more holistic approach that looks at different ways of doing things. The project takes an approach that estimates the GHG emissions of whole 'activities' rather than individual 'things'. The research behind the project logically uses ideas from Activity Theory.

Keywords: Green House Gas (GHG), Small and Medium Enterprise (SMEs), activity, Carbon Footprint, Activity Theory, Wikis, forms, dashboard

Introduction

In Australia, large organisations are required to report their direct, Scope 1, and indirect, Scope 2, Green House Gasses (GHG) emissions annually through the National Government Emissions Reporting Scheme (NGERS). These organisations must therefore find the resources and means to measure these aspects of their Environmental Footprint. SME's are not yet required to report to NGERS and most do not have the knowledge and resources to do it. Many however would like to know more about their environmental impact and how they can reduce it in simple, cost-effective ways.

In recent years, more and more businesses have come to embrace the concept of having green business activities. While there is information on the carbon emissions and energy consumption of things (cars, computers, equipment etc.), there is little information regarding the carbon emission released into the environment or the energy consumption of whole business activity.

This paper accepted by special expedited review

The project described in this paper concerns the design of a freely available online information system that would enable managers of Small and Medium Enterprise (SMEs) to determine and track the contributions to their Environmental Footprint of their various business 'activities'. There are many online "carbon calculators" that can help people estimate the amount of Green House Gas (GHG) or carbon emissions associated with 'things' such as vehicles for transport, plant equipment of all kinds, office equipment and so on. These are either direct emissions (e.g. truck exhausts) or indirect emissions due to equipment which uses electric energy from non-renewable sources. Business can take steps to be more environmentally responsible by reducing their use of 'things' that pollute the environment or by choosing equipment that is more environmentally friendly; but this will only get you so far. Further gains need a more holistic approach that looks at different ways of doing things. This project takes an approach that estimates the GHG emissions of whole 'activities' rather than individual 'things'. The research behind the project logically uses ideas from Activity Theory.

This paper is structured as follows. We first provided some background and an introduction to the research projects. We then summarise the results of the literature review, leading to the research questions and a justification of the methodology used. We then provide sample results and a discussion of these concludes the paper.

Background

The research reported in this paper is motivated by the concerns that have been raised for more than forty years for the deterioration of the environment associated with human activities, in particular the consequence of Green House Gas (GHG) emission. Building an environmentally responsible eco-civilisation is becoming one of the main elements of the future vision of the governments, businesses, NGOs and other interested groups. The consumption model that we witnessed in the last twenty years is slowly destroying the "Earth's life-support systems, ecosystems and environment" (Xinsheng, 2012). This has manifest itself in the United Nations (UN) focus on responsible sustainable development.

One of the first initiatives took place in 1972 at a UN Conference on the Human Environment in Stockholm (UNCHE, 2007). Later in 1980 the world leaders started to be more aware of problems created by heavy use of resources through industrialisation and a new international organisation was launched named the World Conservation Strategy (McCormick, 1986) which combined several existing environmental organisations at that time as International Union for the Conservation of Nature and Natural Resources (IUCN), U.N. Environmental Program (UNEP) and World Wildlife Fund (WWF) together with the *United Nations Educational, Scientific and Cultural Organization* (UNESCO). The World Conservation Strategy is present in more than thirty countries which are following the guidelines suggested by this environmental authority.

From its inception the purpose of the World Conservation Strategy was to develop sustainable solutions to global problems of degradation of the environment. Three years later in 1983 the Secretary of United Nations and its assembly decided to ask the Prime Minister of Norway Gro Harlem Brundtland to establish a new organisation independent of UN known nowadays as Brundtland Commission with the mission of uniting countries with the aim of sharing the environmental problems and solutions in order to develop a sustainable future. The Brundtland Commission's definition of sustainable development is now widely accepted, i.e. "meeting the needs of current citizens without compromising the ability of future generations to meet their own needs" (Brundtland, 1987).

As a consequence many developed countries decided to implement a set of regulations in order to protect and conserve the environment for future generations. Australia is one of these countries and has implemented a reporting system for large corporations based on Scopes -1 (direct GHG

emissions), Scope 2 (non-renewable energy use) and Scope 3 (indirect GHG emissions), report which is recorded under the database of the National Government Emissions Reporting Scheme (NGERS, 2013). However, SMEs are not yet required to keep a record of their emissions produced by their activities. Nevertheless environmental experts and researchers consider it one their society responsibilities to educate and possible regulate SMEs to embrace sustainable business practices for the benefit of the environment and cost savings.

The project report in this paper is a response to the sustainability needs of SMEs who are not yet required to report through the NGERS authority. While concerned about their impact on the environment and their reputation as a green business, they do not have the expertise or can they afford to allocate resources to this. The project reported here is part of the Green Information Systems (Green IS) movement to discover how IS can help in this regard. At the onset of the project we did an audit of the free online "Carbon Calculators' that SME's might use to calculate and monitor their Carbon Footprint. This showed that such calculators were all about things (vehicles, heaters, air conditioning systems, IT desktops and servers etc...). However when we talked to SME's they were focussed more on their business activities such as delivering goods or maintaining a suitable temperature. They needed to know how to conduct these activities in a more environmentally and cost-effective way.

The aim of our project then became to find a way to produce a free online application whereby SMEs could easily estimate the environmental footprints of the activities of their business and how they could reduce these. The contribution of IS to environmental responsibility of SME's is investigated by identifying those activities that have a substantial environmental footprint and by studying ways to evaluate the footprint of these activities. The study involved SME's from different industries in the Illawarra region of NSW Australia.

The output of the project will be a significant contribution to more environmentally sustainable business practices in different industries across the Illawarra region. As most of the businesses here are small, a transformation of their business activities from the traditional approach to the Green approach will improve the environment of the entire region.

In order to conduct research to identify, understand and develop such an application a theory was needed and the most suitable one is the Activity Theory as developed by Vygotsky (1978) , Leontiev (1981) and Engetrom (1987). According to this theory, an *activity* is someone or several people (the *subject*) doing something to transform an *object* using tools (physical, psychological and cultural) to achieve desired outcomes. These tools can include information systems so that IS researchers find Activity Theory useful (Hasan, 1998, 2001).

Literature Review

Small and Medium Size Enterprises, (SME's), represent around 90% of the world's enterprises (Hillary, 2000). Most definitions of SMS's are based on number of employees, turnover/ balance sheet total and ownership (Hillary, 2000). In Australia, a small enterprise can have between 1 and 50 employees and a medium enterprise fewer than 200. For the purpose of our research, an exact definition is not material and our results would apply to any of these.

Despite making a great contribution to global economies these enterprises experience many challenges compared with the big corporations. Some of these challenges are: possible limited access to finance, less adaptability to market changes and lack of human resources. Consequently, SME's face difficulties in managing new pressures such as environmental regulations or concerns of their stakeholders about their environmental impact (Hillary, 2000).

This topic has a huge importance in today's society. Many businesses realize the impact of their daily activities on the environment and how essential it is to change to more environmentally sustainable business practices (Watson, Boudreau, & Chen, 2010).

As more and more businesses have started to embrace the concept of green business activities there are growing imperatives for each business to investigate how to determine its total environmental Footprint and to find ways to reduce it. Large firms devote resources to do this because of government reporting requirements, but small businesses are unlikely to have the required incentives, time, expertise or budget (Hillary, 2000).

In the future SME's may want to take action to monitor and reduce their footprint based on either a desire to do so or alternatively on the anticipated need to do so for business or regulatory reasons. A simple to use, online system through which they could track the GHG Footprint of their business would overcome this problem (Berners-Lee, Howard, Moss, Kaivanto, & Scott, 2011). Despite the prevalence of various Carbon Calculators for devices, we have not yet found any real online IT support for easily calculating the footprint of sets of business activities.

In the last half century, Information Systems was one of the greatest forces in improving productivity using technology (Avital et al., 2007). Results from recent research in the field of IS have established a critical role for IS in their environmental responsibilities and general sustainable development. In a seminal paper by Watson et al. (2010) there is a call that issues of environmental sustainability be taken into serious consideration by the IS community. According to Watson et al. (2010),

> "in the practitioner literature, much of the current attention is devoted to Green IT. We argue that this exclusive focus on information technologies is too narrow and should be extended to information systems, which we define as an integrated and cooperating set of people, processes, software, and information technologies to support individual, organizational, or societal goals. To the commonly used Green IT expression, we thus prefer the more encompassing Green IS one, as it incorporates a greater variety of possible initiatives to support sustainable business processes. Clearly, Green IS inclusive of Green IT." (p. 23)

The results of poor environmental practices are reflected in waste, unused resources, energy inefficiency, noise, friction and not least, emissions; while in general past business practices have totally neglected the environment, many organizations currently realize its importance and have initiated Green IS practice. (Watson et al., 2010). The article offers a new environmentally sustainable energy informatics system, which when implemented by all types and sizes of enterprises will lead to a significant reduction in energy consumption and CO_2 emissions and emphasizes the importance of Green IS in teaching, leadership, research, and writing and IS Associations.

Currently, one of the driving elements of the IS research and business practices is energy and how IS can contribute to reducing energy consumption and CO_2 emissions. In this article the authors proposed the development of an energy informatics framework and a new subfield called energy Informatics. (Watson et al., 2010).

A second seminal article by Melville (2010), provides a new discourse on IS for environmental sustainability". The basis of the discourse is the belief-action-outcome (BAO) framework and an auxiliary research agenda. The need to develop the BAO framework came with the conclusion that "business enterprises are a dominant form of social organization and contribute to the worsening, and enhancement, of the natural environment" (Melville, 2010, p.1). The main objective of this article is "to galvanize IS research on environmental sustainability" (Melville 2010, pp.1). It is very important that any definition of sustainability includes the concept of "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987, p. 43).

Two global enterprises that are examples of organizations that adopted environmental management strategies: Marks & Spencer who committed to a five-year plan to reduce its greenhouse gas (GHG) emissions (Rose, 2008) and Google who installed a solar power facility at its U.S. head quarters (Melville, 2010) The environmentally sustainable measure taken by Google is very much related to the proposed research. The organization has developed Power Meter to manage information from smart meters and energy management devices and display it on the iGoogle homepage.

Based on the most recent research on environmental sustainability, the activities of businesses and organisations are the main focus of study that can be facilitated using the Activity Theory which treats the activity as a unit of analysis.

In this research we turn to Activity Theory (Leontiev, 1981) for an understanding of how tools such as ICT mediate cycles of human activities. According to Leontiev (1981), an activity is not a reaction and not a totality of reactions, but a system that has structure, its own internal transitions and transformations, and its own development. In simple terms, Activity Theory is all about 'who is doing what, why, and how'. In Activity Theory, the relationship between *subject* (human doer) and *object* (the thing being done) forms the core of an *activity* (Vygotsky, 1978).The *object* of an *activity* encompasses the activity's focus and purpose while the *subject*, a person or group engaged in the *activity*, incorporates the subject's/s' various *motives*. The *outcomes* of an *activity* can be the intended ones, but there can also be others that are unintended. Vygotsky (1978) believed that tools play a mediating role in all human activities and mental processes which can only be understood in terms of the tools and signs that mediate them (Verenikina & Gould, 1998). This is a two-way concept of mediation where the capability and availability of tools determine how the activity is able to be done, and tools in turn evolve to improve the way the activity can be performed. This is particularly powerful when the tools are computer-based (Kaptelinen, 1996). In the conduct of activities, intended and unintended outcomes are produced.

Activity Theory thus provides a rich and holistic understanding of activities and their mediation by IT tools such as the one we propose. It allows for the variety of circumstances of different SMEs which demands a flexible systems, data repository and interface that can accommodate these differences.

In summary the following four main points have been revealed concerning business activities and their environmental footprint.

Point1. Information Systems and Information Technology can have a major involvement in lowering the level of emissions as a result of business activities.

Point 2 .This is difficult for SMEs due to financial constraints and lack of knowledge.

Point3. The most updated literature has facts, discussions and recommendations on things used in/by the businesses and not on business activities. Many businesses use Carbon Calculators that can be found as web based applications or some of the businesses could have embedded their own calculator on their website. Most of the calculators measure the carbon footprint of different devices, equipment, vehicles, however not for the business activities.

Point4. Based on SME manager's point of view the business is seen as a compound/sum of activities, hence providing free online application for determining the environmental footprint of business activities is the key in monitoring the impact that businesses have on the environment.

Methodology

This project was based on the previous work of colleagues that involved the setting up of a knowledge repository in the form of a Carbon Wiki with an attempt to 'crowd source' data on the Carbon Footprint of activities. Thus this project started out as an extension to Carbon Wiki project seeking to understand what would be needed to develop a Dashboard interface to this repository that would allow managers of SMEs to easily extract and manipulate data in the wiki relevant to their business activities**.**

Research Questions

Based on literature review and the gaps found two research questions were formulated.

The research questions are:

> **Q1.** What are the business activities of SMEs in different industries that have an environmental footprint?
>
> **Q2.** How can an online application be designed for the managers of SMEs to use in establishing the environmental footprint of their business's activities?

Research Paradigm and Approach

The research questions indicate that this research concerns the understanding and construction of tools to guide SMEs in determining their environmental footprint of their business activities. The emphasis on activities has led us to select a constructivist approach based on Activity Theory.

Due to the dynamic and holistic nature of Activity Theory, it supports the constructivist approach, enabling the design, developmental and construction processes to accurately meet the requirements. Gregor (2002) classifies the main theories used in Information Systems based on their nature: explanation, analysis, prescription and prediction. The five types of theories are classified: "(i) theory for analysing, (ii) theory for explaining, (iii) theory for predicting, (iv) theory for explaining and predicting, and (v) theory for design and action" (Gregor, 2002, p. 5). All are five types of theories can be easily interconnected and used in different areas, however the fifth of them known as "the theory for design and action" is the preferred one in the IS field and matches the purpose of my research This type of theory as "says how to do something". The theory gives explicit prescriptions (E.g. methods, techniques, principles of form and function) for constructing an artefact (Gregor, 2002). This is consistent with the constructivist paradigm

In the last decade with the advent of Internet and development of technology the constructivist approach has adapted to a new era of research and design. Problems are identified and solutions should be created and designed based on research. As a consequence the construction of the artefacts in Information Systems is supported by the principles of design research also called Design Science Research (DSR) defined as "learning through building" (Vaishnavi & Kuechler, 2004).

A constructivism approach is identified as the most appropriate research paradigm for the practical aim of this project, namely to conduct the design of the web based application, the Dashboard that SMEs can use to track their environmental footprint. The aim of the research is to understand the process and consequences of this design.

Research Design

Although the aim of the research did not change the way it was conducted was changed by two unforeseen circumstances. Firstly, it was initially planned to begin by interviewing managers of businesses affiliated with a government sponsored green business program. However when gov-

ernment funding ceased our contact went elsewhere and this was no longer an option. Secondly, the Carbon Wiki project fell short of expectation as the wiki was not designed to support entries in a suitable structure for the dashboard. These changes resulted in the following phases of the research.

Phase 1 - Determining business activities

In the initial phase the business activities of different industries are determined by looking at a variety of websites of local businesses from different industries. The main industries are: production-steel (Blue Scope Steel), services-hotel (Novotel), hospital (Wollongong Hospital), university (UOW, UK University).The identified activities are collected in tables that classified them by scope (Scope 1,2,3). Although these were large businesses it was assumed that the activities for each industry would be easily identifiable.

Based on the information found the project began by developing typical profiles of a business in each industry sector, identifying their typical regular business activities. For example, a restaurant would prepare meals, serve customers, place orders, cleanup, etc. as well as office work which meant maintaining an office. These activities would vary with the type of restaurant, the locations e.g., whether heating or air-conditioning was needed etc. A generic list of activities that would have substantial environmental footprint was produced.

Phase 2 - Structuring the Wiki knowledge repository

The production o the Carbon Wiki that would supply data for the Dashboard was designed to crowd source data on a variety of business activities was done by other colleagues and outside our control. At the end of Phase 1 it was clear that, although it contained forms for data collection, these were not in a suitable form to collect the data we needed. Therefore in the second phase forms were designed for each type of business activity identified in the first Phase so that the Crowd Sourced end-users can enter comparable data in the forms. Every data record would have one variable in Carbon dioxide equivalents (CO2e) but different other variables depending on the activity (e.g., the room cooling form has variables that include volume, time and temperature).

All forms have in common the following fields: the name of the contributor, country of the contributor, the name of the city where the business is located, the date when the contributor entered the data and area field for entering the other type of information that the contributor wants to write about the activity.

Phase 3 – Developing templates

The third phase of the research designed the templates for activities which are specific for each industry. The Templates were designed to help structure the Dashboard for each type of business and support the user experience which would follow a scenario that would allow them to select their specific business and then look for entries in the Carbon Wiki that were similar to theirs- e.g. a small restaurant in a cold/hot climate that uses electrical equipment produced from non-renewable energy supply.

Phase 4 - Interfaces for Wiki contributors and dashboard for business users

This phase concerned the design the interfaces of the dashboard based on the templates created in Phase 3

The Dashboard allow the users (decision makers, employees) who are in charge with environmental responsibility measures of the organisation or cost energy savings to calculate the activities' environmental footprint. Any users of the dashboard can benefit from the interactive techno-

logic tool in order to gain information/knowledge about the organisation's environmental position.

The Dashboard was customised for businesses in each type of industry and its particular departments and activities which are connected with the main operational processes.

One of the purposes of the dashboard is the measurement of the different emissions that are the result of the operation activities present and specific for each type of manufacturer or service. Another purpose should be identifying patterns in usage of resources (e.g., water, energy, fuels) therefore saving on costs or/and replacing them with more environmental sustainable alternatives. The implementation of the dashboard could enhance the opportunities for organisations to reduce their activities' emissions and save on costs in short and/or long term.

Results and Findings

In this section of the paper sample outputs from each phase of the Research are reproduced.

Phase 1

We began by identifying the generic activities that any business would have (see Table 1) and then these were reduced and customised for each industry.

Table 1 Typical Business Activities on which templates for specific industries are based

Generic Activities	Specific Activities
Production Goods and Services	Manufacture goods Provide service
Resources Storage and Transport	Procurement Transport and delivery Warehouse activities
ICT and Technology	Server management, network/email Device lifecycle management
Administration	Maintain offices Heating and cooling
General **Maintenance**	Buildings and grounds Equipment Vehicles Cleaning
Research and Development	Events Training Catering

Phase 2

In this phase forms were designed and implemented in the Carbon Wiki created by our colleagues to collect data via crowd sourcing to match the business activities identified Phase 1

The following form in Figure1 is a sample used to collect data the activity of heating/cooling spaces.

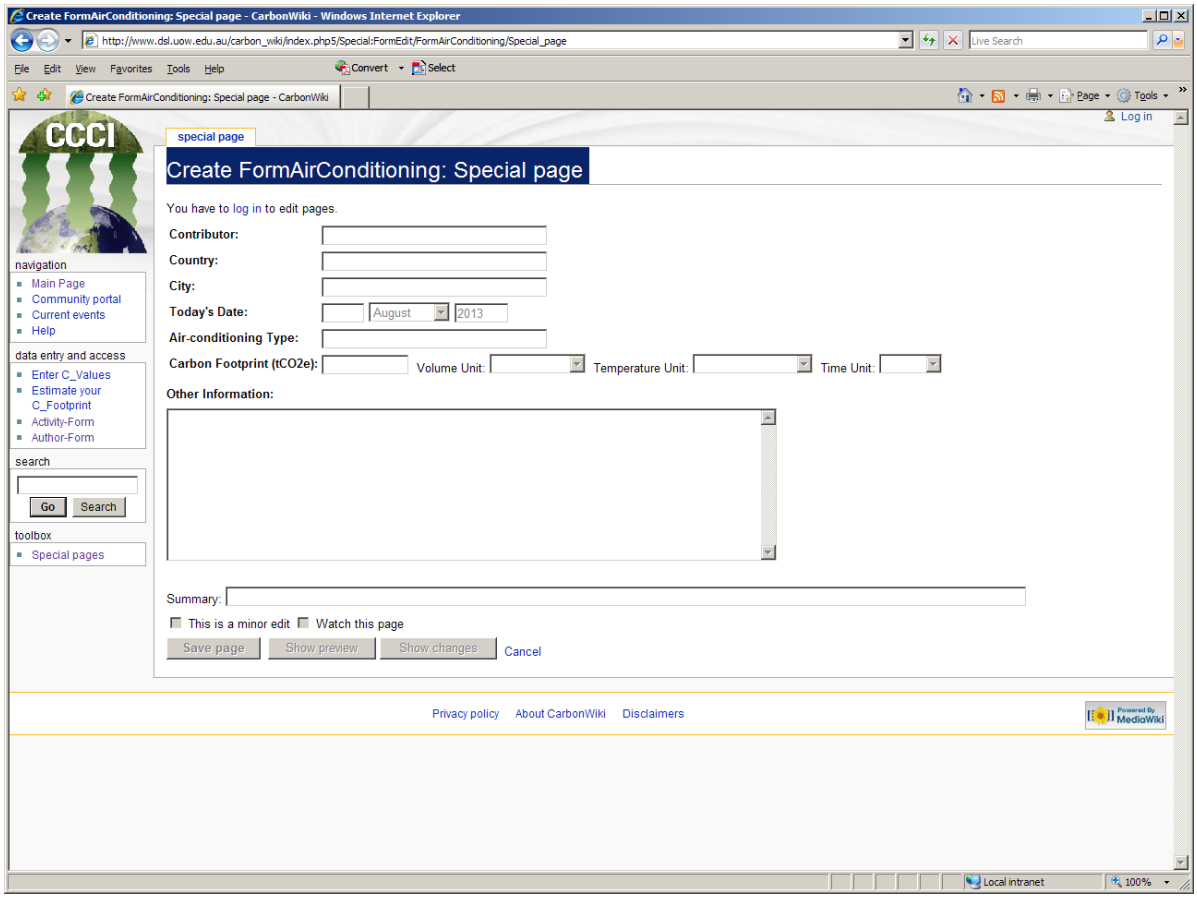

Figure1. Form's interface used to collect data for further calculation of CF from cooling/heating spaces. Note that the user must enter a value of Co2E for a given volume, for a specific temperature rise and for a specified time.

The following forms are present in this project: air-conditioning, running office, space heating, transport, water heating, procurement, data centre, network, cooking, room cleaning, catering, etc.

Phase 3

The results of this phase are a series of Templates were created that could be used to design the interfaces and screens of the dashboard for each type of industry and its activities. Figure 2 is an example of a template from which a user could choose which activities their SME carried out that would contribute to their environmental footprint.

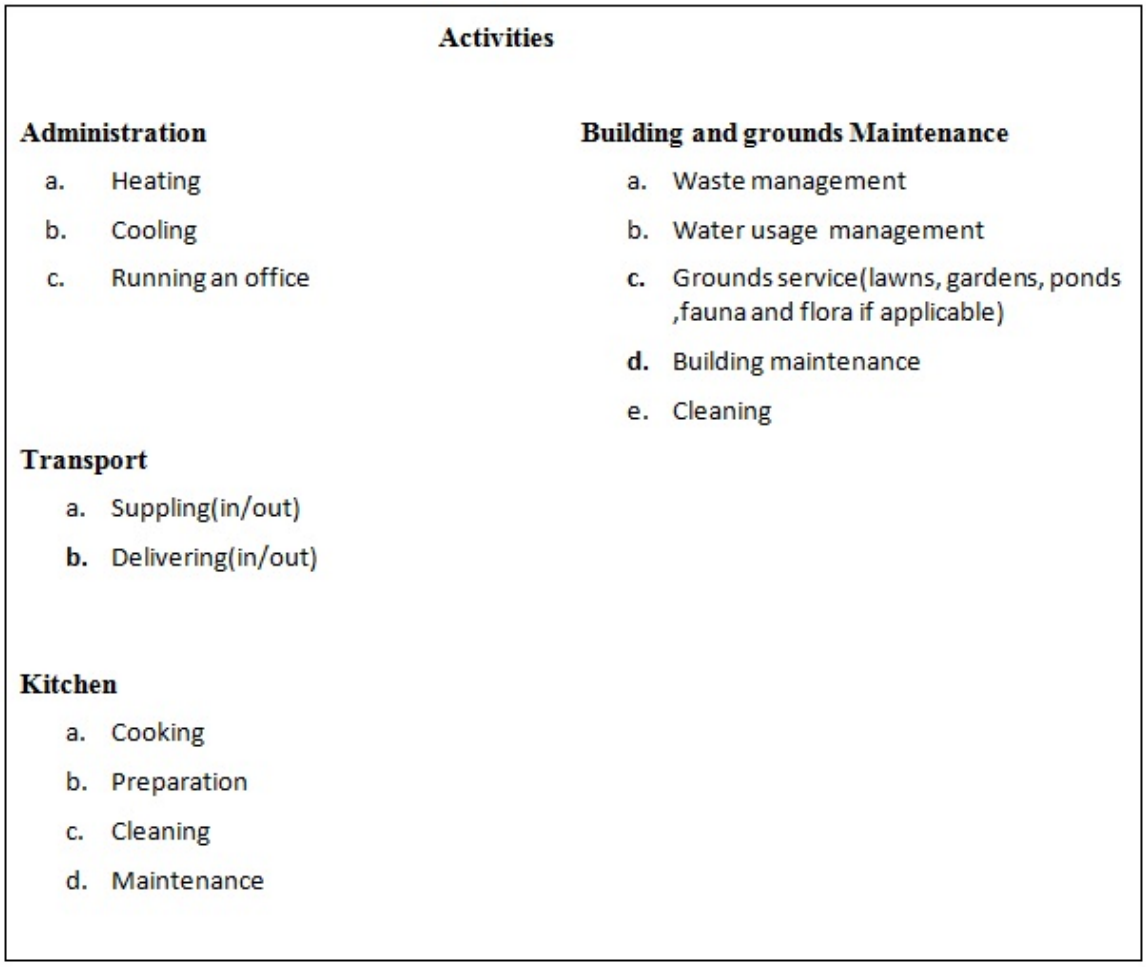

Figure 2. A template that helps a user to identify their specific activities in the hospitality industry

Phase 4

In this phase Dashboard screens were designed as was the navigation between them

In the Dashboards a user would first choose their industry from those in Figure 3. They would then select activities from a screen designed from the Template in Figure 2. They would then be presented with wiki entries (in the format of Figure 4) that would correspond to these from which they could select the ones most appropriate to their circumstances.

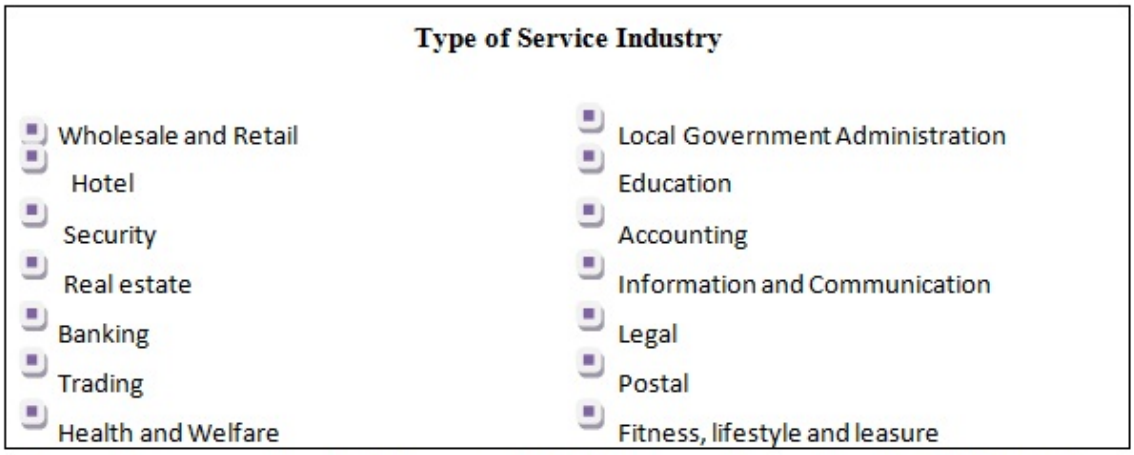

Figure 3. Screen mock up for SME users to identify their specific service. Selecting their industry will bring up a screen with the identified activities from the template for their industry. Then selecting an activity will bring up a list of entries in the Wiki that give data that people have entered on the environmental footprint of that activity.

Heating/Cooling Data

(Please, select one)

Contributor	Country	City	A/C/Heater Type	Volume	Temp.	Time	Footprint CO2e

Figure 4. Screen of the DashBoard with Data from Wiki entered from the Form of Figure 2.

Discussion

The project will contribute to three main areas: to the literature on Green IS, to the practice of helping SME's identify their business activity emissions and cutting costs, and in general to improving the environment of the region's ecosystems.

As mentioned in the literature review, developed countries have taken a series of measures through different protocols and convections in order to maintain and improve the quality of our environment. Recently, Australia has enforced compliance using NGERS (2013) a reporting scheme for corporations and big companies, who are required to calculate their Scope 1 and Scope 2 emissions.

In recent years, many web based applications have been created that allow consumers and businesses to calculate the Carbon Footprint of the various items of equipment they use. However, there are no applications at the moment which can be used by businesses to calculate their emissions according to business activities. As a consequence the Activity Theory was used as a start-

ing point for understanding activity as a unit of analysis and to carry out research leading to design of a Dashboard that would enable SMEs to determine and track the environmental footprint of their various activities.

Due to the variety of circumstances and types of SMEs the interface of the Dashboard was designed to be flexible and easy to use. Using the information they can get through the Dashboard the SME's are able to save on costs and help preserve the environment for the future generations.

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Biographies

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