Lappeenranta University of Technology

School of Business and Management

Degree Program in Computer Science

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INTEGRATION OF SUSTAINABLE DEVELOPMENT IN SOFTWARE DEVELOPMENT CASE STUDY: WEDDING PLANNING

Master Thesis 2019

Supervisor(s): Associate Professor Jouni Ikonen (Lappeenranta University of Technology)

Annika Wolff (Lappeenranta University of Technology)

ABSTRACT

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Master's Thesis, 2019, 83 pages, 17 figures, 6 tables

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Keywords: Sustainability, Software Sustainability, Software Measurement, Software Quality Attribute, Software Development, Sustainability Measurement, Sustainable Development, Software Applications, Software Teams.

Context: Sustainable software development is a set of practices and mindset (principles) that help teams and software organizations maintain and achieve an optimal development pace (Kevin Tate 2005). While the pace of innovation is on a steady increase in the high-tech sector, successful software application lifetime is on the decrease even though not in a way that is relatable. When an application or tool is successful in sustainable development, the demand for it is on the increase, teams are proactive and give customers value for their money and add progress to our environment. Sustainable software development can help in the reductions of inefficiency in software productions which in turn will lead to sustainable practices. **Goal:** The aim of this thesis is to help software organizations; event planners and end-users maintain sustainable practices by creating a software application that reduces wastes in events.

Method: A quantitative and qualitative study was conducted for this thesis. The quantitative study was conducted through survey by collecting 76 answers from different people which ranges from engaged couples, students, working class individual etc., while the qualitative study was conducted confidentially for CEO, Developers, Business developments managers etc., of software organizations and event servicer organizations (as detailed in the results chapter).

The Result: The survey conducted revived that over 50% of the respondents are interested in using the application, which would suggest an emerging need for the services provided by the application and the framework developed in this thesis will help guide in event planning and if some of the practices mentioned be implemented with events planning, it will create sustainable business practice and raise more awareness in the marketing of more sustainable consumption.

Conclusions: An interesting observation from the study is that over 90% of the respondents do not have a current alternative for this service, which indicates that there is a gap in the market for sustainable events service.

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Author

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LIST OF SYMBOLS AND ABBREVIATIONS

ICT Information and Communication Technology

IT Information Technology

GHG Greenhouse Gas

SO Sustainable Development

CEO Chief Executive Officer

SC Software Companies

IEEE Institute of Electrical and Electronics Engineers

NSC Non-Software Companies

SCF Software Company Finland,

SCN Software Company Nigeria,

ESPF Event Service Provider Finland

ESPN Event Service Provider Nigeria

DSRM Design Science Research Methodology

1 INTRODUCTION

Water scarcity, climate change, hunger and inequality are some of the challenge's humankind face today and its effects can be resolved by sustainable development been promoted at a global level. Sustainable development is fast becoming a known name where environmental issues are mentioned or concerned. In 1987, Brundtland Report in his publication first mentioned the term sustainable development, the report talked about the negative environmental consequences of economic growth, globalization and it also tried to find solutions to industrialization and population growth problems. The term sustainable development has many definitions but the most quoted definition is that "***Sustainable development*** is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" which is from the report "Our Common Future", known also as the Brundtland Report (United Nations, 1987).

Many software applications today do not provide enough information as regards to sustainable development. Examples of some of these applications are google maps, project management tools, mapping for planning trips, printing tools, event planning software etc. These applications only give information about planning trips (say for example they provide information which Includes restaurants, stores, side attractions, transport, accommodation if one is planning a trip), managing projects, events, etc. but none of them pays enough focus on sustainable development alongside these apps. They don't mention for examples how the use of some cars can generate less co2 emission to the environment nor do they mention the amount of energy used or waste generated in events.

One scenario could be, David, a project manager in a consulting firm is planning his annual vacation to a resort place. He puts all the necessary information needed in a planning tool he uses to get information about his trip. The tools only provide him with the details of time, date, routes to his destinations but it doesn't give any further information on how his trip could be sustainable. He arrives at the location; David could go with the comfort of renting a car of his choice because he can afford it without thinking of any sustainable measures or he could take a bus going the same way as the hotel he made reservations. He opts for the bus that goes to the same direction with a bus stop in front of the hotel. This way he has reduced the emission of co2 by joining the many others taking the bus instead of renting a car. Because he is

sustainable-minded, he spent a little bit more time in the bus which stops to pick and drop other passengers along the way. Through this means, he saves money using the bus and helps in cutting down on gas emission which influences the climate.

Apart, from the many issues that comes with gas emission as the case seen with David, there are other issues that affects our environment because we are not sustainable minded. In many countries, the cutting down of a tree without replacing or planting more continues to strive. According to the United Nations Food and Agriculture Organizations (FAO), approximately 18million acre of forest are lost yearly to deforestation (Wennberg, 2014)

Our ecosystem suffers from the depleting use of it by we humans and its effects are seen. The future of the generation unborn is at risk of inheriting a depleted ecosystem. The United Nations continues to strive in its goal to reduce the risk that affect both human and the ecosystem at large. They accepted in 2015, 17 sets of new measurable sustainable development goals which will succeed the millennium development goals signed in September 2000 (*From MDGs to SDGs | Sustainable Development Goals Fund*, 2015). They are looking into the different ways to combat, extreme water shortage, extreme weather, food production, deteriorating conditions, ecosystem loss, ocean acidification, a sea-level rise which portrays real danger that could spend up humanitarian crises which could also threaten development. This thesis investigates how to incorporate some of the mentioned dimension of sustainable development by integrating SD into software applications using wedding event planning tool as a case study. This paper will help its readers understand Sustainable development, how it applies to Software applications and its different effect on our social, environmental and economic aspect of productions of Software.

1.1 BACKGROUND

Every nation's arena of economic, environmental and social wellbeing is centered on sustainability and sustainable development. Sustainability been the ability to sustain or maintain in its original form while sustainable development been the development that meets the needs of the present generation without compromising the future of the unborn generations to meet theirs, plays key roles in nation-building because it takes care of the triple bottom lines of economic development, social security and environmental protection. Although the idea of sustainable development in software applications are still quite new and most developers are

still trying to incorporate it in their day to day development, some believe its environmentally friendly because it's virtual, unfortunately, the different phases or process involved in developing, maintaining and deploying are not accounted for. Our population is on the increase and it's expected to be on the increase and so will the use of software applications. The software industries are creating applications that will help reduce the stress that come with our day to day activities but unfortunately, some of these applications created are not done with sustainable development mindset. In the year 2000, the population topped to 6 billion and presently it's about 7.6 billion people and it's estimated to reach 9.9 billion people by the year 2059 according to United Nations Conference on Sustainable (UNCSD), one can only imagine if one quarter of the population uses unstainable applications, its effect on our ecosystem. Excess consumptions and poverty continue to put a lot of pressure on the environment. In some areas of the world, the state of the environment is more fragile and degraded than a few years back. Her high and increasing consumption of scarce resources has led to resulting pollution compounded by population growth.

A framework for change rather than a whole list of prescriptions on how to achieve these is presented by sustainable development in the software world. A whole new way to meeting our needs which can help reduce the level of material consumption leading to a reduction in environmental damage without the quality of life been affected requires limiting the throughput of materials and energy in the economy and finding less ways of meeting our needs through increased efficiency, reusing materials and using sustainable technologies.

1.2 GOALS AND DELIMITATIONS

In the era we find ourselves in, software plays more than an important role to this generation, from the internet of things to the everyday use of software applications features that make the various aspect of our lives easier. The impact of software development practices, thus has a more significant negative impact be it direct or indirect on our economy, social, society, human and the environment at large. The aim of this research thesis is to integrate sustainable development into the software application, exploring the importance of balancing some of the 17 elements of sustainable development into software applications and how if applied will help in reducing some of the problems that our ecosystems face. If software applications are developed with a sustainable mindset, it will help create applications that not only meet the

needs of current but that of the future users while minimizing its negative impacts on the environment and society.

Questions gathered both for the user survey and the interview questions were divided into the following themes:

- **Usability of the Software Application created**

  The aim was to find out how people will react to the mentioned features and what feature is important to them when planning for an event and have their opinions to the usability.

- **Feasibility with other stakeholders**

  The aim was to find out if the software developers find the sustainable features useful when they deal with other stakeholders (event service providers in this case) and in their integration process.

- **Feasibility with customers**

  The purpose was to see if the service providers are willing to use the features and introduce it to their customers (Users in this case) and if users are willing to use the system.

- **Feasibility and compatibility with other systems**

  The aim was to figure out if software developers see any usefulness in integrating the new features to their already developed software app or stick with what they know or have, and what users think of the features.

- **Future development needs**

  The main purpose was the collections of future development needs for the intended features and find out how this service can serve them better while preparing for any events.

1.3 STRUCTURE OF THE THESIS

The thesis paper is divided into six (6) chapters; and how the various chapters are been broken down.

Chapter 1: Introduction that provides information about the research background, the goals and delimitation of this thesis research work.

Chapter 2: State of the art, explores the different practices of software development about as regards to sustainability, what information and work are readily available. What is known in the software industries and how this influence sustainability both in software development, software systems and what requirements are there in software services, Sustainable

development in software applications which investigates the different current practices for SD in SW applications, SD for SW applications, technology used to determine these, maps out the architectural structure and shows how to integrate SD into software applications.

Chapter 3: Methodology, presents the procedure of carrying out this research using design science, literature review, survey to get information from users in order to see how people will react to the product and qualitative research method with the application of case study approach for data collection and analysis and justification for choosing case study. This chapter presents the research study, software organization, event service providers and categorization of participants in the interview and the interview themes.

Chapter 4: Results, focuses on results from the different interview, surveys carried out on how much of information the SW organizations, developers, event planning organization and users understand about SD and results from users about integrating of SD into SW applications.

Chapter 5: Prototype Implementation, shows the prototype developed for applying sustainable development in software development.

Chapter 6: Conclusion and future work, summarizes the thesis and the future work that will be carried out or investigated to promote sustainability development in SW applications.

The References and appendix sections provide additional information to support the thesis.

2 STATE OF ART

2.1 Sustainability

Sustainability originated from two words; sustain + ability(Dictionary.com). It is a requirement expected of our generation to manage the resource base (Asheim, Buchholz and Tungodden, 2001).It can be said to be that which could be sustained, upheld, confirmed and supported. Its principle is based on anything that is needed for survival and well-being which also has a direct effect on the natural environment. For sustainability to be created or maintained, conditions that help provide or produce harmony in relations to human and nature to support present and future generations must be put in place. Sustainability is one of the most keywords in the 21st century. Its importance strives within all industry sectors, in politics and in public perception. Sustainability shows how to enable economic growth and social justice while minimizing the environmental impact. To be environmentally sustainable, we must live within the means of our natural resources. Environmental qualities that are not depleting the natural resources but supporting its long-term ecological balance should be cultivated. Consumption of natural resources such as energy fuels, land, water, material etc. should be utilized at a rate that can be termed sustainable. Sustainability is a wide discipline. It gives humans insights into the most aspect of life ranging from business, technology, environmental and social sciences.

This subject critically investigates how to drastically reduce carbon emission, discover and help in the development of future technologies. Sustainability points attention to politics, economics, philosophy, other social sciences as well as hard sciences. Sustainability helps protect the natural environment, human, ecological health, not compromising the human way of life and driving innovations. When thinking of the word sustainability a lot of things like "balancing the ecosystem of the planet, renewable energy, reducing carbon emissions as well as protecting the environments" comes to mind.

Sustainability studies basically how the natural systems functions and the different things needed to keep ecology in balance. It also recognizes the importance of human civilizations sustaining our resources in this modern way of life. It considers how humans can prevent damages, destructions and live in harmony with the natural world. In the most urban developed world, a lot of natural resources are consumed largely daily. More power is used compared to the rural areas. The use of power (energy) in keeping the streetlights, civic buildings, light up power appliances, heating, household power requirements and other public necessities is used more than average. There is an estimation of over 40% of the resources are been used every

year and this cannot in any way be compensated for. The need to move forward economically, technologically and environmentally has been a great issue for sustainability and sustainable development. Technically, sustainability is not only about our environment but also deals with health. It basically wants to ensure that human or other areas of life don't suffer because of environmental legislation. It examines the long-term effect of the various actions carried out by humans seeking for ways it can be improved.

Thwink.org, a nonprofit research organization in the United States also define sustainability as "the ability to continue a defined behavior indefinitely" (Thwink, 2014). Their definitions connect with the three pillars of sustainability been economic, environmental and social sustainability as described in Figure 1 below.

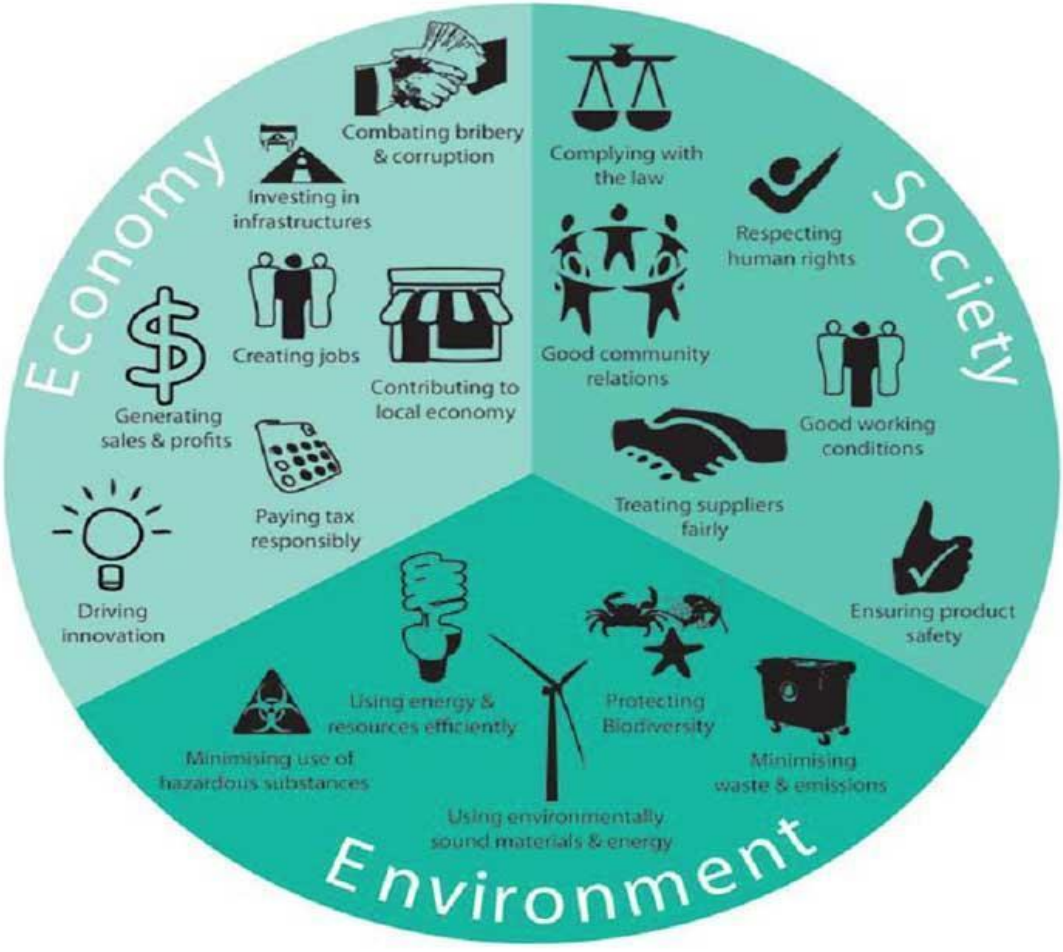


Figure 1: Diagram showing the aspects of sustainability and what is involved in it.

2.1.1 Environmental Sustainability

This form of sustainability encourages measures that would help in the prevention of waste and pollution by encouraging responsible use of resource and restoring them. This, in turn, will help protect the planet from industrial abuse.

The natural resources are often taken for granted forgetting that these resources are not unlimited. The planet must be protected from constant corporate exploitation and neglect. Safeguarding the future of humanity which in turn protects the environment is a human major concern. These concerns range from how we as humans can help protect the ecosystems, sustain our resources and focus greatly on the elements that put stress on the environment. It also investigates how technology will provide a greener future. Initiatives such as renewable energy, reducing fossil fuel consumption and emissions, sustainable agriculture and fishing, organic farming, tree planting and reducing deforestation, recycling, and better waste management should be encouraged and supported.

Business should also be regulated to help protect and prevent pollutions keeping carbon emission on the low. Incentives should be given to encourage the installation of renewable powers for homes and businesses. Thwink.org also added this: “From a system thinking viewpoint, the human system is a dependent subsystem of the larger system it lives within been the environment. They added that if the problem of environmental sustainability problem isn’t solved, no other problem will matter which will in turn result to catastrophic collapse.” It was trying to express the dangers the environment would find itself if not taken care of. Environmental Protection Agency sees the need where developing technology and biotechnology will help protect the environment of the future from any potential damage.

2.1.2 Economic Sustainability

The economic sustainability focuses more on economic growth. The idea behind this form of sustainability is to ensure that people can meet their economic needs; be it food, shelter and any other basic form of living or for profit. Although his aspect of sustainability proves to be the most difficult. People are not economically sound. They only focus on how the effect of how been economically sustainable will affect businesses, jobs employability etc. In the most western or developed world, it is a known theory that people living in these areas are huge consumers of resources. They consume a fairer share. The supply and demand market consume

quite a huge number of resources because the modern life lived here requires a lot of resources daily. While people in the developing countries are constantly growing in population while aspiring to have a rather high consumption lifestyle too. It is important that organizations and businesses provide incentives that will help people adhere to sustainability guidelines helping to get what is consumed under control. A fair distribution sustainable model is needed to help balance, allocate and distribute resources thereby reducing the financial burden and helping human to do the right thing. This will in turn help and maintain the economic growth resulting in a balanced ecosystem.

2.1.3 Society Sustainability

The ability of any society or social group to achieve a very good social wellbeing can be said to be socially sustainable. For an organization, country or a community to achieve or maintain social wellbeing for or in long term shows it socially sustainable. This form of sustainability goes beyond people or society at large to function at a very good standard of wellbeing either for its present generation or the future generation.

This aspect of sustainability addresses issues that stream from poverty, crime, education, public health etc. according to Adams Werbach, in his book "Strategy for Sustainability: A Business Manifesto," (Adam Werbach, 2009), He expressed why a larger kind of sustainability should be investigated. One that would consider the economic, social and he then added cultural sustainability to it. He wanted a means that protects and value the diversity through which a community or communities can show forth their identity thereby cultivating traditions across generations. Social disruption that tends to destroy or threaten the well-being of the environment and people should be discouraged.

Awareness of legislations protections of the health of people, harmful activities and pollution of organization and businesses should be provided. In the most developed world, there are programs that are put in place to ensure people's lives, health and wellness are seriously protected because it's all about the maintenance of basic access to resources without compromising the basic quality of life. Although the same cannot be said for the developing world. The ongoing issues at hand basically deal with how houses can be built in a more sustainable manner raging from the materials used to produce them and educating people on the effect of not doing things in a sustainable manner and the warning dangers if environmental protections are not put in place. Ethical responsibility is for all humanity. We as humans should

join forces in fighting against social injustice, inequality and poverty. We should encourage and support social justice, peace, help reducing poverty, other grassroots movements that will, in turn, bring about social equity.

Paul Hohnen, expressed what will happen if nothing is done as individuals, in his words "We need to understand that these [disruptions in the planetary systems] are not irrelevant or remote developments that might only affect, say, one kind of insect in a rainforest somewhere? These are changes that will sooner or later affect every species on Earth. It is essential to keep in mind that our current political, social and economic systems are built in a healthy and self-replenishing ecosystem. The sooner our political and business models incorporate this reality; the sooner we can put ourselves on a sustainable path". (Hohnen, 2012; Vale, 2016)

2.1.4 The Role of Software Developers in Sustainability

High demand for increasing features that make software applications user's experiences easy and more appealing for its users, drives the need for increased changes in the development of software applications. With the environment in mind, this should lead to the persistent and increasing needs in the software environment of companies regardless of the size and product to be more sustainable in their products, services and above all innovations. The traditional software organizations emphasis is basically on the software features, bugs fixing and the entire plan of the project. Unfortunately, this method in most cases is still the primary method of thought in software development which is the engineering approach to software development which to a large extent is what is been used. Part of the reasons why most software firms are not sustainable in their innovations or been able to achieve sustainability is because software developers do not receive enough educations to prepare them for innovations with sustainable development in mind, they are all about innovations and profits.

Software applications continue to be developed in a complex and ever-changing ecosystem, but the educational system must teach students the craft in a very controlled environment so as they (students) are not overwhelmed. A lot of developers tend to fall back to the ad-hoc variants of the traditional linear approach because it provides them with a degree of comfort which they are familiar with it. Sustainable means of development can be achieved if students are taught to understand the bridge from the practical world to the academic with a mindset of sustainable development culture and a high mindset to sustain development over a long period regardless of our complex surroundings. Sustainable applications will help enable humans to meet their

needs with minimum impact on the environment. Example of some of the technologies in place should be reused instead of investing more resources for new creations. If organizations globally understand that environmental responsibility is for everyone and it is good for business, it will drive them with a desire to protect the environments, reduces costs, reduce risk, drive better sustainable revenues, improve products brands and produce eco-friendly goods to meet the growing consumers demand and to a very large extent comply with governments regulations which will be profitable for the environment and also good for business. Its results will show that sustainable development is a quality attribute in software applications

2.2 Sustainable Development

The term sustainable development is quite challenging in its definitions. A lot of definitions have risen, (Rosalyn McKeown, 2002), defined SD as three components: Environment, Society and the Economy. She believed the well-being of the three areas is intertwined and not separate.

UNESCO according to Johnston Eric, a staff writer of the Japan Times, Promote SD as a development that is socially desirable, economically viable, culturally appropriate and ecologically sustainable. (Eric Johnston, 2004). These definitions all stand with the ability of man to preserve the available natural resources today without it been overused so it can help the future generations. SD can be shortened to be achieving more with less resource and ensuring the ecosystem remains healthy thereby improving the standard of living and the quality of lives for the present, as well as the future. Humanity today believes they are independent forgetting that they can be affected by the different actions carried out by someone else. The world is designed such that different generations and inhabitants live in it. It is, therefore, important that policies and frameworks are put in place for proper utilization of resources to help promote growth, justice and well-being of all human presence and the future generation unborn. SD could address challenges for human and its future. To get this done, a lot of clarity as to how this approach should be applied is necessary. On another hand, SD also relies on the three aspects of sustainability; the environmental, social and economic as seen in the diagram below. These groups are divided into various categories that make it easier to handle and discussed. SD can be discussed in fields such as architecture, politics, software, energy, agriculture, transport, culture etc.

The UN Commission on Economic Development as reported by Brundtland in 1987 definitions seems to be more accepted by all. According to their report titled "Our Common Future", sustainable development is defined as "that which meets the needs of the present without compromising the ability of the future generations to meet their own goals" (United Nations, 1987). Although quite a lot of writers found this definition not appropriate. (Taylor 2002; Jabareen. Y, 2008; Lele. S 1991).

Taylor (2002), in his report, argued his point about the UN definitions, in his argument, he discussed why it is quite difficult to determine the needs of the future generations because it might be totally different from what is readily available now. He also added that developed countries views on needs are different from developing countries. Although the UN definitions caused quite a lot of controversies, it covers some fundamental issues as regards to the environment. An example is the degradation of the environment which results from economic growth. The rate at which the earth is transforming especially in developing countries which are undergoing industrialization is on the increase. According to (Wackernagel & Rees, 1996), raw materials are been consumed and sinks that are used for waste materials is on the increase and growing fast.

Regardless of the definitions, the UN definition covers practically with maintaining well-being over a long period of time and balances economic, environmental and social factors. It also considers the economy, society and the environment as interdependent areas rather than independent areas. As seen in Figure 2 below; the connections represent the society, the economy, and the environment. For the world to reach a reasonable balance, these factors will help in achieving sustainable development.

Figure 2: Sustainable development.

2.2.1 Sustainable Development in Software Development

Sustainable development is fast becoming a growing topic where information technology is involved. It employs software development to help safeguard the future which is also an evolving market segment. With the population on the increase and a reduction in resources, sustainable development is gaining grounds in the research world with fields as energy efficiency, material efficiency, waste efficiency, CO2 efficiency. More industries such as green IT, economics, computer science, consulting etc. all taking sustainable development into account to help safeguard the future and its market. Software development needs to understand how sustainable development can be applied in the use of resources. This will help in the development of sustainable products in a more sustainable process.

Software engineers must take responsibility for sustainable development because there are growing resource problems that are affecting the planet and high productivity that is in conjunction with short life cycles in IT. Although most people in the software engineering world understands the concept as the capacity to endure and as meeting the needs of the present without compromising the ability of future generations to meet their own needs, there are no available guidance from the software engineering point of view, this is because traditional software engineering methods has not fully supported the practice of sustainability (Penzenstadler, 2013), talk less of sustainable development. This leads to inefficient efforts to help address the subject sustainable development. An accepted definition should be put in place

for software engineering where SD is concerned. SD as a subject should also be in the curriculum for software engineering students. This will help all involved (both teachers and students) identify the different spheres of activities for software engineers to build competent solutions and have a broader SD awareness.

Software is commonly assumed to be "environmentally friendly" because it is virtual, the different process and its methods used in the development, maintaining and deploying software have an environmental and social impact. This is not commonly accounted for during software development practices. An example is e-waste, it can be minimized if vendors in the software industries consider the lifetime of old hardware's. Information technology plays an active role in its addressing of environmental, economic and social issues.

IT has the capability to extract knowledge that will optimize resource-intensive processes; an example is analytic for water consumption and smart grids although it materializes activities that otherwise would consume resources (e-mail versus postal mail, virtual meetings versus travel).

Impacts caused by the developments of IT products are not recognized or accounted for in the industry. An example; a computer is no longer in general use for every time a newer one is produced or put in the market although the hardware of that computer is still working or usable, the software renders it useless. If this fact will be considered by software developers, products will initially from its unset be designed from the ground up to also be functional on older hardware. This, in turn, will help software development in a more sustainable manner. Some engineering disciplines (for example, ISO 14000 and LEED for environmental and civil engineering) standardized sustainability, there still is not awareness within the software engineering communities (Christini G, Fetsko M, Hendrickson C, 2004). Any mention of sustainability work in this discipline is commonly referred to or used in the context of software maintenance which does not account for social and environmental aspects.

2.2.2 Sustainable Development in Software Systems.

Software Systems have a requirement to fulfil both environments (human), social and economic needs. The economic aspect of software systems is only viewed in terms of the economy while the social and environmental (human) are investigated as service oriented. In the last 20th century, the software has found a place in the lives of humans and their various activities. Complex software systems had a great impact both on software security and software

safety failures because it was quite common. This led to the researcher in the software engineering departments call for addressing the security and safety of large-scale software systems during development. Nonfunctional requirements were termed security and safety. Taxonomies of these nonfunctional requirements focused on qualities such as efficiency, reliability and usability. IEEE Standard 730-1989 stated that support should be given in a situation where failure emerges during development because it could affect the system causing a large impact on social and financial losses. Although they neither addressed safety or security as qualities.

Software system in this 21st century has become the center of operations for the most industrial sector in the society. They are embedded in almost every function of our lives in an unsustainable way. Although Software systems focus on so many aspects of our lives, software practices only seem to focus on the immediate effects of the benefits of software products and platforms. Research has it that software engineering is concerned about increasing the efficiency, reliability, and cost-benefits of software products for people who own them are focusing only on the various processes, methods, models and techniques that will help in creating, verifying and validation of software systems thereby keeping them operational.

The collective sums of individual negligence for the environment over global responsibility have continued to affect the ecosystem adversely. To operate in a system that is sustainability, we as humans must think and act sustainably.

Software engineering has the great potential to make the world “Green” through information technology by creating a more civilized sustainable environment. Sustainability, where the software system is concerned, should be of uttermost importance alongside other critical attributes in the society such as safety, security, reliability and usability. Rather than the optimization of current systems, transitions that will help change from unsustainable existing system to sustainable ones should be adopted.

The effect of sustainability on the environment is quite a huge challenge and much attention should be given during the development process of projects. Proper measures as to what is involved when developing a software system and how it affects the environment is crucial to the ecosystem that is why the different dimension of sustainability, their value with indicators should form a model for constructing and analyzes for companies where product production is concerned. There have been workshops as regards sustainability in software engineering, an example of such is the 34th International Conference on Software Engineering (ICSE) held in

Zurich Switzerland in 2012. The conference theme was “Sustainable Software for a Sustainable World”.

This conference is aimed at advocating for a sustainable world. Part of their objectives is to ensure that software systems are created and maintained in a sustainable fashionable way because our daily life is in one way or the other is embedded and equally dependent on software systems. The conference aims to provide a strong technical program to researchers, industrial practitioners, educators and students in the software engineering fields.

Software developers most times are driven by the pressure of the time to the market and not educated or enlightening to apply sustainable development mindsets in their techniques in development projects. Although most researchers on software development have a huge amount of different techniques, an overview is not completely investigated. Project managers, architects, developers can follow a proposed guideline during the different phrase of software system production process.

This guideline will foster economically sustainable software systems, making it cost-effective and help in response to changes that affect the environments, business demand and the product usage profile.

In the industrial automation domain, the software systems have a lifespan of 10 years and more. These systems involve a large range of embedded real-time systems to other large-scale control systems that are distributed. Special focus about their design, structure, safety, their performance, availability and other extra functionality should be well constructed because during their life cycle they respond to changes in their environment, which are the software and hardware; business demand which involves new features etc., therefore it is necessary to keep under control during the maintenance and evolution, the cost.

In most cases during the design and development process, SD is not often involved because of lack of expert knowledge, budget or even time and this leads to technical debts, increase in maintenance cost causing major risk in terms of flexibility and even quality.

The agile methods have influenced the development process nowadays. This method proposes a more flexible and lower cost for the handling of change requests. The society is indeed facing sustainable development challenges. Everyday communication, navigation through the storing of health records, security threats identifications, the planetary systems to mention a few are dependent on technical infrastructure. How can it be then sustained? The most common and

perhaps the most effective method to handle the issue of sustainable development majorly deals with existing aspects of software systems. Examples can be laws, generalities, management of these systems evolution and cost-effective evolution. Different writers have proposed different methods to tackle the issue of sustainability of a system to improve it. Examples of some of these writers are Chapin et al and Godfrey and Buckley and a summary of their opinion is seen below.

Ned Chapin et al in their journal, mentioned ways that can be used to help redefine the type of software evolution and maintenance that will help in the improvement of sustainability of a system in its initial development. They proposed these software evolutions be based on classification and maintenance types which are also based on the activities of the maintainer activities. These classifications should be able to recognize; the software, the software properties, the functionality of the customer experience and documentation of the software (Chapin *et al.*, 2001).

Godfrey and German talks about the relations and difference involved in software evolution and maintenance; creating a taxonomy of changes of the software (Godfrey and German, 2008). The taxonomy that is based on characterizes of the mechanism of change and the different factors that affect or influence these factors. The goal of these is to help create a framework that puts in place concrete tools, methods and formalism that is in the domain of the software evolution. They did not provide any solution but rather help to analyze the properties and change in evolution.

In order to achieve long-living software systems that support sustainable development, some structures must be in place. These structures should consider the important aspect of sustainability during the software systems design, development and maintenance and operation process. This will help support various problems at hand and the incorporations of sustainability. The structures should contain various software system approaches with a focus on sustainability; these approaches should also be structured with the software system life cycle in mind to aid easy navigation. The structure should also provide a reference practice orientation on sustainability about software engineering approaches for system designs, developers etc. This, in turn, will help software architects and developers aware of incorporating the newest ideas and features, what benefits as well as risk involved in the project thereby helping projects leads, testers, and requirement engineers to be more aware of sustainability during the process of development while working on a new system and during

the evolution of one that is already in existence. They could avoid pitfalls and mistakes by simply applying the methods mentioned in the structure even if they are aware of the approach, a provided checklist will go a long way, aiding an easy transfer of knowledge daily, provided everyone is disciplined in carrying out the outlined structure.

These sustainability issues can only be impactful if we as individuals and as a group apply it by educating ourselves on what it entails, adapt to the changes that will positively affect the society and the environment, understand safety and security issues that require sustainability. Rather than the optimization of current systems, transitions that will help change from unsustainable existing system to sustainable ones should be adopted.

The UN in its agenda for SD frame for 2030, coiled out 17 key elements issues which will help develop, tackle and improve upon the various aspect of the human life's. The global goals which can also be described or known as the sustainable development Goals (SDGs) are said to actions that should be put in place to end poverty, protecting the planet so people will enjoy peace at its best and prosperity. These 17 keys issues were selected from 70 different countries by an open working group. The key to this SD agenda is to help eliminate poverty, tackle issues that relate to climate change, fight inequality by the year 2030. The goals are shown in Figure 3 below.

Figure 3: Showing Sustainable development Goals.

Some of its top priorities are climate change, economic inequality, sustainable consumptions, innovations etc. They aim to work towards securing the life of the present and the future ahead

by making the right choices to help improve life. Some of its provided guidelines and targets for all countries of the world is in accordance towards tackling environmental challenges.

This laid down guideline will help tackle the root causes of the issues different countries are facing, thereby help our ecosystem fight against poverty and bringing unity to the world at large.

They aim to end poverty, hunger, ensure people live in a healthy environment thereby promoting wellbeing for all ages, provide inclusive and equitable quality education, and achieve gender equality, sustainable management of water and sanitation for all. Build a resilient infrastructure that will foster innovation to mention a few. (Kumar, Kumar and Vivekadhish, 2016)

3 METHODOLOGY

This section investigates the research method used and adopted for this thesis study as well as data collections. Design research approach was chosen because it shows the explorative nature for this study and the process which focuses on the integration of sustainable development into software applications. The design research revolves around the development of solutions in the form of artifacts in software. The applications feature as seen in the prototype is validated quantitatively through survey questions and qualitatively through semi-structured interview by software experts in software organizations, developers and event service providers.

Lots of materials, attitudes and actions will be accessed during the cause of this thesis report. Survey designs, analysis, interviews of software producing companies, and interview with event service providers will be carried out during this thesis process. Data collection through interview of teams, CEOs, in software companies, events service providers, general users and the analysis of data will be used to answer the different research questions. Event service providers and users are the people whom this prototype after development will be beneficial too because this will help in adding value to their services while the software organizations will add the features to an already existing one or create new ones.

3.1 Research Questions and the problems

Events can increase positive thinking and at the same time, generally place a burden on the environment which leads to awareness of environmental issues (Centre, 2014). Wedding planning event as the case study, is an event that takes place all year round regardless of the culture or traditions. A lot of people want it to be elaborate without putting sustainable measures in place either big or small which in turn causes quite a lot of waste during events.

The thesis will examine the integrations of sustainable development in software applications. How much of awareness of the practice of sustainable development is available in the software industries especially in event planning. Its aim to contribute to already known knowledge that is not practiced in the case of events and how to encourage some of the 17 Sustainable Development Goals as stated by the UN member states, how each one of us can play a role in finding shared solutions to the world's urgent challenges by reducing waste as much as we can. It also informs about the different aspects of the concept of sustainable developments and how if handled properly can not only bring joy to any event but also harmony with nature and the society at large through different literature reviews and internet sources. However, the focus in

this thesis research as regards to sustainable development will be largely on wedding planning, even though the subject in question largely affects other aspects of our ecosystem such as; management, law, constructions to mention a few.

Main Research Questions:

	Research Questions	**Goal**	**Action**
1.	How the prototype software application developed will help reduce event waste more efficiently?	Help to understand better sustainable consumption and better business practices	Interview and survey questions
2.	What are the primary use cases for the prototype application developed?	This will help in understanding who this prototype developed is for	Interview and survey
3.	Who are the stakeholders of the prototype developed and for what purpose will this application serve?	This will help to understand the activity flow for the prototype	Conducting of Interviews
4. 4.1	How the integration of sustainable development in software application serve more efficiently? What kind of improved ideas can be found?	Help understand the benefits involved in the prototyped developed and how to further improve on it	Conducting of Interviews

Table1. Showing the research question for this thesis.

3.2 Design Science Research Method

Design science research well known in the engineering and architectural fields focuses on the creation of new features, how things should work in order to attain a certain goal and functions. The design science research help change existing situations or solutions into the ones that are preferred. The design science research creates artefacts for a practical purpose. The design science research should be able to solve a problem that is unsolved in a more unique way or in an effective efficient way. For this thesis, the unresolved problem is the issue of management of waste.

Design science research methodology (DSRM) focuses on the development and performance of design artefacts with the intention of functional performance. The three objectives for DSRM is

- Provide a nominal process for the conduct of DS research
- Build upon prior literature about DS in IS and reference disciplines
- Provide researchers with a mental model or template for a structure for research outputs (Geerts, 2011)

Figure 4 below indicates the DSRM adopted for this thesis which includes the three key (Process iterations, Problem centered approach and thesis) elements in the DSRM which are the conceptual principles to define what is meant by the design science research, the process that is used to carry out and present the research and the practice rules. For this thesis, the problem centered entry point is required because of the observed problem by the researcher and for the prototype been developed.

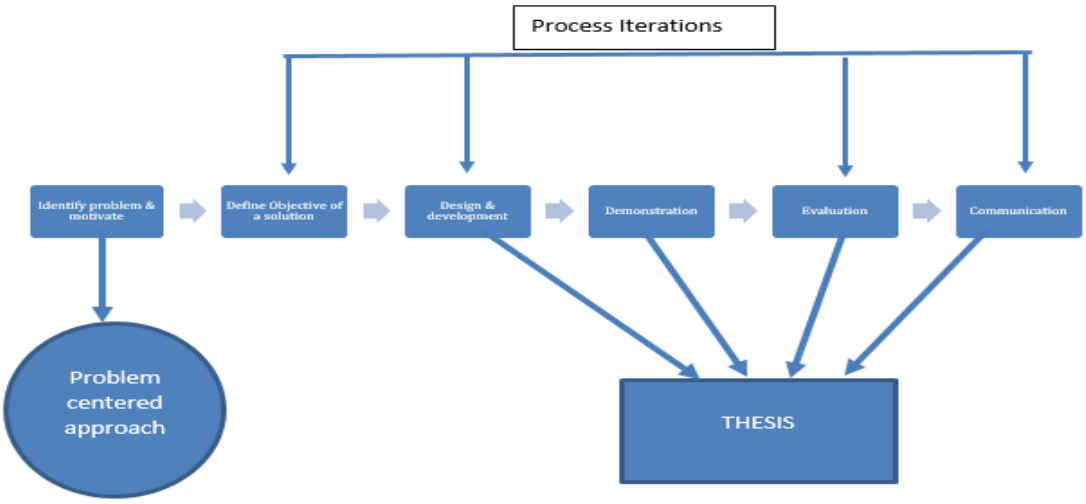


Figure 4: The design science research methodology used in this thesis (Peffers et al., 2007).

DSRM is used for artefacts that include algorithms, computer interfaces, methodologies design and languages. The application of DSRM is most used in computer science and engineering disciples. The research in these disciplines used is typical for the improvement of human performance. Table 2 below describes the DSRM Activities, Activity Description and knowledge base put into consideration during this thesis.

DSRM Activities	**Activity Description**	**Knowledge Base**
Problem identification and motivation	Reduction of waste during wedding events. Users, Software organizations, event planning organizations will help in the eradication of wastes.	Waste is one of the current problems found in wedding events and unfortunately no knew solution is presently available.
Define the objectives of a solution	Creating a new application for this kind of problem or integrating the different solutions mentioned in the prototype to already developed application.	Some of the wedding application today don't have the solutions mentioned in the prototype.
Design and development	Prototype developed with the different solution features.	
Demonstration	The application created will reduce different kind of waste during events	Application creation or embedded into existing ones
Evaluation	The impact of the solutions will easily encourage sustainable development mindset	Creating a good mindset to tackle the problem
Communication	Users will be able to enjoy the different part of their wedding having put different sustainable measure in place	The application will help shape the views of its users because quite a lot of person are not properly guided.

Table 2: Design science research methodology (DSRM).

3.3 Quantitative Research Method

Quantitative research methods are a well-structured manner by which data's that are collected from different sources are collected and analyzed. These methods help in information gathering from customers who are existing or potential ones by carrying out surveys, online polls, questionnaire etc. It involves bringing together quantifiable data and performing techniques that are statistical, computational and mathematical. Cohen, Manion and Morrison, in their book define quantitative research as a systematic and scientific investigation of data and their relationships (Cohen et al., 2009) while (Kitchenham *et al.*, 2002) put it as a means to put data's together as part of an empirical research to get information's.

According to (Fink, 2016), surveys are methods by which information are gotten or gathered to help understand participates feelings, behaviour, social knowledge, preferences and values. Interview and Self - administered are the two types of surveys.

For the purpose of this thesis, a self-administered structured and online survey was applied, the survey was an open one without any form of personal help for participants, survey link was sent via email addresses and they (participants) were solely responsible for answers to the questions and it was done online using internet connected devise.

An introductory section was also added to the beginning of the survey questions which in turn helps data storing action clarifications and a request for answers to the investigations. Doing this, is to further help to comply with the morals of confidentiality and privacy (Fink, 2016).

3.4 Qualitative Research: Case Study Method

Qualitative research is a way the social world is studied, it helps to analyze and describe the behaviour and culture of humans or groups to help understand their point of view on the study been carried out (Shareia, 2016). This method of research help researchers gain access to what the feelings of their participates are, collect descriptive data, understanding people own words as well as their true behaviour. It gives a better understanding of how people describe their different experiences such as; understanding how and why such behavior's. In the medical world, qualitative researches are used to examine arrays of topics (Sutton and Austin, 2015).

For this thesis research, the qualitative methods will help me unveil the different trends of reasoning amongst all stakeholders involved, their different opinions and go deeper into what the actual problem is. This qualitative approach will focus on the "how and why" and the use

of unstructured methods will help in data collections to fully explore the topic or subject in question because qualitative are open-ended, involves focus groups, discussions in groups as well as interviews because it focuses more on why people have thoughts and feelings that might affect the way they behave.

Data collections during this process will be done with a semi-structured interview process. The method was selected because of its characteristics and focus on a holistic approach or perspective and on respondent's view. It also understands the whole process.

Interviews done in Finland were carried out at the different software companies and events planning organizations premises while the other conducted in Nigeria was done via skype. The voice recording answers were kept for later analyses.

Case study which is a form of qualitative research method was used for this process. Its aims to give a detailed description of the case study- its definitions, some clarifications etc.

Case-Study Research

Case study methodology in qualitative research is a method that helps the researcher to better study phenomena that are complex within their contexts and if the approached are applied in a correct form, this becomes a method that is valuable for theories to be developed, develop intervention and evaluate programs (Baxter and Jack, 2008) and their definitions are said to be general not containing classifications of types of study (Rebolj, 2013) while (HayHayes, N. (2000) Doing psychological research: gathering and analyzing data, Doing qualitiative analysis in psychology.es, 2000; Willig, C. (2001) 'Introducing qualitative research in psychology Adventures in theory and method', in Introducing qualitative research in psychology: Adventures in theory and method. doi: 10.1177/1468794106058877.Willig, 2001; Yang *et al.*, 2018), gives detailed information's on the ***Characteristics of Case Study Method.***

For the purpose of information gathering during the interview section for this thesis, the case study method was used for conducting interviews in the various organizations as seen in the results in Chapter 4 of this thesis. It provides tools for researchers to study phenomena that are complex within their context, it helped guide me to understand the future of the proposed prototype developed, its market, what software organizations, developers and event service provider's views on sustainable developments in software applications during the course of the interviews because it interplays all variable for the purpose of understanding situations

surrounding each social unit of these organizations, offer new questions, variables for further research, provides detailed information of each organizations situations and also helped the collections and drawing of conclusions although intensive but in a comprehensive manner all for the goal of understanding hidden dimension of human life.

3.4.1 Justifications for using Exploratory Case Studies Method

For data collections and analysis during the interview process, I will be working with the exploratory case study. Case study methods involves, ***Illustrative case studies, Exploratory, Cumulative*** and ***Critical instance***(Colorado state university, 2019)**,** but for the purpose of interviewing with the different organizations involved, I did choose the exploratory case study. The exploratory case study is a more concise studies that are performed before implementing its investigations on a large scale. This form of case study helps to identify questions and what form of measurement to apply. One of its downfalls is that convincing conclusion can be made from its initial findings which might be premature. (Elmore, 2008)

My justification for using this method of research for this section of information gathering for this thesis topic is because it helped to gather concise case for the prototype to be developed during the survey results received and during the interview process. It will help identifies some of the problem within the software industries as regards to problems of sustainable development mindset that has not been properly defined in the software industries. The method helped to observe the software organizations, event service providers and help explore, to draw a definitive finding with extreme caution. The formal discussion with developers, focus groups, some employees, CEOs etc. through in-depth interviews, observatory methods, projective methods and pilot cases through an interactive nature helped me understand what happens in the software industries and why some of these mindsets don't seem so important in the different phases of development.

3.5 Sampling and Data Collections

The table 3 below details all the methods used for collections of data.

Methods	Details
Survey method	Online
Interview conducted (confidential)	Semi-structured
Design method	Cross-sectional
Number of sample groups	3
Number of survey sections	5
Time duration	2 months (From August 2017 to October 2017)
Selection method	Convenience Sampling
Sample requirements	Software organizations, events planning organizations, Random smart phone and internet connected users
Survey administration Interview	1. Via google survey forms 2. Done by me
Processing the data collection	Data is automatically generated after entry.
Survey distribution Interview	1. Invitation to answer questions was sent to participates email with a link 2. Carried out in the premises in Finland and via skype
Survey answers collected	78
Survey questions sent	100

Table 3: Sampling and data collections

3.6 Data Analysis

The results as presented in chapter 4 was done after data analysis, summaries and correlations following the methods described by Fink Arlene (Fink, 2016) and Press Academia (PressAcademia, 2018). The data collected are properly analysed in a tabulated, categorized and crossed checked in order to address the initial purpose or proposition of the study. Graphical techniques, creating matrices of categories or flow charts etc. aids in approaching these data from a different perspective and avoid premature conclusions. Multiple investigations are also examined to give a wide range of insights into the data available for

development. Excel sheet was used to input or rather analyze some of the results collected manually during the interview sections which were based of usability of the software application created, feasibility and compatibility with other already created systems, feasibility with customers coupled with sustainable development mindset and how the prototype can be improved.

3.7 Data Overview:

Personal interview was conducted in person by for the software organization companies and the event planning organizations, while the population of the survey attendee were quite mixed because it included students and staff from University of Eastern Finland in Kuopio (this is because I live in Kuopio and it was easy to approach students there with the survey questions both on my notepad, mobile phone and also sent survey links to emails of some who provided their email contacts), students in Lappeenranta university, friends back in Nigeria helped too in sending the survey links to some of their work and school colleague and I also sent the survey link via email to some of the workers in the software organizations and event planning organization I did visit while conducting other physical interview. A total number of 76 people responded to the survey.

4 RESULTS

This section presents results based on the methodology described in Section 3. The interviews are designed using a combination of the DSRM, quantitative and qualitative methods. The results of the interviews conducted by me on some software companies, their development term, events planning companies etc. are seen in this chapter of the thesis. The interview was done to see how much of awareness these software companies' and event planning services know about sustainable development and how much of it is used during production and usage. Altogether nine companies and twelve persons were involved in the process of interviewing, they represented software companies and software service providers. Five were individual interviews and about 7 grouped interviews which involved focused group consisting of two to three members. (Appendix 2).

Interviewee were the CEOs, developers (they are the focused group in this case because they develop the applications used for event planning) and business managers. These groups are quite homogenous or rather comparable, and it explains the reason why some of the answers from the interviewee questions were quite similar, giving room to saturation in this case where with low sample size (the number of sizes of software companies interviewed), the researcher can conclude his or her findings.

The saturation point is said to be achieved when information's to the research questions has gotten to a point whereby analysing more sample data won't yield to further results or provide any more information to the questions researched in scientific research. It also shows that researchers have enough empirical data, aiding the analysis of (Cohen &
Crabtree 2006).

Collection of data was done in a semi/structured interview process. Questions were created before the interview in a formal way, but the interviewer can stray away from the list created, this was done to help the interviewee feel more relaxed (*UNEP Annual Evaluation Report 2001 | UN Environment*, 2001). The prototype to be developed was presented to the interviewee during the cause of the conversation, their opinion and perception towards the features developed were asked in a more relaxed and interactive manner but in a structured interview format used in the different discussions. This is done to help them share their opinions and observations freely.

The appendix 1 contains the survey questions asked users during the cause of this research and the results are seen in the charts. The survey questions helped enlighten users on the issues of wastes generated during events which are harmful to the three pillars of sustainability (Environment, social and Economic) and how the features developed in the prototype can help reduce and manage some of these wastes. An interesting observation from the study is that over 90% of the respondents do not have a current alternative for this service, which indicates that there is a gap in the market for sustainable events service. In addition, the results also show that over 50% of the respondents are interested in using the application, which would suggest an emerging need for the services provided by the application. The result showed the individual is ready to make the necessary changes that will, in turn, affect our behavior on the ecosystem.

4.1 Company Orientations

Nine companies were involved in the process of interviewing, they contained three software companies in Finland, two event planning service provider companies (because they use software applications for their services) in Finland, two software companies in Nigeria and two event planning companies in Nigeria. I decided to also involve these companies (event service providers) in Nigeria because growing up back home and attending events, I see the number of wastes generated after these events and how some of this waste even though can be used afterwards but because of improper knowledge to how to go about it, becomes unusable.

Interviews were conducted with CEOs, CIOs of these companies, their software developers, business development manager etc. I decided to go with this group of persons because they are one of the key elements in the companies deciding factors. The interview session on different days was about half an hour to one hour and it also involved skype video meetings with those in African because of logistics and funds related issues. A list of questions was prewritten beforehand, and similar questions were asked during the interview. The interviewee which ranged from CEO of these companies to the software developers, although in different continents but still had similarities and it did explain why some of the answers to the questions presented were quite similar. The software company's sizes ranged from 1- 10 persons, in one of the software companies in Finland and the other two software companies, ranged from 1-40 staffs. The two event providers in Finland all range from 1-15 staffs in both companies. The Nigerian event service providers range from about 50 staffs' members in both companies, while the software company about 30 staff members and the other about 20 staff members.

This gave more reasons why moving on to analyses of the data was considered after the meetings. Data collection was carried out with a semi-structured interview process. A formal way of questioning was put in place with creations of a list of questions and topic for conversation although these questions may be followed in the best manner that suits. Along the way, the topic at hand was presented to the interviewee and their perceptions and opinions towards this development were asked in a more interactive manner. This way, the interviewee can be more relaxed and share how they feel in a more freely manner although a structured way was used for the interview process. Table 4 shows the background of the companies that participated in the survey.

Categories			
Type of the company	Company size	Business Model	Location
1st Software Company	1 – 10	Software Development	Finland
2nd Software Company	1 – 40	Software Development	Finland
1st Event Service Provider	1 – 15	Uses software applications for their services	Finland
2nd Event Service Provider	1 – 15	Uses software applications for their services	Finland
1st Software Company	1 - 30	Software Development	Nigeria
2nd Software Company	1 – 20	Software Development	Nigeria
1st Event Service Provider	1 – 50	Uses software applications for their services	Nigeria
2nd Event Service Provider	1 – 50	Uses software applications for their services	Nigeria

Table 4. Showing the different companies' orientation

4.2 Knowledge of Sustainable Development

Company	Type of the company	Knowledge of Sustainable Development	How much of understanding / definitions.
Y(SCF)	Software Companies in Finland	Yes	Not so much (Understands it as what pertains to the environment and preservations)
Z(ESPF)	Event service providers in Finland	Yes	Understand it as it relates to the environment not in event services
Y(ESPN)	Event service providers in Nigeria	Yes	Relationship to the environment
Z(SCN)	Software Companies in Nigeria	No	Not much
Z(SCN)	Software Companies in Nigeria	A little bit	Not much

Table 5. Showing information gathered during the interview.

The results from Table 5 show the Y(SCF), Z(ESPF), understand SD as an environment issues which somehow does not apply to software in some ways during the planning, designing, integration/development of some of their software applications. While Y(SCN), also understands it in the same manner as Y(SCF), Z(ESPN), does not understand it, which explains why there quite a lot of waste in an event in most underdeveloped countries. Although the second Z(SCN), had a bit of understanding of what SD is, but not as used in the software application.

4.3 Generalized Results of Interview

Company Type / Interviewee	Awareness of sustainable development in software applications	Measure of sustainable development in software applications	Integrations of sustainable development in software development	Integration of the proposed prototype	Value of sustainable development in software applications
Y(SCF) (D)	Not thought off/ having the agile mind set but doing nothing about it.	Don't understand how to apply it	Most times not considered	Very well accepted and hopeful to work with it	Understand the value but no time for integration and implementations
Y(SCF)(BD)	Not thought off	Don't understand how to apply it	Usability and end results is their priority.		In between
Y(SCF)(CEO)	Not thought off	Don't understand how to apply it	Not thought off	Added value	In between
Y(SCF)(CIO)	Not thought off	Don't understand how to apply it	Understands it a bit but it's not a priority.	Added value	In between
Y(ESPF) (CEO)	Not thought off	Don't understand how to apply it	Don't understand how it applies	Added value	In between
Y(ESPN)(CEO)	Not thought off	Don't understand how to apply it	Don't understand how it applies	Added value	Not aware

Y(ESPN)(USE)	Not thought off	Don't understand how to apply it	Don't understand how it applies	Added Value	Not aware
Y(SCN) (D)	Aware but not much	A little bit	Don't understand how it applies	Added Value	In between
Y(SCN) (CEO)	Not aware	Don't understand how to apply it	Don't understand how it applies	Added value	Aware but to the environment.
Y(SCN) (BD)	Aware but not a priority	A little bit	Don't understand how it applies	Added value and hope to integrate it.	Aware but feels it's not yet applicable in the region
Y(SCN) (D)	Aware	A little bit	Don't understand how it applies	Added value	In between

Table 6. Results from the interview

4.4 Summary of the Interview Results

Table 6 above goes to show how most software companies develop applications without integrating sustainable development mindset. Most of them understand the concept as an environmental issue which does not apply to software in most cases because they believe software application is virtual. They don't look at the aspect of energy efficiency and that of manpower.

The developers, on the other hand, go with the mindset of producing features that are interactive and waste is not one to investigate. The business developers are concerned with the competitors

and how to develop more intuitive features, in as much as most of them understand a bit of this concept, they look at it as one which concern should be about the environment. The CEOs in the companies are for results thereby the issues of sustainable development are not well understood. The software service providers who use some of these applications for their services has zero to no knowledge about the importance of sustainable development, even in the software organizations although important but unrecognized amongst teams and their organizations. In as much as it's a principle set of practices that help software organizations and their team to achieve and maintain an optimal development pace, it's very not used or even understood. As regards to software applications, SW organizations forget the more successful an application or its tool is the demand increases indefinitely.

Because most of their practices are done in a very unlikely sustainable manner, these developers are reactive to the changes in the ecosystem. They are thrown in a cycle of working longer hours and harder which in most cases results in anger and hate for their jobs as against when they can be proactive about changes in their ecosystem and give value to their customers with a mindset of continual improvement. The CEOs and other heads in the companies seem to be more concerned about meeting the needs of its stakeholders, customers, the end results and profits for the business they are into. The event service providers on the other hand who provides services with these software applications seem to be very unaware of sustainable development, they are all about meeting the needs of their customers to make the event more glamour's and the issue of waste control is not what they have really investigated or even considered.

The overall process shows how these companies lack the knowledge or information's of sustainable development during productions of software. Unfortunately for our ecosystem, this kind of mindset will prevent the growth of sustainable software. The world is really gaining awareness into climate changes and sustainable lifestyle and if software organizations don't that start working towards integrating sustainable development into their software applications, it may hinder them from growing and providing services to customers who are sustainable-minded. The automobile industries get tax incentives for productions of a car that emits less co2 and in some countries, it also applies to an individual that buys electric cars. This, in turn, shows some of the benefits that software companies will get if the integration of sustainable development is in place.

The next chapter covers the prototype development for events service providers using software applications. A lot of measures have been advocated for sustainable developments in all areas of our lives. Everyone, nations, understand the importance and need to grow its economy but not everyone understands the negativity an unbalanced economic growth can have on the environment and its inhabitants. A strategic balance has been put in place to attain this by the United Nations (being a huge advocate for sustainable development) together with governments, businesses and most civil society. A massive concentration exercise of 17 goals to help transform the world by 2030 are laid out. Its agenda is to help improve the lives of people living everywhere in the world by taking actions. It's about the big picture complemented with details. It's not about harming the environment, it's about looking at things differently, to live in a world where people and planet benefits.

The survey conducted with individuals, software companies, event planning companies coupled with research papers carried out during this thesis, showed with the growing trend of sustainable development in mind, eco-friendly weddings will have a huge impact in our society. People using the application will understand better how waste can be mitigated during events especially wedding. Unfortunately, some of the software applications tools that exist for wedding planning doesn't really provide enough or provision for sustainable development measures for the wedding planning process. These applications are still not aware of the huge, non-sustainable measures will be on our ecosystem. The added tools will bring as described in the prototype will be effective to the society as regards to the management of the different aspects of waste during events. The prototype developed will help advance sustainable development mindset in the society where events are concerned. Event planning organization using these tools will help their clients better understand sustainable mindset thereby having a great impact on the society.

5 PROTOTYPE IMPLEMENTATION

Between picking a date, venue, caterer, sending out invitations to invitees, the whole concept of planning a wedding can be very stressful even if the wedding is on a low key or high note. Although there are thousands of wedding tools, applications and websites that make it easier to help plan most of them are not sustainable minded. A lot of these applications give information of events venues, catering services etc. but some of them don't provide budget-friendly solutions or even solutions as regards to waste.

Environmental protection is very vital. They are a lot of ways to have a sustainable wedding or event using biodegradable materials and reusable decorations, from serving ware, vessels, and utensils etc., this way events can be sustainable, waste-free using sustainable foods, venues, flowers to be more ecologically responsible. With the heavy cost of wedding flowers, food, decorations, energy(power) more couple are encouraged to help extend the life of what they have invested in during the cause of the wedding by donating some of their leftovers to where it is needed the most. Flowers can be given to brides who cannot afford them or send to hospital or hospices center's just to brighten up another people's day. Leftovers foods can be repacked and given to people who equally need them. That is where this application is helpful. It combines vendors or rather service providers who are sustainable-minded, and the couple are encouraged to use them to help reach the goals of eradicating some of the issues raised by the united nations about sustainable development.

The concept of the application created is to help people who plan an event or a wedding to be sustainably minded. The entire design of the system shows from the beginning to the end of how to have a sustainably minded wedding and enjoy every bit of it. The system shows budgets friendly vendors that can cater for events with SD in mind from the concept of reducing electricity and fuel to giving back and re-purposing. It also shows what happened when an event has leftover and what to do with them with different service providers.

Table 3 below discusses some of the 17 keys elements of sustainable development the United Nations hopes to eradicate. The human issues raised and the measurable impact it does have on the society.

Some of the 17 key issues raised by the United Nations

Human issues	Measurable Imparts	Application Solution
End-Hunger (Food waste)	Hunger is a universal problem that the world face today. A lot of developing countries still live under one dollar per day. This can be mitigated if a sustainable way of the food production system and resilience agricultural practices is investigated and applied. Food and nutrition security strategies are one of the ways some developed countries are using to combat hunger problems, but the facts remain, if some of the strategies are not systematically structured or integrated, then the underlying problem will remain. An example is when planning a wedding, quite a lot of guest are invited for the events and different food are made. In the United States alone, an average of 2.4 million wedding takes place in a year and the average guest is estimated to be around 300 per event. For some of this event, most quests are not available to come. If we have 10 different delicacies prepared for 300 people and at the end of the day only 200 quest shows up, that brings us to about. X- calculated for the total number of guests invited Y - number of guests absent Z – Number of foods wasted U – Number of celebrated wedding	With this application, the left-over foods are repacked and send to people who are hungry, thereby cubing the number of hungry people around the society.

	X – 300 guests invited Y – 70 absent guests E = Y x U = Number of foods wasted per year 70 x 2.4million = 1.68 millions of wasted foods around the United states only.	
Build resilient infrastructure, promote inclusive and sus tainable industrialization and foster innovation	Developed infrastructures that are built without sustainable development in mind are some of the challenges our environment is having. Most of these structures enable networking, high-performance computing and in most cases manpower to operate these in most developed countries. When disposing of some of these equipment's, it causes harm to both human and the environment because some of the materials used are toxic in nature.	For national growth, manufacturing should be a key engine of economic growth. This will yield a quantitative increase in the gross product for the country's economy and also cause structural changes. If goods are produced faster, its cost declines to make families been able to afford them. If any economy or country tints towards industrialization, it helps the economic growth of that nation and brings about innovation. The application solves the issues of educating people on how to minimize waste thereby giving chance for an individual to investigate a more positive means of disposal.

Sustainable consumption and production patterns	Extraction and natural resources use require the production, processing and consumption. For this to happen, it also requires factories creations. Some of these factories' places create by-products waste that is toxic which pollutes the ecosystem. Our consumption pattern is another problem that is also responsible for pollution. Our habit of consumption and disposal will be quite difficult to change. The sea is full of waste products generated by a human.	This can be achieved if countries adhere to a framework which enables businesses to practice sustainable patterns and the consumer's behaviour is also in line with sustainable development practices that goes well the proper management of chemical and wastes that are hazardous to the ecosystem. With the application created, waste will be properly disposed of by experts who have been trained to carry out such and leftover repackaged and consumed by those who need them. Food will be produced in a more sustainable fashion if people go in line with the consumption of sustainably grown foods

Table 7: Some of the17 key issues raised by the United Nations and how the prototype can solve these issues.

5.1 The Home Page

Planning in a strategic way can be said to be a method whereby things are carried out in a more careful fashion that will result in the success of its intentions. For an organization, it said to be a method that shapes them in achieving their purpose or rather a road map that positions the organization strategically. Some couple might have a big picture of what they are anticipating for their big day but may not know how to go about it, some other may know how to go about it without considerations of how it might affect the ecosystem. This is where this application comes in, it will help to identify all the details that couples think about as much of it details depends on a budget because it incorporates all the key items that would help the event to be term successful.

Figure 6 shows the application home page with several sections in the menu-bar that will help prepare the couple to understand the bigger picture of planning their wedding. Tools like the checklist list of the wedding events will help prepare the couple see all that will be required for their big day, helping them also consider the sustainable aspects of planning their wedding. The applications will help suggest the best practices that are very important to follow for their events. It will help couples have quantifiable metrics of success to help them achieve a sustainable event. The Budgeter help them with the pricing of the events, this will allow them to understand how much it will cost for the venue, florist, food, etc. depending on the number of guests they are looking to have which will in turn help towards budgeting for the event. The guest list will allow guests to see who’s closest to them, this will help in situations of carpooling.

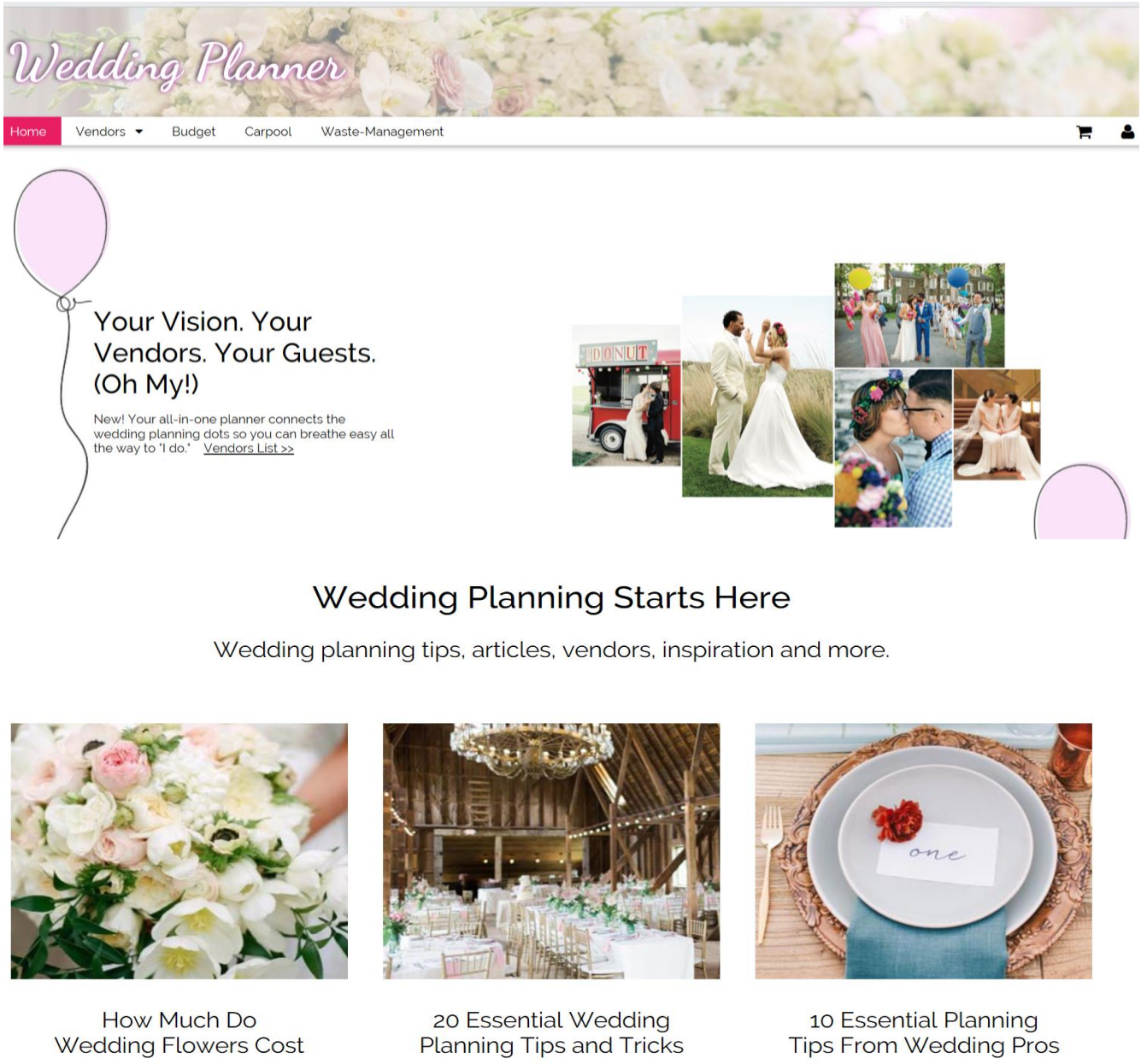


Figure 5: Welcome page for wedding planners.

5.2 Electronic Invitations Cards & Paperless Cards

It's no brainer, a lot of great ideas today all started with writing on papers, the education some of us are privileged to have today started with papers, love, on the other hand, is written on paper, justice is also served and issued on paper and so is other important news around the globe. Tree fibers make up papers from our growing forest or recovered papers, but deforestation is a huge problem today. Forests provide carbon sequestrations, the raw material

used in the medical field, flood protection soil erosion and landslides, plants and animal-rich bio-diversity to mention a few (Phil Covington, 2013). Chinese used rags, bits of hemp, stone mortals and grasses in the early 100 ADs in the productions of its first papers. The process was quite simple which employed easily sustainable agricultural resources and this method continued until the 1800s before mechanization and industrial revolution and the demand for higher literacy rate was welcomed. This led to a greater demand for paper, currently one of the environmental sustainability crises today. (Daniel Matthews, 2016)

Our forests cover a huge sum of about 30percent of the land area of the world according to National geography. Operations of logging provide the world wood and paper products which in turn results to the cutting down of countless trees each year. According to the united nations food and agriculture organization (FAO), about 18 million acres which are about 7.3million hectares of forest roughly the size of Panama (a country in Central America) is lost yearly (Bradford. A, 2018) and about 40 per cent of the annual wood harvest globally is been processed for the paper and paperboard industries and the volumes produced has doubled since the 1960s, deforestation is said to be responsible for about 12% of greenhouse gas emissions.

Of course, some of the other forms of deforestations affect our ecosystem in other scale but for the purpose of this subhead, paper production through the cutting down of trees yearly to make paper products and other things have a great effect and cause pollutions to the environments. Couples who are sustainably minded can make use of paperless invites otherwise known as E-invites. All information's as regards to their events is been captured electronically. Wedding websites are created for people to see details of the wedding through these invites and the use of paper contact is eradicated completely. Figure 7 below shows a paper invite on the left and the electronic version on the right side. The prototype developed will also provide the same invitation information as the paper one, but this is done in a smarter and more sustainable-minded manner thereby eradicating the use of papers.

Figure 6: Paperless wedding invitation.

5.3 Eco Friendly Reception Venues

The theme for every event is what sets the stage and basically is the first stage to planning for the big day. One way to cut down on energy is to get wedded outdoors. Farmyards, vineyards, beautiful garden, refurbished barns that offer modern facilities that are still convenient are some outdoor ways to the wedding where sunlight provides almost all the lighting cutting down on energy usage. Of course, for some couple, the outdoor setting might not be what they really want. There are several ways to make the event venue still sustainable. Some of these venues are painted in modern white interior and exterior which of course brings natural lighting to the venue. The venue for the ceremony and the reception can be held in the same place. This will help cut down on movement from one place to another and reducing fuel emission. The ceremony and reception can also be held during the day but a venue that gets tons of sunlight

during the day will be an added advantage, to keep the energy minimal. Hotels and venues that use biodegradable products and energy appliances that are efficient should also be considered.

This application developed provides environmentally friendly hotels for use to make any event more sustainable. Figure 8 shows the venue page which provides information about the different available sustainable wedding locations based on individual preference. The venue offers solutions to garden places where wedding events can take place eliminating the use of extra energy to power up lights to cover an event. Even in a situation where it's a closed place, the energy used in these places are eco-friendly.

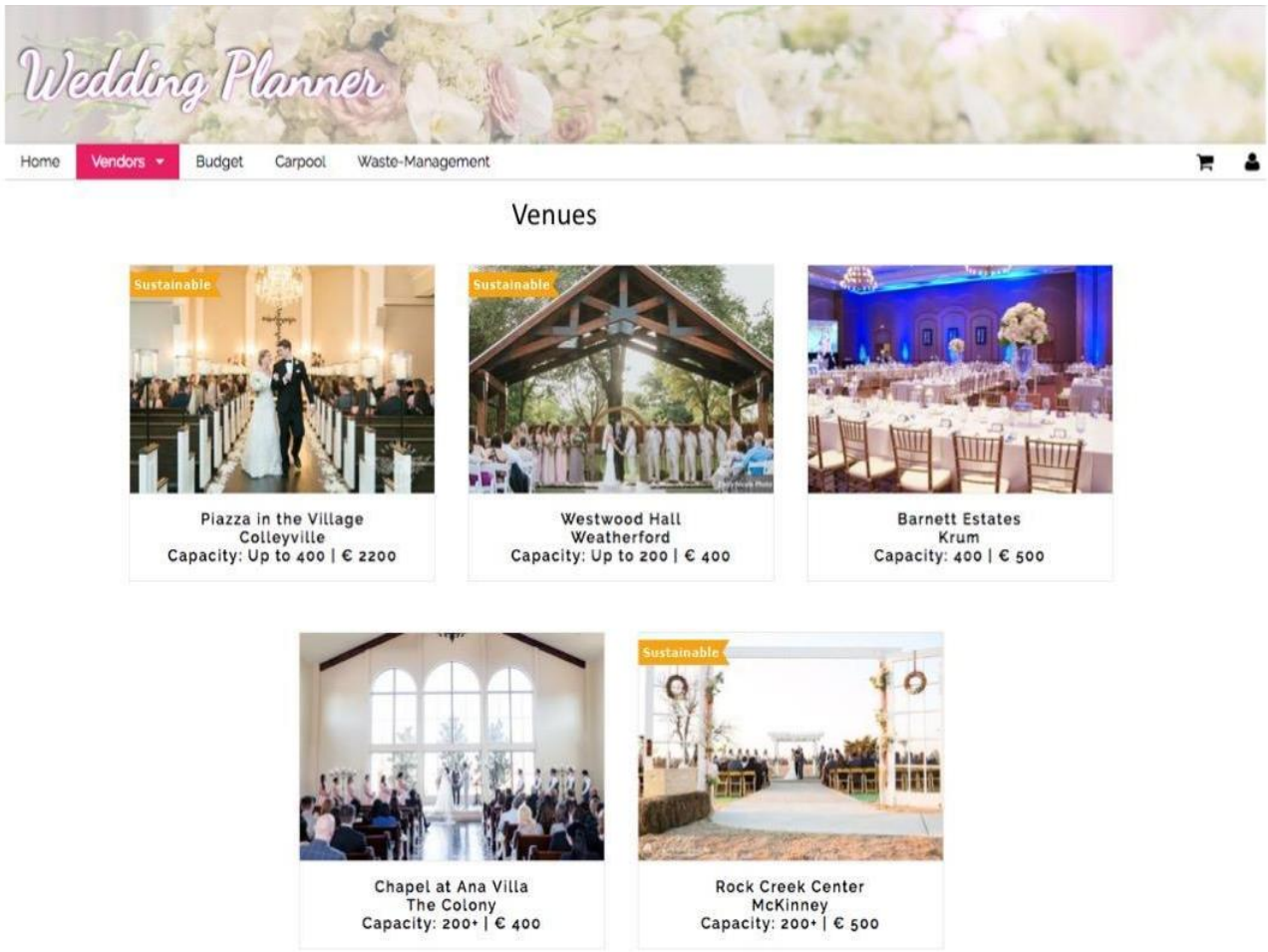


Figure 7: List of sustainable venues.

5.4 Florist

The beauty of flowers attracts anyone. Its fragrances, beauty, etc. symbolizes love, friendship, sometimes sorrow and it also shows the beauty of nature. It uses are enormous, used for decorations, medicinal purposes, in funerals, school graduations etc.…Amongst all its beauties and usefulness, the amount of flower waste generated during any of these events cannot be quantified. Most of the flowers used in some wedding events are inorganic. The different ways flowers are been planted do influence the environment and might also lead to workers illness. Pest control medium, Land degradation, Fossil fuel emission during transportation, water etc. It is estimated that one hectare of a flower farm takes about 900 cubic meters of water in one month. Some of the flowers grown are grown with intense irrigation and so many pesticides that prevent pests on the flowers.

Another issue of environmental concerns is the cost of shipping to other parts of the world because most of these flowers are grown in warmer regions like South America and the African regions, they are shipped on planes and refrigerated to preserve them, this amounts to producing about 9,00metric tons of carbon dioxide emission to regions like the United States alone (according to Flowerpetal.com reports) let alone Europe and other parts of the world. If one takes a closer look at some of the way the floriculture industry operates, you will notice they generate quite a lot of chemical pollution through the use of pesticides and the applications provide flower vendors that sustainable. These companies provide flowers that are straight from the farmyards, the flowers are not refrigerated in a long period of time thereby cutting down on electricity use. Flowers that are termed VeriFlora-certified are known to be non-chemical grown flowers. After the events flowers are also picked by companies that reuse them

either by donating them to hospice home to brighten someone day. Figure 9 shows the Florist page from the prototype application.

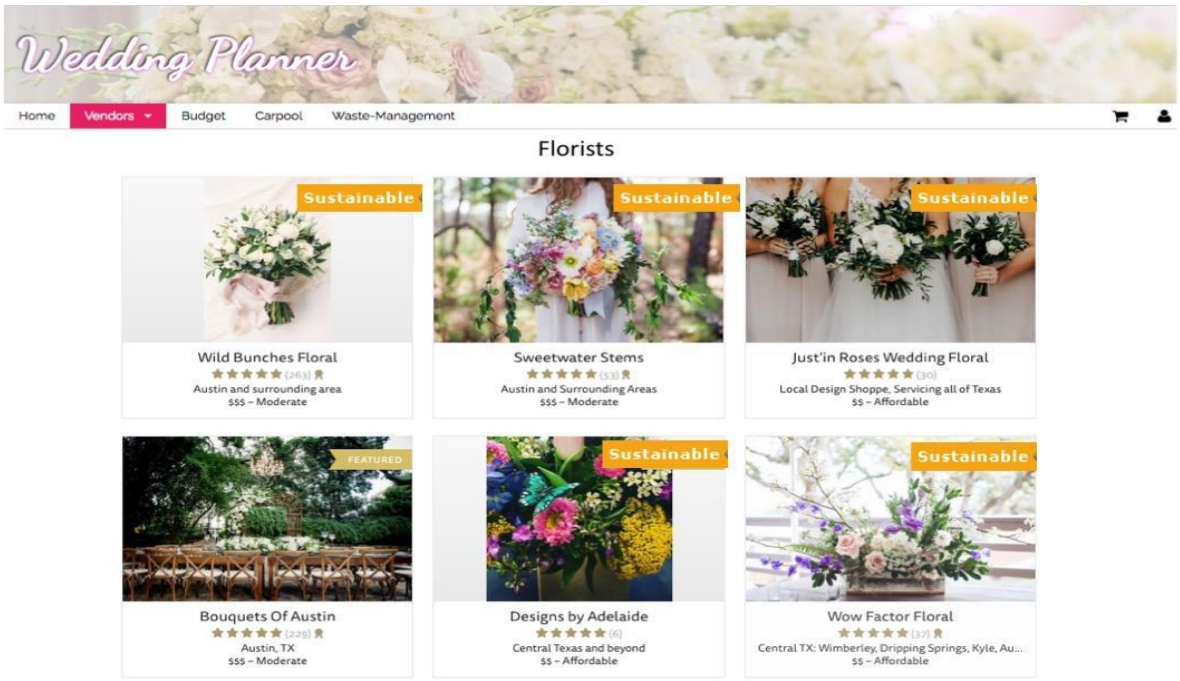


Figure 8: List of sustainable florists.

5.5 Caterers and Drinks

For any wedding event to be termed beautiful, food is considered the center of attention. Taste can't be sacrificed if locally grown products used for the events. Foods can be catered for and menus tailored to the food that is available during those seasons. Local suppliers can also be used to supply products needed this will not only reduce the time to supply the products needed but will cut down on gas emitted during long distance travels from one country to the other. This will not only keep the cost down but also guarantee the freshness of it.

During the summer, lots of beautiful fruits stone fruits can be used and vegetarian soup can be incorporated during the winter. Locally sourced ingredients such as eggs and some dairy products can be used for wedding cakes. When food products are gotten directly from the local grower, the food will require less refrigerating time and less packaging time keeping the food fresh. By doing so less fuel is required for transportation. The application will help couples work with a wedding planner who work with local suppliers and help set up a disposal system

that includes recycling containers for cans and bottles and a compost bin for biodegradable products. Figure 10 shows the Catering page from the prototype application.

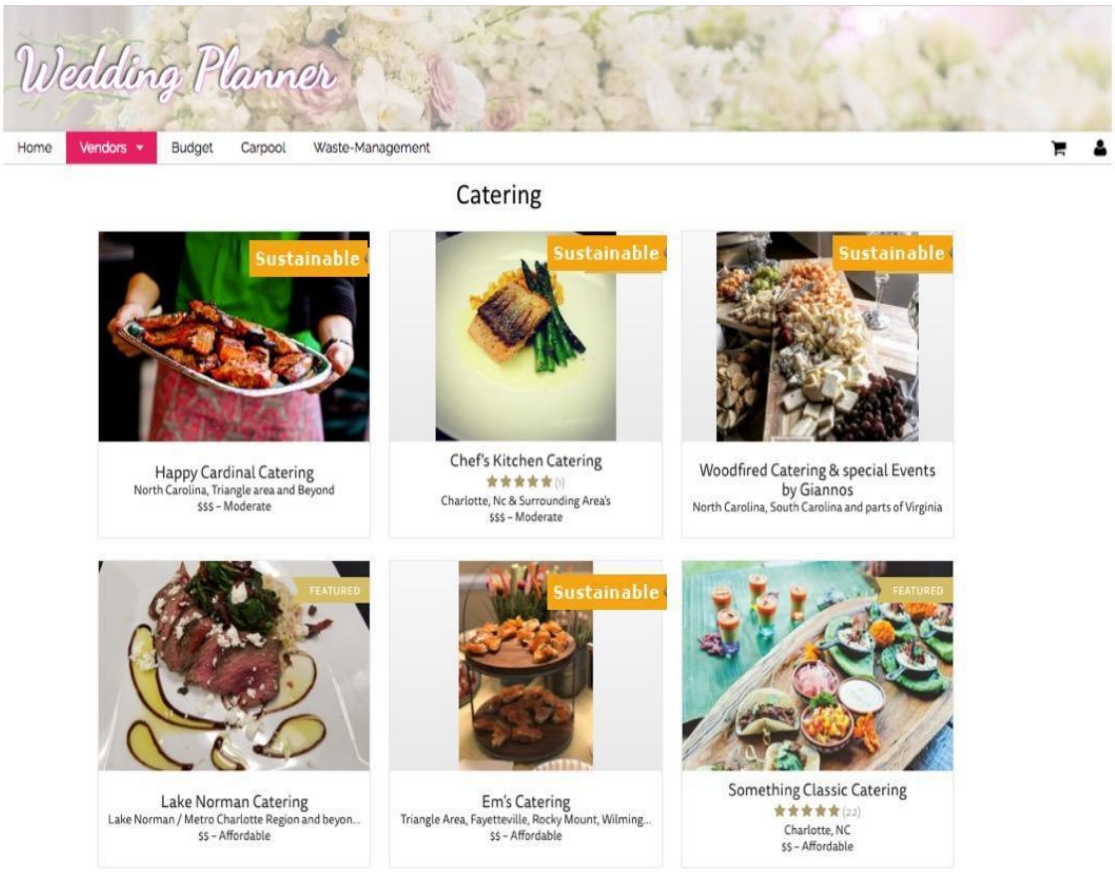


Figure 9: The Catering vendor as seen from the prototype developed.

5.6 Car Pooling

For some of us, driving in our cars seems to be the most efficient or effective way of transportation. The bitter truth is the amount of carbon emission per person that goes into our ecosystem and the spaces taken up on the road which most times leads to hold up on our roads have effects on our ecosystem. The emission of gaseous oxides in this scenario will greatly have a great effect on our environments. Global climate change is been said to be the number one issues that are faced by this 21st century. The combustion of fossil fuel from vehicles which involves gaseous releases affects the environments. Some of these air pollutants from a car are been deposited on the soil and water surfaces which in-turn affects the food chain thereby causing problems on the respiratory, reproductive system, immune and neurological systems of animals that are also consumed by a human.

The Figure 11 and 12 below illustrate the comparison of what people look like in cars, when on buses, with bikes and on a light train. The research was carried out with about 200 commuters using their individual cars. The pictures gathered by the international sustainable solutions (i – sustain) in the town of Seattle, shows what cities will look like and the different effects it will have on the environment if some of these practices are put in place. The 1st pictures show about 200 people in 177 cars on a road. (Urban Strategy Firm, 2003)

These calculated examples give the co2 emission generated by a petrol and diesel car engines as reported by an urban strategy firm called I – sustain in Seattle USA. (Urban Strategy Firm, 2003)

Vehicle CO2 Emissions Footprint Calculator by mileage.

Figure 10: Showing calculated results of co2 from petrol cars.

Figure 11 shows the co2 produced by petrol car that uses about 6litres of petrol per 100km while driving. When multiplied by the total amount of cars on the road it produces about 14.34kg x 177 cars = 2538.18kg of co2 of waste at a time.

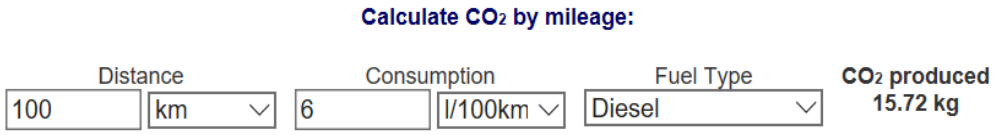


Figure 11: Showing calculated results of co2 from diesel cars.

The same can be calculated for the diesel car which produces even more co2 waste. 15.72kg x 177 cars = 2782.44kg. (Urban Strategy Firm, 2003)

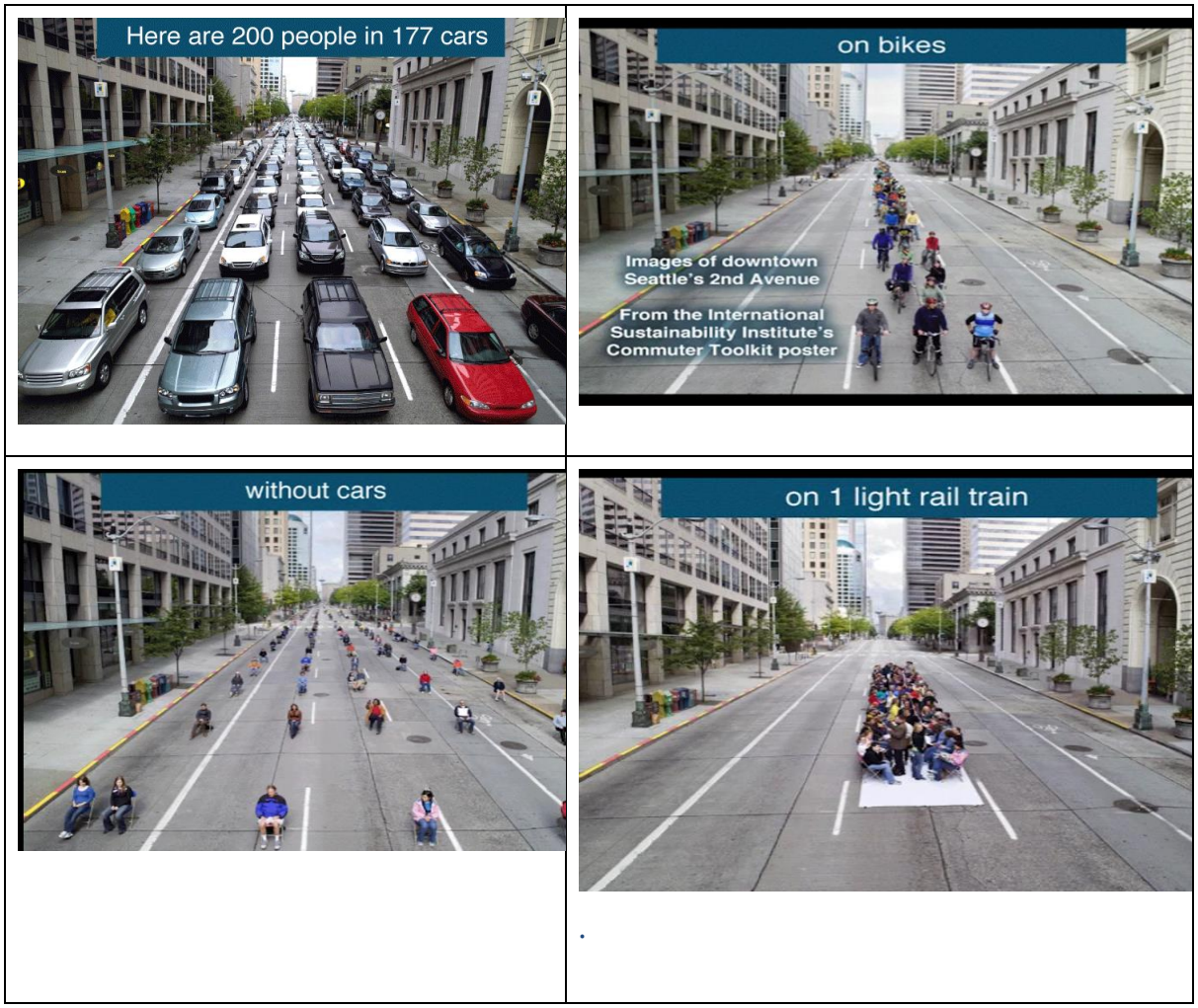
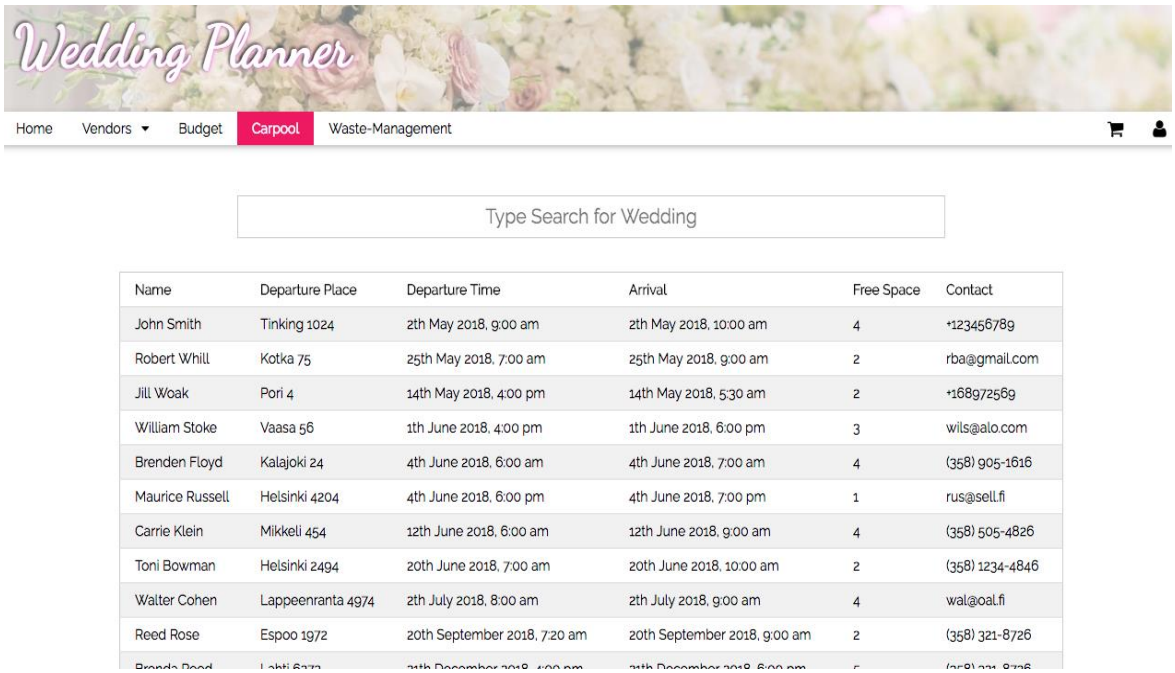


Figure 12: Showing the different aspects of the cities with cars, bicycles, on train, and without car.

The pictures in Figure 13 above show how differently, our roads will look like with fewer cars, bike and when people opt to use trains. (Urban Strategy Firm, 2003)

Government policies in some countries are encouraging people by giving tax incentives for low carbon emission cars like electric cars. To cut down on these emissions, the wedding application created will help guests invited to the same wedding be able to connect and share

rides (as seen in the Figure 14 below) instead of everyone going in their own cars because this will reduce the total number of carbon emission on the road.



Name	Departure Place	Departure Time	Arrival	Free Space	Contact
John Smith	Tinking 1024	2th May 2018, 9:00 am	2th May 2018, 10:00 am	4	+123456789
Robert Whill	Kotka 75	25th May 2018, 7:00 am	25th May 2018, 9:00 am	2	rba@gmail.com
Jill Woak	Pori 4	14th May 2018, 4:00 pm	14th May 2018, 5:30 am	2	+168972569
William Stoke	Vaasa 56	1th June 2018, 4:00 pm	1th June 2018, 6:00 pm	3	wils@alo.com
Brenden Floyd	Kalajoki 24	4th June 2018, 6:00 am	4th June 2018, 7:00 am	4	(358) 905-1616
Maurice Russell	Helsinki 4204	4th June 2018, 6:00 pm	4th June 2018, 7:00 pm	1	rus@sell.fi
Carrie Klein	Mikkeli 454	12th June 2018, 6:00 am	12th June 2018, 9:00 am	4	(358) 505-4826
Toni Bowman	Helsinki 2494	20th June 2018, 7:00 am	20th June 2018, 10:00 am	2	(358) 1234-4846
Walter Cohen	Lappeenranta 4974	2th July 2018, 8:00 am	2th July 2018, 9:00 am	4	wal@oal.fi
Reed Rose	Espoo 1972	20th September 2018, 7:20 am	20th September 2018, 9:00 am	2	(358) 321-8726

Figure 13: Showing carpooling results from the prototype.

5.7 Budget

A budget is known as a financial plan for a period. These plans include cost, expenses, revenue, resources, cash flows etc. The whole operations of how any events depend solely on the budget. It does have an influence on how the event of the day will go. Whether planning a big event or a small one, budgeting comes to play. It's the process of creating a plan which allows for spending. It helps the spending be under control to avoid in most cases debts.

For every wedding, there is a price tag that comes with the wedding cost. From the price of the venue to the cost of food, flowers, makeup etc., the list goes on and on. According to a study carried out by the knots (a wedding service provider) in 2017 shows an average wedding cost in the USA cost up to $33,391 including honeymoon getaway. It surveyed about 13000 couples to find out their budget cost, not including the high spenders. The below figures give information's of the different cost (*Couples Spend an Average of $33,391 on Weddings, According to The Knot | The Knot Worldwide*, 2018).

- Venue - $16,107

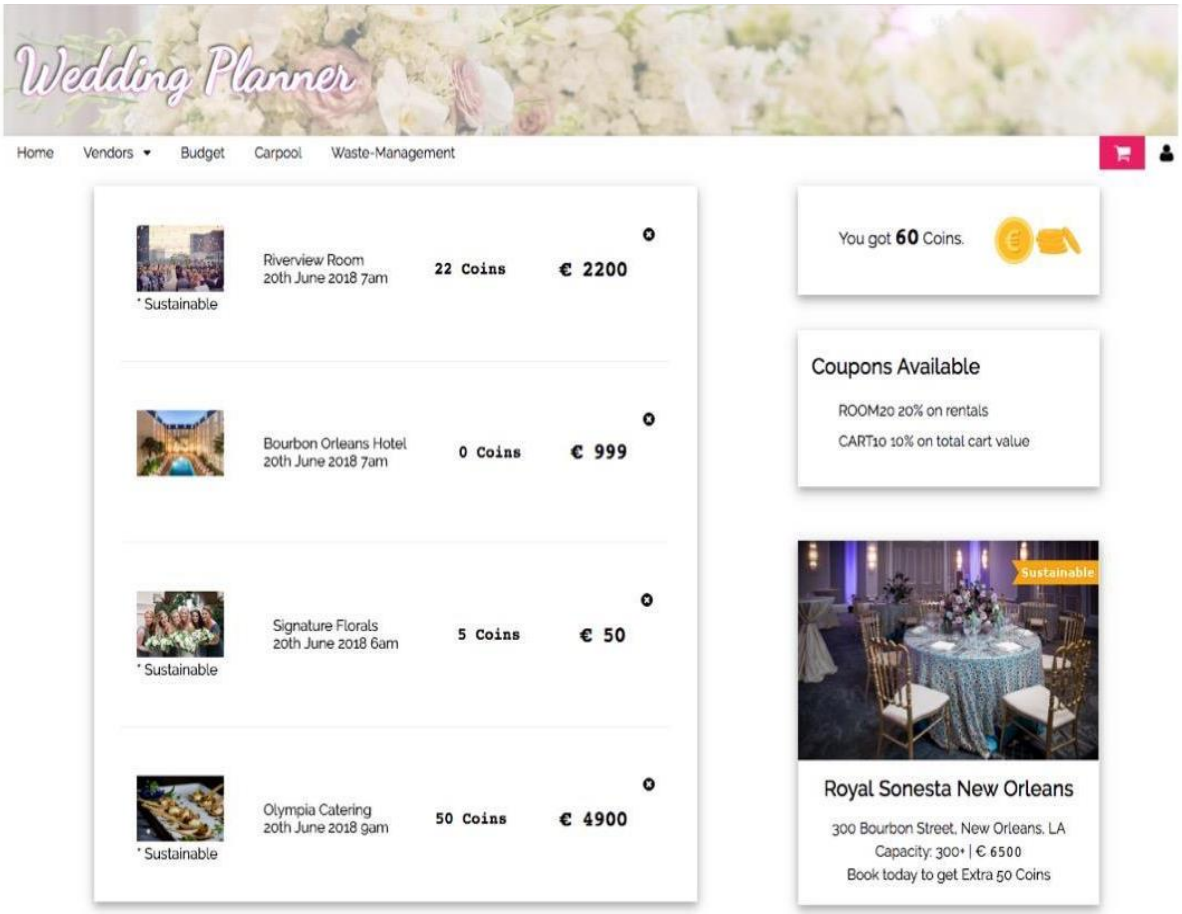
- Photographer - $2,783
- Reception band/music - $4,156
- Florist - $2,534
- Videographer - $1,995
- Wedding dress - $1,564
- Groom's attire - $280
- Wedding cake - $582
- Ceremony site - $2,197
- Ceremony musicians - $755
- Invitations - $462
- Transportation - $859
- Favours - $268
- Rehearsal dinner - $1,378
- Engagement ring - $6,163
- Officiant - $278
- Catering (price per person) - $71
- Wedding day hair care - $119
- Wedding day make-up - $100

(*Couples Spend an Average of $33,391 on weddings, According to The Knot | The Knot Worldwide,*2018)

These information's varies with couples as well as the number of guests invited but everything boils down to the number of guests and how much the couple in questions can afford for their big day. The application shows the different service providers, the services rendered, cost etc. It also shows service providers that are sustainable-minded, this will assist couples to choose from and help them calculate the different wedding options according to their needs. Some of the services included in this application give couples the benefits of having their wedding in a garden where little or no electricity is required thereby saving on energy.

5.8 Coin Rewards

For most businesses, cost reduction and improvement of their products and services are of importance. Rewarding employee and recognizing their efforts are some ways of encouraging them. Rewards are tangible and they dependents on the consequences of our actions. Prudent use of the resources provided in the application will reward couples who chose a sustainable pattern in almost all the choices in terms of venue, food, energy etc. The number of coins collected for every sustainable choice accepted will be rewarded at checkouts. This will give them monetary rewards by giving some percentage of their total payment and reinforce the occurrences of the desired results and increase awareness of sustainable development practices in events. Figure 15 shows the Coin Rewards page from the prototype application.



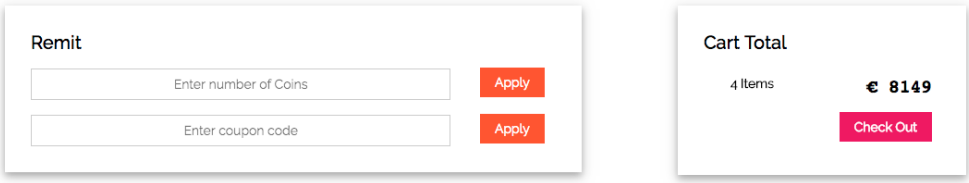


Figure 14: showing application feature for coin rewards.

The illustrated example in Figure 16 below further explains how these coin collections work. The couple in the scenario choose different sustainable services which gave discounts leading to some percentages off their payment.

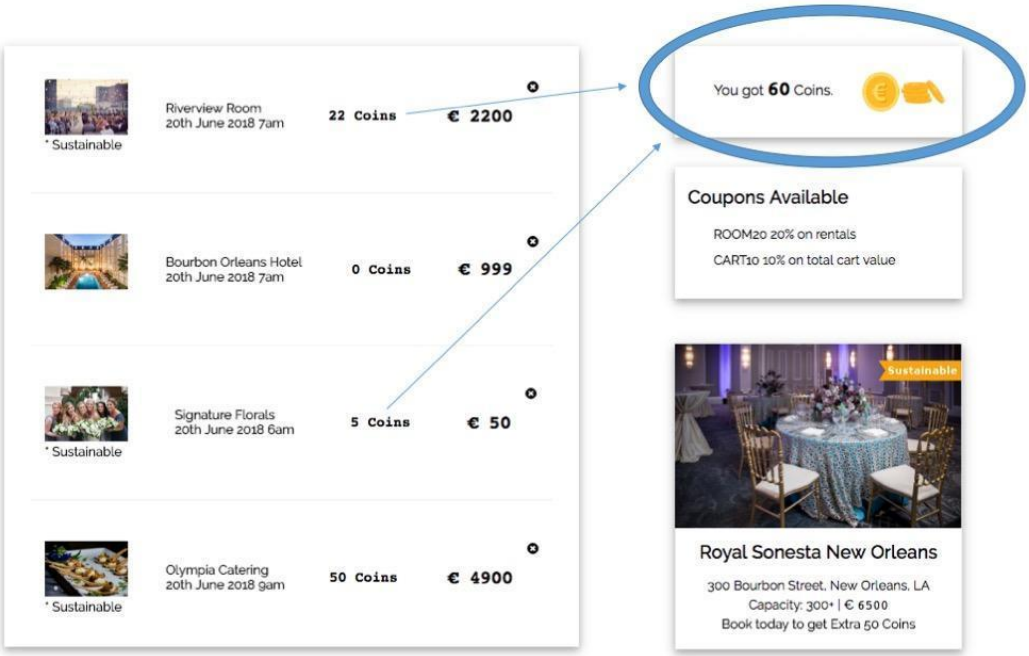


Figure 15: Showing coin reward features.

5.9 Waste Management

Weddings considered celebratory is one beautiful event that a lot of people look forward to because it brings families and friends from different part of the world to be reunited and see each other. It's most stylish and colorful, from flowers fragments used in the decorations of the halls to paper programs, drinks and excess foods, these are some of the waste generated during the wedding events and it typically does the environment quite a lot of harm.

In the United States alone, it is estimated that about 2.5million wedding take place yearly and these wedding events produce 400 to 600 pounds of garbage and about 62 tons of carbon dioxide, which is a greenhouse gas. According to an article by the conserve energy future, American alone produce waste of about 220million tons per year. That is more than any waste in other countries. According to a factsheet as seen below on marine pollutions during "The Ocean conference by the united nations held in New York in June 2017. The effect of human activities on our ecosystem is leading to its degradation (UN, 2017).

As much as food waste is a nationwide problem, wedding on the other hands are no exceptions. The prototype developed in this thesis will help the unserved food donated to homeless shelters and this can be very much coordinated on time way before the wedding to help organizations who do these kinds of services have time to pick up the food.

Flowers either live flowers or plastics ones on the other hand, beautiful as they are and adding colour to an event also generate tons of waste. The prototype encourages couples to use eco-friendly alternatives and helps donate the leftover reusable ones to hospices home, brides who can't afford them and other places where needed.

Waste that is disposed of in an environmentally friendly manner is important to both humans as well as the environment. These sections of the application discuss different aspects of waste. Waste in terms of left-over foods that can be repacked, flowers and even the outfits of the bride and groom can be given to the less privileged in the society.

The other form of wastes is assessed, and the right recycling and disposal solutions are implemented thereby making the event greener. It goes from collections, transportations and the disposal of garbage. The applications encourage a couple to use waste service providers to help properly dispose of the different materials used during the cause of the event by providing

proper garbage places and at the end of the day, the waste service providers transport these wastes. Figure 17 shows the Waste Management page from the prototype application.

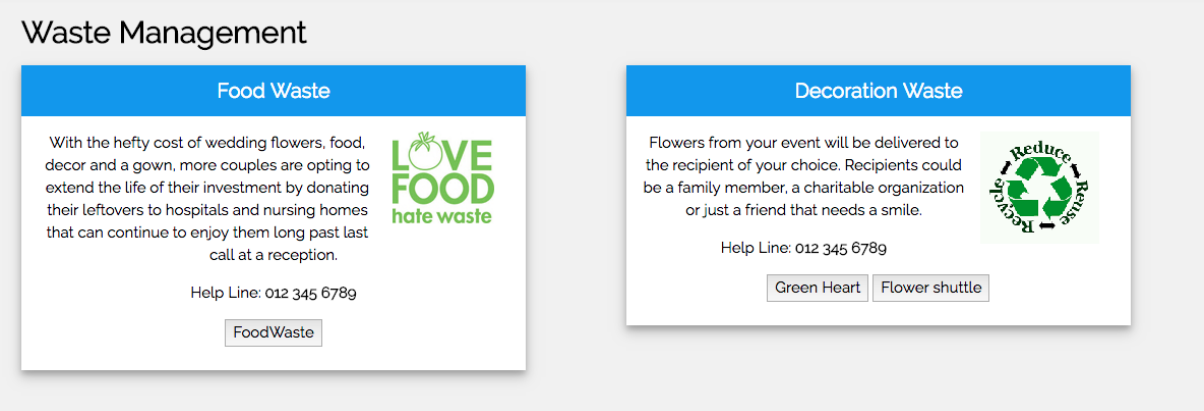


Figure 16: Waste management features from the prototype developed.

The above diagrams display the different section of the waste management for food and decorations. In the food waste section of the prototype created, one of the functions created is to help with the leftover food. Different service providers who use this application can be contacted by couple before their wedding to help with the repackaging of leftover food for the sole purpose of giving it out to people who are in need of them or that it will be beneficial to them and also flowers that are still reusable can be given to hospice home patient or brides who would love the flowers but can't afford them. Other form aspects of the food waste, which can't repackage, flowers, that are quite bad and can't be reused can be properly disposed as either biowaste or other form of waste like life flowers from decorations, plastics drink bottoms, drink bottle etc. This form of service providers is educated on how to properly dispose of these kinds of waste and this is their sole business. Plastic and bottled waste used from drinks and water are also no exceptions. They are packaged and disposed of in an appropriate manner that does not endanger our ecosystem. Doing all these through the application will not only create a beautiful wedding but at the end, most of the sustainable development goals are put in place by society.

What was learned from the prototype?

The developed "Sustainable Events" application promotes sustainable development by incorporating waste management into various services offered within the application. For example, the concept of re-using any leftovers from the event is an interesting way of reducing

waste at events. In addition, the proposed recycling services for proper disposal of physical waste is also an eco-friendly idea. In conclusion, the prototype application provides a sustainable solution and improved resource management to event planning by aggregating several services into a single application.

6 DISCUSSIONS AND CONCLUSIONS

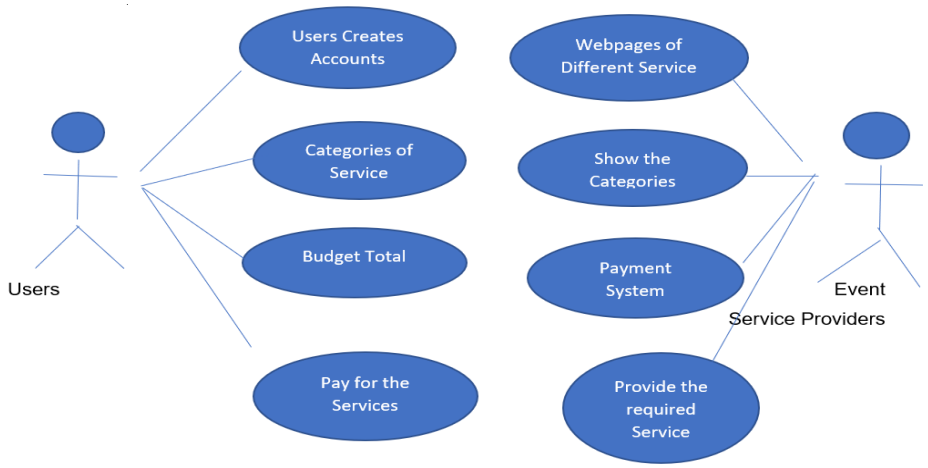
In this work, a better understanding of sustainability and sustainable development as regards to software applications was studied through literature reviews to help enlighten about the nature of research carried out. Interviews for companies and survey questions was done to help with the integration of sustainable development into software applications (Prototype developed). Throughout the study, research objectives are studied and analyzed to achieve the research question and its goals as found in table 1 and the goals which is discussed below:

How the prototype software application developed will help reduce event waste more efficiently?

The implantation strategy developed in this software application prototype will help not only the software organization in developing the sustainable features but also help users who use the app manage their event in a more sustainable manner. Leftovers products will be reused, and logistic solutions provided for all the services listed in the application. This will yield sustainable consumption and business practices.

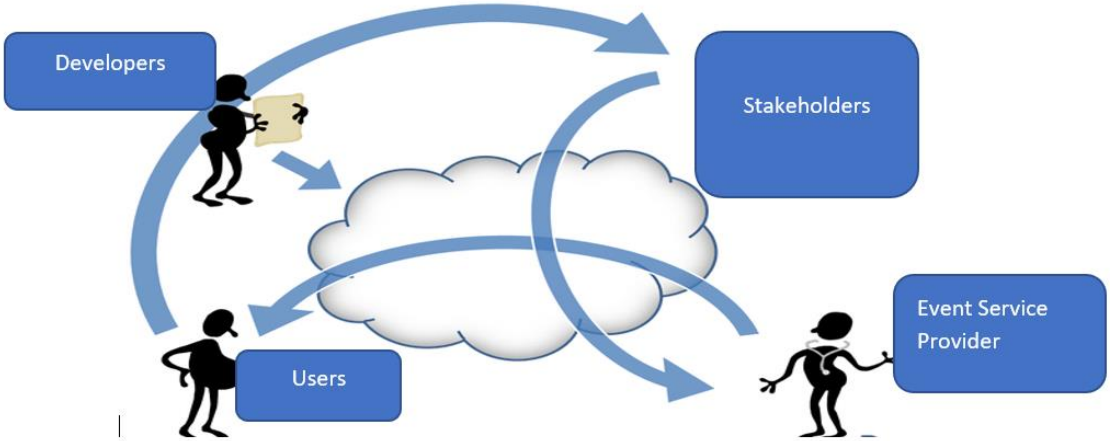
What are the primary use cases for the prototype application developed?

If the software organization and its developer have the agile and lean methodology in colorations with sustainable development mindset and incorporate some of the features listed in this study during the development of these wedding planning applications, the primary use cases for this service will be the users who purchase the services offered and the event service providers who provides the services. As seen below, the users will create an account, search for the list of services that are required for their event, and purchase the service while service provider will have the web pages of the different service providers in their system, publish it their page and create the different categories that make it easier for users



Who are the stakeholders of the prototype developed and for what purpose will this application serve?

The primary stakeholders for this service are the software organizations, who develops the features used in the applications and sales to event planning organizations, event service providers provide the services to the users and the users who use these sustainable features. The below diagram shows the activity flow.



How the integration of sustainable development in software application serve more efficiently? What kind of improved ideas can be found?

Long term thinking in the development of software applications and practices has been a major issue for the software developer, the maintenance of software applications has basically been improving architectures, the decrease of managing technical debts etc. Even though progress

is made in designing of software applications, how its benefits users in a more sustainable way remains a secondary attribute. Its impact on the software artefacts on the society and the natural environment at large is not routinely analyzed. Integrations of sustainable development in software applications can serve more efficiently from the study conducted only if software design development continues to be a key driver of continued automation and the design choices that is been embedded in the software application comes with a sustainable mindset from inception.

Sustainable development as much as it is a topic that trends with issues that concern our ecosystem, it is still very much not practiced even in the software world. Principle, policies and practices still affect the daily use of these in alignment to the goal of sustainable business. Technical factors are not being achieved even with different policies put in place. Businesses have a mindset of producing new software without fulling understanding the key dimension of eliminating waste.

Although, the agile way of working is helping most software industries cut cost by working smart, the acquisition of more knowledge in terms of sustainable development for all involved can be applied and practiced. Innovations that are instructional such as new production method, better material and practices should be adhered to and implemented in a more coordinated fashion. Sustainable development method of change should be the vehicle of change that is supported by society, policy makers, etc. This, in turn, will have a great effect on our ecosystem.

Interviews results and survey papers analyzed showed the following below:

- A lot of known factors were not properly taken into considerations because managements want jobs to be done in a faster manner without consideration of human effects or the amount of energy wasted.

- Enough knowledge is not properly applied in term of what sustainable development means in the software industries as a lot these organizations consider sustainable development to be virtual and thereby believe they don’t apply in term of software development.

- The case study analyzed also presented issues of waste. It shows the amount of waste generated at events and how these wastes are not properly taken care off by some of the software applications available.

- Users, software service providers etc., now understand the importance of adding some of these features to their already known applications are open to using it.

- The data collected from the various research conducted showed that users, the software organizations and events services provider are interested in the proposed prototype. One problem that was visible noticed is that of software organizations inadequate understanding of waste in software development.

- The finding of this study showed that a good number of people are coming to terms with sustainable development mindset where events are concerned and willing to use the prototype when developed.

- The software developer should incorporate into their development designs, sustainable development mindset patterns which will, in turn, help the society in reducing.

In conclusion, the finding of this study showed that a good number of people are coming to terms with sustainable development mindset where events are concerned and are willing to use the prototype when developed. The software developer should incorporate into their development, designs, sustainable development mindset patterns which will, in turn, help the society in reducing waste, especially during events.

7 SUMMARY AND FUTURE WORK

This study has found issues that pertain to software developments in software applications and the results presented in some of the different features of the prototype highlighted showed the amount of waste generated in some countries, in terms of flower waste, co2 waste, food waste etc. Needed actions are required immediately and the present applications feature clearly need improvements. Software organizations lack the concept or an understanding of sustainable development, they employ a lot of business rules to help guide the services and added value they wish to provide for their customers. These rules need to be well designed, executed and monitored in a more sustainable manner. Unfortunately, some of these applications as seen in this study showed that the software applications for events lack some of the features that will enable or help regulate proper waste during events.

The current analysis and webpage created is a start point with which further studies and results of the present wedding waste situation will be put into perspective and worked further on to help improve the integration of sustainable development into software practice. The results gathered can lead to a better improvement for software applications planning tool or application which will ensure proper waste management. The current prototype proposal is a starting point that requires further study to explore more areas to have an improved definition of sustainable development as a quality attribute and its measurement

- The results gathered from the surveys and interviews conducted can lead to the development of a better application system to assist companies in incorporating sustainable development into their management and development processes.
- Testing of the features developed in the prototype in different event planning applications will further provide more feedback on how to improve the applications and better see ways to manage wastes.

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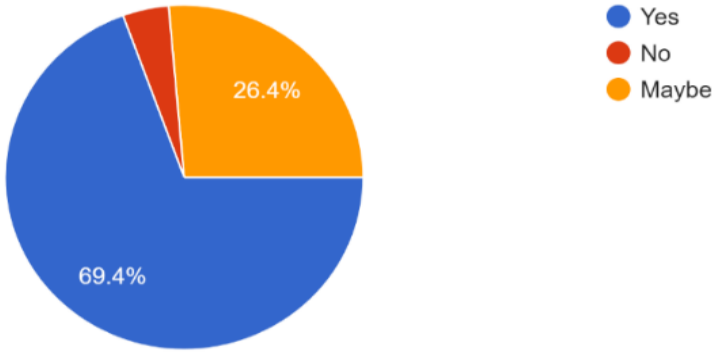
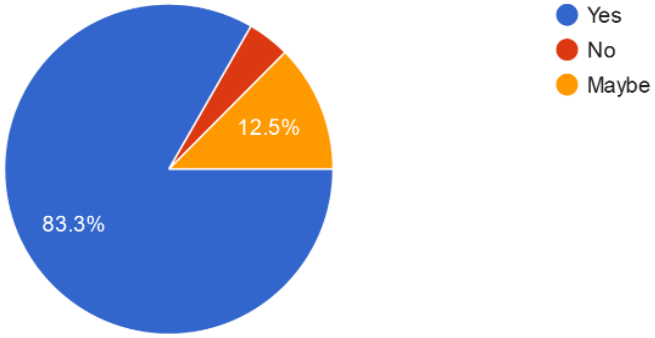
APPENDIX 1 SURVEY QUESTIONS

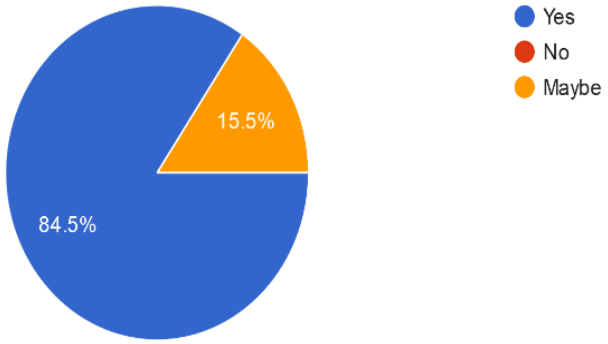
1. When planning for an event, would you use applications that has all the services such as catering, event venue, photographers and videographers etc



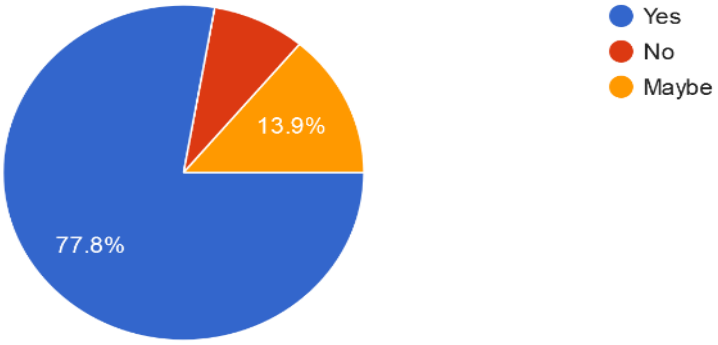
2. Would you use a budget planner calculator that would help with the different event services you need for your event based on your budget?



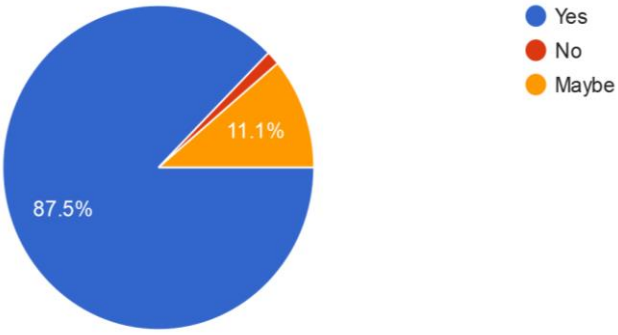
3. When planning for an event, would you use biodegradable materials capable of being decomposed by bacteria or other living organisms and thereby avoiding pollution on the environment?



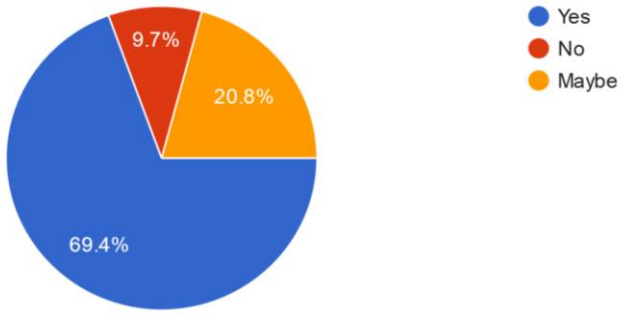
4. In order to reduce the number of carbon footprints (emission of carbon dioxide in the atmosphere) would you be interested in carpooling (sharing your car with others or sharing in their car) when going for the same event?



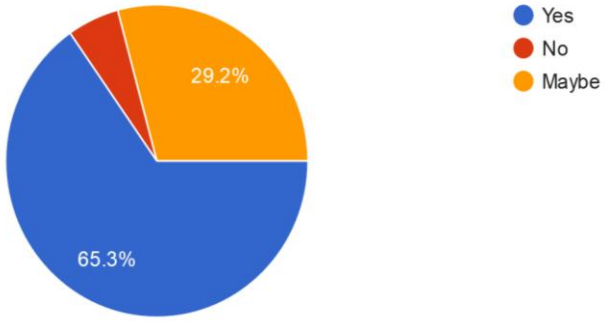
5. When you have excess leftover products such as food, flowers, drinks etc, in your event, would you use service providers that will repackage them for people(needy) who need them or can pay a little amount for the products



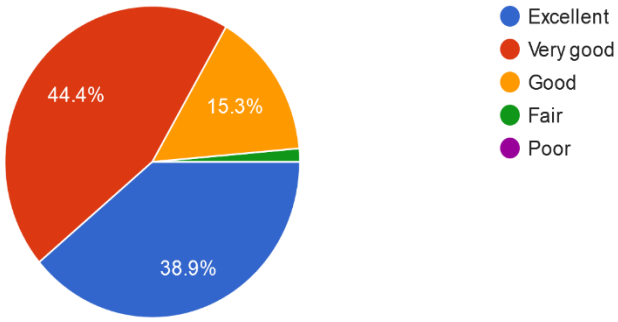
6. Most times during an event, there are always different kind of waste e.g. food waste, plastic waste, bottle waste, life flower or plastic flower waste, paper waste etc that are not properly recycled, would you use a professional waste recycling service provider to properly dispose of such in order to help protect the planet.



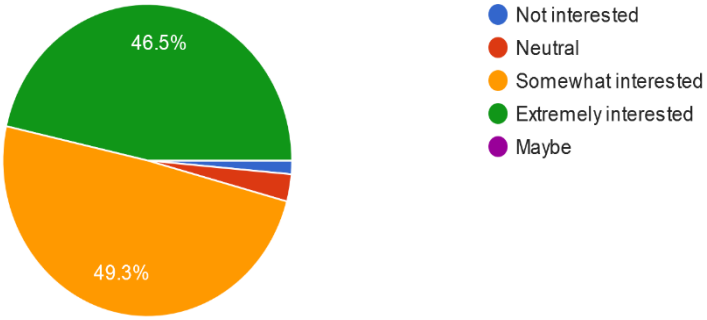
7. For your events would you use food vendor service providers that are environmental conscious to cater for the food.



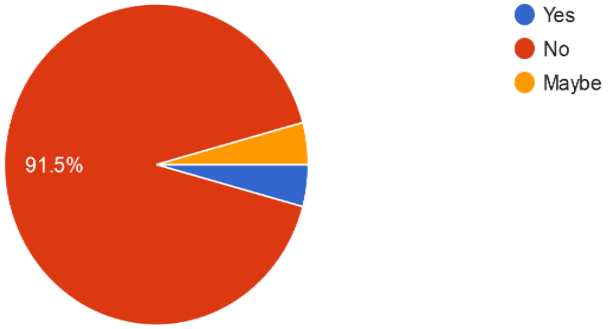
8. Overall, what is your reaction to the described product?



9. How interested would you be in using the described application?



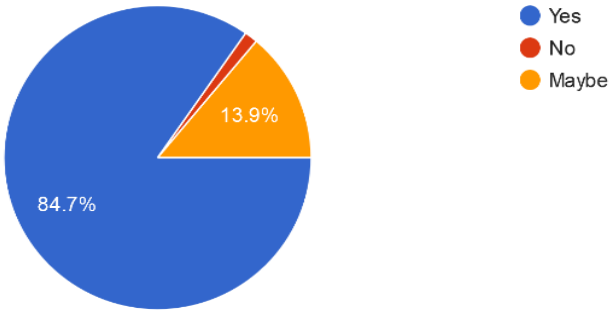
10. Do you have or know an alternative that is currently in use for similar service?



11. If yes, please mention the alternative

- No responses

12. Would you recommend the app to a friend?



13. Would you be willing to pay for using the application?