29 November - 1 December
Kuala Lumpur - MALAYSIA

STE 2013
International Conference
Sustainability, Technology and Education

PROCEEDINGS

Edited by:
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Nurfadhilina Mohd Sharef
Tomayess Issa and
Pedro Isaías

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International association for development of the information society
INTERNATIONAL CONFERENCE
on
SUSTAINABILITY, TECHNOLOGY
AND EDUCATION
(STE 2013)
PROCEEDINGS OF THE
INTERNATIONAL CONFERENCE
on
SUSTAINABILITY, TECHNOLOGY
AND EDUCATION
(STE 2013)

KUALA LUMPUR, MALAYSIA

29 NOVEMBER - 1 DECEMBER, 2013

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FOREWORD

These proceedings contain the papers of the International Conference on Sustainability, Technology and Education (STE 2013), which has been organised by the International Association for Development of the Information Society and co-organised by the Faculty of Computer Science & Information Technology, Universiti Putra Malaysia, Kuala Lumpur, Malaysia, 29 November - 1 December 2013.

The International Conference on Sustainability, Technology and Education (STE2013) aims to address the main issues which occur by assessing the relationship between Sustainability, Education and Technology.

Broad areas of interest are: Sustainability and Leadership, Sustainability and Green IT, Sustainability and Education. These broad areas are divided into more detailed areas (see below). However innovative contributes that do not fit into these areas will also be considered since they might be of benefit to conference attendees.

- Sustainability and Leadership: Sustainability and Management, Corporate Social Responsibility and Sustainable Design, Sustainable Design and Business Strategy, Sustainability and Accounting, Sustainability and Finance and Economic, Sustainability and Marketing and Barding, Technology Development and Innovation at Small and Medium-Sized Enterprises, Sustainability and Natural Resources, Sustainability and Sustainable Design, Sustainability and Ethics, Sustainability and Stewardships, Sustainability, value and business strategy, Sustainability and Social, Sustainability and Culture, Sustainability and Environment, Sustainability and Law, Sustainability and Developed Countries, Sustainability and Developing Countries and Sustainability and SME.

- Sustainability and Green IT: Sustainability and Social Media, Sustainability and Online Community, Sustainability, Green IT and Internet, Innovation of Green Technologies, - Green Procurement, Green IT and Energy, Green IT and e-Waste, Technologies and Green IT, Green IT and Sustainable Design, Green IT Development and Sustainability, Green Supply Chain and Logistics, Sustainability and Green IT Policy and standards, Green IT and Sustainability and escorting to change, Sustainability and Green IT business, Sustainability and Green IT Infrastructure and Cloud computing and virtualization.

- Sustainability and Education: Education and Training, Accreditation, Green IT and teaching, Sustainability and Green Campus, Education for Sustainability, Sustainability and Curriculum frameworks, Shifting toward Sustainability, Sustainability and Future Generation and Sustainability and e-Society.
The International Conference on Sustainability, Technology and Education (STE 2013) received 58 submissions from more than 15 countries. Each submission was reviewed in a double-blind review process by an average of five independent reviewers to ensure quality and maintain high standards. Out of the papers submitted, 11 papers have been published as full papers, which mean that the acceptance rate was 19%. These submissions include full papers, short papers, reflection papers, poster/demonstration and doctoral consortia.

Best paper authors from the STE 2013 conference will be asked to extend their papers for possible inclusion in a special issue of WRSTSD - World Review of Science, Technology and Sustainable Development (ISSN online: 1741-2234), indexed by Scopus, among other indexes.

In addition to the presentation of full papers, short papers, reflection papers, poster/demonstration and doctoral consortia, the conference also include a keynote presentation from an internationally distinguished researcher. We would therefore like to express our gratitude to Professor Narayanan Kannan, Faculty of Environmental Science, Universiti Putra Malaysia, Malaysia.

A successful conference requires the effort of many individuals. We would like to thank the members of the Program Committee for their hard work in reviewing and selecting the papers that appear in this book. We are especially grateful to the authors who submitted their papers to this conference and to the presenters who provided the substance of the meeting. We wish to thank all members of our organizing committee.

Last but not least, we hope that participants enjoyed Kuala Lumpur and their time with colleagues from all over the world.

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Nurfadhlina Mohd Sharef, Universiti Putra Malaysia, Malaysia
Conference Co-Chairs

Tomayess Issa, Curtin University, Perth, Australia
Pedro Isaías, Universidade Aberta (Portuguese Open University), Portugal
Conference Program Co-Chairs

Kuala Lumpur, Malaysia
29 November 2013
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Esmahan Agaoglu, Anadolu University, Turkey
Farzad Pour Rahimian, University Of Central Lancashire, United Kingdom
Francisco J. Lozano, Tecnológico de Monterrey, Mexico
KEYNOTE LECTURE

A PLANET IN TROUBLE: APPLICATION OF GREEN TECHNOLOGIES IN ECO-PRESERVATION AND E-PRESERVATION OF ANCIENT DATABASES FOR A SUSTAINABLE FUTURE

By Professor Narayanan Kannan
Faculty of Environmental Science, Universiti Putra Malaysia, Malaysia

Abstract

Homo sapiens sapiens, the wise human beings emerged as the most dominant species on planet earth in the millions of years evolution. The biggest surprise, however, to this dominant species which spearhead the future of this 'spaceship earth' is that no manual was given to him to navigate. He needs to read the vast libraries of nature to understand how it works. Among the several past readings humans understood that nature sustains itself intelligently through complex yet efficient re-circulation processes avoiding any waste production. This guiding principle of sustainability through intelligent design, a non-material life style may lead man kind and fellow beings on planet earth to a prosperous future. The impact of economic developments on environment will be discussed with specific examples from chemical pollution for alternative thinking and sustainable life styles. New cyber initiatives in digitizing ancient manuscripts that contain valuable knowledge on sustainable living will be discussed. Specific examples of E-preservation efforts in India with an aim to digitize manuscripts that are in peril will be shown in order to contemplate whether green technologies will preserve human databases of vast knowledge. Educational modules need to be developed in order to preserve, read, understand and practice ancient knowledge for continuity and posterity.
Full Papers
SCIENTIFIC RESEARCH AS MAIN SUPPORT FOR SUSTAINABLE TRANSPORT DEVELOPMENT – THE CASE FOR ROMANIA

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ABSTRACT

The aim of the paper is to describe the state of scientific transport research capability in Romania in the past decade, particularly between 2000÷2010, in an effort to support the development of a sustainable transport system. Sustainable development of the transport sector has been a theme discussed and addressed largely by the scientific research institutes worldwide, rather than central authorities. Within this context, in Romania, there is limited governmental support and interest with respect to transport sector scientific research. In spite of these shortcomings, a number of projects were supported from the state, as well as, EU budget. They were aimed at promoting the development and modernization of the Romanian transport sector.

More can be done and achieved in the Romanian transport sector if the main causes of the existing disconnect between government intentions to modernize the transport sector and Romanian transport scientific research capacity will disappear. In the same vein, the lack of international projects managed by Romanian organizations must be addressed, in the future, in order to truly increase the visibility of Romanian transport research field capability.

KEYWORDS

Transport scientific research, sustainable transportation, research policy, national research funds, European research funds

1. INTRODUCTION

The last two decades have been marked by a continuous increase of a new type of transport economic analyses based on the principles of sustainable development. It can be observed in this respect a shift in the interest for the transport development sector given its impact on economical, ecological and social aspects. In order to identify the magnitude of such influences an important role was played by the scientific research. Within this context, it is expected that the analysis of the transport specific scientific programs and projects evolution will shed more light and better the understanding of future sustainable transport sector strategic development.

In the past decade, Romania, as a developing country and member of European Union – EU spared no efforts to encourage the development of a sustainable transport sector by employing the use of scientific research methods and analyses. The EU can be considered both a world-class pioneer and promoter of sustainable transport development who is ready and willing to share its core competencies with other non-member communities that share similar environmental interests.

2. SCIENTIFIC RESEARCH STRUCTURE IN ROMANIA

The Romanian Research-Development-Innovation (RDI) system went across a very difficult period after 1989. The underinvestment and postponed restructuring allowed only for a vague connection to the global trends in science and technology and the still fragile enterprise sector in Romania to be developed. Practically
isolated, the Romanian RDI system was somehow fragmented, as various components tried to survive with the minimum available resources, within mostly formal systems, mainly from public funding. In spite of its considerable late registered progress, to the present date, Romania still shows a serious lagging behind competitiveness-wise compared to the other EU states. (Romanian Government, 2006) The reasons behind the lag can be found at the level of all the elements determining competitiveness.

We point out from the very beginning that there has been no separate plan to support transport research in Romania. The projects conducted over the years were financially and administratively supported under a number of research-development programmes, covering various thematic areas, most of them under the State’s authority. Moreover, the national funding of transports specific projects did not represent a priority for the past governments and were placed behind other fields regarded by the Romanian authorities as more important for Romania’s future (e.g. medicine, nanotechnologies, communications etc).

The Romanian RDI system consists of several main types of research institutions: National Institutes, Universities, Institutes of the Romanian Academy and of the branch academies, other public research institutions, private non-profit research institutions and private for-profit research institutions (Figure 1).

The National Authority for Scientific Research (NASR) is the governmental body authorized to elaborate and implement the national Research, Development and Innovation (RDI) strategies and programmes, thus ensuring a unitary coordination of the activities in the line carried out in the universities, national institutes, Romanian Academy institutes and field academies. In this respect, NASR has promoted strategic documents defining the prospects of developing the RDI domain over the period 1999-2013.
3. HIGHLIGHTS OF TRANSPORT RESEARCH ACTIVITY SUPPORTED FROM NATIONAL FUNDS

The release of the first National Research Development Innovation Plan PNCDI (I) in 1999 and funding approach based on the research programmes essentially determined an increase in performance and a change in mentality referring to access to resources. PNCDI (I), which ended in 2006, managed to polarize researchers from all the domains during the period 1999-2006 (Constantin I, Fistung, F.D., Cernat-Gruici B., 2010), but, most of all, engendered a sense of competition and brings forth the desire to propose and offer projects which, by getting applied to the economic and social milieu, may have a positive impact on the life quality in Romania.

PNCDI (I) included 9 programmes and 267 projects which approached the field of transports. The most numerous and the most representative projects were funded under the programmes RELANSIN – Economic revival through research and innovation (128) and AMTRANS – Landscape development and Transport (101).

Table 1. PNCDI (I)-Distribution of R&D programmes which funded transport projects during 1999-2006 period. Source: Constantin I, Fistung, F.D., Cernat-Gruici B., 2010, Transport research capability in Romania, in the Project: Support for realising New Member and Associated States potentials in transport research

<table>
<thead>
<tr>
<th>Research program</th>
<th>Rail</th>
<th>Road</th>
<th>Aeronautic</th>
<th>Sea</th>
<th>Projects whose thematic area covers several transport modes</th>
</tr>
</thead>
<tbody>
<tr>
<td>RELANSIN</td>
<td>36</td>
<td>39</td>
<td>24</td>
<td>16</td>
<td>13</td>
</tr>
<tr>
<td>INFIRAS</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>AMTRANS</td>
<td>21</td>
<td>46</td>
<td>9</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>INFOSOC</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
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<td>0</td>
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<td>0</td>
</tr>
<tr>
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<td>0</td>
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</tr>
<tr>
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<td>0</td>
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<tr>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>INVENT</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>67</td>
<td>95</td>
<td>46</td>
<td>28</td>
<td>31</td>
</tr>
</tbody>
</table>

As it can be seen in Table 1, 31 projects covered several transport modes, namely: rail-road, aeronautical-sea and road-sea.

National Plan - PN II (2007÷2013), currently underway, is coordinated by NASR and includes 6 funding programmes: Human Resources, Capacities, Ideas, and Competitiveness through Partnership, Innovation and Institutional Performance Supporting. Among them, the most important transport projects were funded under the Innovation and Partnerships programmes.

The Innovation Programme started in 2007 and still underway, is aimed at the budgetary financial support of the pre-competitive research projects, initiated by economic agents and achieved in collaboration with research-development-innovation development. The programme is dedicated to technological development and innovation, having innovation capacity enhancement, technological development and research results assimilation into production, as general objectives. Under the Innovation programme, projects having covered all the transport modes, mainly conducted by SMEs, are developed.

For each of the priority domains, representative scientific and technical domains have been identified. Surface transports in the priority domain include „Innovative materials, processes and products” (having the biggest share - 55,5%), with the following representative sub-domains: Transport infrastructures; Means of transport; Transport technologies; Traffic control systems and equipment; Freight distribution and logistics.

Aeronautics is included into the priority domain “Space and security” with the following sub-domains: Airspatial propulsion systems; Aviation- and aero spatial structures; On-board installations and equipment; Airspatial technologies.

PNCDI (I) was finalised in 2006, and the next National Plan started in 2007. In order to make a connection between PNCDI (I), the National Plan 2007 (PN II) and FP7 (European Community), CEEX-Excellence Research programme was released, carried on starting with year 2005, with a significant share in the NASR budget (24,98%).

5
A number of approximately 171 projects in the line of transport were carried out under PN II (2007-2013). The most relevant component programmes, under which transport research projects were funded, are: “INNOVATION” and “PRIORITY DOMAINS PARTNERSHIPS” Programmes. A total number of 48 transport projects are currently underway within the INNOVATION Programme.

Programme 4 – Partnerships in priority domains has created the setting for a better collaboration among the various research-development-innovation entities, economic agents and/or public administration entities, with a view to coming up with solutions to the problems arisen, under powerful partnerships. Under Programme 4 – Partnerships in priority domains, a number of 49 transport projects were funded.

Table 2, below, shows the distribution of R&D programmes/projects funded under PN II in the field of transports according to transport modes during the period 2007÷2013. As it can be seen in Table 2, 11 projects covered several transport modes, namely: rail-road, aeronautics-sea and road-sea.

In Figure 2 it can be observed the evolution of the projects share, in the total granted, according the areas of interest.

Table 2. PN(II) - Distribution of R&D programmes which funded transport projects during 2007-2013. Source: Constantin I, Fistung, F.D., Cernat-Gruici B., 2010, Transport research capability in Romania, in the Project: Support for realising New Member and Associated States potentials in transport research

<table>
<thead>
<tr>
<th>Research programme</th>
<th>Transport mode Railway</th>
<th>Road</th>
<th>Aeronautics</th>
<th>Naval</th>
<th>Projects whose thematic area covers several transport modes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEEX, 2006</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0</td>
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<tr>
<td>IMPACT</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>INNOVATION, 2007</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>INNOVATION, 2008</td>
<td>7</td>
<td>23</td>
<td>3</td>
<td>3</td>
<td>4</td>
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<tr>
<td>Partnerships in priority domains, 2007</td>
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<td>12</td>
<td>15</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Partnerships in priority domains, 2008</td>
<td>0</td>
<td>7</td>
<td>11</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>IDEAS</td>
<td>1</td>
<td>21</td>
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<tr>
<td>CAPACITIES, 2007</td>
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<tr>
<td>NUCLEUS</td>
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<tr>
<td>Grants, CNCSIS</td>
<td>1</td>
<td>13</td>
<td>0</td>
<td>7</td>
<td>2</td>
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<tr>
<td>Total</td>
<td>20</td>
<td>89</td>
<td>36</td>
<td>14</td>
<td>11</td>
</tr>
</tbody>
</table>

Even the number of projects that aims “greening” of transportation decrease from 35 (granted between 1999 and 2006) to 28 (granted from 2007 and 2013) the share from total granted projects is rising with 4% in the same period. That’s a good sign for the sustainable transportation direction.

Figure 2. Distribution of projects carried out under PNCDI I (1999÷2006) and PN II (2007÷2013) according to action types. Source: Constantin I, Fistung, F.D., Cernat-Gruici B., 2010, Transport research capability in Romania, in the Project: Support for realising New Member and Associated States potentials in transport research
In the latter half of year 2008, the management activities were disturbed, mainly because of the financial crisis which leads to:

- A further even out / delay of the payments to the contractors;
- Diminishing or complete cancellation of certain payments;
- Adjournment, over unlimited time duration, of certain contracting activities.

All of the above led to an uncertain atmosphere with consequences affecting the long-term public RDI system’s credibility.

4. TRANSPORT RESEARCH ACTIVITY SUPPORTED FROM EUROPEAN FUNDS

Besides the projects financed under MECTS programmes, in Romania there were previously developed transport research projects from both national public resources (the Ministry of Transports and its subordinated institutions, the Romanian Academy) and international ones (EU through specific programmes), or from private resources (funds provided by private beneficiaries for themes or programmes required by them and which are not necessarily to be In keeping with Romania’s national research strategy).

The “Cooperation and international partnership” Programme - CORINT was part of PNCDI (I) during the period 2001÷2006, its main objective being the integration of the Romanian scientific and technological community into the international and European community, by raising the excellence standard and by increasing the research-development-innovation activities effectiveness by acquiring modern research techniques and management. The CORINT programme structure included, among others, support activities which helped national researchers to participate in EU Framework Partnership5 (FP5) and FP6 and EUREKA EU-RO sub-programmes (participation activities under FP5 and FP6) EUREKA-R. The initiative also provided supports to some transport projects in which Romanian partners participated.

In 2002 Romania’s contribution under FP6 was estimated at a value of 77.266.000 Euros. The totally non-encouraging results at the 2003 - and 2004 calls determined the European Commission to lend support to Romania, with reductions in contribution down to 50%. Thus the final contribution was around 65 mil. Euros.

Under EU framework programmes – FP5 and FP6, Romania participated in the carrying out of 42 transport projects covering both the surface transport and air space and aeronautics. As a matter of fact, Romania’s most participations were registered in the line of air- and spatial transport (18).

EC contribution to Romania in FP6 Transport: around 3 thousand Euros (Aeronautics around 1,3 thousand Euros and for Spatial and Sustainable Transportation around 1,7 thousand Euros).

5. MAJOR ORIENTATIONS OF TRANSPORT RESEARCH PROJECTS AIMING SUSTAINABILITY

From all the transport research projects funded with national or/and international funds, especially from European Union, we can underline several support actions for the sustainable transport development in Romania:

**Intermodal transport promotion.** The operations are aimed at facilitating freight modal transfer, mainly from road to rail / road or naval / road. Consequently, intermodal transport promotion mainly refers to providing terminal infrastructure or logistic centres for the intermodal units. The initiatives include actions aimed at developing the intermodal terminals or the distribution- or combined transport logistic centres covering the terminal infrastructure. Railway intermodal operations support is also aimed at. To be also mentioned that the elaboration of a 12,8 million Euros worth project is in progress, aiming at building / upgrading 4 intermodal terminals by 2015; the project is faced with some difficulties caused by the state aid-related regulations and by certain unclear structural aspects.

**Traffic safety enhancement for all transport modes.** These operations are intended to ensure the implementation of the European safety standards for all the means of transport, the intermodal one included, through interventions aimed at:
- safer roadways (improved road / rail level crossings and building of new overhead- and underground road / rail passages; vertical- and horizontal signalling systems; physical infrastructure improvement and development by taking the necessary preventive measures (e.g. road signs, video cameras, linear villages etc.);
- safer railways (electro-dynamic interlocking modernization, automatic barriers, signalling etc.);
- safer naval transport (improvement of the Ship Traffic Management Information System Nave – VTMIS).

A portfolio of 10 projects was prepared, out of which 2 major projects, amounting to an overall value of 146,9 million Euros. Upgrading 80 railway level crossings and protecting 180 km in linear villages are envisaged by 2015. This should result in a 20% reduction in the number of serious or fatal accidents.

Minimizing transport adverse effects on the environment. The specific operations include the implementation of initiatives intended to efficient and non-polluting / environmental friendly transport infrastructures in line with the European standards and requirements for all the transport modes, intermodal activities included. In keeping with the Kyoto Agreement. A portfolio of 3 projects 11,6 million Euros worth has been prepared so far. The implementation in this domain will reduce the environment impact of the transport infrastructure built prior to the implementation of the sustainable development legislation in Romania and will back up the application of an environment management system to include strategic analysis, evaluation of the transport sector- specific impact, monitoring- and attenuation measures, as well as inter-institution co-operation.

6. CONCLUSIONS AND RECOMMENDATIONS

Creating the perspective of a single European market in transport, based on the principles of sustainable development requires the adoption by all EU member countries of measures that allow for their rapid integration without creating major sector disfunctionalities. In these circumstances, Romania needs to reshape transportation structures and implement these projects. EU Programs in this field aim mainly at achieving sustainable transport and in particular transport balancing the internal market, strongly affected by the accelerated development of road transport in decades. To achieve these objectives imposed, Romania needs to focus on the following major actions:

a) Strengthen and improve internal transport market in order to facilitate the free movement of goods and persons within the Community.

b) Develop a coherent transport system both in terms of infrastructure and legislation that will allow for the integration without major distortions with the Western European system.

c) Reducing regional disparities by developing a proper transport infrastructure.

d) Encourage those transport subsystems that will support sustainable development processes, and

e) Improving road safety and traffic flow.

Achieving these requirements is mandatory, especially since the integration in the European transport system will increase the value of traffic significant, especially in the road. Compared to 1998, an increase of over 20% of the average daily traffic in 2008.

In these circumstances, the EU requirements sustainable transport is an objective necessity. The present analysis of the transport research programs and researchers reveals the extent of researcher links, researcher quality, and the opportunity for researchers to activate within nationally funded research projects. Overall the quality of the researchers in the field of transport research is considered being high, a fact which is reflected in the outcomes of the research projects. However, the low number of joint cooperation programmes and platforms implies that Romanian researchers have a relative low exposure both at a national and international levels.

A reliable measurement of the research capability is the involvement of Romanian companies in European research projects. This aspect reflects the fact that Romanian expertise in the transport field is valued on a European level. Some few Romanian organisations, unfortunately, have successfully participated within European transport research projects but the numbers indicate that there is potential for more involvement. For example in 2007, for FP7 SST calls, 81 proposals in which Romanian companies participated were submitted. Out of the 81 proposals, 19 were selected for funding. In 2008, out of 53 proposals, 8 were selected for funding. A truly negative fact is that up-to-date no Romanian organisation has
managed a European project. While the seventh Framework Programme is the most popular European research program in Romania, the overall national research projects outnumber the European ones at a ratio of 4:1.

From the perspective of university research sector participation several important conclusions can be drawn:

- There is an acute lack of predictability of the funding through public funds both on short and medium term, partially explained by the unfavourable overall economic condition.
- The competitive distribution of most available funding is seen by the government as important but with little chance to actually be aggregated at a national strategic level.
- There is a reduced applicability of research results in various economic practices.

From the several arguments and interpretations that support these conclusions, one is of immediate importance and requires fast implementation of corrective policies; several research fields face major risks to diminish their own developing potential and this implies negative impacts upon other research fields and upon the national development potential.

In the very close future, for supporting sustainability, transport research is expected to focus on:

- Developing and promoting products and technologies for increasing the energy efficiency of the transports and reducing polluting effects.
- Development of intermodal transport systems / technologies aimed at restricting traffic external effects and reducing resources consumption.
- Integrated supply-, technological-, distribution logistics, as well as reverse logistics integrating transport-handling-storing-conditioning-packing-marketing-fabrication-recycling technologies.
- Transport quality management- and traffic monitoring- and control systems.
- Solutions to reducing traffic congestion in urban agglomerations as correlated with urban planning and life quality enhancing.
- Internalization of negative externalities due to transportation.

Priorities are determined by the requirements of the EU in the field, but also by the objective reality of the current state of Romanian transport. For Romania joining the EU has been a great opportunity to create a modern transport infrastructure as well as, the development of a system based on sustainable principles.

The current stage of development of transport sector infrastructure does not constitute an advantage, but rather a handicap, if we are taking into account the fact that usually economic activities develop properly where favorable conditions are in place. Overall, there is an expectation that achieving these goals will enable the creation of a sustainable transport system in line with EU requirements.

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THE USE OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) TOOLS IN EDUCATION WITH THE AIM OF SUPPORTING LANGUAGE DEVELOPMENT OF PRESCHOOL CHILDREN

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ABSTRACT
New interactive technological solutions make it easier to offer creative environments, where children can learn through activities, and at the same time these means are helpful to children for visualising concepts that are harder to learn (Van Scouter & Ellis, 2001; Schomburg, 2012). The study was part of the Nordic and Baltic countries project “Curriculum in kindergarten? Language learning and use of ICT with small children” (CHILDICT), supported by the Nordic Council of Ministers’ Nordplus Horizontal Programme. The aim of the current study was to find out teachers’ attitudes towards using ICT with small children to support their language development. ICT usage in today’s kindergartens is connected to education for sustainable development, since early childhood education forms a basis for lifelong learning and further education. The sample size in Estonia was 58 kindergarten teachers. Estonian preschools use ICT tools mainly for diversifying the learning environment and for differentiating learning activities, paying particular attention to children with special needs and children who learn faster than others. Estonian kindergarten teachers’ attitudes towards the use of ICT tools are very positive, however, there is a lack of new technologies, cooperation with parents, as well as regulations and guidelines.

KEYWORDS
Kindergarten, ICT, language development, policy, education for sustainable development

1. INTRODUCTION
There are several advantages in using modern technologies for language development of the 21st century children. New interactive technological solutions make it easier to offer creative environments, where children can learn through activities, and at the same time these means are helpful to children for visualising concepts that are harder to learn (Van Scouter & Ellis, 2001; Schomburg, 2012). Studies indicate that using information and communication technologies (ICT) is especially useful for the development of fine motor skills, language and communication, writing skills and reading readiness, mathematical thinking, creativity, and problem solving skills, as well as for creating a positive attitude towards learning (Morgan & Siraj-Blatchford, 2009).

In 2010 the Estonian Cooperation Assembly Foundation, NGO Estonian Educational Forum, and the Estonian Ministry of Education and Research signed a trilateral agreement, on the basis of which the Estonian Education Strategy for the years 2012-2020 was drafted. It foresees developing digital culture as an important part of the Estonian educational and cultural space. Vinter and Siibak (2012b) state that young children make active use of computers mainly for entertainment and less so for educational reasons, therefore the role of teachers in leading learning through media tools becomes crucial. Studies show that computer-assisted instruction can help children to gain phonological awareness and word reading (Macaruso & Rodman, 2011), also interactive technology increases children’s communication skills, social interaction, fine motor control, attending, planning, problem solving skills and emergent literacy (Hutinger, Robinson, et al., 2002). Still, other studies (Johnson & Puplampu 2008) reveal that Internet use during childhood can have both positive and negative developmental consequences. Sylva, Melhuish, et al. (2010) show that preschool
attendance has an impact on children’s reading and writing skills, also staff with higher qualifications affects pre-school setting quality and children’s progress. Instructive learning environments and “sustained shared thinking” extends children’s learning. Boyd (2008) claims that it is important that early childhood teachers use technology in their classrooms and recommends that children use assistive technology to enhance their learning.

Concerning the formation of a new digital culture in Estonian education, it is important to study teachers’ competencies and conceptions about the benefits of ICT tools in supporting children’s language development. The aim of the current study was to find out teachers’ attitudes towards using ICT with small children to support their language development. ICT usage in today’s kindergartens is connected to education for sustainable development, since early childhood education forms a basis for lifelong learning and further education. The hypothesis of the study was that availability and personal skills determine whether kindergarten teachers use ICT tools in their educational activities with the aim to support language development of children. It is unthinkable in contemporary education to give quality education without the use of ICT tools.

The current study is part of the Nordplus project CHILDICT and ESF program EDUKO AU 910.

2. BODY OF PAPER

2.1 Supporting Language Development in a Children’s Institution

From primary school through basic school (1st to 9th grade) all systems related to language and speech should be developed, since obtaining the highest level of language and communication skills ensure a more successful life for an individual (Berninger, Abbott, Jones, Wolf, Gould, Anderson-Youngstrom, Shimada & Apel, 2006). It is important to focus on each child in the preschool as an individual, to make sure that the development of all children is supported (Bouchard, Bigras, Cantin, Coutu, Blain-Briere, Eryasa, Charron & Brunson 2010). Hutchinson and Clegg (2011), as well as Crim, Hawkins, Thorton, Rosof and Copley (2008) are convinced that in setting children’s individual language development goals, teachers need to be acquainted with how child’s language and speech develops. This knowledge seems to be sometimes deficient. Mashburn, Justice, Downer and Pianta (2009) found that other children’s expressive language skills can have a slight, but still significant impact on child’s own language expression. Sage (2006: 83) points out that although language develops in regular communication with the child, it is nevertheless important to give the child a chance to: 1) observe, listen and reflect the appropriate forms of communication either in formal or informal contexts; 2) imitate, try out and practice what they have seen and heard; 3) clarify and re-examine communication situations according to their needs; 4) develop independent thinking through expression of feelings, ideas, and opinions; 5) receive encouragement, guidance, positive feedback, and acknowledgement for attempts to communicate.

In an environment that supports language development, children are systematically and at regular intervals introduced to situations, where they have to communicate with both peers and grownups, whereas especially important is the reacting ability of the grownup (Justice, 2004). Vygotsky’s sociocultural theory can be helpful in creating a rich environment for language development, since it sees acquisition of language as a sociobiological process, where both the individual’s innate premise to acquire language as well as opportunities offered by other people for mutual communication, play a role. Communicating with someone with higher level communication skills helps to develop child’s communicative and linguistic skills (Justice, 2004). Mashburn, Pianta, Hamre, Downer, Barbarin, Bryant, Burchinal, Early and Howes (2008) ECERS-R scale indicated a significantly positive relationship between the surrounding environment and child’s communicative skills. Howard, Miles and Rees-Davies (2012) found that when teachers offered preschool children various experiences with using the computer, children associated these activities with play.

2.2 The Role of ICT Tools in Preschool Education

In case of purposeful instruction and usage, information and communication technologies can play an important role as tools in the general structuring of the learning process; they can facilitate cooperation between children and increase efficiency in information processing. Such skills have also impact outside the technical fields (Strakšiene & Baziukaitė, 2009).
Information and communication technology includes different fields and concepts such as hardware, software, applications (e.g. e-lasteenth, EHIS, etc.), software development, telecommunication and networks, communications technology, IT services (e.g. IT administration and support), IT management, society and politics (technology related regulations in the society) (Plowman & Stephen, 2003). Shah and Godiyal (2009) point out that ICT related technological means offer innovative ways to strengthen many aspects in preschool, while the global support and interest favour general development and integration of ICT into educational policies, curricula and educational practice. Teachers should find from the scope of ICT applications those options that enable to teach children in a safe and responsible way, so that in future they would grow up to be cyber citizens that follow ethical behavioural norms (Grey, 2011). Learning activities that are planned through technological means should be seen as new educational possibilities (Amante, 2007). Shah and Godiyal (2009) are convinced that ICT tools should not be seen as endeavours separate from other activities, but they could be integrated into planned or spontaneous learning and playing activities in kindergarten’s classrooms. In addition to programs that develop specific skills, it has been found that children, whose reading and writing skills have developed with the help of various ICT tools, learn globally and functionally better, since such tools integrate other activities and are based on real needs (Amante, 2007).

In the Estonian National Curriculum for Pre-School Child Care Institutions (2008) there is no direct reference to the term information and communication technology, but a few paragraphs support the integration of ICT tools to learning and leisure activities. For example, section 5 paragraph 1 states that learning is a lifelong process, which results in changes in behaviour, knowledge, attitudes, skills, etc., and their inter-relations. The child learns through imitation, observation, examination, testing, communication, play, practice, etc. The fourth paragraph of the same section mentions that learning and educational activities should create conditions that would develop the child's ability to use the acquired knowledge in a variety of situations and activities. These points allow introducing ICT tools to learning and leisure activities in order to enrich and diversify them. When explaining the content of the topic Me and the environment, it has been stated that within its framework children will also be talked about the artificial environment, which includes both home appliances as well as virtual environments.

2.3 Method and Sample

The research method was chosen to be an online survey at the website www.Questback.com. The link was open for answering from 26 March to 30 April 2013. The questionnaire was part of the Nordic and Baltic countries project Curriculum in kindergarten? Language learning and use of ICT with small children (CHILDICT), supported by the Nordic Council of Ministers’ Nordplus Horizontal Programme. The project is based on preschool curricula, which are used in a systematic and holistic way to promote children's learning through integration and play. In broad-based curricula the CHILDICT project focuses on one area – teaching/development of speech and reading skills. In this context the project focused on how the preschool education is supported by the use of information and communication technologies (ICT). Answering the questionnaire was easy. In case of most questions it was sufficient, if the respondent chose an option, which represented his opinion. At the end of the questionnaire respondents could express their own ideas in a free form, or add comments.

2.4 Background Information

The majority of the respondents were over forty years old. 38 percent of the teachers, who participated, were under forty and 62 percent over forty years old. This reflects the general age distribution of kindergarten teachers in Estonia. 55 percent of the respondents had a Bachelor’s degree and 21 per-cent a Master’s degree. Only 24 percent of the respondents had lower levels of education. Work experiences of two-thirds of the respondents were over a decade, and one-third less than a decade. This indicates that the sample comprises of experienced kindergarten teachers. 26 percent of the respondents work in Tallinn and the rest elsewhere in Estonia.

Data collection took place in cooperation with the following institutions: University of Tromsø, Norway; University of Aarhus, Denmark; University of Tallinn, Estonia; University of Helsinki, Finland; Mälardalen University, Sweden; Stockholm Municipality; Stiftelsen Sodemigradsk, Finland; Hakkebakkkeskogen Barnehage, Norway; Arne Trageton, private enterprise, Norway; Børnekulturinstitutionen Galaxen, Denmark;
the Bird's Nest (Linnupesa) preschool, Estonia. All partner universities have access to research data. Data processing is confidential and will take place in the Questback environment. Partner universities receive the data without the e-mail/IP addresses. Research results are anonymous.

The questionnaire was divided into the following blocks: 1) Background Information, 2) Status, which examined the practices, policies, and attitudes/mind-sets about the use of ICT tools in kindergarten, and 3) Competence of the staff, including questions about informal learning. The sample size in Estonia was 58 respondents, all of whom were kindergarten teachers. The number of kindergartens in Estonia is 644 and there are 8779 teachers.

2.5 Results

Cronbach’s alpha of the results ranged from .758 to .944 in different questionnaire blocks, which shows that the reliability of the study is high.

2.5.1 Digital Tools Usage in Kindergarten

The survey revealed that 95% of the respondents stated that they have a PC/computer in kindergarten, 59% have a laptop. Existence of a video projector in kindergarten was confirmed by 62% of the respondents. Kindergartens lack tablets. Smartphones are used only in 7% of the preschool children’s institutions, presentation screens in 28%. Wireless internet is accessible by 29%, whereas 90% of the institutions use predominantly cable internet and 28% a Mobile/wireless internet access. Only 5% of all institutions have an interactive whiteboard.

2.5.2 Media Tools

The results indicated that 76% of the kindergartens have a digital camera, 79% a scanner, 27% an audio recorder, 10% a web camera, and only one institution owned a console game. All agencies have a printer, 95% of the institutions have DVDs. CDs/DVDs are used relatively often. Personal computer is used often. However, 22% of teachers do not use it with children to promote their language and early literacy skills. 10% of teachers use the computer daily and 21% weekly, others monthly or few times a year. Digital video camera and cable internet are used respectively by 41 and 72 percent of teachers. All other ICT tools are used by teachers very seldom. There is a need for more ICT tools as well as a necessity for teachers to use these tools directly with children to promote learning.

2.5.3 The Way Teachers use the Digital Tools with Children

Most teachers use some digital tools and only 7% of all teachers do not use digital tools for learning activities. 52% of teachers use digital tools to keep children busy while they are occupied with other things or other children. 65% of teachers use digital tools to promote cooperation between children. 71% of teachers use digital tools to allow children to freely explore according to their interests and 67% of teachers use digital games to support specific early literacy skills. 55% of teachers use digital tools in training of children who have specific learning problems or developmental challenges and 77% use digital tools to enrich the learning environment of children who are fast learners. 60% of teachers use digital games for children to have fun.

Teachers named their successful language/literacy learning activities and resources, which they carried out with children in their kindergarten and in which they used digital tools: Discussion of the viewed material inspires children to talk more about what they have seen; CD-s (fairy tales, children's songs, music tracks); Using the DVD “Mõmni ja aabits” (Teddy Bear and ABC) for learning letters; Cartoons of Jänku Juss (Bunny Juss) for learning letters, numbers, colours; Using the digital games of Jänku Juss (Bunny Juss); Using overhead projector for learning letters and numbers; Using Internet-TV study films for diversification of learning activities; Using the internet portal Koolielu (School-life) preschool study materials; Using games that develop precision and skilfulness; Using the game Alguse asi (A matter of beginning); Writing each other’s names in Word; Listening music from CD-s and letting children describe what they heard; For speech development of 2-3-year-old children; Children can develop reading and spelling; Cartoons and e-books made by children; Playing the math game 2 plus 2; Games that develop speech; Speech sounds game; Study videos about animals; Inventing stories about letters.
2.5.4 ICT Policies

To the question to what extent do policies/shared guidelines in your municipality promote children’s early literacy learning through the use of digital tools, 35% of teachers answered that they do not have a joint policy. 21% of teachers answered that they have no such guidelines in their kindergarten. 71% of teachers did not involve parents because they do not have such policies/joint guidelines in the kindergarten.

2.5.5 Attitudes towards ICT

Teachers feel that there are expectations from children, parents and the kindergarten management to use digital tools in their work with children to promote language and literature learning, but not so much from national and local policy makers. Teachers agree that the use of digital tools with children can produce pedagogical added value. Teachers also agree that the use digital tools with children supports the development of their listening skills, verbal language learning, reading and writing skills, communication skills, cooperation skills, creativity, play, concentration skills, chanting and singing, and promotes children's working independently and fine motor skills as a pre-writing activity. All this is accomplished through working in small groups and creating new things, not just consuming educational programs available for small children. The integral part of educational practice includes the integration of different skills and abilities.

2.5.6 Staff Competence

Teachers are confident with their own skills in using digital tools and digital media in their work in kindergarten to a high extent or to some extent: PC/Computer – 79%; Laptop – 71%; Video projector – 38%; Tablet – 31%; Smartphone – 38%; Presentation screens – 26%; Internet – Wireless – 72%; Internet- Cable – 83%; Internet – Mobile – 53%; Digital camera/video – 60%; Audio recorder – 53%; Scanner – 52%; Web camera – 43%; Console game – 21%; Printer – 83%; DVD – 83%. Teachers are confident with their skills in using the following digital tools and data programmes in their work in kindergarten: You Tube, Skype/Messenger, Internet/digital games, Blogging, Facebook, Digital camera, Word processor, Presentation techniques. Their skills are not so good in Website builders, Photo Editors, Multimedia Tools.

Teachers had some comments: 1) is not always necessary to use the latest technology; 2) Digital tools are used more frequently; 3) Most kindergartens have limited access to digital tools; 4) When the technical basis of kindergartens improves, teachers will keep up with the times.

3. DISCUSSION AND CONCLUSIONS

Directors, teachers, parents and children in Estonian kindergartens are very interested in the integration of ICT tools in educational work, and in particular for teaching children to read and to write. However, the national and local policies governing preschool education, do not regulate this area sufficiently enough. In schools the usage of ICT tools is on a very good level in Estonia. Preschools on the other hand lack modern technology and resources, as well as specific policies. Although kindergartens have some ICT tools, they fall short of programs that could be used directly with children, as well as sufficient application of freeware programs on kindergarten group level. In particular kindergartens lack tablets, only 7% of preschool institutions have smartphones and 28% have presentation screens. This shows a lack of modern resources. Not using ICT tools has rather economic reasons than negative attitudes or lack of interest. Estonian preschools use mainly DVDs and CDs for watching movies and YouTube for developing children’s spoken and written language.

Estonian preschools use ICT tools mainly for diversifying the learning environment and for differentiating learning activities, paying particular attention to children with special needs and children who learn faster than others. A very large part of teachers do not involve parents in the educational processes, because they lack corresponding guidelines. However, parents consider using ICT tools very important. Previous studies have shown that co-operation between child care institutions and parents is one of the weakest aspects of teacher professionalism (Peterson, Veisson, Hujala, Härkonen, Sandberg, & Johansson, 2012).
Teachers’ attitudes towards ICT tools are very positive. The use of ICT tools is perceived as an opportunity to add pedagogical value to one’s work, and to support children’s development. According to Vinter (2012a) Estonian children use internet and computers mainly for entertainment, but they need professionally guided support to learn specific skills. Most 5-7 years old children are already proficient computer users, so pedagogical guiding is needed. Both teachers and parents do not acknowledge and supervise children’s activities in computer. Vinter (2012a) suggests that teacher training needs to involve more effectively ICT use in teaching. It is also important to think about the specific didactics – how to teach with ICT. The current study supports these conclusions.

Estonian kindergarten teachers’ attitudes towards the use of ICT tools are very positive, however, there is a lack of new technologies, cooperation with parents, as well as regulations and guidelines. We can conclude that the usage of ICT tools supports an integrated method for learning and it should be planned more systematically into kindergartens’ everyday life. Our main conclusions are: 1) mainly personal computers (PC-s) are used and almost all kindergartens have an internet connection, but more contemporary technologies are needed; 2) kindergartens should use ICT tools more often directly with children to promote language and early literacy skills of children; 3) most teachers use digital tools with children to enrich learning environment and to differentiate learning. Teachers described many possibilities how to promote language/literacy learning activities and what resources are used with children; 4) there is a lack of policies and involvement of parents; 5) teachers have more positive attitudes towards usage of ICT tools than local government and policy makers; 6) staff competence is dependent on digital tools. Teacher’s competence is lower in using modern tools such as smartphones, presentation screens, console games, tablets, and multimedia tools as they don’t have access to these tools. This research has a notable limitation. Relatively small sample did not allow us to make overall generalizations and also further qualitative research is needed.

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DESIGN EDUCATION FOR SUSTAINABILITY - ENVISIONING A SUSTAINABLE GUWAHATI RAILWAY STATION COMPLEX OF THE FUTURE

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ABSTRACT
People around the globe recognize that the current development trends are clearly unsustainable and that education, awareness and training are critical to advancing our society towards sustainability. This paper highlights the importance of systems thinking and collective group learning amongst participating students when engaged in the design of complex public systems such as a railway station. It suggests that design education should include approaches and methods that sensitize the students to the parameters of sustainability that are contextually relevant, inclusive and socially acceptable. This paper presents a design proposal for Guwahati railway station complex as a case study undertaken as a studio design project in a Design program at IIT Guwahati. It showcases conceptual directions in the design proposal for a modern architectural space that taps its vast economic potential through socially and environmentally sustainable initiatives. It accesses the anticipated challenges in its implementation and makes a case for an urgent need to include community centric and locally pertinent project proposals. It finally emphasizes the importance of education for sustainability (EfS) in the Indian context and stresses that it should be made inclusive in the curriculum amongst the institutions of higher learning established across the country.

KEYWORDS
Collaborative Learning, Education for Sustainability, India, Inclusive Growth, Social Acceptability, Sustainability in Design, Systems Thinking.

1. INTRODUCTION

1.1 Global Scenario
In the world today, global challenges such as climate change, environmental degradation, persistent poverty, increasing crime, deteriorating quality of life, etc have highlighted the fact that the strong economic growth experienced over the last century has also brought along immense pressure on environmental and social resources. As a result, the terms “sustainability” and “sustainable development (SD)” have not only become axioms but also been adopted as a common political intent and formed the basis of development guidelines for dealing with the planet’s ecological and social crisis by many nations worldwide (McKenzie, 2004). Sustainability, which means “the ability to sustain” (Marcuse, 1998), is often referred to as “an (ideal) end state” (Weingaertner & Moberg, 2011) while SD is referred to as a “process of change towards achieving sustainability goals” (Weingaertner & Moberg, 2011). Although there is no agreed definition, it is generally accepted that SD is “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987) and that all the three dimensions – environmental, economic and social should be incorporated into the design and development context from the beginning and on an equal footing. Another widely used terminology is “Sustainability Science” which first appeared in the World Congress “Challenges of a changing earth 2001” in Amsterdam (Steffen et al., eds., 2003) and since then has been developed as a new academic discipline (Kajikawa et al., 2007: 22) but yet has no commonly accepted definition. Although still vaguely defined, these terms have evolved through powerful lobbying of environmental movement (Colantonio & Dixon, 2011: 19) over last few decades and no matter how they are perceived, viewed or expressed, their need and importance has been realised globally.
As present, as the global and local scenarios call for immediate and intensive actions towards achieving a just and sustainable future, education can be seen as an essential tool. It plays a significant role in increasing awareness, knowledge and understanding (Cortese, 2003:17) needed for our transition towards a sustainable future by not only making our “present and future generation responsive to and prepared for the current and emerging challenges”, but also empowering them to make “informed decision that can trigger market and political pressures to move the sustainable development agenda forward” (Hodge & Mochizuki, 2013). Combined education “for” and “about” sustainability and sustainable development provides learners with the necessary knowledge and understanding of complex issues faced by the world today. It also builds capacity to structure and manage global transition towards sustainable lifestyles and development trends (Tilbury, 2004). McFarlane and Ogazon (2011:83) argue that learning process can provide deeper information to the people about sustainability challenges by influencing people’s current thinking.

Having realized the importance of education in sustainability transition and the role of Higher Education Institutions (HEIs) in supporting the development of innovative ideas and creation of new knowledge (Wals and Jickling, 2002:224), several declarations on Sustainability in Higher Education (SHE) - from Stockholm Declaration in 1972 through to Tokyo, Bonn, Lubeck Declarations and AAU Resolution on Green Energy in 2009 and ISCN/ GULF charter in 2010 (Grindsted and Holm, 2012) - that defines the universities role in ensuring sustainable development, have grown in numbers in the past few decades. The Stockholm’s declaration on human environment and Agenda 21 (chapter 36, UNCED) highlighted education’s importance for sustainability and formed the basis for framing the Education for Sustainable Development (ESD), a concept which involves objectives related to the respect of human life, the development of critical thinking and responsibility, as well as, the comprehension of “environmental values” and “interdisciplinary relations” (Petrovic et al., 2012:34 in Boutou, 2013). ESD which means “including key sustainable development issues into teaching and learning” and “allows every human being to acquire the knowledge, skills, attitudes and values necessary to shape a sustainable future” (UNESCO) has also been promoted through the UN Decade of Education for Sustainable Development (2005-2014) as an important step towards “the integration of the principles, values and practices of sustainable development into all aspects of education and learning”. These initiatives play a crucial role on sustainability awareness and problem solving of sustainability challenges through “education, research and outreach” (Fadeeva and Mochizuki, 2010:250, 254).

Lozano et al. (2010) however, argue that in spite of a number of SD initiatives and an increasing number of universities becoming engaged with SD, most higher education institutions (HEIs) continue to be traditional due to which they still lag behind in helping societies become more sustainable. SD competences can be discovered within the various study programs offered by HEIs but in an implicit and fragmented way, thus not covering all necessary fields of knowledge, skills, and attitudes (Mula and Haute, 2010). The current reductionist and mono-disciplinary education (Lozano et al., 2011) are inadequate for solving the complex global sustainability issues and hence, sustainability education, especially in HEIs requires not only sound theoretical foundation but also grounded understanding of practical problem solving through systems thinking and interdisciplinary approach to issues of sustainable development. Lozano et al. (2010) further emphasizes that universities must ensure that SD is the ‘Golden Thread’ throughout the entire university system.

1.2 Indian Context

India, one of the largest economies and most populous countries in Asia, has consistently played an important role in the evolution of international consensus towards sustainability. It is party to numerous multilateral conventions and sustainable urban development initiatives also parallels the international agreements with poverty eradication and inclusive growth seen as essential requirements. Today, India offers an array of sustainable development opportunities and challenges. The span of past two decades has brought the country’s development story at cross roads for reflection and reassessment. On one hand India’s effort to engage itself as a global player and open its doors to international practices of production and competition has resulted in opportunities for employment generation and economic growth of one of the largest middle class emerging markets. On the other hand this growth has intrinsic dangers of a western model of production and consumption that has already proved unsustainable. It shows stressful signs of the risk of opening the economic gateway too fast resulting in a sudden widening of the gap between the rich and the poor. There is also a grave concern about social issues such as acute poverty, malnourishment, inequity and deteriorating
quality of life that are also some of the fundamental challenges to sustainable development which is now perceived more as a social process than a straightforward technical issue. Moreover, all these issues are increasingly becoming urban as India, a reluctant urbaniser so far (the share of the urban population is less than a third of India's population, 2011 Census) has now embarked upon a period of rapid urbanisation. Its cities will become home to more than half of the total population by 2050 (estimated 54.2 percent, constituting more than 875 million people, UNESCO, 2010), which will be the largest urban movement in the world. With this shift, as the current research suggests, the path to urban sustainability lies in trying to build and manage inclusive and just cities.

In such a situation, the shifting towards sustainability in education becomes essential for educational institutions in India. As Cortese (2003) mentions, “institutions of higher education bear a profound moral responsibility to increase society's ability to create a just and sustainable future”. The aim of Industrial Design as laid out by The International Council of Societies of Industrial Designers has also been redefined with sustainability as an important inclusive. Perhaps, India the only country where environmental education has been mandated at all levels of formal education, which also includes a compulsory undergraduate course (Chhokar, 2010) however, as Chhokar argues that the challenges to effective implementation of this is held back due to the lack of inter-disciplinary competence among staff and students as well as the traditional methods of assessment in HEIs. Principles of sustainable development have been embedded in India's education policy and EIS is, no doubt, becoming a part of higher education curriculums in India yet, a culture of sustainability entrenched within all areas of education (sustainability as not just a split subject) is still the need of the hour.

This paper discusses the widely recognized sustainability issues and the importance of design education and system’s thinking in achieving the goals of sustainable development presented in the form of a case study of an elective studio design project “Envisioning a sustainable Guwahati Railway Station Complex of the future” carried out in partial fulfilment of credits for the subject “System Design for Sustainability” by MDes and PhD students of the Department of Design at the Indian Institute of Technology Guwahati, India during July–November 2011 semester. The project developed among the students a fundamental understanding of sustainable principles in theory and application, capacity to work in multidisciplinary teams and stimulated systems thinking in order to deal with the complex sustainable development context that a design project addresses. It delves into the project description and later discusses the outcomes and way forward.

2. STIMULATING SYSTEMS THINKING AND ENCOURAGING COLLABORATIVE LEARNING

A “system” is a perceived whole whose elements are “interconnected” (Ison in Reason and Bradbury, 2008:140) and “systems thinking” can therefore be defined as an ability to recognize inter-connections. The systems thinking approach to design for sustainability helps to identify and frame sustainability issues and appreciate complex relationships that exist within and between different systems associated with design and its implementation. As Cardenas et al., (2010) argue that such an approach is valuable for sustainability as it “enables the dealing with complex systems with the appropriate scope, depth, versatility and insight to generate qualitative changes that increase the sustainability of products and systems”. Moreover, taking into account the complexity of sustainability challenges, it also becomes clear that a single perspective or solo discipline is insufficient to deal with the current intricate global issues. As MaxNeef (2005:6 in Boutou, 2013) argues that there is also a close link between interdisciplinarity and sustainability as sustainability requires identifying the key interactions or conflicts that may arise between different stakeholders as well as co-operation and collaboration between different disciplines in order to provide design solutions that have a holistic perspective (Boutou, 2013). The term “Collaborative Learning” often used as an umbrella term for a variety of approaches in education that involve joint intellectual effort by students refers to methodologies and environments in which learners work together in small groups and engage in a common task or goal where every individual is dependent on and accountable for the other (Wikipedia, 20.08.2013). This process of shared creation not only increases interest among the participants but also promotes critical thinking (Totten et al., 1991). Collaborative learning and systems thinking thus allow students or learners to develop a mutual path and reflective understanding of the complexity of the system, combine knowledge from different disciplines and cooperate with a critical point of view thus, enabling students to make beneficial decisions (Gokhale, 1995). Such interdisciplinary and collaborative efforts can play an essential role in achieving sustainability.
3. ABOUT THE STUDIO DESIGN PROJECT: ‘GUWAHATI RAILWAY STATION COMPLEX OF THE FUTURE’

3.1 Project Introduction

The studio design project “Envisioning a sustainable Guwahati Railway Station Complex of the future” was undertaken by postgraduate students and doctoral scholars as part of the elective module “System Design for Sustainability”. Emphasis was given to Design for Sustainability, Systems Thinking and Collaborative Group Learning. The project involved students to conduct an initial collective site visit and general analysis as a joint effort in a common group. Later, due to a number of complex systems involved (Figure 1) at the railway station, they worked in three groups focusing on:1) Spaces and Movement; 2) Information Systems and 3) Waste Management in order to conduct a more detailed analysis and outline design proposals. Spatial organizations and stakeholder systems were further divided into three scales namely: 1) City level that looked at the city wide issue with respect to the station and movement; 2) Station level that looked at the design, organization, layout and activities within the railway station building; 3) Personal level that looked at the interaction of the users with spaces at all scales. With a series of study questions, a number of issues were identified at all spatial scales at which the design proposals focused. Such a structured and collaborative approach to design for sustainability encouraged students to identify and frame issues in systemic terms also, creating shared constructs for inclusive design and problem solving.

3.1.1 About Guwahati City

Guwahati, the ancient ‘City of Eastern Light’ is now one of the most rapidly growing cities in India. Within a century, Guwahati has grown from a marshy enclave of just 0.012 million people (in 1911) to an urban agglomeration of nearly 1 million. As the capital of the State of Assam, today Guwahati is one of the most important cities in North-East India (Figure 2) in terms of its location, size, population, transport connectivity and a major centre for industries, administration as well as education and health institutions.
3.1.2 Scenario of Indian Railways as a Public Transportation system

India’s public transport sector is large and diverse which caters to the needs of approximately 1.3 billion people. Since the early 1990s, the country’s growing economy has witnessed a rise in demand for transport infrastructure and services. Amongst various modes of transportation in India, Indian Railways, owned and operated by the Government of India through the Ministry of Railways, has played a leading role in carrying passengers and cargo across India’s vast territory. Today, it is one of the world’s largest railway networks comprising 115,000 km of track over a route of 65,000 km and 7,500 stations. In 2011, IR carried over 8,900 million passengers annually or more than 24 million passengers daily and 2.8 million tons of freight daily (http://en.wikipedia.org/wiki/Indian_Railways). However, most of its major corridors have capacity constraint requiring capacity enhancement plans.

Guwahati Junction, the major station at Guwahati city, is the headquarters of the Northeast Frontier Railway zone of the Indian Railways. Kamakhyain Maligaon and New Guwahati (for freight services) at Narangi, located towards west and east from Guwahati Junction respectively are two other minor stations in the city. Proposals are to expand Kamakhya station as a passenger terminal, develop old Pandu Yard for maintenance of passenger trains and build a coaching terminal at New Guwahati. Two other minor railway stations are Agthori and Azara which lack proper facilities and still to be made properly operational (Figure 3). Hence, Guwahati Junction continues to act as the significant rail station of the city for rail passenger movement.

3.2 Identification of Conceptual Framework for Design Insights

Guwahati Junction railway station is located on the Southern bank of river Brahmaputra in a dense and busy urban quarter of Guwahati. It adjoins Pan Bazar area in the north and Paltan Bazaar area in the south from where most of the private bus companies operate connecting Guwahati with the rest of the state and the Northeast. Guwahati Junction is among the 50 stations that are to be developed into world class stations with international level facilities according to the Railway budget 2010-11. As per the guidelines, the proposed World Class stations would broadly have state of art station building providing all modern passenger amenities including food plazas, currency exchange counter, hotels, retail outlets, departure and arrival arenas to streamline passenger movements with proper connectivity to other transport modes; well illuminated circulating areas, adequate signage, designs to suit people for special needs, etc.

The key design challenges for this were:

1. Re-developing the existing railway station with minimum disruption to the present train and passenger movement.
2. Proposing world-class multi-modal station design which is also Environmentally, Socially and Economically Sustainable.
3. Exploiting the potential of a large-scale project such as this to be undertaken in order to create public spaces with the explicit aim of linking communities and encouraging local participation in urban development.
A conceptual framework forms a backbone of any design proposal. For this project, based on a thorough analysis of the issues, the students developed the following three key project criteria: 1) optimising SPACE utilisation; 2) enabling effective MOVEMENT; 3) reducing TIME taken (Figure 4). Design actions namely a) Effective spatial organisation (zoning and distribution of services and uses); b) Effective Communication/Information; c) Safe and Regulated Spaces; d) Clean and well kept Environment; e) Care, Comfort and Convenience of the Passengers; f) Sufficient and organised parking structure; g) Regulated movement of vehicles and interconnected modal split were laid out in order to achieve these three key project criteria. Associated stakeholders were also identified against each action.

The students further developed design concepts that looked at station as:

A Multi-modal Station: The design finds solutions to regulate and control the traffic around the station area and provide city wide multi-modal transport connection.

An Iconic Station: Design for an iconic architecture, a gateway to North-East, a catalyst for urban change, one that will create ripples and bring about gradual regeneration of the entire area.

A people centric, human scale Station: Building and spaces no matter how large must be designed with individual users in mind. Arriving, Enjoying and Getting Around – are all human activities.

A World Class Station: Design for the future growth in traffic and population, provide state-of-the-art facilities as per the changing needs of passengers and services.

A transformed Station: Transformation is key. Change is needed from individual behaviour to collective thinking and visions for future.

To realize these design concepts the students developed broad and detailed design parameters as shown in the Table 1 below.
Table 1. Broad and Detailed Architectural Design Parameters for the Station Complex

<table>
<thead>
<tr>
<th>Broad Design Parameters</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ARRIVING at the station complex</strong></td>
<td>1. First impressions count! A city that demonstrates friendliness, an assurance to quality and ease of accessibility starts with a lead.</td>
</tr>
<tr>
<td></td>
<td>2. Cities are not just places where people live but are destinations that many people visit. They arrive and leave.</td>
</tr>
<tr>
<td></td>
<td>3. Guwahati railway station is not just a gateway to the city but the entire North East.</td>
</tr>
<tr>
<td><strong>ENJOYING the station complex</strong></td>
<td>1. A large number of small amenities can make the waiting time pleasurable and enjoyable.</td>
</tr>
<tr>
<td></td>
<td>2. Well-maintained and well-kept utilities add to the comfort of the passengers.</td>
</tr>
<tr>
<td></td>
<td>3. Public facilities like a hotel, shopping area and food court at the station premises, plus mechanised parcel handling and additional facilities for the disabled provide convenience and effective use of time.</td>
</tr>
<tr>
<td><strong>MOVING in and around the station complex</strong></td>
<td>1. Allow people to move in safety, comfort and speed.</td>
</tr>
<tr>
<td></td>
<td>2. Improving connectivity with the international airport and other transport interchanges.</td>
</tr>
<tr>
<td></td>
<td>3.</td>
</tr>
<tr>
<td><strong>Detailed Design Parameters</strong></td>
<td><strong>Key Functional Areas</strong> (developed from Kandee, S)</td>
</tr>
<tr>
<td></td>
<td>1. Core Areas - focus on processing passengers.</td>
</tr>
<tr>
<td></td>
<td>2. Transit Areas - connect transit facilities in the core areas to the transportation modes.</td>
</tr>
<tr>
<td></td>
<td>3. Peripheral Areas - support circulation outside the main buildings</td>
</tr>
<tr>
<td></td>
<td>4. Administrative areas - control both traffic and station management</td>
</tr>
<tr>
<td></td>
<td>In addition to these, the physical design of the railway station complex also sets out parameters for an integrated system, clear and convenient circulation for all, station complex design to take full advantage of the time passengers wait around by providing facilities and entertainment.</td>
</tr>
</tbody>
</table>

3.3 Aspects of Station Design

The group focussing on spaces and movement worked out the following aspects of station design.

3.3.1 Phasing

![Conceptual Diagram showing proposed Phasing and Connections.](image-url)

Phasing forms an important element of design as it involves re-developing the existing railway station with minimum disruption to the present train and passenger movement. The present southern approach to the Guwahati railway station is neither legible nor efficient. It is a back-door entry from Paltan Bazar. Although the railway station site includes sufficient area for expansion and redevelopment, acquiring land around the southern back entrance to provide sufficient parking, ticketing and waiting facilities means relocating various
landowners and small business that thrive due to the passenger movement. Hence, the design proposes to remove the last three rail tracks and platforms towards the south and retain the remaining four which are to be refurbished to meet the new design standards. Further, ten new additional tracks will be added towards the north as part of expansion for future increased rail traffic. The station will be able to handle the traffic of approximately 350,000 passengers per day. Creating space towards the southern boundary edge will allow enough space for creating a proper legible approach from Paltan Bazar with onsite parking facilities and a new southern concourse. Once complete, this entrance can be used at the main entry while the massive construction takes place to the north (Figure 5).

3.3.2 Cross-links

At present the station area creates a barrier to the North-South movement between Pan Bazar and Paltan Bazar. As opposed to permeable street network, the huge urban block (approx. 1037m in width), obstructs the movement creating huge congestion around the area. The only pedestrian link across the station building is through a foot bridge. The design therefore extends the existing city lines so that the new transport node becomes an integral part of the city fabric. The two obvious extensions were: 1) Brahmaputra Link (a pedestrian as well as vehicular link with a subway); 2) Judges Field Link (forms the main entrance to the station from both North and South entrances). Various other possible links were also proposed to weave and complete the urban fabric (figure 5). The proposal focuses on strengthening the pedestrian and cycle links to the city as well as creating a multi-modal station. These links will be lined with active uses like small retail outlets and convenience stores, health centre, dedicated space for hawkers, etc with its excitement and variety which forms a very important component of urban public life.

3.3.3 Architectural Form

The vast metal canopy with its gentle curve is an abstract representation of the silhouette of the hills of Guwahati. The horizontal planes in the internal spaces represent calm sheet of Brahmaputra River.

The form is designed to pick-up and reflect the proximity of amazing natural beauty that exists in the landscape of North-East. The form, layout and the building materials used displays care and compassion for its city, countryside, cultures and ethnicity but in a contemporary manner.

This concept has been chosen because cities are becoming more and more busy and stressful places and people often escape to countryside for rejuvenation.

North-East has a spectacular and precious countryside at its doorstep. The design tries to bring this essence into the railway station to make the passengers transit pleasurable.

The intention here is to reduce the feeling of a railway station as a place where passengers are forced to spend time, to an enjoyable aspect of transition.

The Station Building is planned to integrate with the urban environment yet at the same time make a confident statement.

Figure 6. Conceptual diagram showing concepts for architectural form for the station complex

3.3.4 Green Architectural Features

Materials: The Judges Field link forms the main entrance and main link that connects the north and south of the city. The station greets the travellers with a huge bamboo and steel canopy, the structure of which is designed as per the Assamese weaving techniques. The station-building complex is a mix of traditional materials and contemporary building materials. It is envisioned to reflect an amazing blend of futuristic architecture and iconic construction created using indigenous sustainable methods.

Energy: The proposed architectural form reflects energy efficiency and the use of alternative energy sources in its design from the very start. The roof is designed for maximum solar gains and water harvesting system. The building complex is partly air-conditioned and partly naturally cooled. Natural ventilation is achieved through an efficient design that implements two types of ventilation: wind driven ventilation and stack ventilation. The inverted roof over the atrium of the Linear Admin Block acts as wind shaft. The green walls and louvered vents of the building allow for natural cooling.
3.3.5 The Edible Landscape Project

The Edible Landscape Project (Figure 8) is created with an aim to partly formalize the process of waste management that occurs at the railway station and provide more meaningful employment to the poor involved. Physically it is a two level basement parking with a landscaped garden/farm at ground level. The project aims to utilize the strength of such large scale public project to create spaces that brings the communities together and proves benefits to the society. Maintained by an NGO these landscape gardens/farms to the north and south of the new station complex will support and train the poor and homeless at the station to grow organic food, develop a nursery and produce organic compost. Area for formalised plastic bottle segregation and compressing unit is also proposed on site. A vocational training institute housed in the station building complex can also be associated to the project that provides necessary training and skills to the unemployed currently involved in the waste segregation and recycling process at informal level. The activities involved under the Edible Landscape project involve 1) Regularising Onsite Waste Recycling; 2) Organic Waste Collection; 3) Training; 4) Producing; 5) Commercial Viability; 6) Improving Lives.

3.3.6 Information Management and Communication Systems

The railway station integrated information system, with the design of centralizing distributed data processing, combines net communication, passenger transportation, integrated information, and intelligent building control subsystems etc aims to improve the service to be safer, more efficient, and more orderly. The
Information Management and Communication System design was divided into two phases: top-level design and detailed design. Top-level design consisted of the identification of the major types of information systems and their functions. In order to specify the top-level design, a number of alternative system design concepts were synthesized and evaluated in terms of a variety of selection criteria, which included categorisation, global language of information, disability requirements, cultural influences, political acceptability, etc. The detailed design consisted of looking at the information design components such as cost (implementation, operation and maintenance), size and visibility, flexibility for expansion/upgrading, and use of mobile technology for ease of information and communication with respect to railway systems. Proposals were given for the 3 spatial areas as mentioned earlier in the paper. Proposals for general signage, platform ticket via mobile messages, map for station and platform, tourism centre, prepaid taxi centre, broad pedestrian with kiosk and PNR booths, informative kiosk, booth for people with special needs, mobile phone applications, global gate structure-grand welcome and book your parking space via mobile/internet were worked out. Consideration was given to colour coding, 3 languages (Assamese, Hindi, English), global graphical icons, materials, dimension and shape, location while detailing the information and communication systems.

3.3.7 Cleaning and Maintenance Systems

The Cleaning and Maintenance Systems hinged on three aspects: Planning, Installation & Maintenance. It focussed on the following three waste categories: 1) Food, beverages and water involving a) Packaging for railways b) Recyclable and degradable considerations; 2) Waste management involving a) Waste Disposal Unit; b) Waste Segregation Unit; c) Plasma Gasification Unit; 3) Water management involving a) Rain water harvesting; b) Storm water harvesting; c) Fire Fighting. The detail design was given for onsite Plasma Gasification unit and a dedicated water harvesting system.

4. SUMMARY AND REFLECTIONS

We have seen that “Sustainability” and “Sustainable Development” although vaguely defined and variably perceived and expressed, their significance have been realized globally. There is growing consensus about the need for development that has minimum social and environmental costs in order to achieve a sustainable future and therefore, these have been adopted as common political goal. There is also a parallel emphasis on the role of HEIs in fostering awareness, sensitivity and literacy regarding the planetary challenges and develop innovative ideas, new knowledge and explore pathways for sustainable growth. As a result, several declarations that emphasize a number of sustainability issues in HEIs including implementation of sustainability courses, sustainability research and development as well as academic collaborations have been signed in the last millennium. The project “Envisioning a sustainable Guwahati Railway Station Complex of the future” was appropriate as part of the design education curriculum with the present consensus and commitments towards achieving a sustainable future. Academic projects such as this allowed the students to apply their theoretical knowledge gained during the initial tutorials on ‘System Design for Sustainability’ to a real life project. This design exercise sensitized the students towards principles of sustainability and sustainable development, interdisciplinary approaches to design and decision making, systems thinking, collaborative design, stakeholder dialogue and empowerment.

The students developed theoretical understanding of role of sustainability in system designs through various lectures after which the design project was introduced. Following a common site visit and collaborative site analysis, the students formed focus groups for more detailed investigation and design proposals on their chosen design subject. The group presentations were held every week for discussion and interaction among other group members and a final proposal was given as a collaborative design effort. Developing the ability to work in groups gave students from different educational backgrounds undertaking this design programme, to maximise the application of their diverse learning experiences and contribute better to understanding the interconnected complex global issues. Systems thinking, collective learning and design collaboration resulted in a well thought, well reflected and thoroughly discussed design proposal for the railway station complex.
In this design project the students’ proposed a world-class multi-modal station which was also environmentally, socially and economically sustainable. The ecological sustainability as described earlier in the paper formed an essential part of the station complex design right from the conception. Various architectural features, design and layout of the railway station complex were conceived to aptly respond to the cultural and environmental sustainability aspects. Socio-economic considerations were also at the core of collaborative design efforts. The proposals made sure that amidst this thrill of developing a ‘World Class’ or ‘Global’ urban project such as this, the design remained inclusive, catering for the needs of the people at all levels and sensitive to the poor who are employed in the informal activities at the station premises as well as the small retailers or even hawkers around the station building. It promoted economic diversity by providing spaces for both formal and regularized informal employment. Having realised that the informal sector was the backbone of the railways station’s highly successful recycling system that unfortunately remained at a small scale without any access to finance or improved recycling technologies, the design proposed a “Edible Landscape Project” that provided facilities for onsite waste segregation, recycling and organic waste compost activities proposed that generated more meaningful and regularised employment for the poor in the informal sector, also improving their quality of life. The project thus, aimed at utilizing the strength of such large scale public project to create spaces that brings the communities together and proves beneficial to the society.

5. WAY FORWARD

Importance of design education for and about sustainability is recognised by most higher education institutions in India however, they either address specific sustainability issues as an elective or offer full range of curriculum for sustainable design in general. However, we emphasise that sustainability should be well integrated as inherent aspect of design and in all facets of education but not just an elective. Gradually building and nurturing a culture of sustainability entrenched within all areas of design education which enables collaborative systems thinking, working and implementing for sustainability is a way forward. Reorienting design education to sustainability requires recognising that traditional disciplinary approaches are no longer applicable as we live in a world of ever increasing connectivity where individual actions have global implications. Learning about sustainability involves breaking disciplinary barriers to focus on a single complex global issue from varied disciplinary perspectives. In India, we understand that these changes are not occurring as rapidly as desired nonetheless there are sparks of success within education at all echelons as seen through this project “Envisioning a sustainable Guwahati Railway Station Complex of the future”.

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SIGNIFICANCE OF MUSICAL EXPERIENCES IN SUPPORTING SUSTAINABLE DEVELOPMENT

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ABSTRACT
Our focus on sustainable development is on its cultural and social dimensions. It is important that cultural heritage is transferred from one generation to another as a means of producing sustainable cultural and social development. Also, the building and retention of each individual’s own social and cultural identity is important in a multicultural world. The point of view of our article is music as a producer of sustainable cultural and social development. The two researches described were done in Finnish schools in 2010 and 2011, and the data included both quantitative and qualitative elements, but in this article we focus on the qualitative data only.

Two researches focused on Finnish elementary (3rd and 4th grade, N=17), secondary (8th grade) and upper secondary (1st grade) school pupils (N=326). In the research of younger pupils, we explain how experiences are built and described in listening to classical music in different situations in the classroom, as well as in concert situations. The research was done using the starting points of phenomenology. The research of older pupils handled musical memories and significant musical experiences in the pupils’ lives, and was carried out as a paper questionnaire. It included qualitative data in the form of open ended questions, which were analysed using content analyses. We draw a line from experiencing music to building significance in musical experiences. Our goal is to open the connections between significant musical experiences as a means of building sustainable social and cultural development by supporting children’s cultural and individual identities, socializing individuals in the surrounding society and environment in connection with history and ancestors.

KEYWORDS
Musical experiences, significant memories, transferring cultural heritage, education for sustainability.

1. INTRODUCTION
The idea of the first research, focusing on 3rd and 4th grade schoolchildren (N=17), was to discover the meanings and values of classical music in school children. We also explored the ways they describe their musical listening experiences. The second research was targeted to secondary (8th grade) and upper secondary (1st grade) school pupils (N=326), to open up the respondents’ musical memories and experiences. The main idea was to combine these two studies to determine the mechanisms by which small musical experiences change to significant musical memories, which are involved in building the identity and personality, and have a direct connection to the elements of sustainability.

2. THEORETICAL FRAMEWORK
Of the three recognized main dimensions of sustainable development (ecological, economical, and social and cultural sustainability) we concentrate on the cultural and social sustainability aspect (see Wals 2011; Wals et al. 1999; Bart et al. 2007). We understand it as a way to transfer wellbeing from one generation to another by transferring values, ways of acting, history and the cultural heritage of music (Fishbein et al. 1980).

The therapeutic aspect in connection with mental health is included in our focus (Lehtonen 2007; Lilja-Vihrelampi 2007). Cultural sustainability requires development to be in harmony with the values and culture of the society. Knowing and being in emotional touch with one’s own culture opens doors for understanding other, different cultures as well. Socializing processes form an identity built on the values and cultural
heritage of each society. This way it grows strong enough to remain, survive and further develop (see Coutts et al. 2008). In Finland, this identity shows best in handicraft, design and music.

Education concentrating on the built environment and public arts is seen to promote intellectual, emotional and social behaviour among children and adolescents. Education through the arts enables exploring, understanding and investigating the world in ways which are not possible through the sciences. The Finnish curriculum is based on human rights, democracy, equality and the preservation of nature’s diversity and viability, together with accepting multiculturalism. Basic education promotes communality, responsibility and respect for individual rights and freedoms, and supports the construction of the pupils’ own cultural identities and partnerships in Finnish society, as well as in the globalizing world. Additionally, it promotes indulgence and understanding between different cultures. (FNBE 2004; 2006.) Education which builds links between the arts, design and environment forms new relationships between individuals and the environment.

One of the most important aims of sustainable development is to support, respect and maintain the cultural heritage. This requires cherishing different arts and the special local features of culture by supporting individuals’ spiritual activities and mental growth. Knowing one’s own physical and spiritual heritage is an important part of sustainable cultural development, making it possible to understand one’s self as a part of the chain of generations. (Juvenen 2009.) According to Räsänen (2008), arts education may develop the ability to notice differences in human cultures, and include an ethical point of view towards anything new. Arts may raise discussions about moral and social achievement, start debates about values, and resist injustice by suggesting other ways of acting. This should also be done at school by teaching the arts and skills, and especially, in music education. Torniainen (2003) claims, “Arts are one of the environmental builders of a human being. Arts affect as an environmental force which build and form our aesthetic, ecologic and social behavior”. As a child grows, he/she becomes socialized in the musical culture surrounding him/her. Slowly, the child learns the rules of music; he/she learns why music exists, what is old and what is new in music, what the significances are, and the ways to use music. Immediately after the birth, the enculturation process begins and the child socializes and develops cultural skills in the field of music. (Sloboda 1985, 194–196.) Similarly, the child builds his/her own identity through music.

2.1 Music’s Point of View

Music can be seen as a form of communication which may be used in many ways to reach different. We believe that among all art experiences, classical music listening experiences could be used to support children’s emotional health, wellbeing and balanced development. Classical music is a very powerful instrument to arouse emotions. Like Langer (1942/1971) says: music is the language of emotions. It is also a means of building cultural sustainability.

2.2 Building Experiences

During the past decades, a growing interest has focused on the research of musical experience in Finland, as well as around the world. Research has focused on different dimensions of the listening experience, while it should be researched as a whole experience in real-life situations. This means there is a need for research in music as a holistic, contextual phenomenon. (Hallam 2006, 58.)

Behind the first research, was the belief that classical music has a magic and unique power, offering meaningful, emotionally powerful experiences to people of any age (see Reimer 1989). Understanding these meanings and their values is useful for teachers in planning meaningful classical music listening situations. This helps in building children’s cultural heritage for lifelong sustainable development, strengthening identity, growing values and enjoying life through the arts, which may lead to mental wellbeing and enhanced health.

In the first research, the music consisted of classical compositions. The aim of listening to music at school should be opening new musical worlds, to widen children’s musical worldview from the one-sided musical environment of today (Hyvönen 2006, 56). The assignment of the school is to support the individual’s growth processes to become members of musical culture and society, as well as widen children’s musical context and offer him/her an actual opportunity for deepening musical experiences. (Juvenen, 2001.) It is not enough that there is some music playing at school in the background. Hearing music is not the same as listening.
Varto (2003, 55) says, “When music has put one man upside down and let another unimpressed, both have heard the same, but only one has met the invisible.” This viewpoint opens up the ways in which children build their listening experiences, where these first experiences will, after time and repetition, lead to significant experiences from music.

2.3 Finnish School’s Point of View

Many music teachers are worried about the situation of classical music in Finnish schools. There are only a few short periods for classical music in the curriculum, and the focus on classical music listening is formal and historical. This may be important for understanding the structure of compositions, but it keeps children distant from classical music, and does not help them in forming a personal and meaningful relationship to the music. Grasping strongly to this kind of analytical attitude may lead to a situation where the listener can no longer enjoy music, only focusing on the surface level structures of music and finding the inaccuracies in musicians. The misrepresented focus on education aiming to build musical competence, instead of focusing on musical significances (expression, emotions and communality) has led to unfortunate consequences: musical nihilism. In Finland, some teachers still stamp their pupils as musically talented or not talented. The latter group easily grows individuals whose musical self-conception has been deflated, and who do not believe in understanding music at all. (Lehtonen & Juvonen 2009, 97.)

Many Finnish music educators worry about the Cartesian viewpoint underlining the instrumental impact of music (Westerlund 2005; Hyvönen 2001). We already have enough school aims where knowing and skills are mainline. Art education should be based on different values: the appreciation of others, and music as a means for emotional and human growth, building identity in the ways of supporting sustainability.

Finnish school children have achieved very good results in the PISA. Still, Finnish school children’s mental problems have increased during recent decades (STAKES 2012, 78–82). Music therapy is often used to help these problems. The emotional power of music should be used before problems get out of control, and arts and emotional education could functionally support each other in supporting children with problems. This is one way in which music builds sustainability in individual lives.

2.4 Holistic Idea of Man behind the Research

The holistic idea of man consists of a body, a mind and a situation (moments), which are strongly and deeply interwoven into each other (see Figure 1). We cannot understand the parts of the human when they are separated from each other. Taking one’s starting point in the lifeworld (Lebenswelt) (see Husserl 2012), it becomes impossible to separate body and soul, mind and matter. Therefore, if we take a particular viewpoint of the human, for example the body, we have to see the body as a part of the coherent whole. The physiological body is not enough to explain the lived body. The body lives in time and space, and man lives in the world as a body, through a body, and there is no mind without a body (Merleau-Ponty 1945/2002; Rauhala 2005).

3. DATA AND METHODS

Research 1. (Younger pupils) The data (N=17) was collected from a school class (combined 3rd and 4th years) made up of seventeen pupils aged nine to eleven, at the comprehensive school in Savonlinna. They wrote essays and drew pictures after listening to classical compositions of baroque, classicism, romance and impressionism. The verbal description of music experience is not easy, children quite often used the teacher’s words for describing their experiences. Written essays and drawn pictures illustrate the experience of a listener without the intervention of a researcher. A child uses his/her own words and viewpoints.

The method was phenomenological, which may be the deepest way to approach the aesthetic experience as a lived phenomenon. Phenomenology is both a method and a way of thinking. According to Merleau-Ponty (1945/2002, vii), phenomenology is the study of the essences, like the essences of perception or consciousness. Merleau-Ponty states that phenomenology is also a philosophy, which puts the essences back into existence, and does not expect to discover an understanding about man and the world from any other starting point, except “facticity”.
Research 2. (Older pupils) The data was collected using paper questionnaires, including both closed and open ended questions. The number of respondents was 326, and the respondents were aged between 14-18 years-old from 36 different schools from all around Finland. The questionnaire included questions about musical experiences, the significance of these experiences, musical memories and experiences from music lessons at school. The analysis of the older pupils was qualitative in this article; we used text and content analyses. Our aim was to make the pupils’ voice be heard.

3.1 Analysis and Combined Results of the Two Researches

In the analysis of the younger children’s data, we first looked for the subjective meaning units of each music listener; relating them to the individual and common networks, and finding the topical meanings of the music listening experiences, at both subjective and common rates. The idea of the phenomenological analysis is not to generalize the findings, but to describe the experiences at a unique and common level from subjectivity, not toward objectivity but toward inter-subjectivity. There seem to be many children who naturally describe their listening experiences by their imagination. The children live strongly and emotionally through the music. Their stories and pictures reflect the emotional atmosphere of the music; the children wrote the same emotions into the stories and into the direct emotional descriptions of the music.

In this chapter, we open up with the way that children build their experiences from music. Then, we connect the results of the two researches, aiming to open up the building of musical experience to significant musical memories. The data in both researches focuses on the same point, but the pupils in the first research were between 9-11 years-old, and in the second one between 14-18 years-old. The younger ones exhibit fresh experiences, and try to describe them in different ways, while the older ones describe older experiences as they are remembered, which will describe the significance levels of the experiences, and the reasons for significance.

Nine to eleven year-old children have a good imagination, which is a natural way to conceive the world. Children have good possibilities of meeting strange or difficult phenomena through their imagination. They not only fantasize, but live through the music in their narratives. This is important in planning classical music education at school: music listening is also a creative activity.

The older research group is in late puberty, adolescent and almost adult. This means that when they write about their musical experiences they base them on memories. Normally, both positive and negative memories strengthen as time goes by. Additionally, the significance of the musical memories from home become more important during the growing processes, when the individual notices that the childhood is gone and can never be reached again, except through sweet memories. (Lehtonen 2007.) When music memories are brought back into mind, simple musical experiences have exchanged from being single experiences to significant phenomenal experiences, which have been saved in the memory. What is important is that these memories can be brought back to offer joy and wellbeing, even years after the real experience. This is the mechanism by which music brings sustainability to an individual’s life (Lehtonen 2007).

3.1.1 Time, Place and Situation

The music itself is only one part of the music listening experience. Listening happens in context, in time, place and situation (Merleau-Ponty 1945/2002; Hallam 2006). We went to a classical music concert with the 3rd and 4th grade school children, and they were already very excited and enthusiastic, before the concert even began. A few of them attended the concert hall, and the other ones saw the musicians. When they listened to the music samples in the classroom, no one mentioned that waiting for the beginning of the music was exciting. No one noticed the musicians who played on the CD.

I feel happy. I think about the musicians playing their instruments. I’m so excited. (Anna, 10 years)

It is not easy to arrange to go to concerts with school children, but it seems to be a very meaningful experience for them (see Figure 1). There is no need to worry that being at the concert and listening to classical music would be too difficult for children. They have their own ways of handling it, and living through it. One must go outside of the school to meet the real classical musicians in a real environment, in a natural place and situation. In this way, we can bring up the next generation of classical music concert audiences, and carry on this cultural heritage.

Before the concert, I felt bored and tired, and after the concert I was happy. (Peter, 9 years)
Around 41% of the older group of respondents remembered that they used to go to concerts. They had beautiful memories of going to concerts (usually) with their mothers.

I remember going often to classical music concerts with my mother...it was so nice. (Boy, 15 years)
At home we listened to a lot of classical music...I still like it. (Girl, 17 years)

Not one of the older respondents mentioned going to concerts with their school classes. This is surprising, because the future of the orchestra institution in Finland is threatened if there is no growing (new) audience for the orchestras.

3.1.2 Emotions

Both groups researched described emotions in connection with musical experiences, or significant musical memories (see Figure 1). We divided the emotions of the music listening experiences in the group of younger respondents into three main groups:

1) Emotions in the music. To some children, it seems to be natural to observe the music. These children tried to describe the characters, progression and movements of the music, and seemed to keep a distance from the music, analysing it from outside. They could hear some emotions and emotional events in the music, but they usually didn’t feel the same emotions themselves.

Music sounded scary and sometimes peaceful. (Sophie, 10 years)

2) Self-experienced emotions. Some children seem to naturally reflect their own experiences. The music is not outside, but inside them. They really feel the emotions themselves.

I felt myself like a wolf in a prison. I was lonely, sad and a little afraid. (Matthew, 10 years)

3) Emotions included in the imagination. These children, who naturally live the music through their imagination, wrote very emotionally rich and intimate stories about the music listening experience. There is very powerful atmosphere in these stories.

A rabbit is escaping something scary. Then the scary alien disappears, then it attacks again and the rabbit runs away to the freedom of the beautiful world. (Tim, 10 years)

The older respondents saw that the most important elements in the music were aggression, rebelliousness, genre, topicality and attitude. The thing which meant the least for this group was emotionality. This is interesting, because the young children used quite a lot of emotional dimension when describing their listening experiences. This difference might be age related, because the older respondents were in late puberty. Still, there was a small group of older respondents who described musical memories emotionally:

Musical memories connected to my father focus on him singing the songs from his youth while cooking food... (Boy, 18 years)

I remember warm and nice situations, singing while my mother still was alive. (Girl, 15 years)

Music soothed me and gave me a feeling of being loved and being important. (Boy, 16 years)

The touching memories of older respondents described often singing together with parents or grandparents. Some had nice memories of going to classical music concerts with their mothers, or listening to classical music from vinyl records. Buying records is one way in which to transfer the musical heritage to younger generations. In our data, there were many descriptions of listening to records together with the mother or father, which have had a strong influence on the musical taste of the respondents. This means that they carry musical memories from childhood inside their minds forever, as a source of enjoyment. One of the respondents wrote about his grandmother singing while being in the traditional Finnish hot bath “the sauna”.

The singing of these kinds of traditional “sauna-songs” shows the direct transfer from older generations to younger, which translates to saving the cultural heritage. Emotional descriptions were mostly positive; only one respondent stated that she had been afraid to listen to classical music.

3.1.3 Moving with Music

After the data collection from the younger pupils, we asked for some comments of the children’s experiences during the music listening period. The children described “moving with music” as the most meaningful and motivating way to experience classical music. The pupils were very excited when we went to our school’s gymnasium and listened to part of Tchaikovsky’s ballet, Nutcracker, The Waltz of the Flowers. The lights were turned down and the children had an opportunity to start moving or dancing if they wanted. Almost all of the children danced and moved in a relaxed way around the hall, alone or in small groups. Afterwards they
wrote enthusiastic descriptions of their experiences. Many of them felt happy and free during the dancing and movement, even if they were tired, bored, angry or hungry before the music listening situation.

*I felt like everything was going wrong and nothing succeeded.* (Mary, 9 years, before experience)

*The music was nice and fascinating. While the music was playing I felt free, but it was just for a moment. Now I feel the same as before the music.* (Mary, 9 years, after experience)

*I felt like one of the thousands of butterflies, it felt so weightless.* (Rose, 10 years, after experience)

The older respondents often mentioned dancing at home in their answers. Some of them mentioned that they used to visit old-fashioned dancing halls, where traditional dance orchestras played music. The dancing styles consisted mainly of waltz, jenkka, polka and tango; a cultural tradition which has never been stifled in Finland, despite the internet and multiple genres of pop music surrounding us. Some respondents wrote about folk dance as a hobby of their whole family. These examples can be seen connecting the traditional Finnish folk and old-fashioned dance music even more powerfully in modern culture. Dancing to the music and (likely) singing at the same time is a strong way to adopt national culture and make it a part of one’s own identity. The smaller pupils’ answers also showed that dancing and moving with music was enjoyable, and they will surely remember these experiences after years pass (see Figure 1).

![Figure 1. The holistic concept of meaningful musical listening experiences.](image)

### 4. CONCLUSIONS

The combined results of these two researches strengthen the idea of music as a valuable supporter of sustainability in social and cultural development. The results of the younger pupils’ research showed that they were eager to learn, and explore music which they had not heard before. Their ways of experiencing it were spontaneous and often showed emotional connections with the music in their descriptions and reactions. This means that the musical experience had touched their souls in a positive way. While the younger respondent group had a clear connection to emotions in their answers and descriptions of the experiences, they similarly learned to recognize their own emotions, feelings and thoughts. The music listening turns out to be connected to emotional education as a clear part of sustainable development focusing on mental growth and wellbeing. A recognition of one’s own emotions is also a part of building personality and self-conception. The children learned to speak about their emotions after they learned to recognize them. Emotional education has not been focused on in the Finnish curriculum, which may be one of the reasons for school children not enjoying school (Compare: PISA-results).

The differences between the younger and the older pupils are in the ways of talking about their music experiences, showing the mechanism which takes place in the formation of musical experiences. First there is a musical experience, a moment of listening to music, which causes some kind of a mental movement in a child. This experience does not have great significance right away, but it may touch the emotions of the child’s mind. These small experiences gain significance when they are repeated over time as they slowly form into musical memories. The individual is able to bring up these memories of experiences from the depths of the mind to enjoy the impact which the experience offers when placed in reality. Actually, this mechanism forms one of the starting points for music therapy. Therefore, we can claim that offering children different kinds of musical experiences becomes an important means for building musical memories, which become valuable in the lifelong sustainable development of the individual and personality. (Lehtonen 2007.)

The older respondents had already formed the significant memories of their musical experiences. This opens up the mechanism of music as a promoter of sustainable development for every individual who has an opportunity for musical experiences. Getting to know different types and genres of music helps in recognizing and evaluating different musical cultures and styles, which expand the pupil’s ability to understand differences and tolerate them. This is sustainable social and cultural development.
The results of the older respondents clearly show that musical experiences, like going to concerts or listening to records bought by parents, have an impact on the formation of musical identity, reflected in musical taste. The grandmother singing in the sauna created an important transmission of cultural heritage, and made sustainable development possible for her grandchildren. These kinds of impacts have a direct connection to cultural and social sustainability, as the effect is permanent and the memories can be relived to comfort and help in times of difficulty, bringing joy and wellbeing to life.

Last but not least, we should not forget the artistic significance of music. It brings enjoyment to individuals, not only through therapeutic effects, but music, as all other arts, has an intrinsic value in and of itself. Being able to enjoy arts, without having to know theories or the structural matters, is a good target for any educator or any curriculum.

REFERENCES


E-LEARNING PLATFORM ON SUSTAINABILITY AND NEW C2C CRITERION BY THE ITALIAN OBSERVATORY OF DESIGN.
THE FIRST STEP CONSISTS OF CHANGING THE WAY OF LOOKING AT THE WORLD.

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ABSTRACT

Life-long learning and the Collaborative Innovation Observatory need to more effectively integrate crucial elements into designing regional sustainable production and consumption. Creating a new e-learning platform is an important way of building a new design community identity through lifelong learning, a significant meeting space for not only professionals, but also for people working outside established enterprises to assess and make improvements in sustainable supply chain management.

The e-learning platform launched by Università San Raffaele Roma is now raising awareness and opening new markets for the green economy by spreading a positive vision, bringing effective tools to people’s attention, putting players in touch, creating systems, highlighting good practices, and improving good models. A design observatory organizes research and events that run parallel to the big Milan shows all year round. The objective is to create a permanent place for meetings and exchanging knowledge, for spreading throughout the world of design and business the idea that sustainable development is an opportunity not to be missed. In particular research about the 100 success cases regarding the Cradle to Cradle (C2C) that intersects sectors from design, fashion, to food. Cradle to Cradle provides rigorous product development and service consistent with the needs, models of fruition and the symbolic/emotional expectations of users, but also is attentive to the process and production costs and sensitive to environmental themes (minimisation of pollution, ease of waste disposal and the possibility of recycling).

Cradle to Cradle becomes a method for guiding and communicating to businesses the quality of its products, processes and services, new ways of “doing business”, being recognisable, combining quality, innovation and recognition, new ways of better investment, protecting inventions, and increasing the value of “intangible” factors. In selecting those products/services, new and precise criteria is introduced: formal aesthetic, typological, and functional innovation; impact on the environment (production, consumption, recyclability, ease of assembly); communicative value of the object; usability; wider usage; appropriate use of technology, components, and materials; suitability for use; compatibility; adaptability; and reliability.

A network of knowledge about sustainability is created towards developing a system for the communication and the diffusion of an entire system-product that in turn gives life to other tools, such as the updating of training proposals, counselling services for young business people and designers, reception and information, guidance and consultancy, and new relationships between producers and clients (innovative forms of co-production of value). This is to show that Italian design is both aware and an integral part of the life cycle of products and services, together in harmony with private wellbeing and the common good, can reduce environmental impact and improve quality of life. Currently, the E-learning platform makes available excellent skills in monitoring and mapping in order to educate critics and give them the ability to understand what to buy. To actually succeed in spreading a culture that cares about sustainable development it is not enough to simply exert pressure on designers and producers, but requires growing demands from below, a demand that would be capable of directing the system of consumption. The University like a design centre becomes the junction where interaction between ethical subjects, companies, designers, associations, editorial structures, and local institutions that share common goals (Circle Thinking) and values in order to seize all the opportunities, interests, and availability of actors during a phase of radical change in consumption and the market.

This networked system of industrial quality products, created through the analysis of several planning studies, becomes in itself, a compendium of knowledge and good practices. What led to the acceptance of this role was the recognition and the wider vision of this principle that anticipated the “ethical” role of the project. This is the same role that the University currently supports together with an ethical and aesthetic identity that Italian design must adopt at an international level, working towards sustainability together with business, finance and institutions (Design for Business and Business for Design). The necessity to redesign a new system of knowledge and alliances, through a multicultural system that feeds on differences is the most challenging issue that universities and associations must address now along with other international groups.
KEYWORDS
E-learning; Life-long learning; Cradle to Cradle; Collaborative Innovation, School as a "design center"; Knowledge toward specialization

1. INTRODUCTION

Commenting in Stile Industria on the birth of Associazione per il Disegno Industriale (ADI) in 1956, Alberto Rosselli wrote: “we continually perceive that there is not a lack of available means, but of the principles that drive them”. The recognition and the wider vision of this principle that anticipated the “ethical” role of the project, led to the acceptance of that role.

The most recent debate on the subject of economic development ascribes an increasing value to the concept of innovation, a principle factor in filling the competitive and thus growth gap that divides Europe from its closest competitors, and that in a European context, places Italy in a noticeably disadvantaged position compared to its main partners. In any case, the traditional idea of innovation processes as the adoption of technologies and research results through a transfer of technology within a business context, while correct, is only one element of the whole topic.

In reality, innovation both distinguishes and has an extending influence on all the cognitive and professional spheres, as it bring about extremely fast processes of development to adapt to new requirements and influences the labour market, its organization, and the whole system of professional profiles. It may well happen that a company, through the introduction of new product technology into the market or the adoption of technology that is clearly superior to that of the competition, is still unable to take advantage of innovation.

Today the role of the designer is written into a plan where innovation – as a fundamental tool for the growth of businesses – must pass from being characterized as an irregular occurrence to having a more systematic nature in which its individual creative capacity must consequently change to being the creative capacity of the system.

2. BACKGROUND

It is becoming clearer and clearer that the value and significance of design is overcoming the traditional aesthetic dimension, hitherto understood as a generic ability to create beautiful shapes or to improve the functionality of those already in existence. Ethics and beauty are the current key words, to appreciate and transform into actions. The producers of goods and services in the design world, already looking towards the values of aesthetics, functionality and know-how, can improve their profile, even financial, with the consolidated support of local resources (supply chain) and with technological and process innovation from a sustainable point of view. In order to carry out real changes both in our society and in our production methods we need a parallel revolution in our way of thinking that will change our behaviour, starting in the workplace. Less waste of raw materials and energy, and the project at the centre of product life cycle together with actions characterized by corporate social responsibility are the cornerstones of change—a turning point that could affect the current economic crisis, changing it into opportunities and challenges. Incentives for research and training for technical and sales staff are crucial for businesses, together with communication that is more focused and transparent.

Those intangible factors which are decisive in contributing to the success of a product and a company are now being highlighted: sustainability, brands, patents, know-how, entrepreneurial capacity, human capital, design, etc. are elements of extraordinary importance for tackling markets that are ever more complex, together with a public that is ever more demanding and unpredictable.

Sustainability can be seen as a method for directing and communicating the quality of a company’s products, processes and services, with techniques that increase its perceived value. Sustainability is as a new way of doing business, to be recognized, to combine quality, innovation and recognizability, and to invest better and to protect inventions.
In this case it is important to be aware of the business potential of sustainability: which is the potential for innovation, greater competitiveness, and improvement (the intangible factors), and to compare the successful (and unsuccessful) examples in order to identify possible methods of management, development and future synergies.

Unfortunately the limits, in terms of size, financial means and the managerial culture of many companies still do not always allow them to fully exploit the potential that comes with the adoption of a competitive strategy based on these assumptions.

3. E-LEARNING PLATFORM FOR SUSTAINABILITY

In order to increase international understanding and awareness of our respective institutions, Università San Raffaele Roma are always involved in collaborating in a variety of areas related to higher education and program research and to encourage collaboration on research and development between the different institutions as agreed by the coordinators of other open e-learning platforms.

Since 2006 Università San Raffaele Roma has provided the first national Architecture and Industrial Design degree on an e-learning platform. The participants (even if already employed, temporarily unemployed or geographically distant) are therefore now completely free to decide when and where to use the content of the University. The main purpose is “long-life learning”, to upgrade the skills needed for a professional profile that requires mastery of theoretical and practical foundations and large levels of autonomy and responsibility in the fields of design, characterized by increasing technological and organizational complexity and ever-growing competition. Italian Design is seen as a strategy for innovation and business implying a particular set of values. The project has a specific vocation regarding the concepts of transversality and contamination.

The learning and education sector, like all industries, needs strategies, development policies, laws, qualifications and promotional instruments, which require political attention. At the end of the course participants will have developed the following important skills:

- Knowledge of the products and production processes with particular reference to and comparison with Italian fashion and design.
- Designing a collection (product and processes).
- Knowledge of how to plan and carry out market research and a marketing plan for the development of an innovative product (or process).
- Knowledge of how to innovate the local product through knowledge of new styles and trends.
- Knowledge of how to plan and conduct a communication plan that includes promotional and innovative branding.
- Knowledge of the materials and technologies available for the "enhancement" of innovative local production.
- Knowledge of how to plan the process of the distribution and sale of a product.
- Knowledge of how to lead a group at work and motivate them to achieve results.

E-learning, through theoretical study, will allow for the analysis of case studies and group work, allowing for learning by "doing" and contextualizing the concepts of the individual production experience. For each module, lessons and papers are downloadable directly from the online platform at any time of day. The aim is to achieve the highest professional qualification profile. The designer (or project/product manager) is responsible for the programs and innovative projects that will bring about change, and for implementing it and using structured theoretical and practical knowledge with significant experience that can be applied to business processes, which assume responsibility for the organization and its customers.

The main purpose of the course is to upgrade the skills needed for a professional profile that requires mastery of the theoretical and practical foundations and large amounts of autonomy and responsibility in the fields of fashion design, which are characterized by increasing technological and organizational complexity and ever-growing competition. Italian Design is a value system, and an innovation and business strategy.

The most challenging issue that design must deal with now is the redesigning of a new system of knowledge and alliances, a multicultural system that feeds on new suggestions and theory. Cradle to Cradle (C2C) is an example.
4. CRADLE TO CRADLE: MODELS, PROJECTS, AND SUSTAINABLE PRODUCTS ABOUT DESIGN, FASHION AND FOOD. AN INTERNATIONAL PANORAMA BY THE OBSERVATORY

Cradle to Cradle represents the vision of a continuous cycle of use and reuse of materials without producing waste. Cradle to Cradle’s concept of sustainable development is a design approach that regulates the relationship between user and company, helping companies to design products that can be recycled indefinitely, or can go back to nature because they are one hundred percent biodegradable.

The Cradle to Cradle concept was written, explained and detailed, for the first time by William McDonough and Michael Braungart in their book titled *Cradle to Cradle, How to Reconcile Protection of the Environment, Social Equity and Development* published in 2002. The authors created a company in 1995, "McDonough Braungart Design Chemistry", with the aim to assist companies in the implementation of their protocol for sustainable design. It gave rise to the certificate "Cradle to Cradle".

Design according to the principles of C2C means introducing life cycles of products without waste as it is basically inspired by natural systems (Waste = Food).

Objectives:
- Maximize the use of natural raw materials available locally (We are native to our place)
- Harnessing renewable energy (Sun=Income)
- Make a balanced use of air, water and soil without the use of contaminants and toxic (Our air, soil and water are healthy)

The design is now becoming more and more a method to guide and communicate to the company its quality of product, process and service, a new way of "doing business", how to be recognized, how to combine quality and recognizable innovation to invest more, and to enhance the "intangible" factors.

The aim of this investigation is to analyse and catalogue the reality of the product-system, Cradle to Cradle, ability to seize the assets of the differences and ensure identity of the system as the coexistence of a plurality of voices, trends, organizational models, in which the wealth and the articulation of different levels of creativity or production capacity must be safeguarded so that we can develop new kinds of transactions, exchange of information, and participation of all actors involved.

The research aims to demonstrate that with 100 different testimonials by gender and sector identity, ethics, along with the aesthetic, design must take internationally in cooperation with the firm, finance and institutions.

This research demonstrates that, indeed, Cradle to Cradle at the same time contributes to economic growth, reduces our dependence on raw materials, allows better use of the land and its resources, and creates less environmental pollution.

This study interprets the challenge of sustainability as an opportunity for economic development as well, transforming the processes of innovation and economic growth. The three specific areas considered "transverse" industrial design (furniture, lighting, furniture, etc.), fashion (including both the sustainable fashion of the textile industries), and food (including food design, food processing, packaging, but also supply chains court, third generation agriculture, etc.) to report data, setting production standards and policies adopted by each subject, among the most innovative and successful in the Italian, European and global markets. We considered the best producers, designers, stylists, experts, associations and institutions. Accompany the cards, portraits, and images, and is introduced by the statements of opinion leaders of renown and authority. Complete the search a final gloss that, in short, trace the conclusions suggesting critical issues, opportunities, possible instruments related to the spread of C2C in the three areas of industry. This creates the development of a knowledge network that aims to develop a system for the communication and dissemination of an entire product-system to give life to other important tools such as updating or counselling services for young entrepreneurs and designers, reception and information, guidance counselling, and new relationships between producers and customers (innovative forms of co-production of value).

Just as it is important to make the initial monitoring and mapping of Cradle to Cradle available to educate consumer-actors in a critical skill that can help them to understand what they buy. Actually being able to spread a culture focused on sustainable development is not enough to put pressure on designers and manufacturers, as there needs to be more of a demand from below capable of directing the system of consumption.
The aim is to create a proposed system that is a result of the interaction between cross ethical subjects, manufacturers, designers, associations, exhibition bodies, editorial structures, and local authorities, who share goals and values in order to seize the opportunity to set the interests and availability of the actors in a period of radical change in consumption and markets. An important complex factor concerns the extension and evolution of the concept of design, no longer considered (incorrectly) as a synonym for quality aesthetic objects, but in line with the meaning of Anglo-Saxon culture and design methods or development of a rigorous product and service consistent with the needs, usage models and symbolic/emotional expectations of users, but also attentive to the processes and costs of production and sensitive to environmental issues (minimization of pollution, ease of disposal and the possibility of recycling).

This networked system of quality industrial products, generated through explicating various design studies, becomes, in an autonomous way, a compendium of knowledge and good practices.

5. POSSIBLE SCENARIOS

5.1 Vision of Social Responsibility, the Environmental, Ethics and Economics

The intention of some designers to primarily focus their investigation on certain needs of users that do not correspond only to tangible properties such as beautiful and immediate practical functions, also led to designers turning research attention to those projects that are based on immateriality, such as the processing of goods in services, the creation of systems projects, corporate design and corporate image, to the design of software.

Together, designers must now make perceptible the complex and innovative potential of C2C to show that design needs to extend its territory beyond functionality and aesthetics to express a responsible role towards social awareness, the environment, ethics and economics.

Since the buyer, with its various needs, is the true and only major recipient of all the design efforts, industry and the sales organization, the main function of the C2C Network is to promote both the national and international community of design, and for the audience of users and consumers, the perception of a new and broader role of ethical responsibility (social and political) of the design.

Now it is necessary that the social cost of non-quality design is identifiable and quantifiable to determine exactly how to quantify the costs and losses in a company's balance sheet, as it will be, however, the consumer and indirectly the state that has to pay the consequences.

It is essential to move from an intuitive cultural understanding, we might call aesthetic, qualitative and quantitative to a reflection on the mechanisms by which the actual design, or rather the planning system adds value to the products, services, businesses, and social life of the environment.

The C2C Network should therefore promote the understanding and quantification of the value added to the system. This is necessary to be able to perceive the value of intangible and long-term quality of design in order to make people think and steer investors.

As Herbert Simon, a Nobel Prize winner in Economics, says, in design "the systematic will influence their own future," as this belief shall find its roots and strength in a deep confidence in ethics about the possibility of living in a better world, and that it is better for the generations that follow, in a sustainable way.

There will always be industrial production of objects, machines, weekly magazines, and food that takes advantage of the ignorance of others. Instead of helping others to understand, this type of production tries to keep people in their ignorance for the goal of exploitation.

The C2C Network activities should be understood as a work of the same orientation that goes beyond the choice and selection of goods, to be translated into incentive for both designers and producers at the end of a continuous quality improvement process within a mutual sector.

In the Italian scenario industrial awareness of the adoption of a code of ethics could be the key element of Italian design, but it is not very common. In fact, albeit with some differences, we witness the same resistance or misunderstandings that have accompanied the good practice of quality certification, which was a must for companies who first had the courage to make use of it, to become a basic requirement to propose and be allowed on the market.
In an attempt to develop a communication process aimed at the dissemination of quality design, with a careful look at the issue of sustainability ethics, we must not forget the role of acting as intermediaries and catalysts between designers and companies.

The latter, assuming a central role in the system of production and consumption of materials and energy, should be the most sensitive to a change in the direction of sustainability, but their ability to carry it out, however, must necessarily confront the issue of competitiveness.

The current situation of environmental policy, however, is now completely favourable to accelerating the transition towards sustainable processes and to do so in the future in more socially acceptable ways, thus creating a potentially new arena of competition.

We need to be mindful, however, that every choice within companies operating in favour of the environment can only be done as long as it does not adversely affect their competitiveness. Therefore, we need to promote all those promotional campaigns from the state public institutions and Europe and disseminate those methodologies of environmental innovation implemented by businesses more competitively in order to create a new modus operandi that will become the standard in both demand and supply.

It should create conditions capable of changing entirely the whole regulatory environment (economic, socio-cultural and technological).

Concrete examples of the law, based on the concept of polluter pays (financial instruments) that defines a cost to environmental variables, actually considered as the true "scarcity factor".

Projects that promote green consumerism initiatives to raise awareness and education of users, allowing them to make sustainable choices and have a positive affect on the market.

The trend is to extend the liability of the manufacturer to the final stages of the product life and carried out in European EPR (Extended Producmer Responsibility) legislation.

The guiding principle of the policies of each state shall seek to develop a sustainable, in fact make as clear as possible, for each subject and communities, the effect of their choices and their activities. This can happen in physical terms (their tangible verification: for example the amount of waste products), in economic terms (the cost of the consumption of some environmental resources), and both in purely informational and awareness terms.

Ethical responsibility as an added value to the product. The world of design shall promote understanding and quantification of the value added by the C2C system.

Each product is the result of careful planning, which sees more actors engaged in different stages ranging from the development of a concept to prototyping with a continuous series of checks and controls to bring the product up to the point of sale.

The company who places a product on the market must transmit to society, and in a more direct way to the buyer, the whole identity of its merchandise as an expression of the efforts undertaken within it.

The ethical quality of the design of any product or service demands the recognition of the centrality of communication processes: it is essential to ensure transparency and completeness of the information flow between all the actors of the company, giving confidence to the user.

This desire for transparency is legitimately required by investors and in addition to economic and financial data, also wish to be informed about the ethical behaviour of companies.

The reflection of the social impact of the company perceived by consumers is in fact a real analysis in perspective, allowing companies to prevent risks and future costs.

The public image of a company corresponds to the set of messages stored in the common perception, but in reality the dissemination of information is manageable through simple software and can be contaminated in a short period of time by a large number of people, victims too, as they are supportive of the phenomenon of truth, lies with the risk that more and more codes of conduct come to light that are unacceptable to some consumers.

For these reasons, the economic imperative that distinguishes the modern idea of well-being can no longer avoid dealing with a set of common interests that are gradually changing international agreements between countries.

The ethical balance is therefore a key element of connection between ethical values and economic needs.

In recent years, socially responsible investment (SRI) has experienced a strong surge in popularity among mainstream investors.
Responsible policies in the social sector and in the protection of the environment provide investors with an important indication of appropriate internal and external management. These policies help to minimize the risks by anticipating and foreseeing the crisis likely to damage the reputation of the company and to cause a spectacular fall in prices and shares.

Ethics becomes an economic value that is felt especially in the long term and capable of generating an appeal or attraction that is able to convince investors to believe in certain projects.

The world of industrial design will always try to be very close to the customer, because the design is always on the side of the user. The ethical responsibility is the combination of various aspects, but can also be an antidote phenomena restyled front: you can easily clone a successful product, but it is less easy to be able to replicate – in the same way – a communication strategy, a innovation distribution, an ad hoc service, conscious and respectful of certain values. The product is also a system of meaning: the consumer does not buy a product because it has more quality, but because they share the value system of the enterprise, which is communicated through the product.

6. CONCLUSION AND PROPOSALS

The public service announcement: available at no cost, if it meets the real needs of ethical awareness, can be developed by acting on those C2C issues, regarding the industrial product, which today are not addressed. The public information has in fact the aim of contributing to the solution of moral problems, civil and community education by directing the advertisement to the community, through the design and implementation of public interest campaigns, pursuing the aim to demonstrate the usefulness of an professional intervention advertising to promote proper social communication and stimulate civic consciousness to act for the common good.

The creation of free spaces of communication and open spaces of the C2C Community, discussion forums, where the broker or the participants may open debates and launch topical issues. Also a way to introduce people to a physical place that becomes a meeting point, such as the development of wireless stations, already widespread in certain airports or trains, and subway tunnels, and on the platform screens where passengers wait for trains.

Engage C2C business dissemination of information to its dealers through their distribution systems: the development of a quality communication design system is a key role to be played by the retailers themselves, since they are the ones closest to the purchaser. On the basis of research carried out in the field, it was noted that only a very small percentage of dealers are aware that the manufacturer qualifies a product from a retailer as a product of recognized quality.

Brand and Stickers: it is probably the easiest way to introduce a coordinated marking a qualifying C2C products, as they are already on the market, and already have a defined packaging. The stickers have the advantage of being easily distributed to companies. There are also magnetic stickers that can integrate information on the purchased product, or more simply, the sticker may contain a reference number, which will allow the user to investigate through the network hypertext on the quality and characteristics of the C2C product.

Themed Contests. It will be possible to study new proposals for communication to the public through competitions sponsored by the C2C Network. In this way we could constantly offer new ideas and continually developing the attention of users. Through competitions new possible network associations could develop.

Anticipating the spread of the RFID system in the sale of each product associated with her. An RFID tag is nothing but a tiny microchip connected to an antenna that transmits radio frequencies via a serial number associated with the object on which it is applied, and is therefore able to uniquely identify any object, without necessarily being put on the product. Also, the European Union has insisted that they were under strict design rules that required proper labelling of equipment to allow the identification of the manufacturer for the legitimacy of product liability.

Develop an "C2C identity card" product by offering a network system capable of conveying specific information to any interested party: a hypertext system managed by the C2C network to harness all the information regarding the quality of a product-system. The unique characteristic of this system is the possibility of offering more information depending on the capacity and the demand of the bearer of interest.
In any case, the point is to convey specific messages to specific people by giving them the tools to increase their ability to understand the effects of their choices, and to recognize and practice alternatives so that every individual can make the best choices for the environment and society.

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TOWARDS GENERATION FOR SUSTAINABILITY: ILLUSION OR REALITY?

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ABSTRACT

Throughout history, education has been considered a powerful tool for meeting the challenging tasks in any society. More or less scientific surveys and social media networks repeat the message that sustainability is considered important among people of age 50 and over. Youth does not care enough. We have turned to a consideration of the application of life cycle instruments to encourage the generation for sustainability. We are familiar with the life cycle tools for the sustainability development of material flows representing rational resource management within its economic, environmental, and social criteria through the innovative market instruments towards combining private and public interests. A similar approach is used here to analyze the value chain specified for a transformation of human resources matched with the problems of continuous education for sustainability. Not only the school system but the whole society with its management structure has to be involved. Through the examples tested, in Finnish-Russian cooperation, we need a cross-border program to revive discussion of how sustainability should be integrated into the high-school and higher education curriculum, locally and globally. We also add to the Finnish-Russian ecological and economic goals “the big cultural picture”, as we call it. In the future we shall have to find out what could be the role of educational management and cross-border management integration design. That picture will lead to a situation in which management, concrete plans for research on demand, and cooperative cross-border learning programs may lay the groundwork for more open and commensurable curricula and learning.

KEYWORDS

Generation for sustainability; Life cycle management.

1. INTRODUCTION

The challenges of the twenty-first century - resource constraints, financial instability, inequalities within and among countries, environmental degradation - are a clear signal that “business-as-usual” cannot continue. We are passing into a new phase of human experience and entering a new world that will be qualitatively and quantitatively different from the one we have known. Living in this kind of new world calls for so-called 21st century skills, i.e. skills for learning, creative and critical thinking, collaboration, and the ability to take advantage of ICT for these areas [Binkley et al., 2012]. The 21st century skills are vital for 21st century citizens in terms of developing new thinking, learning and working methods and utilize information and communication technology (ICT) for being able to function in the future.

Currently, this is the first generation with widespread knowledge of how our activities influence the Earth systems, and thus the first generation with the power and responsibility to change our relationship with the planet. A responsible stewardship entails emulating nature in terms of resource use and waste transformation and recycling, and transforming agricultural, energy and transport systems. Effective planetary stewardship must be achieved quickly, as the momentum of the Anthropocene threatens to tip the complex Earth system out of the cyclic glacial-interglacial pattern during which Homo sapiens has evolved and developed. Without such stewardship, the global threats to humanity become a one-way ticket to an uncertain future with a new but very different environment.

It has been established that the economic policies would only be efficient if they are accompanied by adequate policies in the field of education. In particular, this would foster a European culture model in line with European integration, which should be conceived in its economic, social, political and cultural
dimensions. This would only be possible by preparing young people intellectually, psychologically and professionally so that they are equipped to participate in the building of the new Community and now the European Union [EU Resolution, 1988]. The level of education and 21st century skills considered to play a key role in securing social cohesion, prosperity, and sustainability in the long term. In this sense, lifelong learning (“continuous education”) has become the umbrella for all prospective training programs and initiatives. Currently, in legal terms, although the right to lifelong learning is strongly recommended, it has yet to be formalized.

The overwhelming dominance of “economy-first” is the main threat on the road to positive attitude building towards sustainability. Culturally disposable lifestyles easily undermine goals such as sustainability. Social and affective skills of learning cannot compete with the hard business interests. The Renaissance showed us that art and science are closely related, that artistic skills are of help in reasoning exercises and in forming of “the big cultural picture” of the learner. There is new empirical evidence that training in the visual arts improves geometric reasoning via the learned cognitive skill of visualization [Walker, 2011]. On the other hand, neurological studies show that social learning is effective when we observe a fellow expert using the best practice she or he knows, the expected payoff is much higher than the average payoff of potential practices we might explore ourselves [Rendell, 2010]. A computer-simulation study emphasizes the importance of social mimicry in the advancement of knowledge. Learning by observing (i.e. socially), not by doing (i.e. asocial trial and error) also include findings that in real team-work, negative sounding words such as “copy” or “exploit” obtain the highest payoff [Sommers, 2010]. Vygotsky’s famous idea of the ‘zone of proximal development’ rests on the basic assumption that learning precedes development [Vygotsky, 1962]. All of this emphasizes the importance of Finnish-Russian cross-border cooperation, namely to start the learning from respect for each other’s culture. This “big cultural picture” may be of vital importance for positive attitude building towards sustainability between neighbors. Actually, this is precisely what we mean by “big cultural picture”: commonly put the Finn’s stereotype is very pragmatic and persistent by nature whereas the Russian’s soul has been rooted more deeply in their culturally versatile heritage. We believe that by combining our best practices into educational studies for sustainability we may build up a concrete goal in our common interests.

In recent years, a number of prominent committees and organizations have addressed the shortcomings in education towards sustainability sciences new standards, guidelines, and benchmarks designed to serve as blueprints for a systemic reform. At the moment, it is agreed that science curricula should focus on reasoning and problem-solving rather than memorization, and that science should be presented as an active process of investigation rather than a set of facts and static theories. This article tries to open up a new page in getting closer to the research design which gives ideas for scholars on “research on demand” - in whatever faculty one may be. This kind of approach demands a lot of planning for the execution of learning tasks: the movement known better as “constructivism” or the team-work known as “social constructivism”. It emphasizes the fact that students build new knowledge in ways integrated with their existing cognitive structures and through exercising the modes of inferences, ‘connection-making of meaning-making’ [Kankkunen, 2004]. The founder of pragmatism, the American philosopher Charles S. Peirce called learning as “reaction which brings habit into an active condition and creates a habit of changing habits “[Peirce, 1976; the italics are the writer’s emphasis].

2. EDUCATIONAL ENVIRONMENT IDEAS FOR A FINNISH-RUSSIAN SUSTAINABILITY CURRICULUM DESIGN

The classroom environment should emphasize active learning through problem-solving, hands-on activities, and small group projects, which could be expected to enhance students’ 21st century skills. In addition, attitude and meaningful science studies can be employed successfully already at the primary level by using a combination of learning methods that enhance problem-solving and modes of inference in practice [Kankkunen, 2001; Kankkunen, 2004]. Because ICT imply radically different learning possibilities, they also demand a radically different framework within which to think about curriculum development [Mäkitalo-Siegl et al., 2010]. Still, especially the use of ICT in teaching and learning has not progressed consistently and new pedagogical approaches are in variety use in schools, which depends rather on the individual teacher and his preference [European Commission, 2013; OECD, 2010]. In place of old learning practices there must be a
view of science curricula as inherently dynamic entities, changing as new data and insights are generated, connected to the inquisitive norms and cultural practices of the scientific enterprise [e.g. Mäkitalo-Siegl et al., 2011].

Not only the school system but the whole society with its management structure has to be involved. It requires careful planning among the various stakeholders, especially when the combination of sustainability sciences and entrepreneurship are taken into account in the curriculum building [Kankkunen, 2010]. Knowledge of the scientific enterprise, its norms and insights lies mostly in the minds of practicing scientists; technology development, software and interface design expertise lies in the minds of computer programmers and "techies"; knowledge of cognitive development and schemes for evaluating learning are the expert "territory" of educational psychologists and researchers; knowledge of what really does and does not work in the classroom is the predominant domain of teachers and students. Each of the engaged group of professionals has a very different set of incentive structures that guides how its members spend their time. The solution may lie in a combination of financial incentives (e.g. a market for the products and services that result from these cross-profession interactions), changes to the reward structures (e.g., promotional incentives for scientists in their science education activities, not just to publications), a meaningful shift in the paradigms that guide science instruction in the classroom, and continuing strategic investments by the public and private sectors [Tosteson, 1997].

The study on the above mentioned problem is based on the networking efforts, in particular, currently being tested for the problems of sustainability. The questions relating to the models of sustainability are embedded in the educational systems, while being responsive to the demands of the new generations and business. The challenge is how to make studies tempting for the students while not causing “the-end-of-the-world” feelings. Attempting to establish the importance of education as an agent with a serious and durable influence on sustainably responsible behavior, this approach is focused on assessing the relationship between global production-consumption issues and human resources in a continuous educational context.

3. LIFE CYCLE MODEL APPROACH

In the pursuit of empowering a generation for sustainability, the Life Cycle Assessment (LCA) provides wide prospects for follow a promising sustainability paradigm [Valdivia et al., 2011]. In particular, there is the LCA approach that provides the “sustainability indicators” [Decoupling indicators, 2010]. In turn, based on a multi-criteria approach, the models for a life cycle chain in solid waste management within its economic and environmental criteria, through the innovative market instruments towards combining private and public interests, have been tested [Voronov, 2007].

A similar approach is used here to analyze the value chain specified for transforming the human resources matched with the problems of continuous education for sustainability. The life cycle chain of a product provides a market of its own for resources, goods, and wastes. Each of these three markets has supply and demand interests (private) as well as environmental and social interests (public) and is controlled by two sets of criteria, profit and utility (economic), and harmfulness (environmental and social). Indeed, “sustainable development” is the state of economy with compromise in the appropriate sense among economic, environmental, social, and institutional objectives, with the notation: <Sustainable Development, SD> = providing Sustainable Consumption and Production. This option admits equivalence between <sustainability> and <sustainable production and consumption> in respect to economic, environmental, and social criteria. In turn: <Sustainable Consumption and Production> = Product Life Cycle which is assumed under Triple Bottom Line for the benefit of both sides, now and in the future, where: <Product Life Cycle, PLC> = product stages at the chain of “Mining” (M), “Production” (P), “Consumption” (C), and “Utilization” (U) activities. And: <Triple Bottom Line, TBL> = vector optimization problem with economic, environmental and social objectives (K, Q). The concept of Triple Bottom Line that is understood as similar to the 3P approach: Profit (=economic), People (=social), and Planet (=environmental) are represented by damage power with K → min (public interest), and by profit & utility criteria with Q → max (private interest). So, there is the model for SD, as the equilibrium in the life cycle chain (structure with specific parameters and criteria):
SD = PLC(M, P, C, U)\Theta TBL(K, Q),

with “\Theta” - symbolic notation for composition, provided by Pareto optimization. This approach introduces the other form, [Klopffer, 2008], by which Life Cycle Thinking is evolved into sustainability efforts with interdisciplinarity in the field of economic, environmental, and social aspects, and converged to a framework for Life Cycle Sustainability Assessment.

Having in mind the concept of life cycle, we can review the activity of Education for Sustainable Development led by the UNESCO towards the objective of helping people to learn how to make informed decisions for the benefit of themselves and others, now and in the future, and to act upon these decisions. The following could be expressed with a notation: “<Education for Sustainable Development> = helping people to learn how to make informed decisions for Sustainable Development (as it is modeled above) and to act upon these decisions. So, there is the following “definition”: “<Generation for Sustainability, GfS> is the functional system with the objective of helping youth to contribute to informed decisions for sustainable development, and to act upon these decisions. With this proposed definition in mind, it is important to point out the key definitions (Oxford American Dictionary, 1992): “<Generation> = “being generated” and “all persons born about the same time”; and “<Youth> = “being young”; and “the period between childhood and maturity, the vigor or lack of experience, etc. characteristic of this”.

To start at some point on the time axis the functional dynamic system mentioned above looks like this (\bigcup\{X\} - symbol of joining the elements \{X\}, “A\cap B” is a common part of A and B, and n = “years”):

GfS(n) = \bigcup_{i=1}^{n}\{GfS(n)\}

GfS(n) is placed at the time axis as well as CEP (continuous education programs) and SA (sustainability activities). So, in accordance with the life cycle concept, the following elements of the educational system will be used:

- Primary school: nurturing talents, “Resources”;
- High school: comprehensive basics, “Production”;
- Higher education: graduating specialists, “Consumption”;
- Sustainability activities: youth contributing to informed decisions for sustainable development, and acting upon these decisions, “Utilization”.

Now GfS is achieved within a specific value chain including the primary school (PS), high school (HS), and higher education (HE) and aimed towards sustainability activities (SA). In terms of continuous education (i.e. educational continuum PS-HS-HE) or lifelong learning, the qualities of SA will be evaluated by advanced specialists (generation for sustainability). So, within the practice of the continuous education services, HE is not a point of conclusion, but a part of the path: one can see that CEP(n) is a part of GfS(n), while GfS(n) \cap SA(n) refers to a time point of acquiring experience by those graduated specialists supposed to contribute to informed decisions for sustainable development, and to act upon these decisions, i.e., after CEP(n), the graduated specialists do not yet qualify for the GfS.

Following from this approach, the model is completed by its cost and utility functions, i.e., respectively CE(U) – for “education programs”, and CA(U) – for “sustainability activities”, where “U” is the vector for “graduated specialists”. A practical way shows the model for CE: CE(U) = CE_{PS}(U_{PS}) + CE_{HS}(U_{HS}) + CE_{HE}(U_{HE}). As for the model for CA, the assumption is that the investment from the sustainability activities into the education programs should be the basic rule. So, we can put this in the form: \langle U, \pi \rangle = a*QS + b*QD, \pi - “price” on the market of graduated specialists, and \sum_{i}U_{i} = \langle \pi, U \rangle; in turn, QS and QD – profit for integrated production (i_production) and integrated consumption (i_consumption), while 0\leq a, b\leq 1 – are the investment rates. If so, we can find, based on the equilibrium equation, \pi = \partial U_{CA}, the following equation for CA(U):

\langle U, \partial U_{CA} \rangle = a*QS + b*QD.

This relation provides a number of options to investigate several principle problems in the management of continuous education systems [Voronov, 2011].

4. MODEL REVIEW

The introduced model is applicable for continuous education helping youth to contribute to decisions for sustainable development, and to act upon these decisions. It will help decision-makers to better understand and track the implications of the sustainability activities and education programs of graduated specialists over
their life cycle in terms of impacts on the quality of activities – the work and lives of people. These activities have to be provided by effective, i.e., with increased criteria values, and available utility and cost functions CD, CS. For instance, 2-criteria optimization task relating to the problem of “Generation for Sustainability” has the form: {KS = (1 – a)*QS → max} & {KD = (1 – b)*QD → max}, here are: CS(V,XS)=CR(resource cost) + CP(product cost); CD(V,XD) = CC(consumption utility) – CU(utilization cost), and with a good practice one can use: XS = XD (=X).

A dynamic analysis of the positions and characteristics of market equilibrium is by far the most widely accepted mode of economic theory. The importance of dynamic foundations is well known, because if the equilibrium model is to be of any use then we must have some confidence that the system is stable, i.e. that it must converge to some stable mode after initial disturbances. A stable equilibrium on the market of graduated specialists could be provided by CE and CA having \( \delta_{\text{V,CE}} > 0 \) and \( \delta_{\text{V,CA}} < 0 \) (here \( \delta_{\text{V,CE}} \), etc., is the positive determined matrix, while for the further simplicity it can be assumed as the scalar). The last one is specifically conditioned, because its sign (S) is followed by the equation:

\[
S = (b\delta_{V} - \Phi/X) + (a - b)*V*(\partial b/\partial X - P/X),
\]

with \( \Phi = b*CD - a*CS \), and \( V \) and \( P \) – equilibrium values (product and price) on the product market of the sustainability activities. Due to time dynamics, the real specialists value, X, is the current number of persons engaged at \( i_{production} \) and \( i_{consumption} \), while “U” is the annual rate, connected, at the equilibrium, to the real value by the time scale “\( \tau \)”: X = \( \tau * U \).

As it could be in practice (\( a \neq b \)), there are the following options for financing the educational system: a > b, i.e., preferred governmental investment by the tax system in \( i_{production} \), and a < b, i.e., preferred private investment, controlled by \( i_{consumption} \). The stability problem of sustainable development now can be tested along the sensitivity conditions of the market criteria to the set of disturbances. In particular, the dynamic model for sustainable development can shift in the direction of competitive equilibrium under the appropriate convergence conditions, closely related to the up-concavity of the social and environmental risk functions. These conditions provide stability of the market criteria for sustainable development, represented by the life cycle chain.

Focusing on market modeling in education in the way described above is very timely, because currently many countries are facing questions of relating the models that are most suitable for handling the increasingly complex and dynamic nature of education systems, which can provide education efficiently and contribute to equity, economic growth and innovation, while being responsive to the demands of youth and business. Many governments have been using elements of the market approach as part of their answer to these questions. There is increasing evidence of the market impact on the outcomes of educational systems, but that evidence as of yet is fragmented and often inconclusive. At the same time, the policy debate about market mechanisms in education is very strong. Proponents claim that education markets would provide higher quality, more efficiency and more demand sensitivity, whereas opponents stress the danger of schools with increasingly unequal quality, unequal access to high quality schools and, as a consequence, segregation. It is clear that in the light of the human right of development the dimensions of “production & consumption” in this model are tightly interlinked. This inter-linkage occurs in both directions, as the educational programs seem to boost sustainability activities and “utilization” activities to provide the economic opportunities that improve the quality of educational systems, where market driving forces are combined with social and environmental objectives. While it is clear that supply and demand are interconnected, it is still common practice to look at production and consumption from different angles. The enterprise-oriented (“corporate social responsibility”) and product-oriented (“life cycle management”) points of view could be addressed (private and public interests analysis, supply and demand responsibility analysis), and the other fundamental problems similar to unsustainable market trends in modern society could also be addressed (speculation challenge analysis, stability option analysis).

As noted by the education community, technological knowledge as a program of education for sustainability has a normative component that scientific knowledge lacks. Therefore, students of technology education need to learn that standards and other normatively determined types of technological knowledge form an integral part of what technologists are expected to acquire. In this vein, relating to the life cycle concept, curriculum designers have regarded standardization as a component of different levels of technology education. There still remains the problem of how to put those standardization education policies into practice, and, furthermore, how to develop and implement hierarchically structured and functionally unified standardization education programs from primary to post-formal education. In our model, the “program approach” was used, following the life cycle approach. On the basis of the life cycle concept one can find the
The following priorities can be identified: of organizing and managing a commercial undertaking that involves market, environmental and social risks. Managers of the company must find a solution, perhaps by turning illusion into reality in seeking the generation for sustainability. This can be done by involving organizations and their demand on both sides of the Russian border. The “feet on the ground” demand here is to support the development of educational management and concrete cooperative cross-border learning programs. This will lead to a situation in which management integration could be. As was seen, management should act for the benefit of financing, and the social, economic and environmental aspects of sustainability into continuous education, including case-study initiatives (e.g., Double Diploma programs at ENGECON = Institute of management, Saint Petersburg State University of Economics, Russia, with THW = Technischen Hochschule Wildau, Germany), short courses for business (e.g., Finnish-Russian Seminars for Environmental Experts / eds. J.Saarela, SYKE = the Finnish Environment Institute), and summer schools for youth (e.g., Finnish-Russian Cooperation Initiative Research for Sustainability Sciences and Entrepreneurship for Double Diploma High School, UEF = University of Eastern Finland, and ENGECON). The last mentioned, apart from being cross-cultural efforts, are designed to support innovative ICT applications. In the most fundamental way, due the multi-criteria core of life cycle thinking, the groupware tools help learners to understand by means of examples what the data reveals about the workings of nature at the manner, applied to the real sustainability problems. It is important too, the group collaboration improves significantly in special conditions the separately taken individual at the basic cognition processes, e.g., selectivity of search skills grows, accuracy of subjectively estimated scales is increased, individual topographical representations are specified, completeness and depth in mastering concepts is increased, etc. Following our approach, the life cycle technique (e.g., UNEP/SETAC Life Cycle Initiative), among other ICT, is applied in summer training. Middle school students, for example, may interact primarily with the higher levels of the LCA environment; they can explore how small changes in certain parameters affect the impact output, and use the LCA model to learn some basic concepts about environmental assessments. High school students, on a pilot programme under a curriculum matched on the university application, may interact with the tasks at the modeling level, exploring interrelationships between system components and using the model as an environmental and social policy analysis tool. Undergraduate students can put the market conceptions more deeply into the scientific assumptions and data that underlie the model's structure. They can build the consumption-production model from scratch and make changes, if justified by relevant scientific work, to those assumptions. Students may conduct their own research into the scientific literature and investigate a hypothesis on what a different functional relationship would imply for the value chain as a whole. This example illustrates the powerful ways in which information technology, combined with a group decision-making mode that enables the manipulation of and interaction with data, can lead in-depth science learning towards sustainability and building a bridge between the student and scientific communities.

In our example tested in Finnish-Russian co-operation, we have undertaken a cross-border effort to revive discussion of how sustainability should be integrated into the high-school and higher education curriculum, locally and globally. A life-cycle curriculum framework is undertaken. Into it we have added Finnish-Russian ecological and economic goals, and also “the big cultural picture”, as we call it. In the future, our approaches have been found productive enough to suggest what the role of educational management and cross-border management integration could be. As was seen, management should act for the benefit of financing, organization, and education technology, including the appropriate curricula. This will lead to a situation in which management and concrete cooperative cross-border learning programs may lay the groundwork for more open and more commensurable curricula and better cross-cultural learning. Also, the “research on demand” design gives access to scholars, teachers, and students for joint work based on all the tacit knowledge there is on both sides of the Finnish-Russian border. The “feet on the ground” demand here is to find a solution, perhaps by turning illusion into reality in seeking the generation for sustainability.

The practical method based on our model, is manifested by the entrepreneurial approach, i.e. the activity of organizing and managing a commercial undertaking that involves market, environmental and social risks. The following priorities can be identified:
the promotion of economic development is the key objective of the entrepreneurial approach, and typical actions such as subcontracting, production cooperation, joining forces in marketing, transfer of technologies; preconditions for further investments in production and infrastructure projects; mechanisms of simplifying international trade; sustainable management practices; developing mutual cross-border business integration; promoting the attractiveness of the region for investments; creating innovative ICT support for markets and education; promoting research and technology development, education, and training in business cooperation; developing an environmentally sound tourist industry; promoting business start-ups; maintaining and improving the quality of the environment and increasing the attractiveness of the participating regions (common challenges) and typical actions such as using at the field of natural resources and implementing sustainable management systems; promoting nature protection and conservation; promoting research, planning, and education in the field of complex sustainable development; supporting public awareness of sustainable development; improving municipal systems of waste management; developing environmentally and socially sound technologies; promoting cross-border cooperation to reduce environmental and social risks; the opportunity to strengthen “people-to-people and civil society contacts” at regional and local levels (social development and civil society) and typical actions such as the promotion of a healthy (i.e. sustainable) lifestyle; mutual research on social adaptation; health protection within the educational sector; promotion of innovative information exchange; improvement of medical services.

5. CONCLUSION

The Marrakech Task Force on Education for Sustainable Consumption (ESC) led by Italy (in collaboration with the United Nations Decade on Education for Sustainable Development) is essential to provide individuals and social groups with appropriate information on the impacts of their daily choices as consumers, as well as on workable solutions and alternatives. Also, we can note that <Sustainable Production & Consumption> is not equal to <Sustainable Production>, nor to <Sustainable Consumption>, while both are insufficient when taken separately. Not long ago, in the era of cleaner production and sustainable consumption, production and consumption were often addressed separately, as if supply and demand were not interlinked. So, the practices and not incompatible outcomes of “education for sustainable development” with those of ESC. In turn, the true subjects and objectives of GfS are embedded in the problems of Continuous Education for Sustainable Development.

The presented GfS-based life cycle approach to the problems of continuous education:
- provides a map which describes the context, the key concepts, the broader field in which tools and techniques are being developed, and the scope of their application such as 21st century skills;
- provides a productive outline that presents the key elements to consider and to guide the goals and scope, while the life cycle thinking provides the necessary basis for the development of databases and the design of software that will facilitate the practices;
- provides a flashlight that helps to identify areas in which further case-studies are needed; the additional efforts following these conceptions could present details of the methodology and further developments notably in regard to impact assessment.

The map is important, because it relates to history, initiatives and ideas that are both molding the life cycle technique and essential to its broad application; the holistic, systemic and rigorous life cycle analysis is the preferred conception in accessing information about potential and real impacts of a specific product being designed; the life cycle conception involves material, energy, and economic flows. Furthermore, it contains stories about production and consumption impacts on the workers, local communities, consumers, society and all value chain actors, including the facts of human resources. The outline is important, because it is a foundation on which a larger group of stakeholders can engage. Adaptations for the consideration of social and socio-economic issues could be described in the framework, formed by the structure, parameters, and objectives needed for a constructive vector optimization model. It proposes a two-fold classification of social impacts: by stakeholder categories and impact categories. A set of subcategories, such as social and socio-economic issues of concern, could be designed in this way. A flashlight is important to enable researchers and practitioners to rapidly identify where additional efforts should be invested. It also helps to prevent the use of techniques that would not be appropriate considering their current state of development. So, on the basis of the above, one can find:
• a current definition of “Generation for Sustainability”,
• an integrated approach to Continuous Education Management,
• abundant prospects for real scale case-study practice.

These represent the reality along the road of seeking the generation for sustainability. But turning illusion into reality will need a never-ending and persistent work, but so is the life-long endeavor to build up the generation for sustainability.

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FIRST-YEAR TEACHER EDUCATION STUDENTS’ REFLECTIONS AND INTERPRETATIONS ABOUT SUSTAINABLE DEVELOPMENT AND ENHANCING LEARNING PRACTICES

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ABSTRACT
The priority objective of every society is to educate students to engage in creating a more sustainable future. In that, teachers play a crucial role. To meet the challenges, the goal of the present study was to investigate how first-year teacher education students (N = 121) reflect on, understand, and perceive the future of education for sustainable development. Participants were asked to complete a questionnaire designed to measure the use of diverse environments, communities, and technology at different school levels and how student teachers perceive them as a part of their past learning experiences and future teaching. The results indicated that, during their school history, the student teachers have had very few experiences with learning in diverse physical environments or social and technological environments outside of the classroom. The earlier experiences also correlated strongly with the intended teaching. Furthermore, most of the student teachers perceived sustainable development only as an ecological phenomenon. This raises a challenge for teacher education programs to widen the student teachers’ perspectives on learning and teaching by involving them in real-life activities and work with communities situated outside the classroom and the lecture hall. New technology can serve as a great support in that type of enterprise. The findings provide grounds for developing teacher education practices and an open learning environment, the “OpenForest” portal, further to meet these challenges.

KEYWORDS
Learning ecosystem, Teacher education, Education for sustainability, OpenForest portal

1. INTRODUCTION
Education is essential in moving toward a sustainable future. The world’s hopes rest with today’s children and young people, as well as their readiness to take up the complex challenges of the future (UNESCO 1998; 2005; 2009). Required for a sustainable society and future, sustainable development is related to the values, activities, and practices of individuals, communities, and organizations. The key challenge of our time should be addressed in multiple ways from different vantage points in locally grounded but globally connected ways (UNESCO, 2009). Therefore, it has become a prime objective of every society to educate the young to meet these challenges; thus, teachers play a crucial role in creating our collective future (UNESCO, 1998; Buchberger et al. 2000). Education for sustainable development calls for new kinds of learning that do not emphasize the transmission of knowledge but are a transformative and continuous engagement in sustainability in formal, non-formal, and informal settings. The complex and multi-disciplinary nature of sustainable development requires intensive collaboration among disciplines, schools, and the wider community, in addition to the capacity to connect and reconcile multiple ways of looking at the world (UNESCO, 2005; 2009).
Kozma (2011) argued that, although people in the “outside world” work collaboratively and use a variety of digital tools and resources to solve complex problems and create new ideas and products, students in schools remain in structured classrooms where teachers cover standard content by lecturing to large classes. Students work individually and reproduce knowledge for assessment; their use of Information and Communication Technologies (ICT) is limited. Furthermore, an international survey of teachers in 23 countries (Law, Pelgrum, & Plomp, 2008) indicated that the three most common classroom pedagogical practices were having students fill out worksheets, working at the same pace and sequence, and taking tests. ICT was rarely used. Given the role of education and schools in society, current practices pose a major challenge for teacher education to prepare student teachers better for their 21st-century careers. To promote sustainable communities, the main focus in teaching should be on learning generic skills, such as general skills, qualities, knowledge, and traits that people must possess to succeed in the future (Pöllänen, 2009; Pöllänen & Vartiainen, 2011). These kinds of generative skills are useful, active, and applicable later in life (Perkins, 2009).

To meet these challenges, teacher education officials at the University of Eastern Finland have collaborated with the experts of the nearby Forest Museum Lusto and Forest Research Institute and forest experts for several years. Accordingly, the students’ learning has been connected with forest-related real-life contexts and real-world problems in the students’ own lives and communities, as well as in global issues. Because of their ecological, economic, and social value, forests are considered an illustrative context for the development of generative skills and knowledge that support wellbeing and sustainable development and reflect value systems and a sense of community.

The present study is a part of a larger design-based research project that aims to develop an open learning environment, the Openmetsa (OpenForest) portal (Vanninen et al. accepted) and the embedded perspectives on learning. The open learning environment is based on three educational pillars: 1) participatory learning in extended and generative communities as a vital concept for learning; 2) diverse technological and information resources and infrastructure as powerful social and personal tools; and 3) co-development as a powerful social innovation in producing information resources that offer multiple perspectives on forest-related phenomena (Liljeström, Enkenberg, & Pöllänen, 2013; Vartiainen, Liljeström, & Enkenberg, 2012; Vartiainen & Enkenberg, 2013a; Vartiainen & Enkenberg, 2013b). These research-based hypotheses provide a basis for analyzing and developing learning ecosystems, consisting of multifaceted phenomena (e.g., sustainable development) and related information resources, communal resources, and technological resources supporting learning (Figure 1.)

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![Figure 1. The conceptual structure of the learning ecosystem](image_url)
The present study provides background information on the development process by examining the learning ecosystems of first-year student teachers (N = 121) in the context of education for sustainable development. The special interest will be in how first-year student teachers reflect on, understand, and see the future of education for sustainable development. The goal of the study is to find out what kind of experience the students have had in the use of diverse environments, communities, and technology during their school history and how the students perceived them as part of their future teaching. Therefore, we address the following specific research questions:

1. How do first-year student teachers perceive sustainable development?
2. How do first-year student teachers see the role of sustainability and forests in the future of education?
3. How did the school history of first-year student teachers support learning in diverse physical (nature and culture), social (extended communities), and technological environments?
4. How do the students perceive the role of diverse physical, social, and technological environments in their future work as teachers?

2. RESEARCH SUBJECTS

The participants were 121 first-year student teachers 18 to 41 years (Md = 20 years, 82% female) at the University of Eastern Finland. Students’ degree programs were class teacher education (N = 46), kindergarten teacher education (N = 41), home economics teacher education (N = 22), and textile teacher education (N = 11). The primary childhood residential environments were city/suburb (42.5%), municipal center or other population center (30%), and sparsely populated area or countryside (27.5%). 62.5% of the participants were forest owners, or their parents or grandparents were. In childhood, most of the participants (89.7%) had often spent time in the forest (e.g., playing, exploring, camping, etc.). 44.5% of the students visited the forest daily or once or a few times a week, 33% once or a few times a month, 19.8% a few times a year; and 2.5% once a year or less.

3. INSTRUMENT AND ANALYSIS

This study was a part of a larger quantitative investigation implemented by the University of Eastern Finland on how students perceive and relate to the forest. The data was collected using a questionnaire that included both open- and closed-ended questions. The data was collected in the autumn of 2012 during the first-year student teachers’ (N = 121) field trip to the Finnish Forest Museum and the nearby Research Park of the Finnish Forest Institute. The questionnaire was distributed at the beginning of the university year. During the field trip, the students were asked to complete the questionnaire. The questionnaire included three parts: the first part included open-ended questions, while the second and the third parts contained closed-ended questions (five-point Likert scale, “never” to “very often”). The reliability of the questionnaire seemed high (n = 41, Cronbach’s Alpha .914).

The first part of the questionnaire included three open-ended questions related to the phenomenon of sustainable development. The responses to the first open-ended question, “In your opinion, what does sustainable development mean?” were analyzed using deductive data analysis, in which the categorization was based on dimensions of sustainable development (SD) (Brown et al., 1987). The responses to the second open-ended question, “What kind of a future do you see for sustainable development in teaching?” and the third open-ended question “How do you think the forest environment could support teaching for sustainable development?” were categorized through inductive data analysis, in which two of the authors read through the responses several times to get an overview of the data. They then constructed an exclusive classification structure based on the data. Two of the authors independently coded all the responses of the three open-ended questions, and the inter-rater reliability ranged between 80.16% and 86.7%. Through negotiation between the coders, it reached 100% agreement. After the qualitative procedures for the three open-ended questions were conducted, the data were quantified (Table 1).
<table>
<thead>
<tr>
<th>Open-ended question</th>
<th>Analysis of data</th>
<th>Categorization of the data and examples of categorization</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. In your opinion, what does sustainable development mean?”</td>
<td>Deductive content analysis</td>
<td>Ecological</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Economic</td>
</tr>
<tr>
<td>2. What kind of a future do you see for sustainable development in teaching?”</td>
<td>Inductive content analysis</td>
<td>Teaching content (e.g., ecosystems and natural resources)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teaching method (e.g., giving examples, recycling with children, and integration of school subjects)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Learning environment (extended learning environment, e.g., family home, forest, learning spaces outside of school)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Combination (e.g., previously together)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Value judgment of sustainable development (e.g., SD is important/not important in future teaching)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other: Not clear</td>
</tr>
<tr>
<td>3. How do you think the forest environment could support teaching for sustainable development?</td>
<td>Inductive content analysis</td>
<td>Enrichment of formal teaching (e.g., trips, projects, examples of the real-world environment)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teaching content (e.g., the cultural landscape, natural resources, forest-related products)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Environment for demonstration and concretization (e.g., seeing, experiencing, and making real things)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Different values, perspectives, and ways of working (e.g., improving the relationship between students and nature.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other, (not clear)</td>
</tr>
</tbody>
</table>

In the second part of the questionnaire, the aim was to measure the use of diverse environments, communities, and technology at different school levels and how the students perceived them as part of their future teaching. The second part of the questionnaire included four sum variables and seven items altogether. Each of the seven item included five sub-items: kindergarten, primary school, secondary school, high school, and future teaching (Table 1).

In the third part of questionnaire, the aim was to measure the use of technology and tools in learning projects outside of school. The main variable (alpha .749) comprised six sub-items: physical tools for making, tools for searching for information, tools for collaboration, tools for collecting information, tools for organizing, constructing, and presenting data, and tools for reflecting on and evaluating knowledge and information (see Table 2).
Table 2. Main variables and related items describing different dimensions of the questionnaire

<table>
<thead>
<tr>
<th>Main (sum) variables and the related items</th>
<th>Sub-items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Learning outside school in forest and nature environments (<em>Items 1, 2, and 3, n = 15, alpha .854</em>)</td>
<td></td>
</tr>
<tr>
<td>1.1. Using the environment outside the school in learning</td>
<td>History (<em>n = 4</em>)</td>
</tr>
<tr>
<td>1.2. Effectiveness of using the environment outside the school in learning</td>
<td>In kindergarten,</td>
</tr>
<tr>
<td>1.3. Learning projects situated outside of the school environment</td>
<td>In primary school,</td>
</tr>
<tr>
<td>2. Learning projects that integrate school subjects (<em>Item 4, n = 5, alpha .839</em>)</td>
<td>In secondary school,</td>
</tr>
<tr>
<td>3. Collaboration with expert communities (<em>Items 5 and 6, n = 10, alpha .866</em>)</td>
<td>In high school</td>
</tr>
<tr>
<td>3.1. Visits to expert communities</td>
<td>Future (<em>n = 1</em>)</td>
</tr>
<tr>
<td>3.2. Experts’ visits to the schools</td>
<td>In the future in their own teaching</td>
</tr>
<tr>
<td>4. Using ICT for collaboration with expert communities (<em>Item 7, n = 5, alpha .805</em>)</td>
<td></td>
</tr>
</tbody>
</table>

4. RESULTS

4.1 Perceptions of Sustainable Development

The analysis of the responses to the first open-ended question revealed that 62.2% of the first-year student teachers perceived sustainable development as only an ecological phenomenon (Figure 2). One student perceived sustainable development as only a social phenomenon, and no one perceived it as purely an economic phenomenon; 25.2% of the students’ responses were categorized as approaching sustainable development as a multi-perspective phenomenon. Some answers did not indicate any perspective on sustainable learning as defined by UNESCO.
4.2 Future of Education for Sustainability

When the students were asked how they perceived the role of sustainable development in their future teaching, 17.9% saw it mainly as teaching content, 25.6% saw sustainable development mainly as a teaching method, 1.7% saw it as a learning environment outside of school, and 17.1% saw it as a combination of content, method, and learning environment. However, 37.6% of the responses included only opinions about whether the student perceived sustainable development as important or not in their future teaching, but they did not elaborate. All the students described sustainable learning as important in future teaching, except one student who thought it would be difficult.

When they focused on the role of the forest in education for sustainable development, 42.5% of the students perceived the forest as an environment for demonstrating and concretizing issues of sustainable development; 8.5% of the students saw the forest mainly as an added enrichment to teaching, and 10.5% saw it as teaching content; 34.9% of the students saw the forest as a mediator of multiple perspectives of SD, sustainable values, goals, and ways of working.

4.3 Learning in Diverse Physical (Nature and Culture), Social (Extended Communities), and Technological Environments

4.3.1 Physical Environments

The use of different physical environments in kindergarten and at school was evaluated by three sum variables (alpha .854), which all consisted of four sub-items of different school levels. The mean value for the use of physical environments was 2.71 (1: never to 5: very often), indicating that different natural and cultural environments were seldom used in the student teachers’ school history. The use of out-of-school environments was most common in primary school and least utilized in high school. In the future, the students intended to use out-of-school environments often (M = 3.55).
The students seldom took part in learning projects that integrated different school subjects, and over half the students had never participated in such projects (M = 1.75). No statistical difference was found in the different school levels; in high school, secondary school, primary school, and kindergarten, the natural and cultural surroundings of the school were rarely the object of learning projects (M = 1.35-1.91). In the future, the students intended to implement learning projects a few times (M = 2.88).

4.3.2 Social Environments (Extended Communities)

Visits to expert communities or visits of experts to school were rare in the school history of the students (M = 2.20). In the future, the students would like to invite experts to school (M = 3.06) and visit expert communities outside the school more often (3.24), at least a few times. Eighty-two percent of the students responded that they had no experience in using technology to collaborate with expert communities, and 15% responded that they seldom used technology for expert collaboration, mainly in high school. In the future, the students intended to use technology for expert collaboration (M = 2.75), but 30% of the students responded that they would use technology for expert collaboration rarely or never.

4.3.3 Technological Environments

When learning in environments outside the school and in related learning projects, technology was used a few times or less (M = 2.58) (Table 2). The students responded that they often used technology, such as the Internet, to search for information (M=3.61). They used technology such as digital cameras, mobile phones, and measurement tools for collecting data a few times (M=2.66) and that they used technology for collaboration, such as wikis, Facebook, and Web environments (M=2.52). For making things, they seldom used physical tools, such as a hammer, knife, etc. (M = 2.32). Technology such as Web pages or blogs was seldom used to support, build, present, and organize knowledge (M = 2.08), and technology in the form of learning diaries or blogs was seldom used to reflect on or evaluate knowledge (M=2.32).

<table>
<thead>
<tr>
<th>Estimate how often you have used of technology and tools during learning situations and projects situated in or related to places outside the school environment. (n=6, M = 2.58, alpha = .749)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>**Never (1)</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>Physical tools for making (e.g., hammer, knife, drill) (missing 4).</td>
</tr>
<tr>
<td>Tools for searching for information (e.g., Internet) (missing 4)</td>
</tr>
<tr>
<td>Tools for collaboration (e.g., Web pages, wikis, blogs, Facebook) (missing 3)</td>
</tr>
<tr>
<td>Tools for organizing, constructing, and presenting data (e.g., Web pages, blogs) (missing 2)</td>
</tr>
<tr>
<td>Tools for reflecting on and evaluating knowledge and information (e.g., learning diaries, blogs) (missing 2)</td>
</tr>
<tr>
<td>Tools for collecting information (e.g., digital cameras, mobile phones, and measurement tools) (missing 2)</td>
</tr>
<tr>
<td>Tools for reflecting on and evaluating knowledge and information (e.g., learning diaries, blogs) (missing 2)</td>
</tr>
<tr>
<td>Tools for organizing, constructing, and presenting data (e.g., Web pages, blogs) (missing 2)</td>
</tr>
<tr>
<td>Tools for reflecting on and evaluating knowledge and information (e.g., learning diaries, blogs) (missing 2)</td>
</tr>
<tr>
<td>Tools for collecting information (e.g., digital cameras, mobile phones, and measurement tools) (missing 2)</td>
</tr>
</tbody>
</table>

Table 3. Frequencies and descriptive statistics of the use of technology and tools in learning situations and projects situated in or related to places outside the school environment.
4.4 Correlations between Students’ School History and Future Work as Teachers

The preliminary analysis, which was performed using Pearson’s correlation test, revealed statistically significant correlations between school history and intention in future teaching (Table 4). The correlations indicated that students who had used the surroundings of the school and participated in learning projects that integrated school subjects perceived them as valuable in their future teaching. The same relation was evident in collaborations with experts in the students’ school history and in their future teaching. Further preliminary analysis of correlations in using technology for collaboration with expert communities was statistically significant between school history and intention in future teaching.

Table 4. Relationship of student teachers’ school history and intent in future teaching

<table>
<thead>
<tr>
<th>Main sum variables</th>
<th>School history (number of items and descriptive)</th>
<th>Future work (number of items and descriptive)</th>
<th>Pearson’s correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning outside of school in forest and nature environments ((n=15, \alpha=.854))</td>
<td>(n = 12) Mean = 2.71 Sd. = 0.53</td>
<td>(n = 3) Mean = 3.55 Sd. = 0.61</td>
<td>.438 (p = .000)</td>
</tr>
<tr>
<td>Learning projects that integrate school subjects ((n=5, \alpha=.839))</td>
<td>(n = 4) Mean = 1.75 Sd. = 0.73</td>
<td>(n = 1) Mean = 3.30 Sd. = 0.78</td>
<td>.538 (p = .000)</td>
</tr>
<tr>
<td>Collaboration with expert communities ((n=10, \alpha=.866))</td>
<td>(n = 8) Mean = 2.20 Sd. = 0.59</td>
<td>(n = 2) Mean = 3.16 Sd. = 0.64</td>
<td>.523 (p = .000)</td>
</tr>
<tr>
<td>Using ICT for collaboration with expert communities ((n=5, \alpha=.805))</td>
<td>(N = 4) Mean = 1.53 Sd. = 0.61</td>
<td>(n = 1) Mean = 2.75 Sd. = 0.77</td>
<td>.418 (p = .000)</td>
</tr>
</tbody>
</table>

5. CONCLUSION

The results of the study indicated that understanding the multidisciplinary nature of sustainable development is a clear challenge. Most of the student teachers perceived it only as an ecological phenomena. Such a narrow perspective could be partly explained by their school history, as the student teachers had very few experiences of learning situated in diverse physical environments or social and technological environments. Current education systems tend to anchor learning in formal environments, mostly in classrooms and textbooks (c.f. National Education Technology Plan 2010). Environments and communities that lie outside the school seemed to have little significance in learning and education in the school history of the student teachers. Although technology dominates the workplaces of many professions, the student teachers did not discuss the role of technology in relation to learning and teaching for sustainable development, and the results of the study also indicated that technology was not used to enhance learning in diverse settings in the school history of the student teachers. In addition, the preliminary results of the study indicated that the experiences in the students’ own school history and their perceptions of the roles of diverse environments, communities, and technologies in their future careers are deeply connected. This raises a clear challenge for teacher education to widen student teachers’ learning ecosystems and perspectives on learning and teaching by involving them in real-life activities and communities situated outside the traditional classroom and
supported by the use of new technology. Although, in the light of this study, the perspectives on sustainable learning by student teachers is rather limited, it seems that most participants recognized the importance of this global challenge, and some of them saw the forest as a fruitful mediator of multiple perspectives and sustainable values, goals, and ways of working.

Although there seems to be uncertainty with regard to how to educate our students and pupils to have successful lives in the future, there is also widespread recognition that the traditional ways in which schooling has been organized are no longer sustainable in providing the knowledge and skills that students and pupils need to live and work in a knowledge-creating society (Thomas & Brown, 2011; Mizuko et al., 2013; National Education Technology Plan, 2010; Scardamalia, 2001; Scardamalia & Bereiter, 2006; Schank, 2011; Binkley, et al. 2011; Valtonen et al., 2011). Complex challenges, such as sustainable development as a global phenomenon, are multifaceted and require people with different points of view to collaborate in designing and redesigning solutions from various perspectives (Vartiainen & Enkenberg, 2013a). Meeting these challenges requires building learning communities consisting of students, fellow educators, and professional experts from museums, community centers, and other settings (National Education Technology Plan 2010). It also requires the development of technologies and new types of resources of learning, such as the OpenForest portal, that enhance the activities in which students learn and work together with the wider community, including different expertise, responsibilities, and multidisciplinary perspectives. These results also pose further important questions about the evolution of student teachers’ learning ecosystems during their studies and how the OpenForest portal supports them in this learning. Future research should also include long-term studies to explore further the use of the OpenForest portal and related perspectives on learning in diverse contexts with diverse target groups.

ACKNOWLEDGEMENTS

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DEVELOPMENT AND EVALUATION OF A SUSTAINABLE E-LEARNING FRAMEWORK FOR HIGHER EDUCATION INSTITUTIONS IN MALAYSIA

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ABSTRACT
Teaching, learning and technology are colliding faster and more strongly than ever, as they are facing increasing pressures in respect to innovation and research while concurrently keeping costs at an absolute minimum and reducing the consumption of raw materials. New technology provides enormous possibilities for higher education to use it in an effective and efficient way and e-learning is considered as the new vehicle to exploit these opportunities to improve students’ skills and knowledge, which are not limited to the current study but can be utilized in the workplace in the future. However, the recycling of Information and Communications Technology (ICT) end products via e-learning becomes a major dilemma for users as well as the education sector. Currently, numerous e-learning frameworks aim to enhance students’ professional and personal skills, but are inadequate as a means of raising students’ awareness of sustainability in the context of teaching and learning, minimizing the environmental impact, and assisting Malaysia to become one of the developed countries by 2020. Therefore, this research aims to develop and evaluate a sustainable e-learning framework for higher-education institutions in Malaysia. This framework will introduce new, sustainable teaching and learning principles, applications and technologies to improve students’ teaching and learning process, and reducing the environmental impact in Malaysia. Design Science Research Process and mixed methods (qualitative and quantitative) will be employed to assess the new sustainable e-learning framework with various stakeholders. The research outcome is a sustainable e-learning framework to support students’ continuous, self-directed learning and provide new and meaningful resources to support e-learning to improve students’ learning interaction and satisfaction in Malaysia.

KEYWORDS
Web 3.0, sustainable, e-learning, Higher education, Malaysia

1. INTRODUCTION
Malaysia is a developing country that has become an export-driven economy motivated by high technology and industries. By the year 2020, Malaysia aims to become a developed country. One of the National Missions is to enhance Malaysia’s capacity for knowledge, creativity and innovation and develop ‘first class mentality’ (Malaysia Economy, 2006). Therefore, to ensure Malaysia’s future success as a knowledge-based economy, Malaysia should undertake complete enhancement to the education system by providing an environment and innovation system such as e-learning. Nowadays, most all Higher Education Institutions (HEI) in Malaysia launched their own e-learning platform, set up with e-learning units, committees and policies. However, there are many challenges in implementing an effective e-learning in Malaysia such as a lack of strategic planning and funds on an e-learning project (Raja Hussain, n. d), low awareness and adoption rate that were caused by users who preferred traditional learning, internet connections’ limitations and poor interactivity of e-learning content. Nowadays, technologies are constantly and dramatically changing and evolving, as they become a utility to improve communications, collaboration, interaction, performance, and productivity for business and individuals locally and globally. Green Technology has become advantageous for reducing carbon emissions and production of Green House Gases (GHG). As climate change has become a critical global issue, most countries are now aware of the concept of sustainable development. In Malaysia’s education sector, there are several sustainable development initiatives geared toward sustainable education organized by some universities, which include the Green Campus Initiative.
(GCI), Integrated Approaches to Sustainable Development Practice, and the Recycle Project. This research will focus on supporting sustainable development by developing a framework that consists of guidelines and recommendations on how technology, applications, and teaching and learning principles can be used, integrated, and combined to achieve a sustainable e-learning environment. In order to develop the new Sustainable e-learning Framework for higher education, this research intends to ascertain the characteristics of developing a sustainable e-learning framework for Malaysia, also, identify the stakeholders' perspectives and expectations to sustainable e-learning characteristics. Furthermore, this research aims to ascertain if the new sustainable e-learning framework will meet Malaysian higher-education stakeholders to become more sustainable. The primary research question is "What are the characteristics of developing a sustainable e-learning framework in higher education in Malaysia?" The secondary research questions are "What are the stakeholders' perspectives and expectations of sustainable e-learning characteristics?" and "How can the new sustainable e-learning framework assist the Malaysian higher-education stakeholders to become more sustainable?". This paper outlined the research objectives, research questions, literature review, research methods, research gaps, proposed framework, and future research. The literature review covered aspects on e-learning, sustainable development, sustainable education, sustainable e-learning, and Malaysia's education background.

2. SUSTAINABLE DEVELOPMENT AND EDUCATION

Sustainability is defined to support long-term innovation processes while benefiting the people, economy, and environment (Foo, 2013). Sustainable development involves technological, organizational, and social changes (Sahid et al., 2011). To meet the triple bottom line, decisions on sustainable development will influence people, economy, and the environment (Manitoba, 2000). Sustainable people involve an agreement between communities and nature. Sustainable environment is where natural resources are protected and restored. Sustainable economy refers to decision, policies, and practices that allow access to resources and opportunities to minimize the environmental impact. In Malaysia, the Ninth Malaysia Plan 2006-2010 was promoted to ensure a balance between developmental and environmental needs (Abdullah, 2006). Currently, thrust four in the Tenth Malaysia Plan 2011-2015 is focused on improving the standard and sustainability of quality of life. Sustainability Principles will be applied to economic development to ensure that the environment and natural resources are preserved. In addition, the National Climate Change Policy and the National Green Technology Policy were implemented in a move towards a low-carbon economy and to attain sustainable development (Razak, 2010). Sustainability of education is sustainable practice execution within education development, management, and innovation (Davies and West-Burnham, 2003). On the other hand, education for sustainability aims to provide a sustainable environment through education solutions. Sustainable development theory can become practice through active, creative, resourceful and cooperative citizens (Lampa et al., 2013). In higher education, the level of awareness of sustainability issues among students is high. However, the meaning of sustainable development in higher education is low (Yuan and Zuo, 2013). There have been several initiatives towards sustainable education taken by some of Malaysia’s universities. These include Green Campus Initiative (GCI), Integrated Approaches to Sustainable Development Practice, and Recycle Project. For instance, Universiti Sains Malaysia (USM) promotes its vision of sustainable tomorrow such values as equity, quality, availability, and affordability (Foo, 2013). Therefore, in my perspective, awareness on sustainable development is important to ensure quality education while preserving green environment in the future.

3. E-LEARNING AND E-LEARNING 3.0

E-learning comprises learning activities within virtual learning environments, which allow users to use various learning tools via the Internet (Kanninen, 2008). The e-learning content can be tagged for advanced search ability. In addition, the e-learning content is stored in a central database repository such as a database warehouse where the user can support data mining in order to control data and transform them into meaningful information. The e-learning design process will adopt an iterative process of use, feedback, redesign, and reuse. Virtual space for a course is used to allow users to read, re-purpose and improve the
e-learning content from year to year. A ‘learning loop’ of feedback allows the design quality to be improved steadily over time rather than having to recreate everything from scratch (Robert and Goodyear, 2010). The e-learning 3.0 is still a new concept and therefore, there are only insufficient researches on e-learning 3.0 that have been done worldwide. Most researches on e-learning 3.0 are focused on the technology used in e-learning 3.0 such as Intelligent Agent, Big Data (Rubens, Kaplan, & Okamoto, 2011), Cloud Computing (Sharma and Sharma, 2009), and Semantic Web (Harris, 2008). On the other hand, insufficient research was carried out to e-learning 3.0 models and framework. This research will discuss and examine the current models to identify the characteristics, which are required to develop a new e-learning framework, especially among higher education in Malaysia.

4. SUSTAINABLE E-LEARNING

Sustainable e-learning has become normative in catering for the needs of the present and future (Editorial, 2013). One of the characteristics of sustainable e-learning is its support of reusable or transferable e-learning contents. This allows advanced searches for existing content that can be reused and shared. Sustainable e-learning content can be delivered through various media such as smart mobiles and tablets. Furthermore, it consists of three domains which are resource management, educational attainment, and professional development and innovation (Stepanyan et al., 2013). The resource management domain concentrates on assessing student success and development. The professional development and innovation domain focuses on continual improvement and adaptation to environmental changes. By the year 2020, Malaysia aims to become a developed country. One of the National Missions is to enhance Malaysia’s capacity for knowledge, creativity, and innovation and develop ‘first class mentality’ complete enhancement in the education system by providing an innovative environment that comprises e-learning. Nowadays, most universities (public and private) have established their own e-learning system by offering Internet-based degree programs and delivering online learning materials. In addition, many workshops, seminars, and conferences are organized to promote knowledge sharing, information exchange, and collaboration.

5. RESEARCH GAPS

Various e-learning frameworks are mainly focused on managing e-learning administration, community, content, information quality, implementation, and evaluation, training, and activity components (See Table 1). Table 2 shows the current e-learning frameworks in Malaysia. By noting the missing and studying the present characteristics of the e-learning frameworks worldwide and in Malaysia, it was noted that these frameworks are inadequate for this research; therefore, a new framework needs to be created to address the shortcomings in the current e-learning frameworks and take into account the principles of sustainability. This framework will include guidelines and recommendations regarding key technologies, application, and teaching and learning practices that can be used, integrated, and combined to provide a sustainable e-learning system in Malaysia.
Table 1. Current e-learning frameworks worldwide

<table>
<thead>
<tr>
<th>Framework</th>
<th>Year</th>
<th>Author(s)</th>
<th>Available Characteristics</th>
<th>Missing Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Theoretical Framework</td>
<td>2008</td>
<td>Georgouli et al., 2008</td>
<td>Administration, content, activities, and community components.</td>
<td>Sustainable, technology, and applications</td>
</tr>
<tr>
<td>Information Quality Framework</td>
<td>2010</td>
<td>(Alkhattabi et al., 2010)</td>
<td>Information quality</td>
<td>Technology quality and software quality.</td>
</tr>
<tr>
<td>Conceptual e-learning framework</td>
<td>2011</td>
<td>(Glancy and Isenberg, 2011)</td>
<td>Crisis, information search, information reflection, knowledge, database, assessment, and reference</td>
<td>Sustainable development and technology/innovation.</td>
</tr>
<tr>
<td>Theoretical Framework for Blended Learning for Adults</td>
<td>2012</td>
<td>(Fang et al., 2012)</td>
<td>Learning collaboration, tutor facilitation, and content interaction.</td>
<td>Personalization, sustainable development, and technology/innovation.</td>
</tr>
<tr>
<td>End User Training Framework</td>
<td>2012</td>
<td>(Ramakrisnan et al., 2012)</td>
<td>Technology, learning technique, individual differences, support, learning outcomes, learning process, and interaction process.</td>
<td>Sustainable development and Application/Software</td>
</tr>
</tbody>
</table>

Table 2. Current e-learning frameworks in Malaysia

<table>
<thead>
<tr>
<th>Framework</th>
<th>Year</th>
<th>Author(s)</th>
<th>Available Characteristics</th>
<th>Missing Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaysia Public Sector E-learning Implementation Framework</td>
<td>2011</td>
<td>(EPSA, 2011)</td>
<td>Strategic alignment, content sourcing, content repository, delivery, learning administration, operation and administration.</td>
<td>Sustainable development strategy and technology innovation.</td>
</tr>
</tbody>
</table>

6. RESEARCH METHODS

A mixed methods approach will be employed for this research to minimize the gaps in the findings, and both qualitative and quantitative techniques and procedures will be used (Saunders et al., 2009). Survey and focus groups will be conducted to collect data from the participants, including students, academic staff, IT staff, and university’s management. Academic staff and students will have the opportunity to share their knowledge and ideas to support the framework via the survey. After analyzing the survey’s results, a second draft of the sustainable e-learning framework will be developed and evaluated through focus groups. Four focus groups (two for each stakeholder: i.e. IT staff and university’s management) will be conducted in each university to acquire their perspective to the new sustainable e-learning framework. A Malaysian government university and a private university will participate in this research to enrich the sample size of the survey and focus groups to evaluate the framework.

7. THE PROPOSED SUSTAINABLE E-LEARNING FRAMEWORK

### Table 3. Elements of initial sustainable e-learning framework

<table>
<thead>
<tr>
<th>Key Element</th>
<th>Component</th>
<th>Characteristic</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching and Learning Principles</td>
<td>Teaching Principles</td>
<td>Curriculum</td>
<td>The e-learning curriculum is intended to develop skills among users such as creative thinking to solve complex problem in real world. This can be done through academic activities, mentorship, assessment and feedback, systematic syllabus, skills development and practice, and peer and collaborative learning.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pedagogy</td>
<td>An excellent pedagogy can come from a good practice, teaching and assessment method, personalized, collaborative, and conditional learning method.</td>
</tr>
<tr>
<td></td>
<td>Learning</td>
<td>Learning Theories</td>
<td>There are two learning theories which are</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Pragmatism – Provide connections between the user and information.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Connectivism – Distributed knowledge across network of connections.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Learning Models</td>
<td>• Learning Model allows large scale data to be available.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Semantic Web allows Learning Models to provide Web-based services and ontology-based model.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Learning Environment</td>
<td>• A physical or virtual setting that engages learners in reasoning about large resource sets.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Learning Models include Emersion World, 3D Environment, 3D software and libraries, virtual community, Avatar-based world, and augmented and virtual reality.</td>
</tr>
<tr>
<td>Technology</td>
<td>Green Technology</td>
<td>Consolidations</td>
<td>Reduce energy consumption as it manages multiple applications on a shared virtualized resource pool.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Energy Efficiency Algorithm</td>
<td>Energy efficient algorithm was designed to support complete energy efficiency system by delivering solutions for energy saving, balancing hardware and system-based methods.</td>
</tr>
<tr>
<td></td>
<td>Semantic Web</td>
<td>Data</td>
<td>Intelligent Learning requires data such as:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Metadata – description of the learning object content to make the learning object accessible.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Linked Data – allows data to be processed directly and indirectly by machines.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Data-Driven – data that leads to hypotheses and new information.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Global Database – uses standards that make information readable by different systems and cross-platforms.</td>
</tr>
<tr>
<td></td>
<td>Pedagogical Agents</td>
<td>Pedagogical Agents</td>
<td>Enables the flow of information and content by supporting learning activities through interaction with students, teachers, and other agents.</td>
</tr>
<tr>
<td>Applications</td>
<td>Mobility</td>
<td>Extended smart mobile technology</td>
<td>Distributed computing in combination with smart mobile technology will enable learners to have access anytime and anywhere and will provide intelligent solutions to Web searching, document management and organization of content from virtually anywhere.</td>
</tr>
<tr>
<td></td>
<td>Personal Development</td>
<td>Personal development of skills and knowledge through short courses, and online communities.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mentor</td>
<td>Personal mentoring provided by ICT applications of communication, which is known as an effective strategy for support and development.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Learning Environment</td>
<td>A set of different applications, services and various other types of learning resources which are constructed by individuals.</td>
<td></td>
</tr>
<tr>
<td>Sustainable Development</td>
<td>Sustainable Education</td>
<td>Environment</td>
<td>The responsibility towards natural resources and environments.</td>
</tr>
</tbody>
</table>

The criteria for the initial sustainable e-learning framework are based on the literature review as shown in Table 2. The initial sustainable e-learning framework for higher-education institutions in Malaysia will include various elements such as teaching principles, learning, green technology, and applications. In addition to these, sustainability will be added to confirm that the new sustainable e-learning framework will assist the higher-education sector to become more sustainable in its learning and teaching while reducing the production of carbon emission and GHG. Finally, the initial users of the new sustainable e-learning framework are the higher education institutions in Malaysia.
Based on the critical criteria in Table 1, the initial sustainable e-learning framework was developed (see Figure 1). This initial framework shows the key elements of designing a sustainable e-learning framework to determine sustainable e-learning in the Malaysian higher education sector. The final framework for this research will look similar to the initial framework and will consist of guidelines and recommendations on how the key technology, application, and teaching and learning practices can be used, integrated, and combined to provide sustainable e-learning in Malaysia. In addition, the framework can be used in other countries. Table 4 illustrates the fundamental key elements and supporting sustainability of the proposed framework. These elements ensure that the framework is adaptable to changing environments, and does not become obsolete in the near future. Thus, the framework will be flexible and capable of including new elements at a later stage.

<table>
<thead>
<tr>
<th>Key Elements</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching and Learning Principle</td>
<td>Meet the user’s basic education needs that can be achieved for a long time.</td>
</tr>
<tr>
<td>Technology</td>
<td>Use of technology that reduces, recycle, and reuse energy.</td>
</tr>
<tr>
<td>Application</td>
<td>Use of application that support green technology.</td>
</tr>
<tr>
<td>Sustainable development</td>
<td>Develop initiatives towards a sustainable education.</td>
</tr>
</tbody>
</table>

8. **RESEARCH SIGNIFICANCE**

The aim of this sustainable e-learning framework is to provide support for sustainable education in Malaysia’s universities and assist Malaysia to achieve sustainable development. In many institutions, education and research on sustainability is at an early stage (Editorial, 2013). Therefore, the sustainable e-learning framework will help the institutions to develop a sustained e-learning system that increases the benefits and quality of e-learning, while reducing the cost and environment impact. It is envisaged that the development of a sustainable e-learning framework for higher education will assist Malaysia to become a country with an expert-driven economy (Malaysia Ministry of Education 2012), and will encourage Malaysia and other developing countries to become more sustainable, especially in e-learning. Furthermore, this research will assist the institutions to reduce their production of carbon emissions. In order to improve Malaysia’s education among other developing countries and protect their populations and natural resources, this research will help Malaysia to create sustained and effective teaching and learning in a rapidly changing society and technology.
9. CONCLUSION AND FURTHER RESEARCH/WORK

Sustainable e-learning allow users to maintain quality of education while reduce the environmental impact. This research will focus on supporting sustainable development by developing a framework that consists of guidelines and recommendations on how technology, applications, and teaching and learning principles can be used, integrated, and combined to achieve a sustainable e-learning environment. The proposed e sustainable e-learning framework will assist and contribute slightly for Malaysia to be part of the developed countries by 2020, as it will maximize the use of ICT for distance, and self-paced learning to expand capacity and allow for more customized learning. This research aims to investigate and identify characteristics of developing a sustainable e-learning framework, and identifies stakeholders’ perspectives and expectations of sustainable e-learning characteristics toward the e learning in Malaysia higher education. Based on the literature review, it seems that slight or not any research has been conducted in developing sustainable e-learning framework for Higher Education Institutions in Malaysia. As a conclusion, this research aims to develop and assess a sustainable e-learning framework that will lead Malaysia to become an expert-driven economy country.

ACKNOWLEDGEMENT

I would like to express my high appreciation to Dr. Tomayess Issa, my main research supervisor, for her patient guidance, valuable and constructive suggestion, and her professional support during the planning and development of this research work.

REFERENCES


TOTAL DESIGN CONTROL WITHIN THE SUSTAINABLE ENGINEERING DESIGN PROCESS

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ABSTRACT

Any new engineering product or system which is presented to the global market has to be designed before manufacture. Normally the driving fundamental for any new product is that of cost. The product must be able to be produced as cheaply as possible to increase the profit margin. It is increasingly important to consider environmental issues when creating new products, but consideration alone is not enough it is important that products and services are created to incorporate “low environmental impact”. This however is a very broad brush approach and needs to be refined so that the product creator (Engineering Designer) can apply principles of sustainability to the new product.

This paper reviews sustainability principles and incorporates and enhances the design and manufacture model to encompass the whole life of the product from “cradle to grave”. Though this is not a new concept the novel sustainability model considers six elements which the product experiences during its whole life and applies the principles of engineering design to each sustainability element. Within this model it is put forward that the design function is the only function within the whole product creation process that can define and direct sustainability principles and apply them to a new product or service. The concept has been developed therefore of “Total Design Control” where it is the designer or the design function which controls and specifies all the phases of product creation from material sourcing, product design, manufacture, product use, maintenance and product disposal.

KEYWORDS

Sustainability, engineering design, design control, embodied energy, environmental protection, Brundtland commission, triple bottom line, whole life model, cradle to grave, natural energy, synthetic energy.

1. INTRODUCTION

In 1987 Gro Harlem Brundtland published the first part of the "Brundtland Commission report" entitled "Our Common future". The report was wide ranging and summarised the three main areas of interest as:

- economic growth
- environmental protection
- social equality

These three elements are commonly known as the triple bottom line. More importantly the Brundtland commission defined sustainability as:

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs”.

True sustainability can be summarised as: Development and use of products and services where ZERO resources are taken from the Earth.

It is evident however that true sustainability can NEVER be achieved but may be slowed appreciably by applying sustainability techniques. Excellent examples exist in the built environment where recycling of materials has been used for thousands of years. Figure 1 shows an example of re-use of materials where Byzantine figurines have been used to help refurbish the citadel walls in Ankara, Turkey.
The practice of using materials from disused buildings has been used elsewhere, where castles have been levelled by peasants who reused the material to build their own homes.

The application of sustainability principles in mechanical engineering has hitherto rarely been implemented but it is evident that many large companies are now taking the issue seriously.

2. SUSTAINABILITY: WHOLE-LIFE ASSESSMENT

2.1 Classic Design and Manufacture Model Extended to Encompass Sustainability

Sustainability affects a product from sourcing the material through to its eventual end of life disposal. Many people consider recycling materials as the only element of sustainability that can be applied but that can never be enough, being only a small fraction of the possible implementation of sustainability which can be achieved should those principles be applied throughout the life of the product.

The classic design and manufacture model shown in figure 2 has been used for centuries. The designer receives the brief, creates the concept design, converts the concept design into manufacturing drawings which are then used by the manufacturing function to create the product. The product is then shipped to the market where it fulfils its purpose. The company however is inclined to forget about the product preferring to concentrate on new production and earning new revenue. This model is adequate if resources are plentiful but it does not allow any mechanism for sustainability principles to be applied to the product.

The whole life view of the sustainability model is now applied to the classic design and manufacture model modifying it as shown in figure 3. The novel sustainability model shown in figure 3 proposes six elements which govern the total life of the product into which sustainability values can be inserted.

1. sustainable sourcing
2. sustainable design techniques
3. sustainable manufacture
4. sustainable use
5. sustainable maintenance
6. sustainable disposal

It can be seen that several extra elements have been included enhancing the original design and manufacture model. Sustainable material sourcing begins with when the briefest received. Sustainable techniques can then be applied at each stage. It is important to understand that the application of sustainable design techniques stretches from receiving the brief through all the phases of product creation, right through to disposal of the end of life product.
The view is taken that if a product's life can be extended indefinitely then there will be a reduced need to manufacture new products. To this end the model in figure 3 shows that product maintenance has now been elevated to a major phase within the life of a product. Maintenance along with remanufacture and refurbishing are applied to extend the life of the product and are much kinder to the environment than extracting primary materials. Remanufacture and refurbishing are included within the end of life disposal phase.

A typical example of a long-lasting product is the 70 cc motorcycle shown in figure 4. These machines are the preferred mode of transport for millions of people in India and Pakistan. They are simply constructed and easily maintained with every part either repairable or replaceable. Sacrificial components such as tyres, bearings and seals can be wholly or partially recycled when they have worn. In use the small engines offer minimum pollution to the environment and when finally at the end of their life components can be refurbished, recycled or reused.

2.2 Traditional Approach

Design for manufacture has been a theme of designers for many years but the demands and expectations placed on the designers of new products means that the design function has to be expanded. There has always been a drive to reduce the creation costs of products. Indeed cost reduction of new products is a primary objective for designers and manufacturers alike. A quote from an anonymous industrialist defines the problem:

- "Everything costs money"

Recent years have seen a growing emphasis on providing products which are environmentally friendly (sustainable). It is a fact that many businessmen, designers and manufacturers consider this as an expensive enterprise but in reality the design and manufacture to sustainable values and requirements often leads to lower cost production.
2.3 Design for Sustainability: Umbrella Model

The traditional design and manufacture goal of designing to cost has now been joined by the need to design and manufacture to ensure sustainability. The quote from the anonymous industrialist can be enlarged as follows:

- "Everything costs money and everything has an environmental impact"
- Perhaps this can be redefined as:
  - All new products cost money
  - All new products "take" from the environment

All new products therefore need to be developed for low cost and high sustainability.

Sustainability and low cost often go hand-in-hand. It can be argued that products designed with sustainability as one of the primary objectives can also be designed under an umbrella of sustainability covering all other facets of the design process.

2.4 Embodied Energy

Energy is required whenever a process is applied to a material. A finished product has had expended on it a certain amount of energy which can be considered as "Embodied Energy" [1]. This value of energy is a combination of Synthetic Energy and Natural Energy.

The Embodied Energy can be gleaned from two broad sources which can be termed "Natural Energy" and "Synthetic Energy". "Natural Energy" is energy gleaned from the environment and can be replaced or re-gathered such as through wind generation or solar generation. "Synthetic Energy" can be considered as energy whose source cannot be replaced. This is essentially fossil fuel generated energy. The current usage between natural energy and synthetic energy can be seen in figure 5. This shows that current fossil fuel energy (Synthetic Energy) is around 88% with natural energy contributing only 12%. Projections indicate [2, 3] that by 2050 synthetic energy will have reduced to only 60%, natural energy contributing 40%.

![Figure 5. Embodied Energy Proportions [2, 3]](image)

It is important that the Embodied Energy value is quantifiable. Since every aspect of the design and manufacture of a product demands that energy is applied it seems that a value of energy process is an appropriate measurement value. This complicated process has been instigated by Granta Design Ltd of Cambridge, UK in their software package CES Edupack. Granta Design have created a very sophisticated software tool which calculates the embodied energy at various stages of a products development. [4]

3. TOTAL DESIGN CONTROL

Under normal design activity, where reducing cost is the main focus the design function generates 80% of the manufacturing cost [5]. It is therefore reasonable to expect the design function to implement sustainability techniques as part of the design focus alongside cost reduction.

It can be seen from the Sustainable Whole Life Model in figure 3 that the overall design of a product requires the consideration of the whole life of the product from sourcing through to disposal. This design overview can ONLY be achieved in its entirety by the designer or the design team. The designer or design team has to be in control of all aspects of the design from instigation through to manufacture including other necessary sections such as marketing. This then is TOTAL DESIGN CONTROL.
The application of TOTAL DESIGN CONTROL means that the designer needs to acquire wide ranging skills which cover the whole life of the product. This is a large requirement of any single person. The designer must not design in isolation or there may be a risk of missing some aspects of sustainability through inexperience or ignorance. The alternative is that the designer assembles a design team with expertise in material sourcing, transport, manufacturing, maintenance, marketing, recycling, etc. The product is then TOTALLY created at the design stage reducing the need for expensive iterations and modifications as each expert processes his own particular element of expertise during the life of the product. The thought given to a product at the design stage can therefore suitably include sustainability where processes can be selected for low energy input.

This approach therefore reduces the Embodied Energy within the product thus reducing the costs of sourcing, manufacture, lifetime use and eventual disposal. The truth is that any product will be expensive if created with inefficient or ill-considered processes. A reduction in embedded energy is also a major goal of "Design for Sustainability" and is therefore symbiotic with a desire to create products at a low cost.

The design and manufacture process should now involve:

- design for low-cost product creation, and
- design for sustainable product creation

Products designed and created with sustainability as the primary objective can be created under the umbrella model of Sustainability which encompasses all the facets of design and manufacture.

Consider the Sustainable Whole Life Model shown in figure 3. This can be used as a guide to show the elements which the designer needs to consider and which are set out in the Sustainable Design Objectives Model below in figure 7.

<table>
<thead>
<tr>
<th>Sustainable Sourcing</th>
<th>Transport, Source Certification, recycled materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Function</td>
<td>Sourcing, optimisation, strength, modularisation, manufacture, maintenance, usage, disposal</td>
</tr>
<tr>
<td>Manufacture</td>
<td>Manufacturing techniques, smart factories, modular design, common parts, tolerances</td>
</tr>
<tr>
<td>Lifetime Usage</td>
<td>Power sources, pollution, mass reduction, optimisation, energy usage</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Replacement parts, easy access, dismantlable, longevity</td>
</tr>
<tr>
<td>End of life Disposal</td>
<td>Recycle, Re-Use, Refurbish, Reduce</td>
</tr>
</tbody>
</table>

Figure 6. Sustainable Design Objectives Model

The application of sustainability techniques at each stage of the Sustainable Design Objectives Model, figure 6, ensures that all sustainability and cost constraints and requirements are present within the final product. These requirements include standard design requirements such as efficient manufacturing and low manufacturing cost.

The application of the Sustainable Design Engineering Whole-Life Model in conjunction with the Sustainable Design Objectives Model ensures that the designer controls the whole design process and in doing so includes all the design objectives, old and new, required of a new product. The great advantage of adopting the whole life sustainability model is that the designer can oversee the whole process, integrating appropriate procedures and techniques throughout the life of the product. This integration will in turn, create cost and sustainability efficiencies throughout the six phases of the life of a product.
4. DESIGN OPTIONS FOR IMPLEMENTING SUSTAINABILITY WITHIN A PRODUCT

The reduction of Embodied Energy is now the main focus for the design team. If this can be reduced within each of the six phases of the product's life then a higher level of sustainability can be achieved plus a reduction in cost since less energy will be used. Inevitably there needs to be an element of compromise as with most design decisions but a change in attitude by designers which favours sustainable techniques can make positive improvements to the product’s Embodied Energy Value.

In order to implement sustainability techniques the challenge for the design team is wide and varied and will demand a different approach with each varied product. There are, however, universal items which can be implemented for almost any product. There follows brief suggestions of the approach designers could take on each of the six elements of the Whole Life Model.

4.1 Sustainable Sourcing

*Designers Duty:* It is the duty and responsibility of the designer to source materials from sustainable sources or at least from sources which have a reduced impact on the planet’s resources. This emphasis would reduce the Embodied Energy Value.

- source materials from a renewable source (certificated timber, vegetable oils, etc)
- source materials from a local source (thus reducing transport consequences)
- Re-use components
- source recycled materials
- design smaller components where possible, thus choosing less material
- use wind powered/supplemented ocean transport systems as in the Skysails MV Beluga shown in figure 7.

![Figure 7. Skysails MV "Beluga" [6]](image)

4.2 Sustainable Design Approach

Being the major overview element of the product creation process it can be understood that the design function can apply many processes which can improve sustainability values. Some of these processes are obvious and are principally used to reduce cost but equally they can be used to improve sustainability values in a product. Some of these are listed below:

- specify sustainably sourced materials
- use local industries where possible (reducing transport implications)
- design using analytical techniques to refine the product thus using less material/prolonging product life
- design on modern 3-D CAD systems which can build the prototype in a virtual 3-D environment, thus reducing the need for expensive prototype build.
- Reduce tolerances thereby reducing expensive machining time
- reduce loading time on fabrications by stitch welding rather than continuous welding
- design for easy assembly thus reducing assembly time
- design for ease of manufacture, thus reducing manufacturing time
- design the product with easily removable components which can be refurbished or recycled
• reduce the size of the product (reduction of vehicle engine size results in reduced body size, reduced brake systems, improved fuel consumption, etc)
• reduce envelope size for easy packaging and transport
• design for easy maintenance and replacement of parts
• reduce the sophistication (this leads to easier maintenance)
Designers have to take responsibility for the environmental impact of their equipment.

4.3 Sustainable Manufacture

Energy is used to run manufacturing facilities. When a product is manufactured a portion of energy used to run the factory has to be added to the Embodied Energy of the product. It is important for factories, therefore, to reduce their energy output and this can be achieved by several methods some of which are listed below:
• develop efficient manufacturing and assembly procedures
• insulate buildings
• develop rainwater capture systems (“grey” water can be useful toilet flushing, water collected on the roof systems can be used to run water driven turbines)
• introduce skylights rather than use artificial lighting
• apply LED lighting over benches
• anaerobic digestion of sewage
• waste recycling
• low energy evaporative cooling systems to replace air conditioning
• use computer control techniques to plan and implement efficient component distribution

4.4 Sustainable Use

For certain classes of machinery and equipment, life as a working unit is arguably the element in the product’s life which has the most impact on sustainability. In the field of construction equipment and road transport, the energy consumed by a machine in use during its lifetime far outweighs the energy consumed during its production. There follows some suggestions which might reduce the energy consumption and pollution during the life of a product.
• Smaller is better (reduction of mass, engine size, etc. is a major improvement for sustainability of the product)
• optimise the design for specific purposes
• apply electric motors where possible (potentially these can use natural energy)
• use natural energy where possible
• employ systems that "Gives Back"
• use the product less (use a bicycle rather than a car to "pop down to the shops"
The complete non-use of fossil fuel power may not be practically achieved in the short-term but it may be significantly reduced in the future as improved technologies become more prevalent.

4.5 Sustainable Maintenance

If a product's life can be extended through careful maintenance the sustainability value is massively improved since a new product does not have to take its place. During recent decades products have been designed to be "throw away" which is consumer attitude which needs to be changed towards products with a longer life. Techniques of maintenance are generally designed into the component but could include:
• sacrificial elements such as bearings or seals
• components which can be refurbished
• easily disassembled and assembled products
• service in the field function rather than service in the factory
• modularisation of product internals (this makes for easy and quick change of worn parts)
• efficient lubrication
4.6 Sustainable Disposal

The designer is the creator of the product and has the influence to create a sustainably friendly disposal technique. There are several ways that a product at the end of its life may be utilised or disposed of in a sustainable way:

- Recycle (common practice for many materials such as steel, glass, paper, card, rubber, etc.)
- Repair/refurbish (could be included in the maintenance element but is likely to include substantial work other than pure maintenance)
- Re-use (here standard components can be gleaned from end of life products. The use of second-hand vehicle components is an excellent example.)
- Reduce (reduce the size, use, transport of a product will reduce energy use and improve the sustainability)

5. CONCLUSION

As world resources gradually diminish the principles of "build it and forget it" can no longer be valid. The original design and manufacture model is therefore is invalid, out-of-date and increasingly irrelevant. The novel model introduced in figure 3 incorporates the Principles of Sustainability using the original design and manufacture as a base. This new Sustainability Model considers a product from "cradle-to-grave" and embodies six sustainability elements. These include: sustainable sourcing, sustainable design, sustainable manufacturing, sustainable usage, sustainable maintenance and finally sustainable disposal.

It is a truism that 80% of the manufacturing cost is defined at the design stage[5]. Similarly the Principles of Sustainability can only be applied at the design stage. It is within the gift of the designer or the design team to take an overview of the product from sourcing the materials through each phase of the product life down to designing the product so that it can be sustainably disposed.

The application of Sustainability Principles to a new product can only be efficiently achieved by applying the principles of a relatively new concept which is that of Total Design Control where the design function is in total control of the whole process from "cradle to grave". The Design Function is the only element in the creation process that can oversee and influence the creation of a product so that the end result possesses efficiencies to achieve low cost and a high sustainability value.

REFERENCES

SUSTAINABLE LIVELIHOOD THROUGH NATURAL DYEING IN HIMALAYAN REGION

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ABSTRACT

The art of natural dyeing dates back to the Neolithic period, which continued till the onslaught by synthetic colors due to the presumed advantage of reduced costs, durability, brightness etc. Since, natural dyed textiles besides being less pollutive, have an appeal to an eye, are soothing to human body and have important functional properties such as antimicrobial, antiseptic etc., hence have made a comeback, though as a luxury. Apart from these advantages, use of natural dyes also creates income generating opportunities, specifically for those communities, which reside in far flung rural areas like Himalayan region through need of manpower for growing, procurement, processing, distribution, and application besides replenishing the forest, necessary to harbor natural dyes. The paper reviews traditional practices of Natural Dyeing adopted by inhabitants of the Indian Himalayas and derives from the best practices viable in the present context in pursuit of getting insights to further develop sustainable and economically viable micro ecosystems.

KEYWORDS

Himalayan Spectrum of hues, Traditional knowledge driven local economy, Himalayan reservoir of traditional knowledge, Natural dyes and its allied activities, Harvesting of ancient wisdom, Correlation with consumption patterns

1. INTRODUCTION

In the pursuit of satisfying the basic and the cognitive need of looking attractive, the cover ups done by humans on themselves were further decorated through coloring them in different hues, since prehistoric times Saraf D.N.[1]. Evidently, the colors used were derived and painstakingly extracted from abundantly available resources in the surroundings of their dwellings. Ancient communities required plant species for providing a unique Himalayan spectrum of hues for beautifying ourselves and though selfishly, yet enriching the ecosystem. This perfect harmony with nature continued till the onslaught by synthetic colors, due to the presumed advantage of reduced costs, durability, brightness etc. As evident from excerpts from Arthashastra, pictorial representation of colored costumes in Ajanta caves, and usage of mordant fabric and yarns in Mohen-Jo-daro, use of natural colors in diverse canvases has been Indian craftsmen specialty from ancient times [2]. However capital model of growth focusing on industrial and assembly line productions, augmented by invention of chemical dyes, nearly eliminated the use of natural dyes for coloration of textiles. However, due to inherent advantages of using natural colors, growing health concerns among the society has led to inclination of end users in traditional art forms and practices, which has in turn rejuvenated these languishing practice. The psychographics of people in today’s society has undergone a transition; consequently concern; for environment (2), in view of threat to human existence, has reemerged. Textiles and apparels dyed with Natural dyes look great, have an appeal to an eye, have therapeutic usage (3) and can last even longer with sheen and shine. Hence, traditional knowledge vested in the local communities in terms of know-how, extraction of colors and their usage, can be utilized for development, more so for Himalayan ecosystem where self-reliance is the key to sustenance, provided proper precautions are taken. Restoring the use of these dyes may not only provide employment to locals but also supplement their already existing livelihood opportunities. Craft techniques, products and processes from Himalayan region using indigenous material and dyeing techniques have been discussed below to understand the significance and relevance of the same to native communities. Further some of the key initiatives, which have been successful in achieving the desired goals of development and preservance both in terms of traditional knowledge and environment have been
outlined to exhibit the underlying potential of harvesting these traditional practices for coloration of textiles through locally available plant and minerals. Needless to mention, the society and the environment both will be beneficiary in the process. The market potential for natural dyes has substantially increased and hence opens new opportunities for various stakeholders. However, participatory and responsible approach towards its procurement, extraction and distribution has to be ensured, which needs to be undertaken in an ethical and sustainable manner. Banerjee G, Fareedi M. (n.d.)[4]. There are many dyeing clusters in India like Bagh (Madhya Pradesh), Bagru (Rajasthan), Sanganer (Rajasthan) etc. wherein natural dyeing and its allied activities have regained its popularity and as a consequence, dispersed prosperity. Likewise communities from Himalayan range, which traditionally used natural dyeing for coloration of textiles may be encouraged and supported to evolve in making use of these mutually gainful opportunities. Many such Government and Non-Government initiatives have begun yielding results, paving the path forward thus validating empowerment through traditional knowledge driven local economy.

2. CULTURAL REGIONS IN THE HIMALAYAS:

The Indian Himalayan region occupies a special place in the mountain ecosystems of the world. Although a tremendously difficult terrain, the Himalayas are inhabited by sizeable population of 65.67 million belonging to different indigenous tribes, of this 36.32 million reside in India Banerjee G, Fareedi M. (n.d.). The Himalayan region may be considered to be a cultural complex composite of several cultures, cosmoses, rolled into one, each little valley or plateau with its distinctive cultural form. Its altitude changes create different agro climatic conditions and diverse ecosystems. The geographical isolation and adaptation has in fact helped the communities to create and preserve some features and form a unique “Himalayan Way of Life” common across the range. In hilly tracts the vegetation is demarcated on the basis of altitudinal gradient because topographic climatic and associated factors tend to be altered with altitude (Rawat V S, Rawat Y.S. & Shah S, 2010) [5]. Due to substantial isolation, scantily populated areas and lesser means of communications, there is mind boggling diversity. These variations exist at every mile with language, craft, dialect, traditions, agricultural practices, changing patterns. Based upon display of relative consistency, homogeneity and distinctiveness in inhabitant’s lifestyles, this cultured complex can be differentiated into multiple cultural regions: Vertical variation predominantly flowing from ecological factors and lateral variations mediated by ethnicity and migration Banerjee G, Fareedi M. (n.d.). Based upon several socio ecological factors including the main agricultural regime and social organizations, choice by the population of production strategy and potential of change/evolution of the production strategy, the Himalayas, inhabited by many clans, ethnicities and communities can be traced back to four distinct ethnic strains visible today. Guillet David, (1983) [6]. These are:

- **Indic people**, predominantly of the Hindu faith with Indo Aryan languages and art forms, and settled agriculture as occupation
- **Tibetan people** following Buddhism with Tibetan and associated languages, art and culture, and agro pastoralist as the occupation
- **Afghan Iranian people** following Islamic faiths and Islamic influenced art and culture and both pastoralist as well as settled agriculture
- **Burman/southeast Asian people** with a mix of faiths with animist origins and animism influenced art forms and cultures, practicing shifting or settled agriculture or even pastoralist.

These geodynamical important mountain peaks from the stand point of climate and as a provider of life, giving water to large part of Indian subcontinent harbor rich variety of flora and fauna with cultural diversity. However, the unscientific and irresponsible exploitation of natural resources is leading to increased environmental degradation and aggravating the impact of natural hazards. There is need to develop new paradigm to restore the balance between economic interest and ecological imperatives with due regard to socio cultural principles. Tribal communities as well other inhabitants are the repository of knowledge on various aspects of plant utilization, however transformation into botanical systems of many uses remain untouched. Dyes is one the significant usage of a plant as it is associated with customs, traditions, arts and crafts, rituals, weaving etc. Crafts of Himalayan region are in keeping with the available resources, climatic conditions, and tough terrain of the Himalayas. The isolation of the region and long periods of hibernation during severe winter allows considerable time for practicing of crafts and has necessitated self reliance in
their production. Most crafts also serve certain functions of clothing, food and various socio cultural and spiritual traditions. Many Himalayan communities therefore developed superior craftsmanship in bamboo, wood carving, silver and gold articles, weaving of shawls, carpets and rugs. Weaving is almost a household activity for many communities and tribes from Himalayan region, which essentially required yarns to be colored in natural colors, thus exhibiting the inter alliance of the communities with local vegetation with exception when the products are preferred either plain white or naturally colored. In ancient times most of the colors used were produced indigenously or derived from local raw materials.

3. **NATURAL DYEING IN INDIAN HIMALAYAS:**

Each community and tribe, inhabiting Himalayas, and demarcated by virtue of occupying different meadows and valleys, peaks and turfs, living amid formidable conditions, risking their lives for livelihood and cut off from other parts of the world, developed its own distinct way of sustaining the hardships on offer. Yet, similar geographical factors helped shape cultures which were diverse yet strikingly similar. Due to harsh weather conditions during winter, isolation from the rest of the world and prolonged hibernation of these native communities occupying the snow clad mountains, allowed lot of spare time to express their respective creativity which not only was their indigenous solutions to cater to spiritual, social, religious and basic requirements but also way of self-reliance. These unique geographical and cultural dispositions have created inequitable Himalayan reservoir of traditional knowledge. The weaving of shawls, carpets, chaddars and durries in the region is of prime importance as they are used extensively by distinct communities not only to protect them from harsh weather but also express their respective identities amongst the sea of these tribesmen. The striking bright colors used by some communities specially Ladakhis, tribes from Manipur, Nagaland, Arunachal Pradesh etc. and subtle colors used by some of the weavers of Kashmir, all were traditionally derived from naturally available resources. The process of extracting colors from these resources like bark of trees, petals of flowers, turmeric, shrubs at very high altitude took lot of time, skill and traditional know how which was carefully preserved amongst themselves from generation to generation. Use of these colors and beauty of these crafts took a beating after onset of synthetic colors. A distinctive style of carpet weaving is adopted in mountainous regions of India. Right from Leh to Darjeeling, Gangtok (Sikkim), Imphal ( Manipur), Bomdila and other places in Arunachal Pradesh the carpets are made in glowing colors. The technique of making is essentially central Asian. The Bhutia’s in Darjeeling region of West Bengal make Durries largely with the motifs of dragons, flowers etc. in bright colors. Tibetan craft center at Darjeeling (West Bengal) produces a wide range of colorful products intimately related to Tibetan way of life. Here carpets made up of cotton for warp yarn and thick woolen weft yarn is, woven. The carpets are traditional in designs and yarn dyed in vegetable colors.

Carpet weaving with pre dominantly Tibetan motifs is a specialty of Arunachal Pradesh. Till 1860’s carpets in Kashmir were made from dyes extracted from vegetable or animal sources. The people were experts in the art of dyeing and the results of their artistry provided an extremely subtle yet luminous range of colors. Dyes were made of madder root which grew in wild provided the most important range of pinks and reds. Cochineal and turmeric were also used for the shades of red. The saffron crocus, cultivated in the fields of pampore in Kashmir provided yellow while its wild counterpart as well as pomegranate skin and distilled turmeric provided the reddish yellow. The rhubarb plant is said to provide dark red and copper red. Green came from the local grass and brown from the leaves of kikkar trees. Cited by Jaitley J. ed. (1990a) [7] “when one contemplates on early carpets, the pile is brought to life with an interplay of infinite reflections, it is impossible to achieve such an alluring sheen with chemically dyed wool”. The carpets from Ladakh have a distinctively Tibetan influence. The colors used are vegetable dyes including indigo which are used in monasteries by lamas during prayers. There are many women weavers for whom weaving is a way of life in Assam, Manipur, Tripura and other North Eastern states. Here weaving is more vocational than occupational supplementing livelihood which comes mainly from agriculture and animal husbandry. Women generally weave cloth and men and women share equal status in the society. Each tribal community has specific motifs and colors for shawls and sarongs, which are also used for welcoming guests in place of garlands. It is customary for Assames girls to make a present of self wovenbihuan (gamosa towel) to her beloved as token of love and to elders as a symbol of respect on BohagBihu (New Year’s Eve) Jaitley J. ed. (1990b) [8]. The weaving is done on comparatively larger looms in Arunachal Pradesh. The colors which are used for dyeing
of yarns are obtained from bark, roots and leaves and seeds of the trees found in the vicinity. Tudub Jackets, shawls, Aptani jackets, loin cloths are some the products which are woven. Carpet weaving is done with wool dyed with some naturally obtained vegetable dyes. Many plant based technologies are available with Adi tribes for multifaceted harvesting of rich biodiversity conserved in jhum land and community forests. The revival and sustenance of these indigenous technologies is only possible through integrated and holistic approach Singh R K, Singh A, Hui Tag and Adi Community, (2007) [9].In Mizoram, ‘Punas’ in numerous designs are produced by the inhabitants on traditional handlooms, products include lungis, shawls, shoulder bags, and silk weaving is also extensively undertaken. Use of natural dyes is still in practice in some parts of Assam. These dyes are obtained from various parts of plants and herbs such as stem, wood, root, bark, leaf, flower, fruits, and seeds etc. Women of the rabha tribe weave beautiful ‘rabhakambang’, which is a shawl worn over the shoulder. The art is taught by every woman to their daughters when they are 12 or 13. Weaving is carried out along with the major task of mustard and rice cultivation so the pattern progresses slowly. Assameese weavers produce beautiful dragons on the borders of their mekha, chadar, riha, and gamosas. Cotton decorative textiles include bed spreads, furnishing materials, shawls and saris. The lasingphee produced by weavers of Cachar district is extraordinarily warm and soft. Dyeing traditionally is closely associated with weaving and is an ancient art in Assam.Chakravort R, Dutta P &Ghose J, (2010) [10].

Dyes are extracted from bark, seeds, flowers, leaves, fruits and roots. The most extensively used include Indigo, turmeric, morinda, madder, elephant apple etc. Those derived from animal sources such as lac, kermes, cohneal, lichen etc. are often used for dyeing of eri silk. The textile weaving on narrow loin looms varies from tribe to tribe in Nagaland. Cotton is grown in plenty and hence naga clothes are made of local materials. Nagas are famous for their shawls and within the same tribe everybody is not allowed to wear any type of shawls as per their respective choices. The famous amongst the shawls these nagas weave are decorative warrior shawls ‘subgkotepsu’. Natural dyes extracted from tree roots and leaves are used for coloring threads [11]. Tripura, spread across 19 tribes has a variety of tribal crafts (especially textiles), which are often associated with their social or religious life. Handloom weaving is the most important craft of the state. The tribal people produce their own garment material with elegant designs, unique color combinations and lasting lusture. It was a prerequisite for every tribal girl to know how to processes and weave the garment otherwise she would not be considered eligible for being a bride. Traditionally the yarn used was cotton, which was cultivated in the jhum fields, hand spun and naturally dyed by the weavers themselves. Up to nineteenth century every family had a handloom, irrespective of the cast or the community. Generally the women would learn weaving and allied processes from their mother or grandmother but gradually this tradition is decreasing due to other avenues for earning. Frame looms are used to produce ‘riha, lungi’, ‘sari, chaddars’ with vertical and horizontal stripes along with scattered embroidery in multiple colors. The fine warp striped ‘phaneks’ (sarongs) woven on loin looms in the valley are beautiful examples of the traditional craft omnipresent in Manipur. Vegetable dyes are still used for dyeing in this part of the country; juice of wild indigo is used for obtaining black or dark blue while green and yellow are produced from the bark of the jungle trees. Moirangphijanbapheematek (women’s chadar), leirum (shawls), rani phee(chaddar), are woven with various distinct motifs and shades and are treated as status symbol. Artistic weaving in Meghalaya is well known for its multicolored effect. Traditionally, cow dung and phijuhidak (traditional powder made from plant) were used to bleach; this practice is no more in use since it was time consuming. Detergent and blue such as neem was used for bleaching warps, wefts and fabrics. Rice and maida powder was used for sizing and dyes from barks, leaves and roots of different plant sources for coloring.Pandya Thoudam J (2010) [12].

Although the weavers of Kashmir were deeply involved in shawl weaving but due to mechanization and some external factors they shifted to carpet weaving during nineteenth century. Designs are codified in paper and then sung as a talim, wherein other fellow weavers follow the rhyme to match it while interpreting the code and weaving accordingly during preparation of Kani shawls. It takes two weavers three months to produce one kani shawl during training.Jaitley J. ed. (1990a). Pre loom and post loom activities includes stretching the yarn out of the twisted hanks which is done by women and children. The farmer is also a part time weaver. The long chill of winter keeps him indoors where his womenfolk spin yarn from the fleece of their goats and settles down in his loom to weave thick ‘chaddars’ which serve as large shawls or blankets. Bandipur and pamparechaddars have solid body color with a decorated selvedge and janjeer or chain-stitch of multicolored thread. Gujjars and Bakriwals, the nomadic Shepard’s carry these chaddars over their shoulders all through the year. Kishthwarchaddars spots bold checks often in combination of red cream and black made from vegetable dyes. The ‘Gujjars’ ‘Banihara’ and ‘Bakriwals are more or less nomadic. They travel across
back and forth borrowing, returning and taking from the crafts and cultures and drawing the invisible thread of all these into themselves as a unique face. Shatoosh shawls woven out of the fleece of the Tibetan goat, is collected at high altitudes of Ladakh and brought to Srinagar where women engage themselves in spinning it to very fine yarn. This is then woven into shawls which are light, warm and extremely subtle. Traditional chhimba (sheet printers of the town) from old printing center in the north ‘Samba’ in Jammu were best craftsmen. They developed many number of patterns on wooden blocks to emboss on hand-woven cotton sheets in soothing vegetable hues. Samba was famous for its calico printing at the time when the printing industry in other parts of India had yet not developed. Items produced include floor coverings, bed spreads, table cloths, yardage and masnads. It is hardly known that tie and dye technique is also practiced in Ladakh. Soft shoes made of felt with leather soles are worn by local population along with their traditional dress. The stripes of their shoes are tied and dyed in the tiny felt used for village of ‘Shey’ outside Leh. Portions of felt are knotted and dipped in the dye leaving the main portion of felt in the basic colors of cream Jayitley J. ed. (1990b). As in Kashmir, Ladakhi women do not do weaving traditionally as they do so in nearby regions of Spiti, Nepal and Tibet, but spend there spare moments in spinning yarn on wooden spindles. The artisan of Ladakh region exchanges his skill, time and labor through exchanging of goods from the locals. The yarns for Ladakhipattu, frukpattu etc. are spun exclusively by women which is their perennial occupation Saraf D.N. (1985). The special quality pattu from Sopre was in compact weave and was made out of fine quality yarns mostly in natural colors though use of vegetable dyes like walnut bark were occasionally used. Unfortunately the craft had died because of alternative livelihood opportunities of using the land in form of apple cultivation. In tilled, rawa type chaddars are made using yarn colored with locally available vegetable dyes. Till now the local needs of the population is being catered by local craftsmen weaver who work under the master craftsmen in workshop system. The artisan has more or less remained linked with the mountain ecosystem supplementing his rustic agrarian livelihood through craft traditions. Shawls are Himanchal’s specialty. The favorite designs include geometric patterns and intense purples, blues, emerald greens and burnt saffron’s are used. Hill folk rear sheep and goats high in the Himalayas for the famous wool and hair that goes into making of the Himanchal blanket and rugs. Carpets, furnishings and even horse saddles are woven for personnel usage in brilliant hues. Nearly 20 plants species are used by Gaddi tribes for preparing dyes to impart various colors to these shawls, and textiles and carpets.

The population of Uttarakhand is heterogeneous with several tribal communities like Bokshas, Bhotias, Gujjars, Marchchas, Tolchas, Jaunsaris, Koltas, Gangwals, BaunRauate etc. occupying the terrain. The main occupation of the locals is agriculture, substantiated with livestock farming, Marchchas, Bhotias, gangwal are well versed with sheep farming and wool based profession including natural dyes. Light solution, of organic manure, cow dung or urine, cream of tartar, curd water, ash ofwood or bark, lemon juice are some of the materials which are used by the locals for mordanting. The Bhotia tribes of Garhwal region are well known for their expertise in making woolen garments, besides processing and coloring of wool Sharda N L, Rastogi D. (2009) [13]. Women are the real keepers of this indigenous knowledge on the making of natural dyes. The entire division of labour is based upon the internal adjustment of the family, right from collection of raw material to the marketing of woolen products. The indigenous practices evolved to maintain the industry which were based on personnel interactions and keen observations of the environment Kala, C.P. (2002) [14]. The handlooms and handicrafts are integral part of the cultural tradition of Garwhal and of all the cultural regions of Pandit P (2009) [15]. The vibrant natural colors, the intricate designs that characterize the Himalayan woven crafts, are also an expression of the rich natural & cultural heritage of the region. Sharda N L, Rastogi D. (2009), Deriving from this repository of knowledge, the best practices thus can be summarized as follows:

(1) The communities and tribes of Himalayan region have been using indigenous colors and locally available resources for the pre-processes, dyeing and printing. The crafts are best suited to the available resources and to the immediate environment.

(2) The product gamut does have a correlation with consumption patterns. The whole process including dyeing can be said to be vertically and horizontally integrated and the communities practicing them are more or less self-reliant. This increases the scope for allied industries and activities to rejuvenate.

(3) The processes involved have association with the social and religious values. Weaving beautiful designs from naturally colored yarns in brilliant hues is socially desirable skill cutting across cast and communities.
(4) The craft practices are often supplementary to main livelihood activities like farming and animal husbandry and are function of occupational pattern of the respective communities. There is a strong interdependence and interrelation amongst various sources of livelihood leading to differentiation advantage.

(5) The crafts practiced are also expression of respective Identity of the communities practicing them. Transfer of knowledge to young generations from their mothers as a custom is embedded in the social fabric.

(6) There is clear segmentation of various functions involved amongst the family members, probably to optimize resources as well as time.

(7) Protection of intangible assets which were in form of skill set and indigenous know how and trade secrets was confined to the respective communities or tribes practicing it.

(8) Indigenous communities can gain through protecting their secrets through strong Intellectual property (IP) protection like Geographical Indication (GI) and harvesting of ancient wisdom by current and future generations by putting suitable systems in place.

4. SUCCESSFUL INITIATIVES DERIVING FROM TRADITIONAL KNOWLEDGE

Initiatives to preserve and promote indigenous traditional knowledge including art of natural dyeing have been undertaken by handful of agencies and individuals deriving from the best practices. Natural dyeing, being a predecessor activity is an integral part of weaving traditions:

Appropriate Technology of India (ATI) is working in District Rudraprayag on exploring the viability of commercialization of Natural Dyes Production from Invasive Species. The project is addressing the environment conservation issue by finding the utilization aspects of the invasive weed and livelihood generation by involving the communities in eradicating the weed and using it as the natural dyes. ATI has also been working on eliminating the economic disadvantages of the usage of natural dyes. The dyes are derived from a number of locally available natural substances and Dyeing operations are carried out by the trainees, under the supervision of master craftsmen well versed in his trade. Avani, working in the Kumayon region is trying to revive the skill of natural dyeing in the area through intensive training inputs and an increased color palette. New sources from which dyes can be extracted have been identified so that the raw material is available in abundance in the micro environment of the respective communities and colors are stable. "MAGRAUS" is working with the Bhatia tribes of Dharchula and Munysari in standardizing the process of natural dyes for carpet weaving which is undertaken by tribals as a household chorus.

Pragya, a voluntary organizations working in twelve high altitude districts in upper Himalayas including Ladakh and Spiti. The strong interrelation between people and plants is being documented and revitalized by the initiatives undertaken by them. Ethno-botanic Centers and Museums have been set up in each distinct Himalayan zone that displays the herbal wealth of the area along with the traditional knowledge about the species and their many local uses including crafts.

Indian Institute of carpet technology has initiated to revive the indigenous crafts of Kashmir and their dyeing process with bright natural colors. As the buyer sentiments are changing and shifting towards greener processes the institute has started providing ‘green dying’ facility to the weavers. Almost thirty different shades have been prepared by them to cater to all possible hues. To complete the pelothra of color range even dye powders from outside Kasmir is also being procured. The facility shall be available to the weavers on nominal charges. iictgr.org (n.d).[16]. Adequate training for standardization of dyeing process, technical knowhow and technical assistance is being provided at the Institute and it’s Design studios, so that the side effect of using chemical dyeing on quality and properties of fiber may be known by the practicing artisans. Software called ‘Naqash’ for the development of designs easily and speedily has been developed along with the establishment of carpet designing studio. fibre2fashion (n.d.) [17]. Kani shawls of Kashmir have been provided Geographical Indication (GI) status. A kani shawl is produced from pashmpina fiber which is known the world over as cashmere wool and is obtained from goats bred at altitudes between 12000to 14000 feet. Micro chips on each of the kani shawls shall be used to ensure quality products. The patima and the ‘Kashmir sozni’ shawls have also got the GI tag Jammu & Kashmir update (1010) [18].
IGNOU Institute for Vocational Education and Training (IIVET) is conducting training programs at its Shilong center in the Natural dye technology sector. The target of the initiative is to provide vocational training to farmers, unemployed youth, school drop outs, street children and domestic workers, the initiative will help in preserving and promoting indigenous knowledge and technology in North Eastern states and also provide the necessary skill sets to the beneficiaries so that they can earn their livelihood (IIVET) [19].

Under the KVIC-IIT Guwahati TBU interface project, eco-friendly vegetable dyeing of Silk available in North Eastern Region has been carried out and implemented through NGOs. The project involves Standardizations for various input materials and shade cards. Indian Institute of Entrepreneurship has set up states’ center in seven North Eastern states with its regional center in Guwahati which is working towards catalyzing the growth of indigenous crafts through capacity building, handholding and devising policy interventions in sustainable cluster development. Such a mechanism will provide shared platform to all the clusters for mutual interactions which would help create a repository of knowledge of best practices and learn from each other’s strength. One such successful intervention is the umdenEri cluster, comprising of 17 villages 20 kms from District Headquarters of Nongpoh, where, weavers, rearers, dyers and spinners are the major stakeholders. The unique characteristics of the artisans here is their expertise in Natural dyeing and indigenous designs. The number of active artisans is 246 and interestingly all are female. Special purpose vehicle has been initiated for cluster development with the participatory approach with all the stakeholders like banks, Government Institutions etc. Indian Institute of Entrepreneurship (2009) [20].

5. CONCLUSION

Clearly indicate advantages, limitations and possible applications. In almost all of the Himalayan region, the traditional processes of extraction and application of natural dyes has evolved in view of availability of resources in the immediate environment and sustenance of local ecology. The concerned population developed the art of usage of natural dyes and its use in the local crafts has also been exuberantly prevalent and pre-dominantly articulative. The basic theme behind the development of this art form has been expressively towards the mechanism of economic development concerned with self-employment generation and consumption of manufactured goods and thereby creating an economy towards sustainable development. Though, structured development may lead to reduction in poverty amongst the local populace of the region, yet revival of these traditional processes evolved through centuries and adapting itself by taking cues from the changing immediate environment seems to have much more potential in achieving twin goals of attaining development and addressing sustainability concerns. For centuries, this economic activity created an access to the growth of local ventures into larger components of variable, markets for such produced goods. Nonetheless, the use of the chemical dyes has brought into a new dimension to such economic activity with creation of new growth components. However, old pattern has prevailed over the newer techniques with the factors of regional cultural pattern creating more feasibility of acceptance than the new patterns of coloration by chemical dyes. Revival of the art in a responsible manner and optimum utilization of Intellectual property vested in the Himalayan reservoir of traditional knowledge for coloration, will not only preserve the social and religious fabric but will also provide boost to the respective local economies more so in high altitudes as livelihood opportunities are rather limited.

REFERENCES


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INTERNATIONAL COMPETITIVENESS OF JAPANESE ENVIRONMENT-RELATED TECHNOLOGIES: AN ANALYSIS USING PATENT DATA

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ABSTRACT
In Asia where industrialization and urbanization are still in progress, there is no doubt that environment-related technologies play a crucial role for its sustainable development. Responding to its needs, Japanese firms as well as its central and local governments are active to market their environment-related technologies for Asia. However, there seems the gap between the technological advantage and the international competitiveness of Japanese environment-related industry. Japanese environment-related industry must have the technological advantage in general, but has not gained the international competitiveness yet. The purpose of this study is to investigate whether there is actually the gap between the technological advantage and the international competitiveness of Japanese environment-related technologies using the patent data. The study found that Japan has the relatively higher specialization in overall environment-related technologies and particularly in the three fields such as energy efficiency in buildings and lighting, emissions abatement and fuel efficiency in transportation, and technologies with potential or indirect contribution to emissions mitigation. It also found that Japan has the relatively lower specialization in general environment management such as air pollution abatement, water pollution abatement, waste management, soil remediation, and environmental monitoring though its share in the world’s international patent applications for general environment management is 20.3%. The study also investigated the technological advantage of Japanese environment-related technology using the patent data filed by Japanese nationals to Japan Patent Office and by other nationals to the patent offices in respective their own countries. It found that the number of patents filed by Chinese nationals to China Patent & Trademark Office is the largest whereas the one by Japanese nationals to Japan Patent Office is the second largest. However, this finding can’t say much about the gap between the technological advantage and the international competitiveness of Japanese environment-related technologies since it is uncertain whether the technological fields covered in the environment area in the database of Japan Patent Office and those covered in the environment-related technologies in the OECD patent database are consistent.

KEYWORDS
Environment-related technologies, international competitiveness, Japanese environment-related industry, patent data, revealed technological advantage index.

1. INTRODUCTION

In Asia where industrialization and urbanization are still in progress, there is no doubt that environment-related technologies play a crucial role for its sustainable development¹. Responding to its needs, Japanese firms as well as its central and local governments are active to market their environment-related technologies for Asia. However, there seems the gap between the technological advantage and the international competitiveness of Japanese environment-related industry. It is generally acknowledged inside and outside Japan that Japanese technologies are advanced. This common view is particularly referred to its manufacturing industry including automobiles, electronics and etc. It has been built up over many decades,

¹ Environment-related technologies referred to in this paper is intangible, thus being different from tangible products such as environment-related equipment, machines and etc. to be produced using those technologies. Furthermore, the OECD categorizes environment-related technologies as one of new technologies. Others are ICT, nanotechnology, biotechnology, nuclear energy and fuel cells (OECD, 2008, pp.14-23).
which has led to the international competitiveness of Japanese manufacturing industry. On the other hand, it seems that Japanese environment-related industry (though being considered to belong to a category of a manufacturing industry) has not established such a solid international competitiveness yet. Pollution abatement technologies have been advanced owing to Japanese tremendous efforts to address serious air and water pollution which Japan faced during its high economic growth period. Energy-saving and recycling technologies have also been advanced owing to external “oil shocks” in the 1970s whereas the development of renewable-energy related technologies are in progress. Japanese environment-related industry must have the technological advantage in general, but has not gained the international competitiveness yet. Possible reason behind this gap between the technological advantage and the international competitiveness of Japanese environment-related industry might be the lack of its marketing strategies, for example in prices, responding to the needs of clients and patenting activities. The purpose of this study is to investigate whether there is actually the gap between the technological advantage and the international competitiveness of Japanese environment-related technologies using the patent data. In this study ‘international competitiveness’ is considered as a result of technological advantage and marketing strategies as well.

Section 2 discusses why an analysis of patent data is appropriate to investigate the technological advantage and the international competitiveness of Japanese environment-related technologies. Section 3 explains the patent data used in this study, particularly the OECD patent database on international patent applications filed under the Patent Cooperation Treaty (PCT). Section 4 explores the development of environment-related technologies in the world using the patent data. Section 5 investigates the technological advantage and the international competitiveness of Japanese environment-related technologies based on the patent data. Finally, section 6 concludes with the summary of the study findings.

2. METHODOLOGY

There are several studies which investigated the technological strength of the countries’ environment-related technologies. For example, Marinova and McAleer (2003) compared the technological strength of environment-related technologies for twelve industrialized countries in the USA using several technological strength indicators based on patent data from the US Patent and Trademark Office during 1975-2000 and empirically demonstrated that three countries, namely Germany, Canada and Japan have the strength in environment-related technologies. Marinova (2008) also conducted a similar study for Asian countries, namely China, India, Japan, Russia, South Korea and Taiwan, to compare their patenting activities in the USA particularly in the area of renewable energy using the patent data during 1975-2007 and found that Japan is not dominant among these six countries whereas Russia and India are active in patenting activities in the area of renewable energy. These studies proved the specific countries’ technological strength in the USA using the patent data. However, it is not certain whether their results are also true in other countries or regions besides the USA. Furthermore, it is not certain whether their results fully reflect the technological strength of the selected countries since patenting in foreign countries is made when conducting international businesses (trade, foreign direct investment, or patent leasing) relating to relevant technologies. Therefore, patenting in foreign countries does not necessarily reflect the country’s overall technological advantage.

This study uses the patent data on Japanese patenting activities at home to investigate the technological advantage of Japanese environment-related technologies whereas using the patent data on Japanese patenting activities abroad to investigate the international competitiveness of Japanese environment-related technologies. Patent data is suitable to investigate the technological advantage and the international competitiveness as well of specific technologies for the following two reasons. First, patent data is more appropriate to measure the research & development activities for new technologies than other indicators. To measure the research & development activities for new technologies in a firm, a region, or a country, several indicators are used. One of such indicators is the investment (the expenditure or the number of personnel) made for developing new technologies. It is an indicator which attempts to measure the research & development activities by their inputs. For example, if a country A makes more investment in developing new environment-related technologies than does a country B, then a country A is considered to be more

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2 Though Japan Standardized Industrial Classification has no category named ‘environment-related industry,’ a wide range of what is generally called ‘environment-related equipment’ is included in a category of a manufacturing industry.
active in the research & development of environment-related technologies and thus to have an advantage in
environmental-related technologies than a country B. Another indicator is the patents. It is an indicator which
attempts to measure the research & development activities by their outputs. If a country A applies for a larger
number of patents of environment-related technologies (or gains a larger number of patents of environment-
related technologies approved) than does a country B, then a country A is considered to be more active in the
research & development of environment-related technologies and thus to have an advantage in
environmental-related technologies than a country B. While more investment does not necessarily guarantee
the development of new technologies, more patents indicates more new technologies developed since the
patents are outputs of the research & development activities. Furthermore, while the amount of expenditure
and the number of personnel for developing even a similar technology must vary across nations, a new
technology is simply counted as one when being applied for its patents. Second, patent data can reflect not
only the technological advantage of a specific country’s specific technology but also its international
competitiveness. Patent data can capture the technological advantage since patents are outputs of research &
development activities. Patent data can also capture the international competitiveness since firms apply for
patents to protect their new technologies in foreign countries when they export the products manufactured
using new technologies to or manufacture them or conduct businesses of leasing their patents, though they
might not necessarily do so in all of the cases.

3. DATA

As discussed in the previous section, the patent data are useful to investigate the international
competitiveness of a specific country’s specific technology. Guellec and Pottelsberge de la Potterie (2001)
demonstrated an increasing trend towards the internationalization of technology, particularly cross-border
ownership and research cooperation, for OECD member countries using the indicators based on a data base
of patents applied to the European Patent Office (EPO). The patent data used in this study come from an
annual report of the Japan Patent Office and also the OECD patent databases, specifically the OECD patent
database on international patent applications filed under the Patent Cooperation Treaty (PCT).

Inventors or applicants file patent applications at domestic patent offices (e.g., Japan Patent Office) or at
regional patent offices (e.g., European Patent Office) or at foreign patent offices. To protect their
technologies in foreign countries, they have to file patent applications directly at foreign patent offices where
they want their technologies protected or file international patent applications under the PCT at domestic
patent offices and then designate specific countries where they want their technologies protected (Japan
Patent Office, 2013a). An international patent application under the PCT is a convenient way since inventors
or applicants do not have to prepare separate application documents for respective countries where they want
their technologies protected. (Filing a single application at a domestic patent office is enough since it is
considered as filing applications to all of PCT member countries.) The term, an ‘international patent
application,’ used in this study implies the patent application filed under the PCT. Counting of international
patent applications is based on the priority date (the date of a first application), the inventor's country of
residence, and the fractional counts on patent applications (OECD patent databases)3.

4. DEVELOPMENT OF ENVIRONMENT-RELATED TECHNOLOGIES

According to the OECD patent databases, the total international patent applications in the world increased 1.5
times from 102,705 to 154,607 during 2000-2009. Figure 1 shows the international patent applications in the
world for selected technological fields, namely biotechnology, information and communication technology
(ICT), nanotechnology, medical technology, pharmaceuticals, and environment-related technologies in 2000
and 2009. ICT shared 40.0% of the total international patent applications in the world in 2000. However, its
share declined to 34.3% in 2009 (though its number increased from 41,061 to 52,982). The shares of
biotechnology, nanotechnology, and pharmaceuticals also declined from 11.9% to 6.2%, from 1.0% to 0.7%,

3 'Fractional counts mean that, for example, if an international application is filed by inventors from two countries, the patent for
respective countries is counted as 0.5 each.
and from 11.9% to 7.1% respectively during the same period. On the other hand, the shares of medical technology and environment-related technologies increased from 7.9% to 8.1% and from 5.6% to 9.4% respectively. These figures indicate an increase either in the relative importance of the research & development for medical and environment-related technologies or in the internationalization (cross-border ownership, cross-border research cooperation, and international businesses) of these technologies during 2000-2009. Among others, the number of international applications for environmental-related technologies in the world increased about 2.5 times from 5,717 to 14,570 during the same period.

Figure 1. International patent applications (filed under PCT) in the world for selected technological fields. (2000 and 2009). Data source: OECD patent databases - Patents by country and technology fields

The OECD patent databases classify the environment-related technologies into seven technological fields, namely, general environmental management, energy generation from renewable and non-fossil sources, combustion technologies with mitigation potential, technologies specific to climate change mitigation, technologies with potential or indirect contribution to emissions mitigation, emissions abatement and fuel efficiency in transportation, and energy efficiency in buildings and lighting. Figure 2 shows the international patent applications of environment-related technologies by selected economy/countries such as EU (27 European countries), US, Japan, Korea, China and India. Particularly, EU, Japan and US are dominant. Their combined share in the international patent applications in the world for environment-related technologies is 87.2% in 2000 and 80.0% in 2009. The average annual growth rate of the international patent applications for environment-related technologies during 2000-2009 is 8% for EU, 20% for Japan, and 9% for US whereas it is 11.8% for the world.

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4 In the OECD patent databases these seven technological fields are further classified into more detailed technological fields.
5 The average annual growth rate of the international patent applications for environment-related technologies during 2000-2009 is 31% for Korea, 35% for China, and 41% for India.
5. INTERNATIONAL COMPETITIVENESS OF JAPANESE ENVIRONMENT-RELATED TECHNOLOGIES

This section tries to investigate whether there is a gap between the technological advantage and the international competitiveness of Japanese environment-related technologies. As mentioned in section 1, the international competitiveness of technologies is the result of the technological advantage and the marketing strategies as well. Therefore, the strong technological advantage of a specific technology does not necessarily imply its strong international competitiveness in the market. Even if a specific technology has a strong technological advantage, its international competitiveness in the market might be weak (and vice versa). A possible way to measure the technological advantage of Japanese environment-related technologies is to compare the number of patent applications by Japanese nationals filed to Japan Patent Office with those by other nationals filed to patent offices in respective their own countries. Table 1 shows the number of patents in environment area filed to domestic patent offices by different nationalities for selected countries, namely Japan, European countries, US, China and Korea during May 2009 - April 2010.

Table 1. Patents in environment area filed to domestic patent offices by different nationalities (May 2009 - April 2010)

<table>
<thead>
<tr>
<th>Nationality Country</th>
<th>Japanese</th>
<th>European Nationals</th>
<th>American</th>
<th>Chinese</th>
<th>Korean</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>3,745 (83.5)</td>
<td>225 (5.0)</td>
<td>361 (8.0)</td>
<td>6 (0.1)</td>
<td>47 (1.0)</td>
<td>106 (2.4)</td>
<td>4,490 (100.0)</td>
</tr>
<tr>
<td>Europe</td>
<td>433 (15.6)</td>
<td>1,362 (49.2)</td>
<td>658 (23.8)</td>
<td>15 (0.5)</td>
<td>50 (1.8)</td>
<td>251 (9.1)</td>
<td>2,769 (100.0)</td>
</tr>
<tr>
<td>US</td>
<td>845 (23.8)</td>
<td>438 (12.4)</td>
<td>1,807 (51.0)</td>
<td>48 (1.4)</td>
<td>139 (3.9)</td>
<td>266 (7.5)</td>
<td>3,543 (100.0)</td>
</tr>
<tr>
<td>China</td>
<td>510 (8.5)</td>
<td>186 (3.1)</td>
<td>427 (7.1)</td>
<td>4,725 (78.4)</td>
<td>62 (1.0)</td>
<td>115 (1.9)</td>
<td>6,025 (100.0)</td>
</tr>
<tr>
<td>Korea</td>
<td>155 (10.5)</td>
<td>52 (3.5)</td>
<td>140 (9.4)</td>
<td>6 (0.4)</td>
<td>1,068 (72.1)</td>
<td>60 (4.1)</td>
<td>1,481 (100.0)</td>
</tr>
</tbody>
</table>

Notice: The figures in the parenthesis are %.
Data source: Japan Patent Office
Japanese nationals filed 3,745 patents (83.5%) out of the total patents filed to Japan Patent Office (4,490). It is the second largest number followed by Chinese nationals who filed more than that, 4,725 patents, to China Patent & Trademark Office. In addition, the numbers of patents filed by Japanese nationals to the patent offices in Europe, China and Korea are not significantly large.

The international competitiveness of technologies can be measured by the international patent applications since firms file them when they engage in international businesses. The larger number of international patent applications implies more trade/foreign direct investment/patent licensing relating to the relevant technologies. Table 2 shows the number of international patent applications in seven fields of environment-related technologies by selected economy/countries. Japan’s total international patent applications of environment-related technologies shares 25% of the world’s total international patent applications of environment-related technologies in 2009 whereas its share was only 15.7% in 2000. The fields of environment-related technologies in which Japan accounts large shares in the world as of 2009 are energy efficiency in buildings and lighting, emissions abatement and fuel efficiency in transportation, technologies with potential or indirect contribution to emissions mitigation, and general environment management. However, Japanese share in general environment management such as air pollution abatement, water pollution abatement, waste management, soil remediation, and environmental monitoring is lower than what is expected from the common view about Japanese advancement in this field.

Table 2. International patent applications in seven fields of environment-related technologies by selected economy/countries (2009)

<table>
<thead>
<tr>
<th>Seven fields of Environment-related technologies</th>
<th>EU</th>
<th>US</th>
<th>Japan</th>
<th>Korea</th>
<th>China</th>
<th>India</th>
<th>Other countries</th>
<th>World</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Energy efficiency in buildings and lighting</td>
<td>365 (33.5)</td>
<td>138 (12.7)</td>
<td>379 (34.8)</td>
<td>46 (4.2)</td>
<td>39 (3.5)</td>
<td>2 (0.2)</td>
<td>120 (11.0)</td>
<td>1,088 (100.0)</td>
</tr>
<tr>
<td>(2) Emissions abatement and fuel efficiency in transportation</td>
<td>1,200 (44.6)</td>
<td>332 (12.4)</td>
<td>860 (32.0)</td>
<td>101 (3.7)</td>
<td>56 (2.1)</td>
<td>20 (0.7)</td>
<td>120 (4.5)</td>
<td>2,686 (100.0)</td>
</tr>
<tr>
<td>(3) Technologies with potential or indirect contribution to emissions mitigation</td>
<td>736 (25.3)</td>
<td>603 (20.7)</td>
<td>1,034 (35.5)</td>
<td>176 (6.0)</td>
<td>102 (3.5)</td>
<td>5 (0.2)</td>
<td>257 (8.8)</td>
<td>2,912 (100.0)</td>
</tr>
<tr>
<td>(4) Technologies specific to climate change mitigation</td>
<td>108 (35.9)</td>
<td>95 (31.6)</td>
<td>34 (11.3)</td>
<td>9 (3.1)</td>
<td>2 (0.5)</td>
<td>4 (1.3)</td>
<td>49 (16.2)</td>
<td>302 (100.0)</td>
</tr>
<tr>
<td>(5) Combustion technologies with mitigation potential (e.g. using fossil fuels, biomass, waste, etc.)</td>
<td>86 (31.0)</td>
<td>118 (42.5)</td>
<td>19 (6.9)</td>
<td>13 (4.5)</td>
<td>5 (1.9)</td>
<td>1 (0.3)</td>
<td>36 (13.0)</td>
<td>278 (100.0)</td>
</tr>
<tr>
<td>(6) Energy generation from renewable and non-fossil sources</td>
<td>1,419 (33.5)</td>
<td>1,150 (27.2)</td>
<td>691 (16.3)</td>
<td>269 (6.4)</td>
<td>171 (4.0)</td>
<td>30 (0.7)</td>
<td>503 (11.9)</td>
<td>4,233 (100.0)</td>
</tr>
<tr>
<td>(7) General environment management</td>
<td>1,065 (34.7)</td>
<td>609 (19.8)</td>
<td>622 (20.3)</td>
<td>195 (6.4)</td>
<td>111 (3.6)</td>
<td>32 (1.0)</td>
<td>435 (14.2)</td>
<td>3,069 (100.0)</td>
</tr>
<tr>
<td>Total</td>
<td>4,979 (34.2)</td>
<td>3,045 (20.9)</td>
<td>3,639 (25.0)</td>
<td>808 (5.5)</td>
<td>485 (3.3)</td>
<td>94 (0.6)</td>
<td>1,520 (10.4)</td>
<td>14,570 (100.0)</td>
</tr>
</tbody>
</table>

Notes: Figures in the parentheses are %.
Data source: OECD patent databases - Patents by country and technology fields

Table 3 shows the revealed technological advantage indexes of seven fields of environment-related technologies for selected economy/countries as of 2009, which are derived from the data in Table 2. The revealed technological advantage index measures a country’s relative specialization in a specific technology compared to other countries. If it is larger than one, it indicates that a country has a relatively higher specialization in that technology. Japan has the relatively higher specialization in the fields of energy efficiency in buildings and lighting, emissions abatement and fuel efficiency in transportation, and technologies with potential or indirect contribution to emissions mitigation compared to other selected economy/countries while having the relatively higher specialization in overall environment-related technologies. On the other hand, the specialization in the fields of technologies specific to climate change

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*"Revealed technological advantage index is based on patent counts and provides an indication of the relative specialization of a given country in selected technological domains" (OECD 2011, pp.182-3). For example, ‘Japan’s revealed technological advantage index for energy efficiency in buildings and lighting’ = ‘The share of Japan’s patents for energy efficiency in buildings and lighting in Japan’s total patents for environment-related technologies’ ÷ ‘The share of world’s patents for energy efficiency in buildings and lighting in world’s total patents for environment-related technologies’
mitigation, combustion technologies with mitigation potential (e.g. using fossil fuels, biomass, waste, etc.), energy generation from renewable and non-fossil sources, and general environment management are relatively lower than EU and US.

Table 3. Revealed technological advantage indexes for seven fields of environment-related technologies for selected economy/countries (2009)

<table>
<thead>
<tr>
<th>Seven areas of environment-related technologies</th>
<th>EU</th>
<th>US</th>
<th>Japan</th>
<th>Korea</th>
<th>China</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Energy efficiency in buildings and lighting</td>
<td>0.98</td>
<td>0.61</td>
<td>1.39</td>
<td>0.76</td>
<td>1.06</td>
<td>0.30</td>
</tr>
<tr>
<td>(2) Emissions abatement and fuel efficiency in transportation</td>
<td>1.31</td>
<td>0.59</td>
<td>1.28</td>
<td>0.67</td>
<td>0.62</td>
<td>1.15</td>
</tr>
<tr>
<td>(3) Technologies with potential or indirect contribution to emissions mitigation</td>
<td>0.74</td>
<td>0.99</td>
<td>1.42</td>
<td>1.09</td>
<td>1.05</td>
<td>0.25</td>
</tr>
<tr>
<td>(4) Technologies specific to climate change mitigation</td>
<td>1.05</td>
<td>1.51</td>
<td>0.45</td>
<td>0.56</td>
<td>0.16</td>
<td>2.06</td>
</tr>
<tr>
<td>(5) Combustion technologies with mitigation potential (e.g. using fossil fuels, biomass, waste, etc.)</td>
<td>0.91</td>
<td>2.03</td>
<td>0.28</td>
<td>0.82</td>
<td>0.56</td>
<td>0.39</td>
</tr>
<tr>
<td>(6) Energy generation from renewable and non-fossil sources</td>
<td>0.98</td>
<td>1.30</td>
<td>0.65</td>
<td>1.15</td>
<td>1.21</td>
<td>1.11</td>
</tr>
<tr>
<td>(7) General environment management</td>
<td>1.02</td>
<td>0.95</td>
<td>0.81</td>
<td>1.15</td>
<td>1.09</td>
<td>1.63</td>
</tr>
<tr>
<td><strong>Total (Environment-related technologies)</strong></td>
<td>1.12</td>
<td>0.77</td>
<td>1.36</td>
<td>1.01</td>
<td>0.49</td>
<td>0.66</td>
</tr>
</tbody>
</table>

Data source: OECD patent databases - Patents by country and technology fields.

6. CONCLUSION

This study attempts to investigate whether there is a gap between the technological advantage and the international competitiveness of Japanese environment-related technologies using the patent data. As shown in the previous section, the study found that Japan has the relatively higher specialization in overall environment-related technologies and particularly in the three fields such as energy efficiency in buildings and lighting, emissions abatement and fuel efficiency in transportation, and technologies with potential or indirect contribution to emissions mitigation. It also found that Japan has the relatively lower specialization in general environment management such as air pollution abatement, water pollution abatement, waste management, soil remediation, and environmental monitoring though its share in the world’s international patent applications for general environment management is 20.3%. The study also investigated the technological advantage of Japanese environment-related technology using the patent data filed by Japanese nationals to Japan Patent Office and by other nationals to the patent offices in respective their own countries. It found that the number of patents filed by Chinese nationals to China Patent & Trademark Office is the largest whereas the one by Japanese nationals to Japan Patent Office is the second largest. However, this finding can’t say much about the gap between the technological advantage and the international competitiveness of Japanese environment-related technologies since it is uncertain whether the technological fields covered in the environment area in the database of Japan Patent Office and those covered in the environment-related technologies in the OECD patent database are consistent.

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Short Papers
CORPORATE SOCIAL RESPONSIBILITY AND SOFTWARE SUSTAINABILITY

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ABSTRACT

Corporate Social Responsibility (CSR) refers to the obligations of a firm to society or, more specifically, the firm’s stakeholders. In general there are five dimensions of CSR: voluntariness, stakeholders, social, environmental and economic. Until now, the environmental dimension has received a lower attention than the others. However, is becoming more and more important, and is being introduced into the industry as part of its business processes. As part of the environmental perspective, we think that the inclusion of new aspects, related to the big presence of software systems into industry is of prime importance. So, in this paper we argue about the importance and necessity of including the software sustainability as part of the CSR of a firm, concretely into the environmental dimension.

KEYWORDS

Corporate social responsibility, software sustainability, Green IT, sustainable development.

1. INTRODUCTION

Corporate Social Responsibility (CSR) involves the voluntary integration by companies of social and environmental concerns in their business operations and relationships with their partners (Green Book, 2000). To ensure its success must involve the entire organization (shareholders, executive committee, directors, managers, employees) and it should be able to be measurable and tangible. CSR is carried out through the implementation of actions from different perspectives: (1) Ensuring good working conditions and social benefits to its employees; (2) Fostering the dialogue with stakeholders; (3) Developing environmentally friendly practices and (4) Enhancing social action. Nowadays there is consensus on the benefits of CSR for organizations. These business benefits of CSR can be classified into monetary (direct financial effects and those indirect benefits that result in cash flows, eg, an increase in the value of the brand) and non-monetary benefits (that influence the competitiveness of the company and its financial success). In Dahlsrud (2008) a collection of definitions of CSR has been recovered deriving that all are consistently referring to five dimensions: voluntariness, stakeholders, social, environmental and economic, concluding that the environmental dimension received a significantly lower attention than the other dimensions. The author exposes as explanation that, as shown by Carroll’s (1999) literature review, the environmental dimension was not included in the early definitions, and this might have influenced current definitions to not include it either. Another and related reason is that the environmental dimension is not explicitly included in the definition, although it is considered to be a part of CSR. This last is also displayed by the World Business Council for Sustainable Development (WBCSD), who differentiates between ‘corporate social responsibility’ and ‘corporate environmental responsibility’ and issue two definitions of CSR, neither of which includes the environmental dimension (World Business Council for Sustainable Development, 1999, 2000). However, nowadays, the environmental aspects are becoming more and more important and are being introduced into the industry as part of its business processes. Moreover, the presence of software systems into industry is also of prime importance, and it is unusual to find enterprises that do not use software systems for their business development. This has been even increased with the usage of web applications and of data centers that have set the trend on the software systems, giving more power to the users by allowing them access to the information anywhere, anytime. But it is not possible to look only to the advantages of the usage of software.
We need to be conscious that all these systems need a great amount of energy to work. The fact that, for example, a query on Google© emits only up to 0.02 grams of CO2 is a confusing data because if we think that 3,333 millions of queries are being executed each day, we derive that the usage of Google© emits more than 770 grams of CO2 per second (more than 66 tons of CO2 per day). This is a relevant data for just the queries of the search engine (it is important to remark that Google© is one of the firms that has a special sensibility with sustainability and has an initiative for paying attention to the sustainability denominated Green Google-www.google.com/green). We think that the example of Google queries and other similar examples underscore the importance that, from the sustainability point of view, has the software systems usage. In the area of Information Technology (IT), for quite some time, there have been efforts related to the so-called Green IT. Green IT (also called Green Computing or ICT Sustainability) is the study and practice of environmentally sustainable computing or IT. This can include "designing, manufacturing, using, and disposing of computers, servers, and associated subsystems—such as monitors, printers, storage devices, and networking and communications systems—efficiently and effectively with minimal or no impact on the environment (Murugesan, 2008). On Green IT several works and research can be found and some results related to the improvement of energetic efficiency have been applied successfully. However, from the software point of view, the research is just starting, and there are few works. Although we consider fundamental to incorporate sustainability aspects as part of the software development (which implies that software development companies are becoming aware of the impact of the products they develop in the environment), we also think that this is not enough. The use of sustainable software should be part of the business objectives of the companies, as part of their corporate social responsibility. This means that it will be necessary to assume that the possible increase of costs of this type of systems (rather than unsustainable software systems) will have a ROI (Return of Investment), both on monetary and non-monetary benefits. In this paper we defend the necessity to include the software sustainability as part of a company's CSR. In the next section we present the environmental dimension of CSR and some general concepts of software sustainability, how to include the software sustainability in the CSR of a company is shown in the third section and the paper ends with our conclusions and future work.

2. ENVIRONMENTAL DIMENSION IN CORPORATE SOCIAL RESPONSIBILITY AND SOFTWARE SUSTAINABILITY

CSR refers to the obligations of the firm to society or, more specifically, the firm's stakeholders—those affected by corporate policies and practices (Craig, 2003). Corporate social responsibility can only have real substance if it embraces all the stakeholders of a company, if it is reinforced by changes in company law relating to governance, if it is rewarded by financial markets, if its definition relates to the goals of social and ecological sustainability, if its implementation is benchmarked and audited, if it is open to public scrutiny, if the compliance mechanisms are in place, and if it is embedded across the organization horizontally and vertically (Frankental, 2001). As mentioned previously, the sustainability perspective of the CSR is the one that has been paid less attention. However, Thorpe y Prakash-Mani (2003) present six business success factors of sustainability: (1) growth in revenues and market access; (2) cost savings and productivity; (3) access to capital; (4) risk management and license to develop the business; (5) human capital; and (6) value brand and reputation. Following Schaltegger and Wagner (2006), the sustainability indicators can be used to identify five effects that arise when addressing some environmental and social issues: direct financial effects (eg, fines, charitable contributions); market effects (eg, customer retention); effects on business and production processes (eg, lower production costs); and none market effect’s (for example, a lower resistance of the stakeholders in terms of production facilities). It is possible to speak about three sustainability pillars at the business level (Castelo and Lima, 2006): (1) economic sustainability (for example, wealth creation through the goods and services produced); (2) environmental sustainability (for example, efficient environmental management and protection); and (3) social sustainability (for example, enhancement of social wellbeing through corporate philanthropy). So, we think that it is of prime importance to pay the necessary attention to the environmental dimension of the CSR and as part of it, to the impact of software on environment.
Sustainable Software is software, whose direct and indirect negative impacts on economy, society, human beings, and environment that result from development, deployment, and usage of the software are minimal and/or which have a positive effect on sustainable development (Dick et al., 2010). This idea can be extended and cover the whole software development process. Thus, we can refer to a sustainable software development defined as “a mode of software development in which resource use aims to meet product software needs while ensuring the sustainability of natural systems and the environment” (Calero et al, 2013a). While sustainability is a standardized practice in a number of engineering disciplines there is currently no such awareness within the software engineering community, as remarked in (Penzenstadler et al, 2012). From the results obtained from a SLR (Systematic Literature Review) in Calero et al. (2013b) it seems that most of the effort on achieving sustainable software is focused on improving its power consumption. However, this is a very restrictive interpretation of what software sustainability is, and nowadays it is possible to find works where other aspects related to software sustainability are covered. Some works are being developed on software systems but most of the work has been done on data centers because energy consumption of data centers is significantly higher than that of commercial office space, as proves the results on Masanet et al., (2013). The huge energy consumptions of data centers (in 2010 of about 1.3% of all electricity used for the world, Koomey, 2011) demonstrates the significant potential of energy saving, and make data centers the desired target of energy conservation measures, driving the creation of next generation datacenters (Sharma et al., 2008). In Masanet et al. (2013) authors estimate that the present day primary energy combined footprints of systems for business email, productivity, and CRM software in the United States add up to as much as 373 PJ per year (as an upper bound).

As we have tried to illustrate, although in its beginning, the software sustainability is a very important topic of research that will be of great importance on the next years. But a general work on the importance of it is needed, with the aim of raising awareness to each of the people involved with software: the firms that develop software, the ones that buy software and also the people that use it. This means, more or less, anyone. And that can be achieved, at least in part, by including software sustainability as part of the CSR.

3. SOFTWARE SUSTAINABILITY AS PART OF THE CSR

The environmental dimension of CSR refers to an organization impacts on living and nonliving natural systems, including ecosystems, land, air and water. Environmental indicators cover performance related to inputs (materials, energy, water) and output (emissions, effluents, waste). They include performance related to biodiversity, environmental compliance and other relevant data such as environmental expenditure or impacts of products and services. The Global Reporting Initiative (GRI, founded in Boston in 1997) has pioneered and developed a comprehensive Sustainability Reporting Framework that is widely used around the world. The Framework enables all organizations to measure and report their economic, environmental, social and governance performance. (www.globalreporting.org). According to the GRI, the environmental section should include a concise statement of each of the elements of the management, in relation to the following environmental aspects: Material, Energy, Water, Biodiversity, Emissions, Waste, Products and Services, Compliance, Transport and general aspects. Looking at these indicators and focusing on software sustainability, it seems that those that can influence are the ones related to energy and materials. The others do not seem to be related to software sustainability, at least in a direct manner although it can be an indirect impact due to the mandatory usage of hardware components (more related to GreenIT). It is hoped that at some point also the regulatory compliance should be taken into account although presently no regulations exist. It would be possible to consider the inclusion of emissions and waste, however, we believe that a software system does not emit pollutants by itself and does not generate wastes (even if we consider the physical repositories of data or computers as part of the system they cannot be considered as waste because they only are discarded once, at the end of their life cycle). If we focus, then, in the areas of materials and energy, then the sustainability issues within the CSR software should be included in: Materials: EN1 Materials used by weight or volume, EN2 Percentage of materials used that are recycled input materials and Energy: EN3 Direct energy consumption by primary source, EN4 Indirect energy consumption by primary source, EN5 Energy saved due to conservation and efficiency improvements, EN6. Initiatives to provide efficient products and services in the consumption of energy or renewable energy based, and reductions in energy requirements as a result of these initiatives, EN7 Initiatives to reduce indirect energy consumption and reductions achieved through these initiatives.
As can be seen this means that it is necessary to work on aspects such as improving the energy efficiency of developed software products, and also in the use of other resources such as hardware, time execution or bandwidth usage. The idea is to implement and have sufficiently powerful software for the users and also environmentally friendly. Perhaps this means do not have the most optimal results although good enough. It will be also necessary to look beyond the simple data results in terms of execution times. It will be necessary to pursue the obtaining of software capable of lasting over time, not dependent on the version of the operating system or the hardware. It will be necessary to end with the so-called built-in obsolescence, being necessary to defend the durability of software systems. Obviously this is not easy to do understand to a society increasingly dependent on technology and with more haste. A society used to search everything, to want everything, now and quickly. So, it will be necessary to work also in other areas to potentiate the necessity of the software sustainability in society in general and in companies’ CSR in particular. So, from the company’s CSR it is necessary to made clear the policies that define the overall commitment of an organization as a whole with respect to environmental issues. It is also necessary to indicate the organizational structure identifying the distribution of operational responsibility for the company's environmental aspects, and to define a training plan on environmental issues. Of course it is also required the capability to measure, evaluate and monitor, apply corrective and preventive actions, from the organization and from the supply chain. It would be also needed to collect other contextual information such as: key successes and shortcomings, major risks and opportunities related to environmental issues, major changes to systems or structures made during the reporting period, and main strategies and procedures for implementing policies or achieving goals. If a company introduces all these aspects (of as much as possible) it will be giving to software sustainability the importance required and finally, it will be contributing to the environmental sustainability.

4. CONCLUSION

Software is more and more present in our lives and help us on most of the tasks we have to do. The automation of services of all kinds is a reality and issues such as cloud computing and the possibility of the ubiquity of our applications both time and support, has made the software use widespread and has increased our dependence on it. Although it appears that so far the main objective of the companies that develop software (or the ones that provide software services to people) was to get faster, more ubiquitous, more intuitive and more similar to reality products, lately the need to pay attention to environmental effects that this has is taken importance by means of the newly created software sustainability. Software sustainability is a new research topic that is growing in importance and, from our point of view is going to become one of the major themes of work in the coming years. From these research efforts are emerging the first results and will again, without any doubt. However, when we talk about software sustainability it is required an additional effort to educate development companies, purchasers companies and users. It is necessary to make clear to all the stakeholders the importance of developing sustainable software even if it means an increase in cost, or a decrease in its capacity. It is necessary to end with the idea that running a software does not have side effects. Or, what is more dangerous from our point of view, to think that the side effects of using the software are minimal so it is not necessary to pay much attention on them. This, as we say, is more dangerous because, even if it was true that the effects of the use of the software by a person are minimal, the extremely high number of software users makes the final result devastating from the environmental point of view. Although awareness work should be done from different perspectives and in different ways, we believe it is essential that the software sustainability becomes part of CSR companies imminently. If we start from the companies that produce the software and the ones that consume the software, we will be able to reach all the other users. As already mentioned there are large companies that are engaged in this and in the future must be more without any doubt. In this paper we have tried to indicate which part of a CSR should incorporate aspects of software sustainability. As future work we plan to help a company in incorporating these aspects of software sustainability into their CSR, providing indicators, best practices and other tools that allow its application. With the results obtained we will be able to prove if incorporating software sustainability into the company’s CSR has a return in the profits of the company either directly or indirectly.
ACKNOWLEDGEMENT

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CONSUMER PERCEPTION ABOUT SUSTAINABLE LUXURY APPAREL

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ABSTRACT

The paper focuses on the study of consumer perception about sustainable luxury apparel and how it affects their buying behavior. The various research questions which were addressed through this survey include the various factors which affect the consumers buying behavior for sustainable luxury apparel. The research also studies the level of awareness of consumers towards sustainable fashion apparels. The research was qualitative in nature where 30 respondents were interviewed in two popular luxury destinations in major cities of India – Delhi and Mumbai. The respondents were subjected to various questions about the reasons why they buy these products, whether or not they will buy the products if charged by extra amount and whether they would buy these products even if it is not their preferred brand. Inquiry was also made regarding acceptability of these brands, sustainable packaging material & general awareness about the concept.

KEYWORDS

Sustainability, luxury, brands, designers, apparel

1. INTRODUCTION

The word sustainability is derived from the latin word sustinere Dictionaries provide more than ten meanings for sustain, the main ones being to maintain, support or endure. Sustainability involves the reconciliation of environmental, social equity and economic demands - also referred to as the "three pillars" of sustainability or the 3 Es (United Nations General Assembly, 2005). Luxury and sustainability can be often seen as two contrasting concepts. While luxury is a considered as a necessity which arises when all the other necessities are satisfied, sustainability refers to the development that meets the needs of the present without compromising the ability of future generations to meet their own needs (United Nations General Assembly, 1987). In his celebrated treatise on the "leisure class," Veblen (1899) argued that wealthy individuals often consume highly conspicuous goods and services in order to advertise their wealth, thereby achieving greater social status. Whereas sustainability focuses on careful resource management at different scales, from economic sectors like agriculture, manufacturing and industry, to work organizations, the consumption patterns of households and individuals and to the resource demands of individual goods and services (Clark, 2006).

2. OBJECTIVES & METHODOLOGY

There have been many drivers that influence the buying behavior of Indian consumers. This research analyzes sustainability as a buying driver for Indian consumers for luxury apparel and the level of awareness among consumers about sustainability. Studies suggest that there are several barriers which affect the purchase of sustainable fashion goods (Johan Kryger, 2012) including lack of information about importance of the use of such products, difficulty in finding sustainable products, price barriers, style barriers, etc. The research has been undertaken with the objective to examine what affects the buying behavior of an Indian luxury consumer for sustainable fashion product (apparels). The research also seeks to study the attitude of the Indian consumers towards sustainable luxury apparel. The study is exploratory in nature and the research has been conducted qualitatively through in-depth interviews within cross sectional framework. The
The objective of exploratory research is to explore or search through a problem or situation to provide insights and understanding (Malhotra & Dash, 2012). The advantage of exploratory research is that it is easier to make new discoveries due to the less stringent methodological restrictions.

![Research Philosophy elaborated through Research Onion. Adapted from: Saunders, Lewis & Thornhill (2009)](image)

The research has been undertaken on three customer profiles: those who are aware of sustainability and buy sustainable apparel, those who are aware of sustainability but do not buy sustainable apparel and those who are unaware of sustainability and don’t buy sustainable apparel. The buyers of sustainable products may further be categorized into occasional buyers and regular buyers.

### 3. LITERATURE REVIEW

#### 3.1 Luxury and Sustainability

Sustainability has gradually started exhibiting a considerable impact on the current luxury market practices. Many designers who earlier used to produce conspicuous luxury fashion have instead started focusing on producing ultra-luxe pieces concocted from sustainable materials — and, most critically, ethical business models — that don’t compromise on desirability. With globalization, growing awareness about health impact of toxic residues present in many textiles and the abusive employment policies and working conditions in developing countries coming to light; the need to sustainable business practices become inevitable. Sustainability in luxury rejects frivolous spending and consumption for the sake of consuming. As a result it values the rarity, uniqueness and timelessness of the craftsmanship. Jean Noel Kapferer stated that luxury and sustainable development share two deep concerns: rarity and beauty. According to him, luxury is, at its essence, very close to sustainable preoccupations because it is nourished by rarity and beauty and thus has an interest in preserving them (Nandwani, 2013). Sustainability acts as a perceived differentiator for a brand and establishes it as socially responsible.

#### 3.2 Technology in Application

Technology has been deployed in several areas for sustainable development in achieving a green fashion value chain (Sahni, 2010). The intervention of green technology in the fashion industry has been multifaceted including green material, green design, green manufacturing, green transportation, green retail, green post-
consumer management and so on. There have been several applications of technology in producing sustainable raw materials used for garment production. Some of these include the interventions in the areas of technology for weaving, printing, dyeing and finishing of yarn & fabric, technology for non-toxic processing and treatments of fiber, testing of fabric for contaminants and technology for stain-free and wrinkle-free fabric (Green Technology, 2009). Not only raw material but technology such as computer-aided design of apparel, automatic manipulation of fabric and color inventory management has also been adopted in sustainable design. Several software modules such as Enterprise Resource Planning, Electronic Data Interchange, Product Life Cycle Management, etc have also been instrumental in aiding the objective of achieving sustainable business processes. As far as green manufacturing is concerned, technology has also been heavily exercised in this area with applications such as operating facilities with alternative or renewable sources of energy such as landfill gas, wind, solar, low-impact hydroelectric facilities etc, technology for reducing harmful emission, chemical-free processes, body-scanning for made-to-measure, ready-to-wear, seamless apparel technology, custom-fit, made-to-order, mass-customization, quality control & assurance, robotics, automated on-line fabric inspection, sewing machines and embroidery technology (Sahni, 2010). Sustainability has also been incorporated in distribution and retail with the use of RFID for effective tracking & securing of fashion products, IT Planning for enhanced efficiency of processes and improved supply-chain responsiveness and use of minimal or eco-friendly packaging using recycled and eco-friendly material. Smart technology has also been instrumental towards achieving the green objective through its smart textile & smart garment by minimizing the use of laundry, development of multi-utility garments and garments with extended life-span. In addition technology has also found its application in post-consumer technology related to disposal, recycling and reuse. The various applications include zero-waste through implementing "Closed Loop" waste-management techniques, fiber-to-fiber recycling and refurbished or recycled fiber and fabric.

### 3.3 Sustainability and Designers

Designers may incorporate sustainable innovation by means of encouraging reparability, upcycling and increasing the longevity of their products. Several designers have made significant efforts to commit towards a more sustainable organizational culture. Stella McCartney explains this prioritization clearly when she refuses to be defined as an 'eco-designer seeking to make chic clothes'. Instead, she considers herself to be ‘a luxury clothing designer with sustainable convictions’. Yves Saint Laurent in an effort towards achieving sustainability economically, socially and ecologically launched Vintage III range: fashionable form of up-cycling that re-exploits unused fabrics from past seasons, employing them to reinvent the emblematic yet contemporary silhouettes of the designer. The range from the designer thus not only maintains what the brand is known for, but also reinterprets it. The Chinese luxury brand by Hermes- Shang Xia is concept which popularizes contemporary handcrafted decorative products. On one hand, the brand supports the local artisans from China on the other it offers a localized adaptation of authentic savoir-faire. The designers not only manufacture such garments but they also tag their creations to inform their customers regarding the concepts related to application of sustainability.

### 3.4 Sustainability and Packaging

The luxury customers place a huge emphasis on the visual appeal of products and their packaging. However, luxury customers must be provided with an alternative to be able to buy recyclable and biodegradable with desired aesthetic appeal. Some of the packaging materials including metallised plastic, metallised glass, etc are extremely difficult to recycle. The packaging is an integral component of the image a brand wants to reflect to its customers and hence many luxury brands have adopted innovative packaging designs and materials. L’Oreal has its own sustainable packaging scorecard to grade the sustainability of its product packaging and review actions to reduce its environmental impact (Environmental Leader, 2011). Nicolas Feuillatte is a renewed brand of champagne which uses recycled metal tins which also have a printed recyclability message to demonstrate the brand’s commitment to sustainable development (Curulla, 2013). Most of the apparel brands have already stopped using non-biodegradable and non-ecofriendly packaging material and resorted to alternatives like paper, non-woven bags etc.
4. ANALYSIS & DISCUSSION

The major questions which were addressed to these respondents included questions on their level of awareness about sustainable apparel. What do they look out for in sustainable apparel? What other sustainable luxury apparel brands are the users aware of? What factors affect their buying behavior for sustainable luxury apparel? What are the difficulties faced while searching for sustainable luxury apparel? Would they be willing to pay more for these products? The interviews also included questions on sustainable packaging material for apparel.

A total of 30 participants participated in the interviews. The respondents were selected using mall intercepts at Emporio Mall, Vasant Kunj, Delhi and Palladium Mall, Mumbai. Both these locations are the prime destinations for luxury retailing. When the respondents were enquired about sustainable products most of them were aware of the concept and could also name a few luxury brands which offer sustainable products. However, two of them were not aware of the concept. Nine of them were aware about the concept but had never purchased sustainable products. On being enquired why they did not buy these products most of the respondents stated that they were apprehensive of the product quality. They also said that some of these products might not be aesthetically appealing.

Table 1. Profiles of the respondents. Source: Primary Data

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Profiles</th>
<th>Particulars</th>
<th>Number of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Group One</td>
<td>Aware of sustainability and buy</td>
<td>19</td>
</tr>
<tr>
<td>2</td>
<td>Group Two</td>
<td>Aware of sustainability but, do not buy</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>Group Three</td>
<td>Unaware of sustainability and don’t buy</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>30</strong></td>
</tr>
</tbody>
</table>

Majority of the respondents had purchased sustainable luxury apparel, they were also willing to repeat their purchases or had already made multiple purchases. Around sixteen respondents who had purchased sustainable luxury apparel earlier were ready to pay extra to purchase these products in future.

Table 2. Selected Excerpts from in-depth interviews. Source: Primary Data

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Issues discussed</th>
<th>Selected Excerpts from in-depth interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Use of innovative raw material</td>
<td>“I am aware of some Indian designers using hand-woven fabric like silk wool for production of sustainable apparel.” Suhasi Gulati, 34, Homemaker</td>
</tr>
<tr>
<td>2</td>
<td>Low Impact/Green Supply chain</td>
<td>“Sustainability in supply chain would involve intervention at several levels such as sourcing, product, logistics.” Prabhat Tandon, 37, Marketing Executive</td>
</tr>
</tbody>
</table>
| 3     | Sustainable processes                    | “I prefer hand printed and hand woven products. I am very fond of Khadi.” Karuna Pawar, 42, Homemaker  
                                         “I have heard about natural dyes made of Pomegranate, Indigo, etc. I have a kurta which is naturally dyed.” Aditi, 44, Government Service |
| 4     | Green marketing                         | “Marketing of products that are safe for the environment is very relevant I will prefer to purchase such products.” Lalit Ojha, 55, Businessman |
| 5     | Reduced or recyclable packaging          | “Recyclable packaging is better as you don’t have to worry about pollution and you can reuse it.” Gurpreet Kaur, 33, Homemaker |
| 6     | Eco-friendly retail outlets              | “I have read about a store called Biostoria in Moscow which has all the elements such as cabinets, shelves, registers etc. made with natural materials.” Jasleen, 21, Fashion student |
| 7     | Refurbishing Post-consumer waste         | “Post-consumer waste refurbishment is a nice way to contribute towards sustainability. I have contributed to Goonj which is involved in textile recycling.” |

The reason which these respondents stated was that they understood how important the concept of sustainability is. The factors which affect the purchases of sustainable luxury apparel were concern for the environment and prestige or premium form the purchase of such products. Very few of these respondents stated that they will not purchase from their preferred luxury brand if they do not offer sustainable apparel, a majority of them said that they would remain loyal to their favorite brands. It can therefore be inferred that luxury consumers give more premium to brand name rather than sustainability of the product. Majority of the respondents stated that they had faced difficulties while looking for sustainable products and they also
mentioned that most of the luxury apparel brands should resort to sustainability. Almost all the respondents were positive about the idea of adopting sustainable packaging for luxury. The various sustainable material the respondents were aware of were metal, paper, non-wovens etc. Some of the excerpts from the interview have been summarized in Table 2.

5. CONCLUSION

The paper discusses the ongoing sustainability developments in the field of luxury. The paper analyses different examples and cases related to the application of sustainability in the field of luxury. The paper also discusses the new technology related to luxury fashion, the various luxury initiatives of designers and luxury brands and applications of sustainable material in packaging design. The study was focused on consumer attitudes towards sustainable luxury apparel. In-depth interviews were conducted with luxury customers and it was inferred that some customers who do not purchase sustainable luxury apparel are apprehensive about the quality of these products. While those who buy these products are willing not only to repeat purchases but are also ready to pay extra amount for these products. However it was found out that these customers face problems while finding these products. Surprisingly, the awareness about luxury fashion apparel was very high in Indian customers.

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AUTONOMOUS KNOWLEDGE IN DESIGN:
ASYMMETRIES OF A FIELD OF ACTION

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ABSTRACT
The dissemination of Design as a tool for social innovation poses some challenges for professionals and researchers in this field in Brazil. As part of Applied Social Sciences, professional activity follows two directions: from the problem towards the solution and contrariwise. By recognizing, in the configuration of the problem-solution pair, the social actors involved and the capabilities and competencies of Design in them, professionals and researchers in this field are confronted with the challenge of an ever-existing asymmetry that now plays a different role: being the basis for social innovations. The role of Design ranges between its positions as an instrument of innovation and as an element in the field of action which integrates and contextualizes social innovation. A clear setting of boundaries in this field, taking into consideration its own level of subjectivity, is a discussion item in the conception of the autonomous knowledge network in Design.

KEYWORDS
Design; social learning; autonomy; networks.

1. FROM THE IDEA OF SYMBOLIC SITE OF BELONGING TO A REFLECTION UPON THE ASYMMETRIES OF ITS FIELD OF ACTION

In the proximity between persons and in the relations composed of symbolic interactions and successive practices, in what is experienced before being conceptually understood, one can see the limits of an intersubjectivity which forms the third pole between the problem and the solution, and, this way, the demarcated field of action of design for Social Innovation. This limit is a shared challenge, but not a projected one, and from that comes the Moroccan proverb presented in the beginning of this essay: “Men encounter each other, but mountains do not.” The encounter is a consequence of free acts, unrelated to a utilitarian and instrumental view (DAGHRI & ZAOUAL, 2008).

2. DESIGN FOR SOCIAL INNOVATION AND SUSTAINABLE EVERYDAY LIFE

By contrasting value rationality, which is substantive and situated, to instrumental rationality, Zaoual (2005) proposes the notion of a symbolic site of belonging, and affirms that each problem presented to a given community will have an unexpected and unpredictable outcome. This unpredictability results from the creative action of the persons who form the community. In a corollary it is concluded that the human development as situated development will be intrinsically plural, and that the existence of diversity is the strongest indicator of the preservation of alterity and of its maintenance as an ethic value.

The production of autonomous knowledge in Design stems from the idea of symbolic site of belonging to reflect upon the asymmetries of its field of action, a field which is no longer approached from the limits of the problem-solution duo, but as an extension of this pair, considering a plurality of mediating activities between each of these poles.
The outline of this extension is not that of an hourglass, with its symmetrical shape and a content characterized by the filling of gap through the creation of another. The production of autonomous knowledge in design implies so great a diversity of social and collaborative actions that it comes close to what Manzini (2008) calls Social Learning. This knowledge takes the shape of a compass rose, full of transverse lines, according to a multiplicity of directions and related contents. The relation of such learning with autonomous knowledge in design cannot be measured or evaluated in quantitative terms. The quality of this learning is at issue. Therefore, the process of Social Learning for the production of autonomous knowledge in Design, in nature and quality, moves from the methods on which it had been strongly based so far, towards the result in terms of socially-produced knowledge, in nature and quality.

In this context, design emerges as a process that unfolds into dialogues and encounters. This certainly poses significant challenges to project methodology. It is not only the fact that this methodology should be built and developed as a dialogic process that guarantees its appropriation by the actors involved in the situation, a local and meaningful experience. It is also the fact that its transfer to other situations require, as a condition of possibility, an effort to achieve a translation … rather than just technical training in mimesis. […] On the basis of this dialogical openness and of these situational foundations, the action of the designer can be in accordance with what Geoff Mulgan (2006) refers to as a process of social innovation, covering a wide spectrum ideas in cooperative work aimed at reaching social goals. (BARTHOLO & MONTEIRO in DAGHRI & ZAOUAL, 2008, p. 200-204).

The designer takes a role of mediator and translator of the result as articulator of a new, autonomous, knowledge, formed transverse and asymmetrically, in a process of social learning. This result overcomes the scope of an answer to a problem and the designer then works as a mediator between the internal and external conditions of social transformation, as a result of social innovation. The designer is, at one moment, the co-author of these changes and, at others, the actor which makes possible and facilitates local experiences and the emergence of knowledge and of innovative possibilities that originate in other contexts (MULGAN, 2006).

In this field, the meaning of the word designer is revised: all participants in the process of conception, development and use of these systems are designers. So, the definition of designer encompasses all social actors as co-authors of the solution, and no longer the specialists in particular. Accordingly, this plurality of mediations demands the establishment of equally plural limits, without which there is no way to ensure and preserve alterity as it is presented by Ezio Manzini, in the form of two modalities of action integrated in practical terms, but distinct in terms of conceptualization:

Design in designing in networks: when the role of the designer is to promote and facilitate a process of specific co-design contributing to an easier convergence of ideas shared and of potential solutions.

Design for designing networks: when the role of the designer is to create conditions to stimulate, develop and regenerate the ability and competence of those who will use an "enabling system". (MANZINI, 2007)

According to Manzini (2007) the social learning configured in accordance with these modalities of action takes into consideration the most varied expressions of creativity, knowledge and organizational capacity, valued in an open and flexible way. To change the designer's idea so as to supply the needs of the consumer concerning the designer's idea, and then enable persons to live as they wish implies active participation in the social process from which new ideas emerge. The emergence status of these ideas is a concern of the author.

The investigation of social innovation practice and of its implications, in the promotion of a more sustainable everyday life in urban contexts and of new sustainable lifestyles, was the main focus of the project Creative Commons for Sustainable Lifestyles (CCSL). Creative Communities are developed inside implemented social enterprises, but adopt different organizational forms from theirs. The CCSL compiled case studies in emerging countries – particularly in Brazil, India and China – and created a chart to compare cases in these countries with cases previously identified in the European context. The comparison was focused on three particular aspects: (1) the nature of the groups of persons who generate innovations (creative communities); (2) their role in the promotion of new sustainable lifestyles (promising cases); (3) the possibility of making the promising cases more accessible, effective and of reproducing them through initiatives and appropriate measures (enabling systems). The case presented by the CCSL included productive activities based on resources and local competences. That enabled - through creative communities, promising cases and enabling platforms - the visualization, valuing and multiplication of socioeconomic and cultural potentialities of social innovations. The promising cases of social innovation
show they represent different stages of the emergence and expansion of new ideas (prototype solutions) towards consolidated solutions (worked out solutions) until their implementation. The prototype solutions correspond to the concept and practice of an idea. The worked out solutions are those which, when put into practice, inspire other groups to develop something similar. The implemented solutions correspond to the enabling platforms (MONTEIRO, 2008).

The promising cases identified in everyday urban life are examples of initiatives which evidence that, for different reasons, some persons have directed their behavior and expectations towards a coherence with sustainable development. These cases show there is an inversion of the previous trend, that is, of a solution which emphasizes the method used. On the contrary, promising cases result from the entrepreneurship and abilities of some persons – creative communities – who have know-how and the capacity to think and to propose new ways to organize solutions created for daily problems. These cases point out promising social and cultural changes generated at the level of the social innovation process (MULGAN, 2006).

Designers are social actors whose everyday activities include the contribution to relationships between people and artifacts. Designers identify, in promising cases, the seeds of a social change which includes themselves but whose solution does not result only from the use of the most appropriate design method. According to Manzini (2006) and Manzini & Jégou (2003), Social Innovation should find energy within local initiatives and the designer plays a strategic role in the accomplishment of a systemic change of these innovations. Their role is to construct a bridge connecting the internal and external conditions of the change in order to create local experiences that will introduce innovative knowledge and possibilities. The construction of this bridge can be facilitated by the implementation of a co-design process which requires the formation of integrated methodological structures, formulated within a dialogical perspective, aimed at establishing relational ties among interlocutors (MONTEIRO & BARTHOLO, 2009).

3. ABANDONING A UTILITARIAN VIEW MAY HELP DESIGN BE SOMETHING OTHER THAN A MOUNTAIN

The demand that arises for designers and professors in this field points to the development of sustainable solutions at the following levels: products and services which propose new ways of being and doing, new ways that differ from the dominant ones (including the being and doing of designers themselves) and that cause less environmental impact, favoring new forms of coexistence. It is a demand for visions of sustainability: settings which show these new forms of doing and that may be a path for the development of new alternative talents at different levels, also presenting directions to several aspects of the lives of each one of us. The outline of these directions is a duty of designers in the sense of promoting quality of life and quality of products and services offered. This new demand refers, therefore, to the development of investigative talents which, considering everyday reality, will foster reflection, proposals and settings regarding the quality of relations, places, communities, shared goods and even of the shared time for being and doing. This demand expands the designer's vocation in the direction of the knowledge dissemination reflected in their professional course of action. This expansion includes the designer’s vocation but also questions their own training as a relevant agent of social innovation.

The reflection upon autonomous knowledge in Design leads to the conclusion that the co-design process helps restructuring the projects developed in popular entrepreneurship. It also stimulates the existence of new incubation practices of those enterprises, with an expected insertion of Design in the enabling platform of Social Innovations represented by the respective incubators. These platforms create a new field of action for the designer, considering the preservation of the memory of traditional and popular knowledge, found in the origin of these enterprises, valuing their actions and aggregating cultural, economic and social values to their products and services (MONTEIRO, 2009).

Some asymmetries are identified in the establishment of limits to this field, which takes into consideration the knowledge generated in the professional practice and the new knowledge coming from the social learning process. One example of asymmetry is the expectation of entrepreneurs who employ design methods to problems faced by their businesses, aiming at a solution. Surpassing this expectation and promoting the understanding of the mediating role played by design in these projects is a way to contrast two ideas: that there is a corresponding solution for a given problem and that different groups of solutions can be offered to solve this problem.
Another challenge is to visualize the limits of these groups in order to know where they intersect. If the shape of these groups can be thought of as the image of a compass rose, the intersections result from transverse lines characterized by the knowledge which form the content of different directions. Thus, this content will no longer have the duty of filling the gaps left by the forces acting on it, as mentioned in the hourglass example. Complementarily, the autonomy of this movement is limited by the transverse axes which constitute its shape. In this sense, the encounter, or the intersections connecting different knowledges, establishes limits to the field of action of Design for Social Innovation. The mediation in this field can take place both from the intersections, in the case of demands formulated for the action of design in a certain context, and from the transverse nature that the autonomous knowledge in Design can have in this field. Abandoning a utilitarian view may help Design be something other than a mountain. That is the biggest challenge for the formation of autonomous knowledge in Design.

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FORESTS IN TEACHER EDUCATION: THE OPENFOREST PORTAL AS A NOVEL RESOURCE FOR LEARNING

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ABSTRACT
Forests are a natural theme in the teacher education program at the University of Eastern Finland. Forest as a learning environment can be a way to concentrate on skills that can be recontextualized outside the original learning context. The main object is to solve a multidisciplinary ( ecological, economic and social) and complex challenge of real-world design and prepare an artifact, digital construction, or collaborative solution. The aim is to encourage generative skills and knowledge that support wellbeing and sustainable development and reflects value systems and the sense of community.

In teacher education, forests are approached in three ways: content, method, and values. An open learning environment, the OpenForest portal has been constructed as a web-based learning tool in order to build and collect our new kind of learning resources. The OpenForest portal is based on three educational pillars: 1) participatory learning in extended and generative communities as a vital concept for learning; 2) diverse technological resources and infrastructure as powerful social and personal tools; 3) and co-development as a powerful social innovation in producing information resources that offer multiple perspectives on forest-related phenomena. OpenForest wiki environment aims to enhance collaborative learning and provides platforms for people to share, develop, and organize knowledge and to collaborate within and outside the school community. Forest-related phenomena are categorized into different domain perspectives by using various media. The Wiki environment combines expert knowledge and personal perspectives, with the intention of breaking down the boundaries of traditional school learning. At present the portal covers over 200 Wiki articles. These articles were produced in collaboration with 145 registered users. The portal has over 70 000 visitors. A selection of Wiki articles will be translated into English in 2014. The Wiki environment is connected to mobile global position system (GPS) technologies.

KEYWORDS
Forest in learning, collaborative expertise in extended community, Wiki resource, GPS

1. INTRODUCTION

In the teacher education program at the University of Eastern Finland, especially at the Savonlinna campus, forests are considered a theme that can be used to teach any subject. The Savonlinna unit educates future teachers of home economics and crafts, as well as kindergarten and primary school teachers. The forest as a learning environment can be a way to concentrate on skills that can be recontextualized outside the original learning context. In a motivating and authentic learning environment, the main object is to solve a multidisciplinary and complex challenge of real-world design and prepare an artifact, digital construction, or collaborative solution. The aim is to encourage generative skills and knowledge that support wellbeing and sustainable development and reflects value systems and the sense of community.

Forests are a natural theme in Eastern Finland where the forests are rich from ecological, economic, and social points of view. Consequently, there is a great deal of forest expertise ( Research Park and Station, Forest Museum, forest authorities, and foresters) near our Savonlinna campus. In teacher education, forests are approached in three ways: content, method, and values. Content can be achieved through collaborative ecological, economic, or cultural expertise (Forest Research Unit, Forest Museum, forest authorities) or our own projects (Vanninen et al., 2006). The method approach attempts to counter preconceived ideas about what and how one should teach. This is achieved by trips to forests (Pöllänen et al., 2011), for example. The
method approach can also refer to phenomenon-based teaching: while playing a game developed by crafts teachers (Pöllänen and Vartiainen 2011), the pupils learn about human rights or silviculture. A good example of a discussion of values as part of the forest theme is the summer school program, “Forest as a learning environment in sustainable development 2013” for student teachers, where their task was to produce a collective vision of the following: What is a valuable forest like? The summer school was carried out in an authentic forest environment and at the Forest Museum Lusto. In general the students have responded positively to the forest theme during the years we have it used. They are usually confused and curious at first. Then thoughts and discussions begin to flow. This leads to discoveries.

2. OPENFOREST PROCESS AND CONTENT

An open learning environment, the Openmetsä [OpenForest] portal (Figure 1), has been constructed as a web-based learning tool in order to build and collect our new kind of learning resources. The OpenForest portal is based on three educational pillars: 1) participatory learning in extended and generative communities as a vital concept for learning; 2) diverse technological resources and infrastructure as powerful social and personal tools; 3) and co-development as a powerful social innovation in producing information resources that offer multiple perspectives on forest-related phenomena (c.f Liljeström, Enkenberg & Pöllänen, 2013; Vartiainen, Liljeström, & Enkenberg, 2012; Vartiainen & Enkenberg, 2013). Participatory learning aims to expand learning beyond the walls of the school or university to authentic forest environments and related social networks, in collaboration with people with shared interests and diverse expertise, such as external experts, teachers, and other students. The heterogeneous participants offer diverse ways of working together, mediating, and enhancing individual and communal expertise. Thus, participatory learning is oriented towards outcomes that are both personal and collective, in which the sharing of cultural knowledge and transforming it to serve individual, group, and social interests and goals, is an inherent part of engaging in meaningful joint activities with diverse co-participants (Wells, 2008).

Figure 1. Screen capture from 360 panorama in OpenForest portal

Wiki, as a technological environment in OpenForest, aims to enhance collaborative learning and provides platforms for people to share, develop, and organize knowledge and to collaborate within and outside the school community. Forest-related phenomena are categorized into different domain perspectives (forest research, forest culture, forest as nature, forest in learning, and our forest), that are produced by special interest groups (e.g. forest researchers, forest professionals, school students and teachers, and student teachers) by using various media (e.g., 360 panorama photos, videos, audios, texts, photographs, and combinations). A single article in the Wiki environment is not designed to provide all the right answers or a comprehensive description of certain phenomena, such as sustainable development, but several articles together can offer different perspectives and interpretations about them (Vartiainen et al., 2013). Therefore, the Wiki environment combines expert knowledge and personal perspectives, with the intention of breaking down the boundaries of traditional school learning.

At present (June 2013), the portal includes to over 200 Wiki articles. These articles were produced in collaboration with 145 registered users. The portal has over 70 000 visitors. A selection of Wiki articles will be translated into English in 2014. The Wiki environment is connected to mobile global position system
GPS) technologies, which provide tools to support learning across different contexts and serve as bridges between authentic objects and related information resources. (Figure 2.) The Wiki articles are valuable for tourism, learning, and ongoing research at the Research Park, attracting people who want to understand the value and sensitivity of our forests.

Figure 2. With GPS technologies the user can locate him- or herself and Wiki objects in across spaces

The OpenForest environment is available for different kind of smartphones (Android, Windows, and Symbian, and iOS in the near future). With a mobile phone, the user can locate him- or herself and Wiki objects by using high-resolution maps. Wiki objects from the Forest Research Park consider real forest research tasks (forest sophistication, real-time growth data, and different kind of field trials). Real-time data are measured in provenance trials where the origins of different trees are studied by forest scientists in the context of the adaptation of trees adaptation to climate change. This research is expanded by interviews with researchers in their work by using video or sound clips in the Wiki articles. In addition, the user can choose between the resolution of maps, which include an old (1915-1918) map of the Research Park. The old map and positioning data of the Research Park are valuable in history projects as part of teacher education. The Research Park is expanded to several summer and winter objects using 360 photography with hyperlinks to data, their location, and a “virtual tour of the park.” The user can also upload objects onto the OpenForest portal, which is available now in Finnish at www.openmetsa.fi. We have started to explore the use of OpenForest portal in schools, and in natural and museum environments with different target groups in order to develop the portal in the future.

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THE WEB AS A COMMON LANGUAGE TOWARDS SOFTWARE SUSTAINABILITY

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ABSTRACT
In this paper, we explore the potential of the Web to constitute a common language in various computing domains towards increasing software sustainability. We discuss various benefits of Web development, which offer sustainable characteristics to software. We demonstrate two case studies, in which the Web can be used for software development. The first is a mobile application offering tourist guide services and the second is a real-world pervasive framework, targeting home automation in a smart home environment. Our experimental results show that both software operate in satisfactory performance, showing that the benefits of Web development can be acquired without significant compromises in response times.

KEYWORDS

1. INTRODUCTION
Generally, enterprises around the world tend to develop their own, proprietary software for providing specialized solutions to individuals and other companies. In this way, they manage to keep their customers engaged and dependent on their platforms and systems, ensuring high profits in the long-term. This creates the phenomenon of vendor lock-in, making a customer dependent on a vendor for products/services, unable to use another vendor without substantial switching costs. Software updates and adaptation to more modern technologies means added costs to the customer in order to keep pace with technological advancements. This means that true software sustainability is not in the interest of most companies.

Sustainability in general refers to ensuring that a development meets the needs of the present without compromising the ability of future generations to meet their own needs. In this context, software sustainability can be defined as the ability of a designed product to operate over long periods of time without degrading itself or the environment (Markiewicz, 2012). To accomplish this goal, sustainable products emphasise features like efficiency, durability, reusability and modular construction.

In the early 1990s, public, royalty-free standards were proposed as a solution to vendor lock-in, in an effort to increase software sustainability mainly through durability and reusability. However, software vendors used "embrace, extend and extinguish" tactics to achieve a dominant market share or to monopolize a product category, by entering product categories of popular standards, extending them with proprietary capabilities, and then using those differences to disadvantage their competitors, rendering the standard obsolete in some cases, e.g. the Microsoft case (The Economist, 2000).

Since this solution did not work, the use of free, open-source software has arisen in the 1990s as a stronger alternative. Because open-source can be modified and distributed by anyone, the availability of code cannot tie a user to particular distributors. This practice makes vendor lock-in less effective, since there is no incentive for developers to invent redundant new formats and protocols if usable, royalty-free standards exist. Although open-source code enhanced even more the efficiency, durability and reusability of software, there is still a long way to go to achieve software sustainability.
In latest years, the Internet has penetrated deeply in our lives while the Web is used extensively by people for work or amusement. The Web is ubiquitous, scales particularly well and has well-accepted and understood tools. The popularity of Web development ensures reusability of software, the wide variety of well-established libraries ensures software durability, while the advancement of Web browsers and languages promises good performance and code efficiency. Hence, we suggest that the Web can become the common language in order to achieve true software sustainability, and that it can be applied in various software development domains, such as mobile computing and real-world applications.

Critics of the potential generality and applicability of the Web in other domains argue that its performance becomes limited in any use other than classical Web browsing. In this paper, we examine whether the Web can be successfully applied in two modern, popular areas: mobile and pervasive computing, in order to provide sustainable characteristics to software in these areas too.

The rest of the paper is organized as follows: Section 2 discusses the general reasoning for using the Web as a common language towards software sustainability while Section 3 presents two real-world applications, one for mobile computing and one for home automation, which have been developed by using Web technologies. Finally, Section 4 defines future work and concludes the paper.

2. USING THE WEB TOWARDS SOFTWARE SUSTAINABILITY

The great success of the Web as a global platform for information sharing educates that simple and loosely-coupled approaches offer a high degree of scalability, robustness and evolvability. This success is partly due to an open and uniform interface, which enables even non-experts to develop interactive applications rapidly. Unlike most protocols used in specialized domains such as embedded computing, Web standards are widely used on the Internet, being open, well-understood and highly flexible.

Using the Web as a common language in various computing domains offers several benefits, such as wide-spread deployment of Web browsers and ubiquitous HTTP support in programming and scripting languages. Users can employ any computing device to manage their environment (e.g. mobile phones, tablets, smart TVs, PCs, home routers, smart meters), provided that these devices have access to the Internet/Web.

Moreover, open access to systems and applications through Web services (WS-*, REST), using open and simple standards and data formats (e.g. XML, HTTP, JSON) enables information to be reused across independent systems, lowering the access barrier that allows people to develop their own composite applications. People may combine more complex services following the classical technique of Web mashups.

3. CASE STUDIES OF WEB DEVELOPMENT IN OTHER DOMAINS

In this section, we demonstrate two real-world applications, targeting computing areas other than the classical Web browsing, where Web technologies can be applied with success, offering various benefits. The first is a mobile application about a tourism guide and the second is a framework for home automation using embedded sensors and actuators. By means of these developments, we aim to show how Web programming can be employed to achieve the required tasks, offering high interoperability, flexible design, reduced costs due to open-source code available and ease of implementation, ensuring sustainable software development with increased life cycle of the product, because of the current popularity of the Web, its promising future and its stable, scalable and well-established structure.

3.1 A Tourism Guide Mobile Application

Tourism is an important source of income for many countries, especially those combining culture and relaxation. Cyprus, a small island in the Mediterranean, is one such example, counting on tourism for its financial growth. Cyprus blends archaeological wealth with beautiful beaches and warm temperatures and it is a popular destination for tourists globally. In order to offer better services to tourists, in regard to informing them about the archaeological and religious attractions of the island and its beautiful beaches, we developed a tourism guide mobile application (Networks Research Laboratory, 2013). This constitutes a sustainable environmental action, since no paper is needed for printing books or magazines serving as guides.
We implemented the mobile application by using Web technologies, namely HTML5 and AJAX. By means of Adobe PhoneGap\(^1\), which is a free and open-source framework that allows to create mobile applications in multiple phone platforms, we created the tourist guide application being able to operate on Android, iOS (for iPhone, iPad), Windows, Nokia phones (Symbian-based), Blackberry and WebOS. PhoneGap helps to acquire the current location of the user, using Wi-Fi, GSM or GPS localization.

By employing the Kendo UI framework\(^2\), which is a comprehensive HTML5/JavaScript framework for modern Web and mobile application development, we managed to select from various designs, themes and layouts which look like a native application on the targeted platform. Figure 1 shows two different versions of the mobile application, one for Android and one for iOS. The reader can observe how similar both versions look to a native application on these platforms. By going native, we would be obliged to learn specific programming languages and methods, such as Java for the Android case and Objective-C for iOS.

We list below the main features, all enabled by means of modern Web techniques and tools:

- View nearby attractions from your current location, either on a list or on the map of Cyprus.
- See detailed descriptions of particular attractions by clicking on them, as well as relevant information such as opening hours, contact details, entrance fees etc.
- Filter attractions according to the user's preferences, to view only places of interest.
- Adjust distance from nearby attractions. It can range from hundreds of meters to tens of kilometers.
- Search for attractions on a lexicographical basis.
- View the most popular attractions in every city or around the island, as they are rated by other tourists.
- Create a tour plan, by adding attractions to a list. This list can be edited even before entering Cyprus, to better organize vacations.
- Mark attractions as visited, to keep a list of visited places as a reference.
- Rate a visited attraction, so that other tourists would be assisted to select only the best places.
- View directions to an attraction, either on the map of Cyprus or in the form of text directions.

We note that the tourist's profile (sex, age, nationality, preferences), as well as his visited attractions, are saved anonymously on a Web server, by means of HTTP calls. Thus, our mobile application offers more personalized suggestions to tourists, such as places visited by people of similar age or same nationality.

Concerning some figures of use, in two months of our mobile application being on Google Play (Networks Research Laboratory, 2013), it has been used by 1,500 tourists from 30 different countries. This indicates some success, especially since most tourists being happy about it, have rated it positively (rating 4.0/5.0).

Comparing the performance of our mobile application with a very similar native one (Quinto Stdio Inc., 2013), offering very similar services, our application is slightly slower, but only in a small degree (10-16%). All actions and features are performed in a few seconds, while the menus are loaded in milliseconds.

### 3.2 A Smart Home System

Embedded computing is largely characterized by vendor-specific standards and specifications, since each manufacturer delivers his own solutions. However, recent efforts for porting the IP stack on embedded devices (Hui, 2008) and the introduction of IPv6, which provides extremely large addressing capabilities, can facilitate the merging of the physical and the digital world, through the Internet. Inspired by the potential Internet-enabling of embedded devices, sensors and actuators, the Web of Things (WoT) (Wilde, 2007), (Guinard, 2010) reuses well-defined Web techniques to interconnect this new generation of physical devices, following the REST architectural protocol (Richardson, 2007).

To demonstrate the operation of a smart home using Web technologies, based on the WoT, we developed a lightweight, Web-oriented application framework providing uniform access to heterogeneous embedded devices via standard HTTP calls (Kamilaris, 2013), (Kamilaris, 2011). The framework supports multiple Web clients and numerous smart devices, placed inside the home environment. Detailed information about the operation and implementation of the framework are available in the technical report in (Kamilaris, 2012).

Figure 2 (left) depicts the general architecture of this framework. It follows a layered model and it is composed of three principal layers: **Device Layer**, which is responsible for the management and control of

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1 Adobe PhoneGap. http://phonegap.com/
embedded devices, Control Layer, which manages the whole system and Presentation Layer, which generates dynamically a representation of the available devices and their services to the Web, enabling the uniform interaction with them over a RESTful interface. A Web Server allows real-time interaction while a REST Engine, implemented by Restlet\(^3\), ensures a RESTful environment. Thanks to REST, Web clients can easily explore available devices and their services by clicking links, as they would browse Web pages.

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Figure 2 (left) depicts the general architecture of this framework. It follows a layered model and it is composed of three principal layers: Device Layer, which is responsible for the management and control of embedded devices, Control Layer, which manages the whole system and Presentation Layer, which generates dynamically a representation of the available devices and their services to the Web, enabling the uniform interaction with them over a RESTful interface. A Web Server allows real-time interaction while a REST Engine, implemented by Restlet\(^4\), ensures a RESTful environment. Thanks to REST, Web clients can easily explore available devices and their services by clicking links, as they would browse Web pages.

The embedded devices used in our smart home system are Telosb sensor motes\(^5\), for sensing environmental conditions (e.g. temperature, humidity, illumination), and Ploggs\(^6\), which are smart power outlets for controlling electrical appliances (by switching them ON/OFF) and sensing their electrical consumption. Telosb motes have been programmed using TinyOS 2.x\(^7\), which is an operating system for low\

\(^3\) Restlet framework for REST. http://www.restlet.org/
\(^4\) Restlet framework for REST. http://www.restlet.org/
\(^5\) Telosb sensor mote datasheet. www.willow.co.uk/TelosB_Datasheet.pdf
\(^7\) TinyOS Operating System for embedded devices. http://www.tinyos.net/
power embedded devices. By means of Blip\(^8\), which is an implementation of the 6LoWPAN stack for TinyOS, we exposed the sensing capabilities of the motes as RESTful Web services, transforming them into embedded Web servers. 6LoWPAN (Kushalnagar, 2007) is an adaption layer that allows efficient IPv6 communication over the IEEE 802.15.4 standard. Through 6LoWPAN, an IPv6-enabled wireless sensor network was formed.

Ploggs are smart power outlets that can sense the consumption of electrical appliances in real-time. A Plogg can be attached to any electrical appliance or device that uses a standard mains socket plug. Through a ZigBee chip, Ploggs can also create a wireless multi-hop network inside a smart home.

Figure 2. Architecture of the smart home application framework (left). Response time in Web vs native case (right).

Figure 2 (right) shows the response times in varying number of arrival requests per residents (lambda = requests/second), in the 6LoWPAN case (6LoWPAN REST) in comparison to a native implementation (Simulated REST). These tests focus exclusively on the wireless network of Telosb sensor motes. Although the native case is almost 2x faster in some tests, in both implementations response times are less than a second, even in high traffic. Hence, the Web-based case is feasible with acceptable performance. When HTTP caching is employed (which is a basic feature of the Web), with 10 seconds freshness time, 6LoWPAN REST executes faster than simulated REST, when lambda>0.8 requests/second. More information about this experiment is available in (Kamilaris, 2013).

On top of the aforementioned infrastructure (application framework, Telosb sensor motes and Ploggs), we developed the following applications, using Web technologies:

- A Web interface allowing residents to view their electricity footprint in real time (Figure 3, left).
- A graphical editor for creating smart rules for home automation (Figure 3, right).
- A task scheduling mechanism adapted to demand response from a smart grid (Kamilaris, 2011a).
- Sharing of home devices and services between online friends through Facebook (Kamilaris, 2011b).

Figure 3. Snapshots of the Web applications built on top of the smart home Web-based infrastructure.

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4. CONCLUSION

In this paper, we discussed the potential of Web in constituting a common language in various computing domains towards increasing software sustainability. We demonstrated two such domains, in which the Web could be effectively used for software development: a mobile application offering tourist guide services and a real-world pervasive application, targeting home automation in a smart home environment. In both cases, satisfactory performance in terms of response times is achieved, showing that the benefits of Web development can be acquired without significant technical compromises. For future work, we plan to evaluate in a larger extend the pros and cons of Web development in the aforementioned domains, measure the impact of the Web as a factor for software sustainability and finally, try to demonstrate the use of Web technologies in other computing domains, such as smart transportation, urban computing etc.

ACKNOWLEDGEMENT

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Reflection Papers
TRADEABLE PERMITS AND EMISSIONS TRADING: A FAILED EXPERIMENT?

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ABSTRACT
Tradeable permits have been the centerpiece of emissions trading schemes in Europe and New Zealand designed to control greenhouse gas (GHG) emissions. They are a form of market-based environmental policy that were advocated strongly as a way of making action for sustainability more attractive to business than the use of regulatory instruments. After initial optimism and a broadening of its application the European scheme has not maintained its importance while New Zealand’s emissions trading scheme failed to be a significant tool for limiting GHG emissions from the outset. This presentation argues that the failure of these schemes shows the limitations of relying on these forms of market-based policy. This has implications for maintaining business support for sustainability given that this has depended partly on the perceived attractiveness of using this form of economic instrument in place of ‘command and control’ regulation.

KEYWORDS

1. INTRODUCTION
Economic or market-based instruments aim to give the greatest incentive to mitigate environmental impacts to organisations that are able to make change at least cost. If this is achieved it should mean that the environment is protected at least overall cost to society. This quality of economic instruments is frequently contrasted with regulatory approaches that seek to equalise the environmental standards adhered to across all organisations. Rather than equalising the standard attained by each individual organisation, economic instruments focus on the overall level of environmental performance for an economy as a whole and seek to equalise the expenditure that regulated organisations must make for this desired level of environmental protection to be obtained. The underlying justification is that it is not necessary to force all polluters to stop polluting as long as there are some who are able to greatly reduce their environmental impacts so that pollution as a whole goes down. This philosophy has influenced environmental policy in recent decades and has contributed to a ‘third wave environmentalism’ in which environmentalists and business have found common ground (Gouldson & Murphy 1998; Stavins 2003). The willingness to experiment with economic instruments has played a major role in encouraging support for sustainability initiatives and the possibility of ‘green growth’ (Laszlo & Zhexembayeva 2011; OECD 2011a; de Freitas & Perry 2012).

Tradeable permits are one type of economic instrument. They involve the setting of some form of quantitative target and then use economic incentives to obtain compliance to that standard (see Tietenberg 1985; 1992 for early advocacy of the benefits of tradeable permits). They require regulation that sets the context in which economic incentives are allowed to influence mitigation efforts. Nonetheless because they can reduce some of the uncertainties associated with price-based instruments they have attracted a great deal of attention.

The theory behind tradeable or transferable permits is that they achieve the same cost minimising allocation of the regulatory burden as a charge system while avoiding the need to be concerned with how individual organisations will respond to the incentives that are introduced. Under a tradeable permit scheme, an allowable overall level of pollution is established and allocated among firms in the form of permits. Organisations that keep their environmental impacts below their allotted level may sell their surplus permits.
to other firms or use them to offset impacts generated by other parts of their organisation that are beyond the permitted level. With these claimed advantages, tradeable permit schemes have been introduced to control GHG emissions in Europe and New Zealand but both these schemes are currently failing to deliver their promise (Chaffin 2012).

2. THE LIMITS OF EMISSIONS TRADING FOR SUSTAINABILITY

The control of sulphur dioxide (SO$_2$) emissions associated with power generation in the USA is frequently referred to as a successful use of tradeable permits for managing a large scale, long term environmental programme (Sterner 2003; Hussen 2004; Kruger 2005). Responding to a growing acid rain problem, the SO$_2$ emissions reduction programme was introduced in 1995. It aimed to cut the annual SO$_2$ emissions from power plants by 10 million tons by the year 2000 under phase one and by a similar amount in phase two running from 2000 to 2010. The scheme set a cap and allocated permits to this emission level and then required individual power companies to hold sufficient permits for their SO$_2$ emissions. Trading was unrestricted allowing environmentalists (who might wish to accelerate abatement by holding but not using permits) and investors speculating on the future price of permits to participate. Other sources of SO$_2$ were excluded to avoid mixing activities with different abatement issues and costs. As well the scheme allowed for offsets, bubbles and banking (all mechanisms designed to avoid making it too difficult to comply).

The scheme was credited with encouraging a major cutback in sulphur emissions at lower compliance cost than could have been achieved with alternative policies and has been used to justify emission trading schemes to control GHG emissions. In practice how much of the success in reducing SO$_2$ emissions can be attributed to permit trading as compared with other conditions working in favour of cutbacks is unclear. The cost of abatement technology fell significantly after the programme started, particularly in the reduced price of air scrubbers. The programme coincided with the deregulation of the rail industry that decreased the cost of freight and increased the attractiveness of purchasing coal with low sulphur content. Some states introduced local environmental regulations that added to the pressure on power plants to cut emissions. Such conditionalities contributing to the apparent effectiveness of the scheme were overlooked when emissions trading was applied to GHG control.

A good understanding of the costs of abatement is required for tradable permit schemes to work effectively. This makes it a challenge to introduce permit schemes to manage a a previously unregulated issue, but this is typically where they have been tried. Prior experience of managing an environmental issue helps give insight to ensure that the right volume of emission permits are allocated and that there will be sufficient incentive for permit trading to occur. If it proves to be the case that many sources can easily obtain large amounts of emission rights, then incentives for abatement at other sources are reduced. Some experimentation and policy adjustment must often take place to improve the effectiveness of emission trading. Even then the success of trading schemes can depend on changes going on alongside the trading of permits rather than the trading scheme itself, such as the availability of new technology to allow emissions to be reduced without comprising the ability of economic activity to continue.

Emission trading schemes can be too uncertain when environmental issues need close control (Sterner 2003). There must be a relatively high level of knowledge about the environmental issue being managed and a degree of stability in the influences on the environmental outcomes. For example, if environmental risks were to change in an unanticipated way the volume of permits allocated might give insufficient control. The difficulty of responding to any such instability arises because permits must be viewed as permanent and reliable if they are to influence business decisions. One response to this is to allow the total number of permits to vary depending on ecological or other conditions. This approach has been followed with fisheries management where tradeable harvest quotas for fish are formulated as shares of a total allowable catch that is set according to the most recent fish population data. This flexibility is accepted as there is widespread acceptance that the dynamics of the ecosystem are difficult to predict much into the future. In other cases where there is a need for close management, as where environmental risks are high or technological opportunities are changing, permits are feasible only as part of a short term adjustment scheme where the limited life of permits was signposted at the outset.
Trading systems work better as the number of parties involved in the exchange of permits increases and there is a large variation in the costs of mitigating environmental impacts among the parties. As well, the system for agreeing and registering trades of the permits needs to be simple as high transaction costs are a deterrent to trade. Recipients of permits must be willing to buy and sell permits if the environmental compliance effort is to be redistributed away from organisations facing the highest costs of making improvement. In industries with only a small number of participants, individual permit holders may be motivated to hoard them strategically as a way of making life hard for competitors.

2.1 New Zealand Experience

New Zealand illustrates the difficulty of seeking to progress sustainability goals through emissions trading. Most of The Climate Change Response (Moderated Emissions Trading) Amendment Act 2009 reaffirmed that the existing emissions trading scheme (ETS) would continue to be introduced. Deemed too onerous by a newly-elected National-led government, the forestry sector only was covered by the scheme while it was reconsidered. A Select Committee Review concluded that a carbon trading scheme covering all economic sectors was preferable to a carbon tax which was the main alternative policy considered. The amending legislation aimed to ease the economic cost of emission trading in several ways.

- A price of $25 was fixed for Government-issued NZETS allowances (New Zealand Units, NZUs) used for compliance purposes during 2010-2012.
- Stationary energy, industrial process and liquid fuel installations (the first sectors to join after forestry) need to surrender only 0.5 NZU for each tonne of carbon emitted.
- During a transition period (2010-2012) there is an unlimited supply of emissions allowances and so no overall cap on emissions.
- Emissions-intensive industries exposed to international trade will receive the bulk of their allocation without cost. These will be allocated on an intensity basis meaning that there is no penalty if total emissions increase providing that emissions per unit of output do not increase.
- The phasing out of free emissions allocations starts in 2013 (2016) for agriculture at a rate of 1.3% a year.
- The entry of sectors is sequenced according to the capacity to cut emissions without damaging their competitiveness in the international market place. Agriculture will not enter the scheme until 2015.
- Prior to full implementation, the scheme would be kept under review to ensure that it continued to be justified, give opportunity for modification and to ensure it matched with schemes expected to be introduced overseas.

The perceived need to ease the introduction of the ETS is partly a response to the concentration of New Zealand’s greenhouse gas emissions from agricultural activity for which there are presently no alternative production methods that offer ways of substantially reducing emissions. The Pastoral Greenhouse Gas Research Consortium (PGgRe) is supported by major rural industry agencies to coordinate industry-wide research into agricultural emissions and their reduction. Its goal is a 10% reduction in greenhouse gas emissions across the agricultural sector by 2013 relative to 2004. This compares with New Zealand’s international commitment reiterated under the Copenhagen Accord (2009) to reduce emissions by 10% below 1990 levels by 2020 or, if a comprehensive global agreement is reached, by 20%. Promising innovation to reduce emissions through the pasture application of nitrification inhibitors is claimed as well as the potential for soil carbon sequestration. On a larger scale, New Zealand in 2009 announced the formation of a Global Alliance on Agricultural Greenhouse Gas Mitigation to bring interested countries together to drive greater international cooperation, collaboration and investment in this area of research.

The OECD (2011b: 155) has claimed that the ETS is a ‘solid basis upon which to build an efficient, fair and effective carbon pricing scheme’ but notes that ‘the broader social acceptability and political durability of this highly complex financial scheme and major economic reform will be an ongoing challenge’. The Parliamentary Commissioner for the Environment has warned that by allocating too many free emission entitlements the scheme is in danger of replicating the initial experience of the ITQ which also was too generous in its initial allocation (Wright 2011:5).

Immediately, offsetting is the main option for addressing agricultural emissions short of production cutbacks or radical changes in farming techniques (such as housing cattle in sheds). In New Zealand, plantation forestry offsets about one-third of New Zealand’s non-forestry greenhouse gas emissions but by 2020 Forestry is expected to become a net source of emissions due to the harvesting of forests planted in the 1990s.
3. CONCLUSION

The case of emissions trading to control GHGs illustrates some of the constraints on the use of economic instruments for achieving sustainability goals. While market-based approaches have been an important part of the agenda promoting support for sustainability big challenges will need to be faced as the experiment with these policy approaches leads to disappointing outcomes. This implies a need to reconsider command and control forms of regulation although it should be noted that the advocacy of economic instruments frequently exaggerated the inflexibility of other approaches to designing environmental policy. For emissions trading to be applied to the control of greenhouse gas emissions progress may depend on its use in targeted schemes where there is a political will to see the eradication of GHGs and where viable alternative technologies exist.

REFERENCES


SUSTAINABLE DEVELOPMENT, FOREST AS A LEARNING ENVIRONMENT AND HISTORY TEACHING – AN INFEASIBLE COMBINATION? A FINNISH CASE

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ABSTRACT

In this paper, the promotion of education for sustainable development is founded in a holistic view of development which addresses the ecologic, economic, social and cultural dimensions. Sustainable development is a cross-curricular theme in the Finnish national core curriculum for basic education, and it must be included in the local curriculum work and it must be apparent in the school’s operational culture. The University of Eastern Finland has included in the basic training of teachers and in educational leadership a relevant knowledge base and pedagogy for assuming a sustainable way of life. Our starting point is that forests can contribute to the learning of sustainable development. We wanted to develop a model that combines the teaching of history, the forest as a learning environment and the use of information and communication technology. Our final product is a website with a simulation, structures supporting visual and multisensory approaches and various forms of show and tell. The forests are considered as exemplifying context for development of generative skills and knowledge that support wellbeing and sustainable development, reflection of value systems and sense of community.

KEYWORDS

Learning environment, history teaching, teacher education.

1. INTRODUCTION

The aim of this paper is to clarify the concept of cultural heritage as a part of sustainable development. The contribution of forests to the learning of sustainable development will be discussed in this paper. An university project, in which sustainable development, the forest as a learning environment and the teaching of history in primary school were combined, will be presented.

2. FOREST AS A LEARNING ENVIRONMENT

In this paper I will present the first phase of a three-year project in which a model of pedagogy where nature, in this case, forest and cultural environment constitute the main context for learning. I will here focus on teacher education for compulsory education in universities. The examples are from my own university, the University of Eastern Finland.

Forests constitute one big learning environment that can be made use of in almost any learning situation. With forests being so abundant in Finland, why stay inside the classroom walls? Located in a region known for its diverse forests, forest-related expertise and forestry, it’s no coincidence that the Savonlinna Campus, University of Eastern Finland, is a pioneer in the use of forests as learning environments.

We wanted to develop a model that combines the teaching of history, the forest as a learning environment and the use of information and communication technology. The Forests as Learning Environments project encompasses an online learning environment featuring various materials intended for teachers and students, including materials on forest culture, projects and students’ videos. The Punkaharju Research Forest area is unique, as remnants dating back to the prehistoric period have been discovered there and the area has also been charted and documented over several centuries. We are using the document and map data to create an
image of what it was like to live in a croft in the old days – what it looked like inside, what was in the yard, what people living there ate, and how the surrounding forest has changed over time.

We wanted to create a community of experts allowing us to interact with people and organisations outside the university. The project, which has been administered by the School of Applied educational Science and Teacher education for nearly two years, is targeted at teacher students, each of which literally gets taken out into the woods. (Vanninen et al 2013)

Our starting point is that forests can contribute to the learning of sustainable development. This kind of teaching and learning takes place in the nature or other environments relevant to the instructional themes and is active learning, hands on and learning through experience. (Vanninen et al 2013; Liljestrom et al 2013)

Nature and the environment can be looked at from a subjective, humanistic point of view. “Environment” and “nature” do not mean the same to everybody; our personal observations and experiences imbue our perceptions of the surrounding environment with personal meaning. There is a particular concept of “place” inherent in mindscapes and subjective environments. In the humanistic approach “place” refers to living environments that carry personal meaning – to places that we live in. (Towards Sustainable Development in Higher Education – Reflections, 87 – 88.) At the heart of the idea is participating students in building our collective memory by creating sharable visible outcomes reflecting their own inquiries related to global phenomena, such as sustainable development, and local objects mediating it. (Liljestrom et al. 2013)

3. TEACHING OF HISTORY, THE FOREST & SD

We wanted to develop a model that combines the teaching of history, the forest as a learning environment and the use of information and communication technology. The Forests as Learning Environments project encompasses an online learning environment featuring various materials intended for teachers and students, including materials on forest culture, projects and students’ videos. The Punkaharju Research Forest area is unique, as remnants dating back to the prehistoric period have been discovered there and the area has also been charted and documented over several centuries. We are using the document and map data to create an image of what it was like to live in a croft in the old days – what it looked like inside, what was in the yard, what people living there ate, and how the surrounding forest has changed over time. (Venhe, 36.)

Can we combine history teaching with the demands of sustainable development? Eight of my students, who are future class teachers, wanted to try the possibility of putting together things that happened long ago and modern technology. We wanted to know if it is possible to make history alive today with the aid of modern ICT. We were searching for the ways to use ICT in the teaching of history in primary school.

The objective was collaborate learning among students, the teacher and outside domain experts. Technology was applied as the main technological mediator in the learning process. It provided an opportunity to expand the learning environment outside the classroom, including the natural and historical environment.

One aim of our project was to find out whether and which technology could support the collection of meaningful information about history. One role of technology has also been to make learning processes and outcomes visible for the learning community and wider audiences. Technology serves as a tool, mediating and connecting the learning community and the experts. In this project, the main context of learning was an environment, the forest, outside the campus. The chosen technology could serve as a bridge between the school and the natural environment.

We went to the forest area in Punkaharju. This particular area is not just a part of our national heritage, it is also a historians’ dream, being well mapped and charted, and holding historical relics from the Ice Age up to the present day. In the woods, we found the ruins of an old Finnish peasant cottage. We sat down and imagined about the daily life and customs of the family living in that cottage, in the midst of a forest, about two hundred and fifty years ago. With the aid of literature, historical sources, and, of course, of the Internet, we produced a presentation of a fictitious family, which, however, could well have lived in this cottage, the ruins of which we discoved. We were, as the historian R.G.Collingwood would say, like detectives, working out what might have happened from a range of clues and sources. (Turner-Bisset 2008, 21.)
And our final product is a web-site, http://www.openmetsa.fi/wiki/index.php/Laukansaaren_Torppa, a virtual presentation of the cottage and its inhabitants with a family, whose members narrates his or her own story in an audio format. We have the drawing of the interior of their house, or an image of how might have been like, with links to Wikipedia pages and additional information. We have produced a reconstruction of the surroundings and the yard of the cottage. And, finally, we have made an example of an everyday struggle with living. We have composed a board game in which one has to embark on an fishing or hunting trip in order to get some food to this family. This game can be played either electronically or, alternatively, the players can print both the gameboard and the playing cards. The students also composed a cookbook full of recipes of authentic dishes made of natural products available in the proximity of the cottage. These recipes and the dishes are still as valid and tasty as they were 250 years ago, as they consist of fish, meat, bread, even of vegetables and berries. We believe that in this project we were able to catch a piece of microhistory, that is, the life of ordinary people of the past.

In other words, we were developing an example of learning material that supports learning and the building of a sustainable future and new requirements and makes genuine use of web-based opportunities. We have here a simulation, structures supporting visual and multisensory approaches and various forms of show and tell, which, we believe, will motivate and encourage pupils. We are still developing new learning materials that support learning and the building of a sustainable future and new requirements and make genuine use of web-based opportunities in which simulations, structures supporting visual and multisensory approaches and various forms of show tell will motivate and encourage pupils.

Our next step was to answer the question: what if the pupils would do the same thing – create this web page? It has been argued that while people in the “outside world” work collaboratively and use a variety of digital tools and resources to solve complex problems and create new ideas and products, students in schools have remained in structured classrooms where teachers cover the standard content by lecturing a large class of students; students work individually and reproduce this knowledge that is then assessed; and their use of ICT is limited.

The question is, however, is the use of ICT beneficial to achieve teaching objectives in primary school history, or is the use of ICT is less effective or even inappropriate? The general rule to apply is that ICT should be used where it enhances the possibilities for learning in history. This is not always the case. (Turner-Bisset 2008, 152.)

History is much more than finding and retrieving information. The key to developing pupils’ historical understanding is their ability to analyse and deploy information after they have accessed it. The most appropriate uses of ICT assist children to do just that. The other centrally important point is that the discipline of history is more than just accumulating information. (Turner-Bisset 2008, 152 – 153)

Simulations and games, like those we have on our web page, put children in a role as decision-makers in historical situations. They engage with the situation, learning all kinds of factual and conceptual information and experiencing cause and effect.

The fundamental point about using ICT for history is that it should exploit those aspects and the power of computers to do things which would otherwise be difficult or tedious using other media. It does, as we have seen, give the pupils a possibility to reconstruct a piece of the past in their imagination using what evidence can be found. They can hypothesise about things they are unsure of, and they can use other knowledge and experience to inform their interpretations. (Turner-Bisset 2008, 154.)

We also wanted to answer the following questions: what kind of learning project emerged? How did the students’ knowledge develop? The research interest was also to depict the learning project and to determine the kind of learning processes represented in this study.

On the basis of the students’ interviews we can say that the criteria of meaningful by David Jonassen (Jonassen et al 1999) were met in this preliminary project. According to Jonassen, learning environments should keep students 1) active, 2) constructive, 3) intentional, 4) collaborative, 5) complex, 6) conversational, 7) contextualized and 8) reflective. This project took four months of the students’ life and time. Was it worth it? According to the students’ written and oral reports, it really was. They learned a new way of working together and exploiting each other’s skills and strenghts, they learned innovative ways of using ICT in their future work and they learned a lot about the past. They took part in a scheduled project and they managed it well. They learned that learning for tomorrow is also about knowing the past, considering the present and recognizing oneself as a distinctive part of a larger entirety.

The data analysis revealed that the learning project challenged the students to develop (explanations for the phenomena and) high-quality learning outcomes.
4. CONCLUSION

And we all learned that ICT can really contribute to the teaching of history. We developed a virtual page which enables any primary school student to project himself in the daily life of distant times, compare his own daily life and times with it, maybe to gain a deeper understanding of it and even to take a trip to a deep forest without really being eaten and tormented by the insects. They are encouraged to examine their own household habits and compare them with those of the past and, for example, look for ways of making their lifestyles more environmentally friendly.

The farther we look back into our history, the more we will understand about where we are going and what the future has in store for us. That is the reason why reflections concerning the future and its sustainable development must start with reflections over the past. Reflection is a form of interpersonal intelligence, an important milestone in becoming a socially aware person. In a rapidly changing world it is crucial to have an acute and flexible sense of one’s own desires, needs, concerns and individuals’ optimal way of learning. Reflecting also helps us see things further back in history and far into the future.

Sustainability represents a harmony which should exist between ecological and social factors to maintain human life. The forests are considered as exemplifying context for development of generative skills and knowledge that support wellbeing and sustainable development, reflection of value systems and sense of community. The present study is a part of larger project aims to participate in the development of the future of education for sustainable development and forest as learning environment.

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NANOTECHNOLOGY, LIFE CYCLE ASSESSMENT AND GREEN ICT

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ABSTRACT
In this paper, the reciprocal relationship among nanotechnology, life cycle assessment and green ICT is explored. The conjunction between life cycle assessment and nanotechnology is briefly described in context with recent growing market of nanotechnology and its adverse impacts to the environment. The major consequences of life cycle assessment on green ICT are also discussed in this paper. A set of experiments is conducted using LCA tool to analyze environmental impacts behavior on different substrates with various possible printing materials. This parametric study gives an overview of the environmental impacts such as global warming, ozone depletion, and average human toxicity potentials in a building process of fixed structural element of a nanoproduct. Epoxy resin, Kapton and Teonex are considered as potential substrate materials while aluminum, ferrosilicon and copper are taken into account for tracing pattern on nano-structural element. In this paper, we will also discuss briefly few issues of green ICT with current technical education system.

KEYWORDS
Life Cycle Assessment, Printed Electronics, Green ICT, Sustainability, Nanotechnology

1. INTRODUCTION

The world is now progressing towards new technological innovations in almost all the sectors of human development such as health, education, agriculture, transportation and so on. The present state of the art research in the direction of information communication systems demonstrate that nanotechnology, sustainability, life cycle assessment, and green ICT together have not been a core focus for the ICT researchers. To reinforce researcher's contribution in developing environmentally friendly products, devising green manufacturing processes, there is a strong need to enhance life-cycle awareness and sustainability understanding among system researchers, so that the next generation of engineers will be able to realize the goal of sustainable life-cycle of the products.

The concept of making the nanoproducts and nanomaterials greener is currently one of the popular research topics all over the world, as it tends to be a practical way for more efficient exploitation of natural resources in the global scale. As the ICT industry consumes around 2\% [1] of the total used energy worldwide, and huge part of it falls on the wireless communication and particularly base stations including wireless instruments and antennas, it is rational to put strong effort on reduction of energy consumption in that sector of economy. Such an approach leads not only to better environmental protection but also reduces the cost of network management. Moreover, in the advent of internet-of-things and smart cities, where billions of devices are foreseen to communicate over the network, the need of efficient energy utilization is one of the key research aspects.

As an international community, people face both the excitement and the challenge that arise with these technological innovations. With nanotechnology already touching most industries from medicine to textiles to electronics the potential for transformational benefits may reach further than revolutionary technologies of the past. At the same time, the challenge of understanding potential risks that nanomaterials and nanoproducts may pose to human health and the environment is critical. We must take complementary steps
to resolve environmental, health and safety issues that might otherwise deprive us of many anticipated social and economic benefits, as nanotechnologies progress from the laboratory to the global marketplace [2].

In recent years, green information and communication technology (GICT) [3]-[4] has become a major attraction for technologists, system developers and manufacturers because present trend of manufacturing industries and the developed products is to minimize the ICT’s carbon footprint and to be green. The impact of ICT on the earth's climate and its dwindling resources is another major concern. The recent research in the area of green technology depicts that carbon dioxide emissions from the data centers alone surpasses the harmful emissions from many individual countries. This is in addition to the fact that current ICT devices contain toxic substances such as leads and mercury. Furthermore substantial amount of these substances enter into the environment after the disposal of the devices.

Moreover, in present context of Green ICT research, environmental awareness has increased in all the sectors of electronics product manufacturing (EPM). With the growing demand of ICT devices, products and services and its adverse affect on earth's atmosphere, green manufacturing process has become one of the key focuses for ICT researchers. “Silicon Systems for Sustainability” and “Electronics for Healthy Living” have become recent themes for ICT designers, and manufacturing industry.

Substantial research has been conducted on several key areas related to end-of-life of the electronic products. Some of them are methods of estimating end-of-life electronics exports, prioritizing material recovery for end of life printed circuit board and tracking the material, energy and value of end of life of lithium ion batteries. In our previous work, we focused on life cycle assessment of printed antennas particularly on raw material and production processes [5] and presented an insight into quantitative environmental analysis of printed circuit board [6]. The present academic literature has not focused on analysis of nanotechnology, life cycle assessment and green ICT together; hence here our work is to give an insight into environmental emissions in particular to the air and fresh water, and to explore global warming, ozone depletion, and average human toxicity potentials in a building process of fixed structural element.

Finally effort has been made to discuss the relationship among nanotechnology, life cycle assessment and green ICT. We also made an effort to describe the case studies.

2. RECIPROCAL RELATIONSHIP

In this section we will be discussing the core facts of this paper. First of all a triangular relationship among nanotechnology, life cycle assessment and green ICT are explained. The life cycle assessment acts as an intermediate role player.

2.1 Triangular Relationship

The reciprocal triangular relationship among nanotechnology, life cycle assessment and green ICT is shown in Fig. 1. These three entities are labeled on the three sides of a triangle. Life cycle assessment is situated on the base line of the triangle and acts as an intermediate role player between nanotechnology and green ICT. LCA also acts as an environmental assessment tool for remaining two. The world market of nanotechnology is growing rapidly and it turns out to be a key factor in future within green ICT frame of reference. Green nanotechnology refers to the use of nanotechnology to enhance the environmental sustainability of processes producing lesser harmful impacts. It also refers to the use of the products of nanotechnology to enhance sustainability.
2.2 Green ICT and LCA

Life cycle assessment and ICT environmental sustainability are one of the main functionalities of green ICT. Environmental life cycle assessment is a system analytical method and model by which the potential environmental impacts can be estimated. It is potentially the most important method for assessing the overall environmental impacts of products, processes or services. LCA is a tool which involves the collection and evaluation of quantitative data on the inputs and outputs of material, energy and waste flows associated with a product through its entire life cycle so that the environmental impacts can be determined. Life cycle assessment utilizes the approach of boundary conditions to model a specific process.

3. CASE-STUDY (PARAMETRIC ANALYSIS)

A case study has been carried out to analyze comparatively the environmental impact assessments in terms of global warming, human toxicity, acidification, eutrophication and ozone layer depletion potentials. The model has been created using an LCA tool that comprises of substrate material, pattern tracer and consumed energy levels. The detailed methodology for creating a model can be seen in the earlier published papers [7] and [8]. We have considered three substrate materials namely epoxy resin, Kapton and Teonex while trace pattern conductive materials taken into account are aluminum, ferrosilicon and copper respectively. Hence the parametric matrix is 3 X 3, which implies that there are nine options of creating models for a composite nano structural element.

Table 1. Matrix between substrate and printing materials

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<tr>
<th></th>
<th>Aluminum</th>
<th>Ferrosilicon</th>
<th>Copper</th>
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<tbody>
<tr>
<td>Epoxy Resin</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>Kapton</td>
<td>4</td>
<td>5</td>
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<td>Teonex</td>
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</table>

Gabi’s balance approach has been utilized to analyze the environmental emissions to the air, fresh water, sea water, agricultural and industrial soils. The overall impact assessment is shown in Fig. 2. For each nine options of the composite nano structural elements, the major environmental impacts are shown in the figure. It is clearly depicted that ozone layer depletion potential in case of Kapton and ferrosilicon composite product is substantially less than other composites. The global warming potential is highly affected in each case. Climate change and global warming is one of the popular research areas in the field of environmental technology.
Figure 2. Parametric Analysis for Environmental Impacts

Though graph shown in Fig. 2 of global warming potential looks pretty flat for all cases, Teonex and copper combination of the nano structural element produces smaller volume of global warming index. The environmental emissions for a specific of epoxy resin and ferrosilicon composite is shown in Table 2.

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Environmental Emissions</th>
<th>Amount</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Emissions to Air</td>
<td>82</td>
<td>kg</td>
</tr>
<tr>
<td>2.</td>
<td>Emissions to Fresh Water</td>
<td>6343</td>
<td>kg</td>
</tr>
<tr>
<td>3.</td>
<td>Emissions to Sea Water</td>
<td>1.7</td>
<td>kg</td>
</tr>
<tr>
<td>4.</td>
<td>Emissions to Industrial Soil</td>
<td>1.1</td>
<td>kg</td>
</tr>
<tr>
<td>5.</td>
<td>Emissions to Agricultural Soil</td>
<td>0</td>
<td>kg</td>
</tr>
</tbody>
</table>

The masses of the ferrosilicon conductive material and epoxy resin substrate are assumed to be 0.1 kg and 1 kg respectively for production of the nano composite.

4. GREEN ICT AND EDUCATION

It has been experienced that there is a mounting pressure on the universities and research institutions to adopt more sustainable approaches to ICT production and in their use. This pressure basically comes from the government, from regulatory sources, and from the public, who are increasingly aware of the environmental impacts. The detailed curriculum for requirement of green ICT course at university level has been revealed in the published literature [9]. The students should able to understand sustainable life cycle of ICT equipments and products. It is necessary to impart knowledge about how green ICT support in giving a sustainable solutions in product manufacturing, in use phase and at their disposal.
5. CONCLUSION

Our work contributes a number of useful findings. We have reviewed the reciprocal relationship among nanotechnology, life cycle assessment and green ICT. The solid triangular shape depicts that these three entities related with one another in several aspects. The concrete conclusion is life cycle assessment is a modest tool for assessing environmental impacts. The quantifying environmental footprint for a rigid and flexible substrate printed nano devices is another contribution of this paper. We have also estimated the environmental emissions such as emissions to air, fresh water, sea water, agricultural and industrial soil for epoxy resin and ferrosilicon nano composite. Another finding is estimation of global warming potential, acidification potential, eutrophication, ozone layer depletion and human toxicity potentials.

ACKNOWLEDGEMENT

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Poster
A WEB-BASED TOURIST GUIDE MOBILE APPLICATION

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ABSTRACT
Tourism is an important source of income for many countries, including Cyprus, a small island in Mediterranean that largely depends on tourism for its financial growth. In order to offer better services to tourists, in regard to informing them about the various attractions of the island, we have developed a tourism guide mobile application, which can assist tourists during their stay at the country. By using modern Web techniques, we managed to develop a tourist guide application that is able to be installed on various mobile platforms, such as Android and iOS, looking very similar to native applications. This practice constitutes a novel technique in mobile development.

KEYWORDS

1. INTRODUCTION
Tourism is an important source of income for many countries, especially those which combine culture and relaxation. Cyprus, a small island in the Mediterranean is one such example, counting on tourism for its financial growth. Cyprus blends archaeological wealth with beautiful beaches and warm temperatures and it is a popular destination for tourists from across the globe. In order to offer better services to tourists, in regard to informing them about the archaeological and religious attractions of the island, as well as about nice beaches and general places of interest, we decided to develop a tourism guide as a mobile application.

This constitutes a sustainable action, since no paper would be needed for printing books and magazines that serve as guides. Moreover, this service would help promote tourism in the country, contributing in a small degree on the further financial development of Cyprus.

2. FEATURES AND IMPLEMENTATION DETAILS
We decided to implement the mobile application by means of Web technologies, namely HTML5 and AJAX, to achieve interoperability across multiple phone platforms, with a small penalty in performance. The pros and cons of hybrid vs native mobile development are discussed in (Icenium, 2013). Mobile development based on common and well-understood, open source Web technologies, has the potential to increase the sustainability of software in general (Kamilaris, 2013).

By means of Adobe PhoneGap (Adobe PhoneGap, 2013), which is a free and open source framework that allows to create mobile applications targeting multiple phone platforms, we managed to create a tourist guide application that is able to operate on Android (NetRL, 2013), iOS (for iPhone, iPad), Windows, Nokia phones (Symbian-based), Blackberry and WebOS. PhoneGap helped to acquire the current location of the user, using Wi-Fi, GSM or GPS localization.

After developing the core functionality, we employed the Kendo UI framework (Kendo UI, 2013), which is a comprehensive HTML5/JavaScript framework for modern Web and mobile application development. Through Kendo, we managed to select from various designs, themes and layouts which look like a native application on the targeted platform. Figure 1 shows three different versions of the tourist guide mobile application, one for the Android operating system, one for Windows phones and one for the iOS platform. The reader can observe how similar both versions look to a native application on these platforms.
Therefore, with little effort, and by using well-known and understood technologies, we managed to perform this task with minimal effort. We list below the main features of the tourism guide mobile application, all enabled by means of modern Web techniques and tools:

- View nearby attractions from current location, either on a list or on the map of Cyprus.
- See detailed descriptions of particular attractions by clicking on them, as well as relevant information such as opening hours, contact details, entrance fees etc.
- Filter attractions according to the user's preferences, to view only places of interest.
- Adjust distance from nearby attractions. It can range from hundreds of meters to tens of kilometers.
- Search for attractions on a lexicographical basis.
- View the most popular attractions in every city or around the island, as they are rated by other tourists.
- Create a tour plan, by adding attractions to a list. This list can be edited even before entering Cyprus, to better organize vacations. This plan can then be viewed on the map of Cyprus with directions of how to visit these places in the most convenient way.
- Mark attractions as visited, to keep a list of visited places as a reference.
- Rate a visited attraction, so that other tourists would be assisted to select only the best places.
- View directions to an attraction, either on the map of Cyprus or in the form of text directions.

We note that the tourist's profile (sex, age, nationality, preferences), as well as his visited attractions, are saved anonymously on a Web server. Thus, our mobile application has the ability to offer more personalized suggestions to tourists, such as places visited by people of similar age or same nationality, which satisfy the user's preferences. After numerous requests from some tourists, we added a feature for selecting their place of stay manually. In this way, people without a sensor for localization on their mobile phones could still use the application and be informed about nearby and general tourist attractions.

Of course, the performance is not as that of a native application, but it is very satisfactory. Comparing the performance of our mobile application with a native one (Quinto Stdio Inc., 2013), offering very similar services, our application is slightly slower, but only in a small degree (10-16%). All actions and features are performed in a few seconds, while the menus are loaded in milliseconds.

By going native, we would have been obliged to learn specific programming languages and methods, such as Java for the Android case and Objective-C for iOS. Thus, the tradeoff of interoperability for a small performance degradation is worth it.

Concerning some figures of use, in less than three months when the Android version of our mobile application is on Google Play (NetRL, 2013), it has been used by more than 1,600 tourists. This indicates a success of the application, especially since most tourists being happy about it, have rated it positively (rating 4.0/5.0).

ACKNOWLEDGEMENT

The Tourist Guide mobile application is supported and funded by the Research Promotion Foundation of Cyprus, under Grant No. BUSINESS/PRODUCT/0609/73, “Development and Application of a Digital-Historical-Cultural Tourist Guide”.
Figure 1. Snapshots of the tourist guide mobile application. The Android version appears on top, the iOS version in the middle and the Windows version at the bottom. From the left to the right, the application shows the main menu, a list of nearby attractions and a filtering of attractions according to personal preferences.

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Doctoral Consortia
BUILDING ACADEMIC CAPABILITY IN THE HIGHER EDUCATION SECTOR: THE CASE OF VIETNAM

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ABSTRACT
Human resource is obviously considered the strategic weapon for emerging economies to survive in the global competitive environment. Developing countries such as Vietnam, are struggling to enhance the capacity of the young workforce through training. However, training is a costly strategy, often arising with the concern of its effectiveness due to the big gap found between training and performance in organizations. The proposed research is an attempt to deal with the issue of academics capability building in the Vietnamese Higher Education (HE) Sector with three key objectives: (1) to understand the process of developing academic capability, (2) to investigate expectations of the Vietnamese HE management system (as evident in academic performance management) to foster that process, and (3) to consider managerial implications for academic capability building in Vietnam.

The topic will be studied under the light of organizational learning theories, using mixed method approach. Data will be collected through in-depth interviews and a survey which are developed based on information obtained from informal scope interviews with Vietnamese university leaders and academics.

KEYWORDS
Academic capability, Higher Education, training.

1. INTRODUCTION
Today, human resource is obviously considered the strategic weapon for emerging economies to survive in the global competitive environment. More and more organizations are interested in investing in human capital to gain advantages during competitions. Organizations in developing countries such as Vietnam, are struggling to enhance the capacity of the workforce. Therefore, training and development in the field has become one of the key concerns in organizational context as it has the potential to increase the organizations’ value through contributing to employees’ knowledge, skills and attitudes as well as employees’ performance (Becker & Huselid, 1999; Noe & Winkler, 2009). In the situation of a global economy, the knowledge, skills and abilities necessary for successful job performance are growing and changing, which leads to the changes in the nature of work and the requirement of employees to develop a wide range of skills (Aguinis & Kraiger, 2009).

In response to this issue, with the belief that training is a strong instrument to create the targeted cognitive, behavioral and affective learning outcomes needed for their survival, organizations make increasing investments in the field (Salas & Stagl, 2009). For instance, American organizations are reported to spend over $125 billion on employee training and development every year (Paradise, 2007). Nevertheless, training is a costly strategy, often arising with the concern that it has to be demonstrated effectively to change performance positively (Martocchio & Baldwin 1997; Kelloway & Barling 2000). Despite the large investments in and potential benefits of training, organizational managers are often not sure to what extent training expenditures have been returned into job performance (Blume, Ford, Baldwin, & Huang, 2010). Some organizations even report the failure to capacity development in spite of the emphasis on training (Grossman & Salas, 2011). Georgenson (1982)’s estimation that only 10 per cent of training expenditures is transferred back to work reveals an enormous gap between training investments and organizational outcomes.
This provides the rationale for investigations into learning and development to bridge the big gap found between training and performance in organizations. Organizational learning and learning at work theories appear to have the ability to bridge this gap effectively; however, the vast literature of organizational learning with inconsistent viewpoints make it difficult for practitioners to make decision about which models to apply. Furthermore, prior research in learning at work has shown that the tendency is to focus on the business sector, so a study of this topic in other sectors, such as education, has the possibility to enrich the transfer literature and reap potential benefits. Additionally, the issue of organizational learning process in the context of emerging economies is, in deed, an urgent need for effective capacity building, thanks to which organizations can eventually make best use of their valuable human resources. However, not much attention in the present literature has been paid to this important area. This calls for further empirical information of how that context shapes the process of human resource training and development.

2. THE PROPOSED RESEARCH

2.1 Research Objectives and Research Questions

The aims of this project are to understand the process of building academic capability in the Vietnamese Higher Education (HE) sector, to investigate expectations of the Vietnamese HE management system (as evident in academic performance management) to foster that process, and to consider managerial implications for academic capability building in the Vietnamese HE sector.

In order to fulfill these aims, the project points out five main research questions:

1. What specific skill and capabilities do academics in Vietnam require to carry out their roles at their respective HE institutions?
2. How do academics in Vietnam develop these skill and capabilities in order to fulfill their roles?
3. What do academics in Vietnam perceive as the factors that affect their work, their academic training and development?
4. What are the expectations of academics, university leaders, HE authorities and Government agencies in relation to the performance of academics in Vietnam?
5. How do these expectations shape the performance management and development of academics in Vietnam?

2.2 Research Method

To answer the research questions mentioned above, the project will employ a mixed method approach with concurrent triangulation design. Semi-structured interviews will be performed to gain information from Vietnamese university leaders as well as Government officials and researchers in charge of the HE sector. Simultaneously, a survey of academics from different levels and positions will also be conducted to understand the topic from employees’ perspective.

The interviews and survey are performed at Vietnam National University, Hanoi (VNU Hanoi) chosen as the case for study based on three reasons. Frist, it is the leading university in Vietnam. Second, it includes 6 universities, which can be seen as a small picture representative for the Vietnamese HE sector. Last, it is selected by the Government as the model for future development of Vietnamese universities.

The qualitative results will be analyzed using NViVo data analysis software, while the quantitative data will be analyzed using SPSS data analysis software.

The data will be examined under different theories in the field of Organizational learning, which have been summarized and categorized by Shipton (2006, p.235) as shown in Figure 1. The project will employ a wide range of units of analysis, from individual learning, team learning to learning embedded into systems, and processes of the organization as suggested by Crossan, Lane and White (1999) that the flow of organizational learning should be across all levels.
3. CONCLUSION

If carried out successfully, the research will make both theoretical and practical contributions to the domain of organizational learning. First of all, the project brings in the theoretical generalization of the human resource training and development process in the new context of Vietnam - a developing country in transaction, especially with the new organizational setting of the Higher Education Sector. Likewise, different theories of organizational learning will be brought together at the same time to examine their explaining power on the mixed data set of both qualitative and quantitative data. Moreover, the study is likely to convey important implications for practitioners in the Vietnamese HE Sector, especially on how to facilitate the process of building academic capability.

However, the case study design of the proposed research, even though bringing a good opportunity for deep analysis, results in the limitation in practical generalization as the study results may not work for the whole HE sector. Other broader studies of the same topic should be conducted for wide application.
REFERENCES


THE POSSIBLE CONTRIBUTION OF SMALL-SCALE VEGETABLE LEATHER TANNING ENTREPRISES TO SUSTAINABLE JOB CREATION IN SOUTH AFRICA

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ABSTRACT
Under the theme sustainable SMEs this paper explores the establishment of Small Medium Enterprises (SMEs) in the leather production sector in order to promote sustainable production and contribute towards sustainable job creation in South Africa. Research has been conducted on SMEs and their contribution to the economy but none of the research focused on the leather industry, which is currently dominated by large-scale chromium tanning. Vegetable tanning sector has been left behind in terms of research and development despite the country being endowed with the Mimosa plant used in the vegetable tanning process. This research therefore, explores small-scale vegetable tanning looking at best practices in Italy which has long standing tradition. The National Development Plan (NDP), Industrial Policy Action Plan (IPAP) and the National Growth Path (NGP) has identified SMEs in South Africa as key to job creation.

KEYWORDS
NDP, SMEs, Sustainable development, Vegetable tanning.

1. INTRODUCTION
In South Africa leather tanning is part of the agro-processing sector, which is the biggest contributor to the economy. In 2011 the sector contributed 20% to the South African GDP and that made it the third largest contributor after metals and chemicals (StatsSA, 2012). The sector has been identified by IPAP, NGP, and the NDP for its potential to spur growth through job creation due to its linkages with the primary agricultural sectors. These are new policies that have been developed to foster economic growth in South Africa through job creation, industrial development and place emphasis on the value-addition processes (The DTI, 2012).

Currently, South Africa is a net importer of leather and leather products despite being in the top 10 hides and skin producing countries in Africa (FAO, 2012). This is due to the country exporting raw hides and skins as well as semi-processed leather. This has resulted in many job loses with the industry only contributing 1% to the to the GDP (Gebrehiwet, 2012). This study specifically focuses on small-vegetable tanning due to its linkages to many other sectors, which have a potential to contribute to job creation.

2. SME IN CONTEXT
SMEs play a pivotal role in the development of a nation and contribute to the socio-economic development by creating employment for both rural and urban labour force (NCR, 2012). Small-manufacturing in the developed countries was established through decentralisation of production system by breaking big manufacturing companies into smaller companies which was used as a strategy to avoid trade union power in Great Britain and Italy in the 1970s to enlarge opportunities to adjust production capacity more easily (ibid). SMEs are the most important drivers of employment gain and structural change (Hölzl, 2009), usually ranging from low-tech self employed to high tech R&D based start-up in manufacturing driven by entrepreneurs with a team (Stam & Wennberg 2009).
Knowledge on innovation based on a synthetic knowledge base that utilises existing local knowledge rather than on the creation of completely new knowledge is important (ibid). Naturally SMEs combine two ideal types of knowledge bases, which are local knowledge and western forms of knowledge. Local knowledge is in reference to the understanding of materials, available resources as well as the ability to add-value to the materials for human benefit. SMEs have transformative capabilities, which allow them to convert global or existing knowledge and tacit knowledge to context specific knowledge. Thus the transformative capabilities combined with general knowledge with practical knowledge about the specific locality and local materials (Hansen 2010). The transformation result in local versions of products and or processes, and the ability to create local solutions, which in the case of this study is sustainable leather production.

2.1 SMEs: The South African Context

According to Morgan, (2012:3), South African SMEs are classified as enterprises that are micro or very small by the National Small Business Act, are often survivalist or lifestyle businesses. Two in three of these businesses are operated and run by the owner and do not have any employees. While, medium-sized firms may not produce bulk of output or production they generally hire most people in any economy. Despite the acknowledgement by the democratically elected South African government SMEs still numerous challenges (NCR, 2012). SBP (2013:3) claim that ‘it is as if South Africa recognises that it needs small business, but it has not yet realised fully that small businesses have needs. It seems as if the development of small business economy is something that is assumed rather than encouraged’.

In South Africa SMEs many challenges including an enabling environment, bureaucratic financial application, lack of collateral and financial records which are required by the commercial banks (Morgan, 2012; Neneh & Vanzyl, 2012). According to Stam and Wennberg, (2009), in order to spur structural economic change and job creation from a policy perspective, policies need to foster high-growth of SMEs and take into account the comparative advantage of the environment and locally available resources.

3. RESEARCH METHODOLOGY

This study benchmarks Italy’s process of small-scale vegetable tanning using activity theory as a lens to understand best practice in vegetable tanning process and how the process contributes to economic, social and environmental sustainability. Benchmarking will be used to identify opportunities, internal dynamics of the production system and strengths within the local sector (Kendal, 1999).

![Benchmarking Methodology](image)

Figure 1. Benchmarking methodology adapted from (Raymond & St-Pierre, 2010)

The above figure indicates the process that will be followed in this study in terms of data collection process as well as the tools that will be used for data collection. While the figure below indicates the entire process of benchmarking which will also be used in this study.
3.1 Cultural Historical Activity Theory as a Lens to analyse the Leather Production Process

Cultural Historical Activity Theory (CHAT) is based on establishing how systems, principles based on the collective activity within a social-historical context work (Koszalka, & Wu, 2004). Activity theory is a philosophical and cross-disciplinary framework for studying different forms of human practices as development process both at individual and social level (Kuutti, 1991). In this study CHAT will used as a lens to analyse the process of vegetable tanning. CHAT is also a descriptive tool that focuses on understanding human activity, practices that incorporate nations, history, interventions, collaboration and development (Foot, 2001; Nardi, 1996). Through examining the production process, new innovations can be revealed by studying current methods in real situations.

Figure 2. Basic structure of activity theory adapted from Engestrom et.al., 1990

3.1.1 Theoretical Paradigm

A paradigm provides a tool for making sense of the social world and helps view the world in a particular way (Burrell & Morgan, 1979:24). The study is situated within two paradigms an interpretive and constructivist (Denzin & Lincoln, 1998; Hantrais, 2009:57-59). The interpretive aspect of the study will focus on understanding and interpreting the process of small-scale vegetable tanning process and how it can contribute to sustainable economic development (Geertz, 1973; Mlitwa & van Belle, 2010). The interpretivist approach will give account of what has been done and why they have done through seeking better ways of making the experience understandable (Denzin & Lincoln, 1998:21).

The Ontological Standpoint is that small-scale manufacturing systems make reference to local knowledge and use tacit knowledge for the development of communities in which they operate, the communities in reference are forerunners for small-scale value adding manufacturing systems in vegetable leather production for generations. The ethnographical aspect will look at the links to the social unit, individual unit, production methods, social structure, meaning making, cybernetics looks at units that are interconnected as beings of a larger whole (Hoffman, 1981; Keeny, 1983; Marshall, 1996:523). The collective responsively is made out social unit, individual unit, LK, culture, social structure and meaning (Dei, 2002). Additionally, peoples' engagement with local knowledge in relation to the context (Dei, 1993).

3.2 Data Collection Techniques

The methodological process of inquiry for this study hopes to increase knowledge in the area sustainability in the production of leather in South Africa and the promotion of small-scale tanning hence the use of exploratory method of the enquiry (Cresswell, Ebersohn, Ellof, Ferreira, Ivanкова, Jansen, Nieuwenhuis, Pierson, Plano Clark, & van der Westhuizen, 2007).

Interviews will be used as the primary tool of data collection. Structured interviews to examine the sustainable development of vegetable tanning and its potential contribution to the local economy (Yates, 1994; Curzon, 1995; Eder & Harris, 1999). The semi-structured method is flexible and uses loose framework so as to accommodate any circumstances, the line of enquiry allows for proving and clarification of answers and requires the researcher to attentive to the responses of the respondents (Cresswell, Ebersohn, Ellof, Ferreira, Ivanкова, Jansen, Nieuwenhuis, Pierson, Plano Clark, & van der Westhuizen, 2007). Observations will be used to allow the researcher to absorb and note details, action and subtleties of the field.
environment, and help illustrate the production process and capture the context and finally, to find out what informs the influence of the physical environment (Pretzik, 1994; Campell et al., 1966; Mulhall, 2003; Cresswell et al., 2007). Purposive sampling is used because there is a set criterion for the study which is to record and analyse sustainable small-scale vegetable tanning process to see how local knowledge is applied to contributes to the knowledge based economic development (Cresswell et al., 2007).

The population consists of rural vegetable tanner’s in South Africa, and those who have been producing leather to supply local footwear and fashion industry Italy. The policy development bodies such as the Department of Trade and Industry (DTI), and the Department of Science and Technology (DST) as the bodies that are driving the knowledge-based economic development in South Africa. The units of analysis consist of the tanning process, Small-scale production, tools and resources, leather producers and their social dynamics. Constructivist thinking through the coding process to identify emerging characteristics and themes will be used to analyse the large quantities of data that will be collected (Leedy & Armrod, 2005). The themes will be used to stimulate interpretations for the creation of pattern of interpretation of data (Alvesson & Skoldberg, 2000).

4. CONCLUSION

The study will possibly contribute to the creation of new body of knowledge in an area where less research has been conducted with regards to SMEs and the issue of sustainability within the leather tanning sector placing emphasis on the use of local knowledge and resources. The study seeks to explore the systems that are in place and their contribution to the economic development. The study want to investigate the potential of SMEs in leather production in terms of dealing with issues of sustainability.

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