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Journal Background and Scope

PROGRESS Multidisciplinary Research Journal is an academic and peer-reviewed journal published bi-annually by the Polytechnic of Namibia. The journal seeks to give visibility and worldwide access to applied research. It publishes research articles written by professional academics as well as doctoral students from original completed and ongoing research, special issues, short communications, and reviews. The journal serves as platform for discussion and dissemination of research findings, new research areas and techniques, conceptual developments, and articles with practical application to any field.

Its scope is multidisciplinary, covering studies in the arts, human and social sciences, economic and education sciences, natural sciences, engineering and technology. All articles are evaluated by the editorial board and two or more international reviewers with scholarly expertise in the subject.

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ISSN 2026-7096
Namibia’s Performance in Mathematics and Physical Science: Implications for Technical Skills

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1. Background
In recent years skill shortages in the labour force have become a key challenge in the SADC region, suggesting that policies for continuous upgrading of skills of the workforce are becoming increasingly important [1]. While Namibia is no exception to the skills shortage dilemma, over the past decade the situation has been worsened by the increased unemployment rates in the country’s urban areas, particularly in Windhoek. Obtaining a junior/senior certificate alone does not guarantee any return to the youth of our country unless accompanied by some technical skills. The curriculum for Namibian Basic Education as set out in “Toward Education for All” [2] includes the following: Aesthetic, social and economic, linguistic and literacy, mathematical, spiritual, moral and ethical, physical, natural scientific and technological learning areas. These, if developed further and applied appropriately to the country’s economic situation, should be sufficient to combat the existing skills deficit.

2. The Skills Deficit
According to Marope [3], diverse analyses confirm the acute shortage of skilled labour across all sectors of the economy, and especially in the science- and mathematics-based professions such as engineers, agro- and natural resource specialists, technicians, business administrators, medical doctors, nurses, and mathematics and science teachers in Namibia. Figure 1 shows the skills deficit projections based on data generated by Links [4] for selected natural science and mathematics related professions.
An increase in demand with a decrease in supply, and hence the gradual increase in deficit is evident for all the professions shown in Figure 1. While the Namibian Vision 2030 and NDP4 point to economic competitiveness; technical skills shortage is proving to be a binding constriction to productivity, economic growth, employment creation, and sustainable poverty reduction; which are key to the country’s competitiveness in the global economy.

3. The Education System
It is evident that education is acknowledged globally to be the single most important aspect of human development, and a critical success factor for economic advancement and increased equality. The National Planning Commission [5] however, reports that despite significant investment and numerous efforts to strengthen education and skills, the country’s education system is still perceived as performing below par. It is therefore not surprising that unemployment, societal inequalities and economic development are identified as key challenges in the NDP4 and hence education remains one of the key strategic focus areas. Some of the key concerns regarding education at present include quality of outcomes at various levels; access to quality early childhood development; vocational training opportunities, and the mismatch between the supply of and demand for skilled labour.

3.1 Initiatives for Improving on Mathematics and Physical Science Performance
The Ministry of Education and Culture’s rationale [6] for the mathematics syllabi from grades one to ten is as follows: (1) Mathematics is an essential
element of communication in modern society; (2) Mathematics is essential for every citizen to cope with the everyday operations of number, money, measurement and space; and (3) Mathematics provides a broader insight into the patterns and relationships in the natural and manufacturing world. Projections set for improvement on Mathematics and Physical Science in the period 2005 -2011 are shown in Table 1.

**Table 1:** Percentage Mathematics and Physical Science Performance (2005 – 2011)

<table>
<thead>
<tr>
<th>Grade/ Level</th>
<th>Subject</th>
<th>Baseline Grade 10 &amp; 12 2005</th>
<th>Target Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2006</td>
<td>2007</td>
</tr>
<tr>
<td>5</td>
<td>Mathematics</td>
<td>51.6</td>
<td>55.9</td>
</tr>
<tr>
<td></td>
<td>Science</td>
<td>55.9</td>
<td>59.4</td>
</tr>
<tr>
<td></td>
<td>English</td>
<td>47.7</td>
<td>51.2</td>
</tr>
<tr>
<td>8</td>
<td>Mathematics</td>
<td>51.6</td>
<td>55.1</td>
</tr>
<tr>
<td></td>
<td>Science</td>
<td>55.9</td>
<td>59.4</td>
</tr>
<tr>
<td></td>
<td>English</td>
<td>47.7</td>
<td>51.2</td>
</tr>
<tr>
<td>10</td>
<td>Mathematics</td>
<td>51.6</td>
<td>55.1</td>
</tr>
<tr>
<td></td>
<td>Science</td>
<td>55.9</td>
<td>59.4</td>
</tr>
<tr>
<td></td>
<td>English</td>
<td>47.7</td>
<td>51.2</td>
</tr>
<tr>
<td>12</td>
<td>Mathematics</td>
<td>51.6</td>
<td>55.1</td>
</tr>
<tr>
<td></td>
<td>Science</td>
<td>55.9</td>
<td>59.4</td>
</tr>
<tr>
<td></td>
<td>English</td>
<td>47.7</td>
<td>51.2</td>
</tr>
</tbody>
</table>

Though the projected improvements in Table 1 seem to be met (Figure 2(a) and (b)), the promising scores in Mathematics shown in Figure 2(a) do not seem to give Namibia the competitive advantage (Table 2) expected.

**Table 2:** Country Mean Scores for Mathematics and Reading [7]

<table>
<thead>
<tr>
<th>Country</th>
<th>Reading score</th>
<th>Mathematics score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SACMEQ II</td>
<td>SACMEQ III</td>
</tr>
<tr>
<td>Seychelles</td>
<td>562.0</td>
<td>575.0</td>
</tr>
<tr>
<td>Kenya</td>
<td>546.5</td>
<td>543.1</td>
</tr>
<tr>
<td>Tanzania</td>
<td>545.9</td>
<td>578.0</td>
</tr>
<tr>
<td>Mauritius</td>
<td>536.4</td>
<td>573.5</td>
</tr>
<tr>
<td>Swaziland</td>
<td>529.6</td>
<td>549.0</td>
</tr>
<tr>
<td>Botswana</td>
<td>521.1</td>
<td>534.6</td>
</tr>
<tr>
<td>Mozambique</td>
<td>516.7</td>
<td>476.0</td>
</tr>
<tr>
<td>South Africa</td>
<td>492.3</td>
<td>495.0</td>
</tr>
<tr>
<td>Lesotho</td>
<td>451.2</td>
<td>467.9</td>
</tr>
<tr>
<td>Namibia</td>
<td>448.0</td>
<td>497.0</td>
</tr>
</tbody>
</table>
Despite efforts to improve on Mathematics and Physical Science performance; the emphasis put on Mathematics, Physical Science and English syllabi; and the performance targets set by the government of Namibia; the country mean mathematics score is still lower than most of the neighboring low population countries (small states of the Commonwealth) like Lesotho, Botswana, Mozambique and Swaziland (Table 2). A similar trend is observed with mean reading scores.

3.2 Initiatives for Improving the Vocational Education and Training (VET)

The vocational education and training (VET) system is implemented with the intention of addressing skills shortages in the country, particularly technical skills at artisan level. The UNESCO Revised Recommendation on Technical and Vocational Education and Training states that: “Given the immense scientific, technological and socio-economic development, either in progress or envisaged, which characterizes the present era, particularly globalization and the revolution in information and communication technology, technical and vocational education should be a vital aspect of the educational process in all countries” [8]. Table 3 shows an increase in enrolment into different vocational centres in the country.

The general increase in enrolment into the VET Centres is a good sign of improvement. It is worth noting however, that vocational training only prepares artisans, it does not address the technical skills shortage affecting the key mathematics- and physical science-related professions. Moreover, there are mismatches in demand and supply of skills to address the ever-growing skills shortages, and this has resulted in industry having less confidence in the public Vocational Education and Training (VET) system. Furthermore, VET qualifications have had little credibility and there has been almost no articulation of credits, which meant that trainees had to retrain and/or repeat subjects to get qualifications from other institutions.
4. The Knowledge Economy

The knowledge economy of any country is directly related to the education, Information and Communication Technology (ICT) infrastructure, economic incentives and innovation (Table 4). The knowledge economy index (KEI) indicates the readiness of a country for knowledge economy. The evident lowest scores for education, innovation and hence the knowledge economy index are concerning. These are normally dependent on application of technical skills. The performance in physical science and mathematics; is currently used by many countries as indicator for acquisition of technical skills; which if applied appropriately, lead to innovative solutions. Performance in Physical Science and Mathematics for the period 2008 to 2012 is shown in Figure 2(a) and (b).

### Table 3: Enrolment into Vocational Training Centres

<table>
<thead>
<tr>
<th>Institution</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windhoek Vocational Training Centre (WVTC)</td>
<td>510</td>
<td>679</td>
<td>796</td>
<td>795</td>
</tr>
<tr>
<td>Rundu Vocational Training Centre</td>
<td>254</td>
<td>238</td>
<td>308</td>
<td>525</td>
</tr>
<tr>
<td>Valombola Vocational Training Centre</td>
<td>418</td>
<td>454</td>
<td>318</td>
<td>536</td>
</tr>
<tr>
<td>Zambezi Vocational Training Centre</td>
<td>63</td>
<td>138</td>
<td>N.A</td>
<td>110</td>
</tr>
<tr>
<td>Okarara Vocational Training Centre</td>
<td>330</td>
<td>326</td>
<td>376</td>
<td>294</td>
</tr>
<tr>
<td>DAPP Vocational Training School</td>
<td>81</td>
<td>108</td>
<td>150</td>
<td>108</td>
</tr>
<tr>
<td>Katutura Youth Enterprise Centre</td>
<td>626</td>
<td>489</td>
<td>1203</td>
<td>N.A</td>
</tr>
<tr>
<td>Community Skills Development Centres</td>
<td>1126</td>
<td>1708</td>
<td>1993</td>
<td>1735</td>
</tr>
<tr>
<td>Namibia Maritime Fisheries Institute</td>
<td>N.A</td>
<td>67</td>
<td>59</td>
<td>93</td>
</tr>
<tr>
<td>Namwater</td>
<td>N.A</td>
<td>N.A</td>
<td>195</td>
<td>202</td>
</tr>
<tr>
<td>NamPower</td>
<td>15</td>
<td>24</td>
<td>25</td>
<td>27</td>
</tr>
<tr>
<td>Namibia Institute of Mining and Technology</td>
<td>918</td>
<td>1124</td>
<td>1583</td>
<td>2409</td>
</tr>
<tr>
<td>St. Charles Lwanga Major Seminary</td>
<td>27</td>
<td>44</td>
<td>36</td>
<td>37</td>
</tr>
<tr>
<td>National Health Training Centre</td>
<td>N.A</td>
<td>8</td>
<td>48</td>
<td>31</td>
</tr>
<tr>
<td>N.I.C.E/Wolwedans</td>
<td>N.A</td>
<td>15</td>
<td>32</td>
<td>186</td>
</tr>
<tr>
<td>Phillipi Trust Namibia</td>
<td>N.A</td>
<td>348</td>
<td>459</td>
<td>241</td>
</tr>
<tr>
<td>Shadonai Beauty School</td>
<td>N.A</td>
<td>88</td>
<td>125</td>
<td>176</td>
</tr>
<tr>
<td>National Occupational Safety Association Namibia</td>
<td>N.A</td>
<td>206</td>
<td>236</td>
<td>392</td>
</tr>
<tr>
<td>International Training College Lingua</td>
<td>302</td>
<td>405</td>
<td>461</td>
<td>621</td>
</tr>
<tr>
<td>ILSA Independent College</td>
<td>N.A</td>
<td>243</td>
<td>275</td>
<td>470</td>
</tr>
<tr>
<td>Helmut Bleks Foundation</td>
<td>N.A</td>
<td>N.A</td>
<td>N.A</td>
<td>30</td>
</tr>
<tr>
<td>TOTAL</td>
<td>4670</td>
<td>6706</td>
<td>8678</td>
<td>9018</td>
</tr>
</tbody>
</table>
Table 4: Relative Knowledge Economy (KE) Readiness [9]

<table>
<thead>
<tr>
<th>Country</th>
<th>Knowledge Economy Index</th>
<th>Economic Incentives</th>
<th>Innovation</th>
<th>Education</th>
<th>ICT Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S</td>
<td>8.69</td>
<td>7.81</td>
<td>9.47</td>
<td>8.43</td>
<td>9.03</td>
</tr>
<tr>
<td>Australia</td>
<td>8.66</td>
<td>8.14</td>
<td>8.68</td>
<td>9.14</td>
<td>8.67</td>
</tr>
<tr>
<td>Japan</td>
<td>8.26</td>
<td>7.23</td>
<td>9.30</td>
<td>8.09</td>
<td>8.40</td>
</tr>
<tr>
<td>Singapore</td>
<td>8.22</td>
<td>9.53</td>
<td>8.60</td>
<td>5.61</td>
<td>9.13</td>
</tr>
<tr>
<td>South Korea</td>
<td>7.70</td>
<td>6.10</td>
<td>7.88</td>
<td>7.80</td>
<td>9.03</td>
</tr>
<tr>
<td>South Africa</td>
<td>5.36</td>
<td>5.22</td>
<td>6.19</td>
<td>4.56</td>
<td>5.46</td>
</tr>
<tr>
<td>Malaysia</td>
<td>5.32</td>
<td>5.52</td>
<td>4.43</td>
<td>4.51</td>
<td>6.81</td>
</tr>
<tr>
<td>Botswana</td>
<td>4.96</td>
<td>6.49</td>
<td>5.17</td>
<td>3.75</td>
<td>4.43</td>
</tr>
<tr>
<td>Mauritius</td>
<td>4.32</td>
<td>4.41</td>
<td>2.64</td>
<td>3.81</td>
<td>6.44</td>
</tr>
<tr>
<td>Namibia</td>
<td>3.42</td>
<td>5.19</td>
<td>1.83</td>
<td>2.65</td>
<td>3.97</td>
</tr>
</tbody>
</table>

Figure 2: Average Grade 12 performance for the period 2008 to 2012 for:
(a) Mathematics, (b) Physical Science
Using a generalised point scale of A - 7 (80% and above), B - 6 (70 to 79%), C - 5 (60 to 69%), D - 4 (50 to 59%), E - 3, (40 to 49%), F - 2 (30 to 39%) and G - 1 (below 30%); the overall performance by most regions seems satisfactory. The scores for Mathematics are higher than the Physical Science scores, which is not common for most African states.

The scores are generally what is expected based on the projections made for the 2005 to 2011 period (Table 1). The question remains why the country struggles with innovation and knowledge economy when the Physical Science and Mathematics performance is satisfactory. Does the system facilitate transference of the right skills at the right level/stage for the learners to be sufficiently prepared for making a meaningful contribution to the knowledge economy? Is the foundation firm enough for the Institutions of higher learning to build on?

5. Concluding Remarks
The following actions common to education and training for knowledge economies are suggested for improvement of the Namibian Education System and ultimate increase in technical skills: (1) Implementation of policies that emphasise wide and equitable access to high quality education in order to quickly build a high threshold of educated and skilled human capital; (2) Curricula that emphasise the attainment of solid foundation skills like numeracy, literacy, language; and the attainment of competencies required for effective functioning in a KE, namely mathematics, science, problem solving, critical thinking, working together in teams, analyzing and evaluating situations; and (3) treatment of subject matters as resources through which learners’ competencies are developed, not as content to be mastered as an end in itself.

Implementation of a concept and skills checklist [10] showing the depth of knowledge and skills acquired at any level of education is also crucial for transference of technical skills.
6. References


[9] WBI 2002, KEI Knowledge Economy Index; Economic Incentive and Institutional Regime; ICTs Infrastructure.

An Exploration of Participatory Mapping Approaches for Integrated Land Use Planning in the Hardap Region, Namibia

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Polytechnic of Namibia, Namibia

Abstract
The paper presents empirical findings on the potential value of participatory mapping for effective Integrated Land Use Plan (ILUP) by local communities in Hardap Region. It reflects on how future participatory approaches should be structured. The research applied a combination of approaches that include sketch mapping, photo-mapping and consultative meetings. Both positive and negative impacts of participatory mapping on ILUP were measured and local communities’ knowledge of participatory approaches objectively tested on the basis of this investigation’s findings. The research established that although participatory mapping is known to the experts in the fields of Geography, Geographical Information Systems (GIS) and Land Use Planning (LUP), it is still not well known to local land users whose knowledge of other participatory approaches that can support ILUP in Namibia is limited. Participatory maps that were produced by local communities in Hardap region suggest that local communities are willing to learn about participatory approaches and willing to share their knowledge on land use. Sketch and photo-maps - although not accurate and sometimes imprecise - were found to be satisfactory approaches to capture and document local knowledge. Local communities are motivated to improve their land use activities by the outcomes of their knowledge input in participatory mapping. Key recommendations include comprehensive participatory land use planning and better knowledge gathering from local communities. The paper presents results of participatory mapping and lessons learned from exploring participatory mapping.

Keywords: Participatory mapping, integrated land use planning, Hardap region, Namibia; local communities.
1. Introduction
Globally, land is a limited but vulnerable and renewable resource but if used properly. Human land use has considerable impacts on the natural environment (Randolph [1]). Human conversion of natural and productive land and inappropriate location of different forms of development such as roads and the construction of buildings and land use practices after development have numerous impacts on the natural environment (Randolph [1]). Several environmental and social planning approaches both in urban and rural communities have been developed. Integrated land use planning through participatory mapping can enhance community involvement in the planning process. Arendt (1996, 1999), Yaro, Arendt, Dodson and Brabec (1988 cited in Randolph [1]) “popularised the conservation residential design approach in protecting rural and small-town values and morals” while other analysts (Audirac, 1997; Golley & Bellot, 1999 cited in Randolph [1]) have focused work on rural sustainability.

Public participation is an important component of ILUP. Currently, GIS is used in ILUP to facilitate the handling of the extensive spatial environmental, ecological, land use, infrastructure, biological, archaeological and cultural data to assist in the decision-making process. The integration of LUP and GIS, however, is generally devoid of a community involvement component while the use of geo-visualization techniques rarely extends beyond two-dimensional mapping. The ILUP process is predominantly a top-down expert-driven quantitative approach that seeks to draw upon public participation at certain stages of specific projects to define and evaluate social, economic, and environmental issues. This public participation is however unable to meaningfully influence the expertise process. It is suggested in this study that such limitations can diminish and undermine community perspectives on a range of important issues in the ILUP process and constrain the public’s ability to participate in defining, examining, and reviewing project development and decision-making.

Although various cost-effective mapping techniques such as sketch mapping and photo-mapping have been used in different programmes in different countries, their potential in terms of social inclusion in decision-making has not been adequately exploited while the use of GIS techniques in Namibia remains under-exploited and poorly documented. Resulting in little information on their impacts on participatory mapping.
2. The Study Area (Hardap Region)

After Namibia’s independence in 1990, the Hardap Region was divided into six political constituencies: Gibeon, Mariental Rural, Mariental Urban, Rehoboth Rural, Rehoboth Urban East and Rehoboth Urban West. In August 2013, the Hardap Region was re-demarcated by adding two extra constituencies (Aranos and Daweb) following the 4th Delimitation Commission’s recommendation to bring about better service delivery to the community of the Hardap Region. This study was confined to the six political constituencies of Gibeon, Mariental Rural, Mariental Urban, Rehoboth Rural, Rehoboth Urban East and Rehoboth Urban West partly because participatory mapping exercises of the study had already been done before the re-demarcation was implemented and also because of lack of data in the two new constituencies.

Approximately 75% of land in the Hardap Region is owned by private farmers on a freehold basis. The second largest landowner is the government that owns the extreme western part that constitutes approximately 15% of the region and is designated as part of the Namibi-Naukluft Park. The central-southern part of the region (about 10% of the area) is designated as communal farmland owned by traditional authorities and small-scale (Government of Namibia [2]).

Other small parcels of land scattered throughout the region are the 10 resettlement farms and protected area surrounding Hardap Dam owned by government which also owns two parcels of land dedicated to government agriculture (Mendelsohn, Jarvis, Roberts and Robertson [3]). Ten (10) designated local authorities are scattered throughout the area with the largest being Rehoboth in the far north and the regional capital, Mariental in the south.”

The study area is located in the south of Namibia, (Figure 1). Hardap Region covers about 110 km² and has a population of approximately 79 000 people (Namibia Statistics Agency [4]). The region was chosen mainly due to a presence of a combination of issues that may easily lead to land disputes. These issues include, environmental issues (the area is prone to flooding), competing land uses notably mining, agriculture and nature conservation and uneven distribution of boreholes, wind pumps and water canals.
Figure 1: Study area

The word ‘Hardap conveys the prominent role of the Hardap Dam in the agricultural, economic and tourism sectors of this region. The participatory approaches for sustainable land use planning were carried out in six different rural, peri-urban and urban sites with different land use practices in the Hardap Region.

3. Participatory Mapping Approaches [The Methodology Perspective]

3.1 The Evolution of Participatory Mapping
The participatory creation of maps started in the late 1980s when development practitioners adopted Participatory Rural Appraisal (PRA) methods such as sketch mapping (Rambaldi et al., [5]) although Participatory spatial information management and communication in developing countries and participatory creation of maps, above and beyond their interpretation started in the early 1980s (Rambaldi, et al., [6]). Preference during this period was given to eliciting local knowledge and building on local dynamics to facilitate communication between insiders (villagers) and outsiders (e.g. researchers, government officials, etc.). Using Participatory GIS 1(PGIS) with communities can add value to local knowledge in support of development mechanism

1 Participatory GIS is an emergent practice in its own right; developing out of participatory approaches to planning and spatial information and communication management (Rambaldi & Weiner (2004 cited in Rambaldi et al. [6]).
(Minang and McCall [7]). The state of affairs in mapping changed in the ‘1990s, with the diffusion of modern spatial information technologies including GIS, global positioning systems (GPS), remote sensing image analysis software and open access to spatial data and imagery via the internet.”

Different participatory mapping strategies\(^2\) including participatory photo-mapping and sketch mapping as well as participatory GIS (PGIS) have traditionally been used in the collection of data for monitoring land use development, urban development, land degradation, deforestation, urban settlement and other development activities.

The two methods, sketch and photo-mapping, were used to produce participatory maps in this study. Knowledge and opinions were gathered from the participants within the Hardap Region on land uses as per the objective. The participatory mapping exercises were applied to different units of land within the Hardap Region; the information for the maps was gathered from the residents of the various units of that land. The information on different land uses such as business, residential, industrial, garage, institution, open spaces and roads were obtained from the participants. Information on land cover such as rivers, riverbeds, dunes and sewage swap was also provide and mapped by the participants.

### 3.2 Sketch Mapping

Sketch mapping or “resource mapping” helps people in picturing resources and features on a given base and in graphically illustrating the significance they attach to them. It is a method for collating and plotting information on the occurrence, distribution, access and use of resources within the physical, economic and cultural domain of a specific community (Integrated Approaches to Participatory Development (IAPAD) [8]). Corbett, et al., [9]) stated that Sketch mapping is a map drawing method that depends on observation and memory without exact measurements, consistent scale or georeferencing. It usually involves drawing symbols on large pieces of paper to represent features in the landscape and is often time-consuming compared to photo-mapping because of its dependence on the participants’ memory, whereas photo-maps are drawn from georeferenced remotely sensed images.

The International Fund for Agricultural Development (IFAD) [10] describes sketch mapping as a “hands-on mapping that includes basic mapping methods in which community members draw maps on the ground (ground mapping)
and on paper (sketch mapping) from memory. Although these maps do not rely on exact measurements, a consistent scale or georeferencing, they do show the relative size and represent key community-identified features on the land from a bird’s eye view. These maps have been commonly used in Rapid Rural Appraisal (RRA) through Participatory Rural Appraisal (PRA) and Participatory Learning and Action (PLA) initiatives.

Sketch mapping outputs may differ according to the specific purpose the exercise is conducted for, and to the characteristics of participants (IAPAD, 2010). It is best associated with other participatory tools and in particular with transects walks, which contribute to a more critical analysis of the individual resource. Knowledge on the social structure of the participating community is a prerequisite for the facilitator because the community may consider resource distribution, use and access as sensitive issues. Sketch mapping techniques are a good starting point for framing important land-based issues and can help provide a broad picture of issues and events covering a large area and can be useful in introducing and acquainting a community with maps by building confidence in using the cartographic medium. Sketch mapping can help the planning of subsequent mapping activities and facilitate the engagement of non-expert users, non-literate communities and those from marginal livelihood systems including indigenous peoples, forest dwellers and pastoralists (IFAD [10]).

Sketch mapping also referred to as resource mapping, has its own strengths and weaknesses.

Strengths include:

• Low-cost and none dependence on technology (International Fund for Agricultural Development [10]).
• Repeatability at given intervals to become an integral part of participatory monitoring and evaluation (IAPAD [8]).
• Ability to provide in-depth resource mapping for a particular resource for times in the project cycle. It can help generating qualitative and quantitative information (IAPAD [8]).
• Ability to deliver in a short time frame and provide tangible short-term outcomes (International Fund for Agricultural Development [10]).
• Applicability to all ecosystems known to the community and amenability to different levels of definition and elaboration (IAPAD [8]).
Weaknesses include:

- In a general assessment of the approach, it was observed that the spatial confinement of the basic input - the participatory sketch map to the social, cultural and economic domains of those who produce it, the sketch maps becomes unrealistic from the practical points of view (IAPAD [8]).

- Dependence on good community mobilization, transect diagramming and plotting of natural and other resources onto sketch maps which make it difficult to produce precisely scaled authoritative information that can be used officially for management purposes hence the tendency of bureaucracies to pay little attention to sketch maps and other informal documents (IAPAD [8]).

Some of the drawbacks of sketch mapping, pointed out by the IFAD) [10] are that “the final map outputs are not geo-referenced and can only be transposed onto a scale map with difficulty. This makes them less useful when locational accuracy is important i.e. when there is a need to determine the size of an area or make other quantitative measurements. This lack of cartographic accuracy undermines their credibility with government officials and thus diminishes their potential for advocacy. Although the final map can be photographed, the long-term usefulness of ground maps is further undermined by their impermanence and fragility.”

However the low-cost, low training requirements and ease of delivery make sketch mapping a useful tool for initially engaging communities - particularly non-literate groups (IFAD [10]). It is a useful process for determining and extracting community views and information and is capable of effectively empowering local communities.

3.3 Photo-Mapping

The photo-mapping exercise is usually carried out on the printouts of georeferenced or orthorectified remotely sensed images (Rambaldi et al., [6]). Orthophoto maps are some of the sources of accurate remotely sensed data that may be used for large scale community mapping. The International Fund for Agricultural Development [10] stated that “local knowledge is identified through conversation and then drawn directly onto a photo copied map or remote-sensed image (or else onto clear plastic sheets placed on top of the map). The position of features is determined by looking at their location relative to natural landmarks (e.g. rivers, mountains, lakes).” This method also works well with aerial and satellite images, which can be particularly helpful when working with people who cannot read a topographic map and with non-literate communities, including those from marginal livelihood systems (e.g.
indigenous peoples, forest dwellers and pastoralists). Additional information can be collected in the field using GPS and later be mapped on the map (IFAD [10]).

Muller and Wode (2003, cited in IAPAD [8]), photo-mapping is one of the “conventional approaches used to obtain land use maps usually conducted by outsiders who interpret remote sensing data without profound knowledge of local resource conditions. Limited field experience possibly results in inaccurate delineation and misinterpretation of land use classes.”

Muller and Wode [11] stated that “the objective of participatory photo-mapping is to enable villagers to carry out the interpretation of aspects of their land resources, which are of significant importance to them. In this process villagers delineate their land use on transparencies laid over an orthophoto. The information on the transparencies will later be scanned or digitized and geo-referenced. Involving local stakeholders with their extensive field experience is expected to improve the accuracy and precision of obtained data.”

Muller and Wode [11] further maintain that “Orthophoto-maps are an effective participatory communication tool on village level to:

1. visualize resource use in order to facilitate discussions without communication barriers and to motivate participants to reflect and discuss about land issues;
2. allow a rapid identification of social, economic, and environmental problems of the village by determining and debating issues related to natural resource use with active participation of the community;
3. create a common understanding among local land users and administrative authorities on spatial distribution and status of resources and resource use;
4. provide a basis for joint and demand-driven decision-making between different villages and between villages and state entities;
5. acquire accurate spatial data on large scale on the basis of local knowledge;
6. provide options for participatory impact monitoring for rural development investments from government and other donors;
7. mediate and solve prevailing boundary conflicts;
8. generate accurately scaled information on land use that can be officially approved for management purposes.”

Photo-mapping techniques are a good format for communicating community
information to decision-makers because they use formal cartographic protocols (e.g. coordinate systems and projections). Information can be incorporated into other mapping tools, including GIS and GPS data can be easily transposed onto these scale maps. When accuracy is required where scale maps are not available, scale maps can be made using survey equipment including compasses and GPS tools. This approach to participatory mapping is important in regions where accurate topographic maps are not available, such as in remote and marginal areas which often tend to be inhabited by indigenous peoples, forest dwellers and pastoralists. The time and energy required to create scale maps from scratch are considerable (International Fund for Agricultural Development [10]).

Like sketch mapping, the International Fund for Agricultural Development [10] maintains that the photo-mapping approach “is relatively cheap and fast and still provides an accurate spatial representation of local knowledge, particularly if the information drawn on the map is ‘ground-truthed’ using a GPS. The resulting map can be used to determine quantitative information such as distance and direction.”

Some of the drawbacks of photo-mapping are that in some countries, access to accurate scale maps is regulated and difficult. Furthermore, maps in some areas might not be accurate or up-to-date. A final drawback is that using scale maps requires understanding formal cartographic protocols such as scale, orientation and coordinate systems which can be challenging for non-literate people (International Fund for Agricultural Development [10]).

According to the International Fund for Agricultural Development [10] “scale maps and images have particular potential for adoption of delineated geographical features. The field application is straightforward, engaging and relatively cheap, although there are photocopying and pen costs. This process also permits the collection of geo-referenced spatial information that can be imported directly into GIS systems.” Like sketch mapping, the impacts of photo-mapping process are minimal in relation to long-term change and empowerment of communities engaged in the process.

4. The Complexity of Integrated Land Use Planning
Wade and Sommer [17] defined land use as the classification of land according to what activities take place on it or how humans occupy it; for example, agricultural, industrial, residential, urban, rural or commercial. Land use should not be confused with the term land cover, which concerns the natural and artificial features covering the earth’s surface like forest, roads, grassland, bare soil, and lakes. According to Wade and Sommer [17] land cover entails “the classification of land according to the vegetation or
material that covers most of its surface; for example, pine forest, grassland, ice, water or sand."

The Canadian Council of Forest Ministers [12], in its integrated forest land use planning projects emphasised that “integrated land use planning seeks to balance the economic, social and cultural opportunities in a specific area of forest with the need to maintain and enhance the health of the area’s forest. It is a process whereby all interested parties, large and small, come together to make decisions about how the land and its resources should be used and managed and to coordinate their activities in a sustainable fashion.” Amler, Betke, Eger, Ehrich, Kohler, Kutter, Lossau, Müller, Seidemann, Steurer, Zimmermann [13] stated that “in many countries there are traditional, non codified forms of agreements on land use which work well at local level. However, they often fail when social relationships become more complex (e.g. spontaneous migration, pressure of use on areas which had previously been reserved for pastoralists). Nevertheless they provide important connecting links for LUP at local level.” Among other things, what are common about the findings of the studies are the aspects of willing to maintain the integrity of the ecosystem as the primary consideration which plays an important role in LUP.

Amler et al., [13] further maintains that “LUP is a partially integrating and sector overlapping process. The planning objects are the land resources. Therefore, LUP is not suitable for solving all local problems, nor can it replace the overall planning for an area.” The basic technical strategy in LUP is to plan land use according to the suitability and the various needs in the area to be considered.

Land use is characterised by the arrangements, activities and inputs of people to produce food, change and maintain certain land cover types (Di Gregorio and Jansen [14]). This definition of land use establishes a direct link between land cover and the actions of people in their environment. For a sustainable land use plan, nowadays, LUP requires more data integration, multidisciplinary and complex analysis and quick data retrieval. Not only does this facilitate the improved accuracy and scope for creating maps for use in land transactions, but also land administration processes. Longley, Goodchild, Maguire & Rhind [15] believe that “land administration can assist enormously in the process of data integration and the creation of a truly national GIS.” According to Cloke [16], “the role of planning is important because of one fundamental premise; namely that planning and policy-making are undeniably an integral aspect of state activity and as such are subject to the context and constraints of all activities.” Wade and Sommer [17] defined land use as the classification of land
according to what activities take place on it or how humans occupy it; for example, agricultural, industrial, residential, urban, rural or commercial. Land use should not be confused with the term land cover, which concerns the natural and artificial features covering the earth’s surface like forest, roads, grassland, bare soil, lakes. According to Wade and Sommer [17] land cover entails “the classification of land according to the vegetation or material that covers most of its surface; for example, pine forest, grassland, ice, water or sand.” LUP should be understood as the systematic assessment of physical, social and economic factors that encourage and assist land users in selecting options that increase their productivity, sustainability and meet the needs of society.

Land use planning is generally applied at three interactive levels; national, regional and local level (FAO, 1993, cited in Nabwire [18]), where different priorities, planning strategies and kinds of decisions are made. At the national level general land use planning policies, priorities and legislation are set. Whereas at the lower levels the plans become more detailed e.g. putting in place water sources and infrastructure (Nabwire [18]). Interaction, information flow and data sharing between the planning levels are important.

In Namibia positive and negative land use changes are taking place naturally. Being the most arid country in sub-Sahara, land use is generally adapted to highly variable and arid climatic conditions. However, certain policies and cultural barriers may have contributed to the entrenchment of inappropriate land use systems.

The Namibian constitution makes provision for central, regional and local levels of government. The central government consists of the legislature or parliament (the national assembly and national council), the judiciary (supreme, high and lower courts) and the executive (the president, cabinet and ministers). At regional level, there are 13 political regions as depicted in Figure 2, comprising of 107 constituencies. According to Mendelsohn et al [3] “these were first demarcated in 1993 for the purposes of regional representation.” Local governments or authorities are provided for by proclamation of settled areas as municipalities, town and villages. This means that each region is responsible for its land management activities within its area of jurisdiction.
Figure 2: Regional map of Namibia

There is no legislation in Namibia that requires the preparation of a coherent, national and regional land use framework but it is envisaged that this will be introduced when the Draft Urban and Regional Planning Bill is enacted.
Currently the establishment of towns and the subdivision of land are regulated by the Townships and Division of Land Ordinance of 1963 while the development and application of town planning schemes is regulated by the Town Planning Ordinance 18 of 1954. Both these ordinances must be read together with the Local Authorities Act 23 of 1992.

An Integrated Land Use Plan (ILUP) considers the full range of resources and values present on public lands and aims to blend or coordinate management strategies and implementation requirements across jurisdictions. ILUP is a tool which provides a means for stakeholders, communities, individuals and civil society to engage in collaborative decision-making about land use and resource management within a defined area.

The Ministry of Lands and Resettlement (MLR), within its mandate to facilitate utilisation of land as custodian of land, are the main actor and coordinator in the planning and administration of land falling within the rural areas of Namibia. As stated earlier, the Division of Land Use Planning and Allocation (LUPA) under the Directorate of Land Reform of the MLR are responsible for developing plans for commercial and communal land use. It is mandated to provide guidelines for drafting regulations on land use planning. The integrated land use plans are the direct outcome of the MLR mandate.

The Hardap Regional Council is instrumental in successfully implementing and monitoring the recommendations made by the Hardap IRLUP as it holds in trust the Hardap Region’s natural and cultural resources for present and future generations, and has a responsibility to the public to ensure that resource management represents a balance of community, economic and environmental needs. The Hardap Integrated Land Use Plan (HIRLUP) provides the mechanism for making comprehensive decisions about the use of land and resources within the Hardap Region, setting out coordinated management directions for future uses of land and resources while allowing for the evaluation of the success of management activities over time. The plan is future orientated and interactive, allowing plans to be adjusted in response to changing social and economic demands and circumstances.

In Namibia, overall development planning including planning of land and other natural resources is vested in a number of different government institutions. Amongst other key responsibilities, the Ministry of Regional and Local Government, Housing and Rural Development (MRLGHRD) through the Directorate of Decentralisation Coordination is responsible for the effective and efficient implementation of a decentralised system of governance through providing management direction, co-ordination, consultation, trading and research to all stakeholders (line ministries, regional and local authorities, non-
governmental organisations, community-based organisations and the public at large). The Ministry of Lands and Resettlement through the Directorate of Land Reform and Resettlement (Division of Land Use Planning and Allocation - LUPA) is responsible for land use planning in the country - more specifically the communal areas and commercial farms.

5. The Participatory Maps [The Results Perspectives]

5.1 Participatory Mapping Results in the Rehoboth West Urban Constituency

In the Rehoboth West Urban Constituency, participatory mapping took place in the Rehoboth formal urban area. The size of the mapped area is estimated to be 1500 square metres. It is managed and administered by Rehoboth Town Council. Seven (7) local community members participated in the mapping activity. In this area, the participants mapped various land uses, such as industrial, business and related infrastructure.

Based on the knowledge that the participants showed, the researcher is of the opinion that the participants could contribute to the development of land use plans because they know their area better than an outsider (researcher). In recent trend, local communities are included in the discussion periods that precede the implementation of land use planning projects (Emery [19]). Land use plans projects should strive to have the broadest possible knowledge base to achieve the best possible results.

As it can be seen in Figure 3 and 4, residential, general residential and open spaces are the main land uses identified and mapped by the participants in the Rehoboth formal area. The main road leading to Windhoek in the North and Gibeon in the South can be viewed on the map. The gravel roads show access to both residential areas and general residential areas are also shown. In sketch mapping exercise, the participants could not map land cover adjacent to the area as the main emphasis was on various land uses. However, the participants mapped land covers when they delineated the same area using an aerial photograph (Figure 4) as base material for photo-mapping technique. New information about other land uses and land covers were mapped.

In the Rehoboth formal urban area, the participants were eager to share their land use issues. Some participants shared their knowledge and opinions about how the town council of Rehoboth rejected their subdivision and consolidation applications for land adjacent to their erven. Through the briefing and random communication with the participants, the researcher is of the
opinion that the participants have reasonable knowledge about land use and their rights regarding their respective land.

Although the maps are not to scale, the researcher acknowledged the participants understanding of the size of their land. The participatory mapping exercises were observed by the researcher to be good methods for bringing communities together to share their knowledge of the various land uses and their experience of their surroundings. The local communities’ experience contributes in a meaningful way to the development of land use plans. This is also supported by the current related legislations on LUP which requires strong participation of local communities in developing and compiling land use plans.

Figure 3: Sketch map of Rehoboth urban area section
Mapped by: Rehoboth local community members, 2012

Figure 4, a map based on an aerial photograph shows comparable results to that of the sketch map results. New detailed information can be seen on the photo-map, this include the riverbed in the South, the garage zoned land (including a filling station) in the south-eastern part of the map and industrial land use in the far South. The open spaces and general residential land uses increased in most parts of Rehoboth formal area and were clearly mapped in Figure 4. Although the aerial photograph was two years old and did not depict some of the recently constructed buildings, the participants could still identify
the land uses. The participants indicated that they found it easier to interpret the aerial photographs than a sketch map.

When discussing the aerial photographs, questions were raised as to how the participants benefit from land zoned as general residential. The participants indicated that the land tenure on general residential zoned land allows the land owner to rent out his or her built units of land to a specified maximum number of tenants.

Industrial land use was indicated as undesired by many participants. This was because industrial land use (such as welding work) is one of the main causes of noise in the neighbourhood.

Figure 4: Photo-map of Rehoboth urban area section from an aerial photograph of 2010
Mapped by: Rehoboth local community members, 2012

The gravel roads with dead end (cul-de-sacs) were clearly delineated as shown on Figure 4. The area has access to electricity, sewerage, voice and data telecommunication infrastructures and streetlights. The most common mode of transport, as revealed by the participants is private cars and taxis.

5.2 Participatory Mapping Results in the Rehoboth East Urban Constituency
In the Rehoboth East Urban Constituency, participatory mapping activity took place in Rehoboth Block E, Extension 1. The mapped area size is estimated
to be 2500 square metres. Seven (7) local community members participated in the mapping activity. Block E. Extension 1 is a description given to the land by the early town planners of the Rehoboth Town Council. It is an informal settlement situated in eastern Rehoboth. According to Shack Dwellers Federation of Namibia [20] this “informal settlement was established in 1983. People in this settlement came from Bahnhof Station and the old location of Rehoboth town.”

The major land uses in this settlement as depicted on the sketch map (Figure 5) are residential, institutions, business (shops) and church. Institutions such as schools can be seen on the centre of the map. The participants indicated that the most desired land use was the residential one because it provides them with access to land on freehold tenure. Institution such as a school was also indicated as preferable because of the need for their children to attend school. There are infrastructures depicted on the sketch map, as shown in Figure 5 and discussed by the participants that there are house buildings and roads in this informal settlement. The nearest primary school was also mapped and was observed to be about 600 to 700 metres away. A secondary school was about the same kilometres away. This kind of mapped results also confirms that “land use is characterised by the arrangements, activities and inputs by people to produce land use change or maintain a certain land cover type” (Food and Agriculture Organization, 1999: 32). There is also a clinic which was observed about 500 kilometres away which the community have access to for health services. The community members stated that part of Rehoboth Block E, Extension 1’s land belongs to the Town Council of Rehoboth. The other part of the land was bought by some community members at a cost of between N$ 300 and N$ 400 per erf in the year 1999. This was also confirmed with the Rehoboth Town Council.

Although the sketch map shows the main land uses and basic infrastructures in the settlement (Figure 5), no great emphases were put to indicate the numbers of houses as there are represented in their respective locations. Figure 5 shows that more efforts were put on mapping roads, businesses (shops) and institutions (schools), than other land infrastructures such as sewerage points, telecommunications and dumping sites.

In addition, a church and natural features such as river and dunes are shown on the sketch map but there were observed residential houses along the riverbed and dunes which were not depicted on the sketch map. This can possibly be a result of lack of participation, lack of understanding of land use features or lack of knowledge of the settlement by the participants. Repeated sketch mapping exercises confirmed that this kind of sketch mapping capability can be improved.
The researcher observed that there are no water borne toilets in this settlement. People use removable buckets, pit latrines as well as the bush to relieve themselves. A public prepaid water system is available to the community. Few households have in-house sanitation facilities with proper water connection in the area.

The results help contribute to improved service delivery to the communities as maps will be used to measure infrastructure services provided to the communities. The appropriate government ministry could then take appropriate steps in planning and budgeting for basic services such as community toilets and water infrastructures in the informal settlement.

5.3 Participatory Mapping Results in the Rehoboth Rural Constituency

In the Rehoboth Rural Constituency, the participatory mapping took place in a village called Kalkrand, managed and administered by the Kalkrand Village Council. The mapped area size is estimated to be 3000 square meters. Seven (7) local community members participated in this participatory mapping activity. Both the sketch and photo-mapping approaches were undertaken in this area. In this area, the local community took their time to map their land uses and related infrastructures such as roads and contribute to their knowledge about the land uses.
Figure 6 and 7 demonstrate that residential, business (shops, offices), church, institution, open spaces and sport fields were the main land uses identified and mapped by the communities themselves in Kalkrand. Although the maps are not to scale, a very good understanding of their land was confirmed. A participatory mapping exercise was observed by the researcher to be a good method for bringing communities together. They were encouraged to share their knowledge and experience of their surroundings. The participants mentioned how open space areas are undesired within Kalkrand because they believe the land has to be occupied by landless people. They also indicated that the land belongs to individual farmers in the Hardap Region. The town council was in negotiation with the landowners (farmers) to purchase the land for residential purpose.

![Sketch map of Kalkrand village](image)

**Figure 6**: Sketch map of Kalkrand village  
Mapped by: Kalkrand local community members, 2012

Figure 7, a map based on an aerial photograph shows different results compared to the sketch map results. The land uses on the photo-map (Figure 7) were more than on the sketch map. Such and similar results could mean that the aerial photograph was well interpreted as the aerial photograph contained relevant data which depicted the current land uses and it was understood better by the participants to compare and describe features depicted on it.
Different land uses were mapped on the aerial photograph as base material, including roads such as gravel roads. Beside gravel roads there are earth graded roads. Streetlights are also provided in the settlement but do not cover the whole village settlement. The most common mode of transport, as revealed by the local community is donkey carts with few people using private cars and taxies. Otherwise most walk to various places. The participants also confirmed that community members in Kalkrand participated in the installation of water pipes as part of a community project supported by the Village Council. This kind of information is also important for inclusion in future LUP of Kalkrand because it helps to provide the socio-economic status of the area.

5.2 Participatory Mapping Results in the Mariental Rural Constituency

In the Mariental Rural Constituency the participatory mapping took place in Stamriet. The mapped area size is estimated to be 2500 square metres. It is managed and administered by the Stampriet Village Council. Nine (9) local community members participated in this activity in this area. As confirmed by
the village council officer and the community members, every part of the land in this village belongs to the Stampriet Village Council.

The Shack Dwellers Federation of Namibia [20] maintains that “the estimated number of households is 500 and the estimated population is 2,500. There are a few brick houses and the rest are made of corrugated iron sheets.” Figure 8 represent the sketch map of Stampriet Village as drawn by the local community.

The various land uses within Stampriet were mapped on the sketch map in Figure 8. These land uses are residential, industrial, cemetery, open spaces and institution. Infrastructures and services such as roads, buildings, bed and breakfasts (B&B), a clinic and a service station can be found in the village. The location of the informal settlement in this village was also indicated as in the northern direction of Figure 8. With regard to natural features, a seasonal water channel was seen as dominating the major part of the village and it is surrounded by residential buildings.

Figure 8: The sketch map of the Stampriet area
Mapped by: Stampriet local community members, 2012
Although main infrastructures and natural feature were mapped as shown in Figure 8, the photo-map (Figure 9) revealed some of the infrastructures which were not mapped in the sketch map. This is acceptable for two participatory mapping methods to produce different results. Many researchers in different parts of the world have taken advantage of various mapping methodologies, i.e. highly participatory approaches such as PRA to the newer participatory approaches such as participatory photo-mapping, participatory GIS, crowd sourcing and more complex spatial technologies, such as GIS. The demand for participatory approaches is far greater than what can be delivered, and the distribution of indigenous mapping initiatives has been extremely uneven (Chapin, Lamb and Threlkeld [21]). Approaches involving the people who live in the area such as participatory mapping promote community engagement in planning, sharing ideas among participants and it help generate new information. Broadening public participation, data access, local knowledge integration and community empowerment are key concepts in a participatory mapping approach to LUP.

The Stampriet photo-map in Figure 9 shows new information such as a sport field. Some of the dominating land uses which were shown on both sketch and photo-maps by the local communities includes the cemetery, open space, industrial and institution such as schools within the village.

![Image of Stampriet photo-map]

**Figure 9:** Photo-map of Stampriet from an aerial photograph of 2010
Mapped by: Stampriet local community members, 2012
In participatory mapping, it is important to map with understanding. Basic knowledge of infrastructure development is useful in mapping in order to produce understandable maps. Figure 9 shows some of the isolated buildings with no access to roads. Some of the buildings do not have access to roads as can be seen in the part of the illustration which shows the southern direction. Although the results of Figure 9 are based on mapping what was visible on the aerial photograph and what is known to the participants, there is a need for better interpretation of infrastructure relationship. For example, a building should always have an access to a road.

Some of the observed services provided to the local communities in Stampriet include public water taps for lower income earning households, as well as electricity for those who can afford to connect. The existence of schools, the police station, churches and a graveyard was also confirmed in this area. There are no constructed roads except for one, which is the main road. Streetlights are provided in the village of Stampriet.

5.3 Participatory Mapping Results in the Mariental Urban Constituency

In the Mariental Urban Constituency, the participatory mapping took place in the informal settlement called Oshiwana Penduka in Mariental. The mapped area size is estimated to be 2400 square metres. Eight (8) local community members participated in this mapping activity. The name “Oshiwana Penduka” is a plea that means “to wake up the nation”, presumably to the plight of the informal settlers. The estimated number of households is 650 with an estimated population of 4,000 (Shack Dwellers Federation of Namibia [20]). With the exception of three brick houses, all the houses are shacks built with corrugated iron sheets.

The Shack Dwellers Federation of Namibia [20] stated that “people in this informal settlement came from different towns and some people came from farms. Most parts of this informal settlement’s land in this area still belong to the Municipality of Mariental as only a few people bought individual plots.”

In Oshiwana Penduka, the researcher observed that the residents have access to gravel roads, earth graded roads, electricity and streetlights. The participants confirmed during the FGD that those without electricity make use of candles, paraffin, gas and firewood. Public garbage drums are also available for solid waste management purpose. The nearest police and fire station is in town which is about 1.5 kilometres away from Oshiwana Penduka community.

Figure 10 of the sketch map produced by the local community of Oshiwana...
Penduka reveals that the community’s land is serviced with basic facilities such as water points, community toilets and roads. The residential erven in this informal settlement are well planned and have access to a road. The sketch map further reveals that there is a church in the area, and that the residents have access to a seasonal river and open spaces.

![Figure 10: The sketch map of the Oshiwana Penduka area](image)

Mapped by: Oshiwana Penduka local community members, 2012

The participatory mapping activity in this area helped to further get the insight on the future development of this informal settlement. The local residents stated that the municipality has been in contact with them to help support them to upgrade the informal settlement from corrugated iron sheets houses to low-income brick housing structures. This was then confirmed by the Municipal official in Mariental, but the process of implementation had not started at that time and will be lengthy.

5.6 Participatory Mapping Results in the Gibeon Constituency

In the Gibeon Constituency, the participatory mapping took place in the informal settlement called Helena Pieters Section. The mapped area size is estimated to be 2500 square metres. Seven (7) local community members participated in the mapping activities of this constituency. Both sketch and photo-maps were compiled in this informal settlement. The Shack Dwellers Federation of Namibia [20] stated that it had been established in 1970 and
people had come from the areas surrounding Gibeon. Legally, the land belongs to the Village Council of Gibeon. The residents were given permission to occupy the land by the Village Council of Gibeon, but no written agreement was signed.

Figure 11 reveals that a few facilities such as water points, toilet point and roads are provided to the small settlement of Helena Pieters Section. These services are not structured. Land uses such as businesses (shops), residential and open spaces can be spotted on the sketch maps. Land covers such as river beds were also observed. The official road access to buildings in this informal settlement is earth graded roads. A sewerage swap can be seen in the western direction of the settlement of Figure 11.

Figure 11: The sketch map of the Helena Pieters Section area
Mapped by: Helena Pieters Section local community members, 2012

Figure 12 of the photo-mapping shows very few features mapped by the local community as the aerial photograph of 2010 depicted only a few housing structures, roads and river beds in the informal settlement. The limitation of this map is due to poor resolution and poor quality of the aerial photography used in the participatory mapping. Such limitations in the quality of the aerial photographs had been expected by the researcher and resulted in disadvantaging the photo-mapping approach.
The estimated number of households in the informal settlement is 300 people. Most of the families live in houses constructed with corrugated iron sheets with a few households who live in brick houses. The estimated population living in informal houses is about 1,500 (Shack Dwellers Federation of Namibia [20]). It was also observed by the researcher that there are about five prepaid water taps. There are no schools, clinics or other social services in this informal settlement. Some local communities confirmed that they only access social services in neighbouring settlements. The delimitation of photo-mapping is that poor resolution and poor quality aerial photographs can be avoided when good quality aerial photographs are available.

![Figure 12: Photo-map of the Helena Pieters Section area from an aerial photograph of 2010](image)

Mapped by: Helena Pieters Section local community members, 2012

As it can be seen on both Figures 11 and 12, there are no tarred roads in this informal settlement. Residents mostly walk to various places. The nearest police station was 2 kilometres away. The community members confirmed that they are not involved in any development activity because there is no development at all in this area.
6. The Participatory Mapping Approaches [The Findings and Participants Perspectives]

6.1 Comparison of Sketch and Photo-Mapping Results
At times the information on the sketch map supplied by the participants sometimes differed from information obtained from the aerial photograph as base material for photo-mapping method due to the characteristics and limitations of each method. However, results from each method were compatible and complementary to each other.

This study confirmed that maps can be created with relevant information from the participants by drawing either on the ground or on a piece of paper large enough for participants to see clearly and mark on the map after discussing where the many buildings, structures and infrastructures are located. According to Wu and Isaksson [22] “participatory maps cover the heterogeneous subjects mentioned by the locals, including land use, movement routes, places that once existed and those that still exist.” Although several areas were mapped within the Hardap Region, they are not categorised or weighed against each other. The two types of maps (sketch and photo) are different in their precision of locations as well. The International Fund for Agricultural Development [10] defines sketch mapping maps as “represents key community-identified features on the land from a bird’s eye view.” Photo-mapping is based on an aerial photograph as base material. This means that location based information is delineated based on the resolution, scale and accuracy of the aerial photograph.

6.2 Advantages and Disadvantages of Participatory Mapping Methods
Participatory sketch and photo-mapping maps have both advantages and disadvantages. Some of the advantages of sketch and photo-maps produced through participatory mapping are that they:
1. are easy to explain
2. can be used to collect additional primary data
3. are inexpensive tools to record information on how the land is used
4. can be used for further studies in the areas of geography, social and environmental science and for any mapping needs where residential areas need to be mapped
5. can be stored electronically
6. can be printed as needed
7. can be mailed electronically as needed
The disadvantages of sketch and photo-mapping maps produced through participatory mapping are that they:

1. are static maps
2. lack flexibility, i.e. data cannot be added or removed.
3. are not interactive
4. not as effective as expected as the participants' level of understanding has an influence on their drawings
5. The sketch map results can be too vague

Although there are general comparisons of both sketch and photo-mapping maps, the outcome of the two might be different. Table 1 shows some of the differences encountered during this study.

Table 1: Differences between sketch mapping and photo-mapping in LUP

<table>
<thead>
<tr>
<th>Sketch mapping</th>
<th>Photo-mapping</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Sketch maps are drawn directly from memory and therefore not to scale.</td>
<td>• Photo-maps are approximate to scale drawing when the base aerial photograph is geo-referenced.</td>
</tr>
<tr>
<td>• They are roughly drawn maps which may be inaccurate but can be quickly created.</td>
<td>• Photo-mapping is usually drawn on large scale (i.e. 1:25 000 to 1:50 000).</td>
</tr>
<tr>
<td>• Sometime the information on the sketch maps can be too vague.</td>
<td>• Features are drawn in their true position (within limitations of scale).</td>
</tr>
<tr>
<td>• Creating a map from memory can be a time consuming exercise as usually more than one person is involved who draw information from memory only.</td>
<td>• Maps can be completed promptly when the features are clearly visible.</td>
</tr>
</tbody>
</table>

6.3 Challenges during Participatory Mapping Exercises (Participants Perspective)

Some of the encountered challenges for the participants of participatory mapping in general are that drawing a feature polygon in the field is very time consuming. Some of the challenges encountered include:

1. Half of the participant had difficulty reading maps and aerial photograph, so in many cases the community members would misread some of the features.
2. Half of the participant had difficulty orienting themselves to aerial
photo-maps because there were few recognisable landmarks.

3. Difficult to keep the participants focused to land uses only. The inhabitants has to continuously be reminded and confronted to concentrate on mapping land uses and related geographical features, the situation which can be challenging to the researcher.

As a tool to facilitate decision-making in land use planning, participatory mapping methods should contribute to adding value to development of land use plans where participants discuss their land uses and contribute to those land uses’ management. Different land uses were created with the two participatory methods (sketch and photo-mapping) from different participants and different areas within the Hardap Region. Land management challenges such as land use conflicts and land allocation are typical examples where stakeholder participation is needed. In many developing countries such as Namibia, Zimbabwe and Zambia, for example, information on the local social values on cultural landscapes is completely missing, and natural resources are under constant pressure from various stakeholders (MA; FAO, cited in Fagerholm & and Käyhkö, [23])

7. Concluding remarks

In this study participatory mapping was identified as an important approach in land use planning, particularly in sharing land use ideas among participants and collecting data related to socio-economic issues. Participatory methods, if applied properly, allow the user to grasp the intangible and invisible through a concrete medium that can be shared with others. Participatory mapping is significant for all areas of land use planning and natural resource management. The study supports participatory mapping as a potentially viable tool, technique and methodology to clarify local community knowledge and create media that permit different voices to enter into dialogue with one another.

Another purpose of participatory mapping was to gather and share information about different land uses among different participants in different areas of the Hardap Region. The participatory mapping methods proved to be an excellent process for allowing local people of all ages to engage with their surroundings and heritage. In an inspiring and motivating way they were encouraged to use their land appropriately, such as avoiding using residential land for industrial purpose.

In addition, the participatory mapping activity offered other advantages of allowing local communities to learn about basic map-making the map. The participatory mapping method proved also to be a catalyst in stimulating memory and in creating visible and tangible representations of the natural
environment. The time spent working on the legend allowed for greater clarity on meanings, and the relationship between natural land features and land use features. The participatory maps are able to capture both land use and natural features.

Many researchers in different parts of the world have taken advantage of various mapping methodologies, i.e. highly participatory approaches such as PRA to the newer participatory approaches such as participatory photo-mapping, participatory GIS, crowd sourcing and more complex spatial technologies, such as GIS.

The demand for participatory approaches is far greater than what can be delivered, and the distribution of indigenous mapping initiatives has been extremely uneven (Chapin et. al., [21]). Approaches involving the people who live in the area such as participatory mapping promote community engagement in planning, sharing ideas among participants and it help generate new information. Broadening public participation, data access, local knowledge integration and community empowerment are key concepts in a participatory mapping approach to land use planning.
8. References


Head Teachers’ Perceptions of Instructional Leadership Practices and Agriculture Teachers’ Effectiveness in Swaziland High Schools

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Olso High School, Hluti, Swaziland

Abstract
A descriptive correlational research was designed to describe head teachers’ perceptions of instructional leadership practices and agriculture teachers’ effectiveness in teaching high school students in Swaziland. A valid and reliable (r=0.69 and 0.97) instrument was used to collect data. Findings of the study revealed that head teachers very frequently practiced democratic (40.7%), coercive and democratic (20.9%), laissez-faire and coercive leadership styles (19.8%). Head teachers ratings of their management practices were rated between 2.06≤M≤5.74; perceived characteristics of an effective teacher were rated high (4.89≤M≤5.76). The teachers were rated to be highly effective (4.34≤M≤5.25), and characteristics of effective leadership had negative, negligible, low and moderate influence on agriculture teachers’ effectiveness in teaching (+/-0.01≤r, rs, rpb≤.37). Stepwise regression analysis was used to measure the relationship between the dependent variable and agriculture teachers’ effectiveness in teaching. The findings revealed that cumulative variance (R²) in teacher effectiveness explained by the independent variables was 75% and coercive leadership, a rival independent variable was found to explain the greatest variance 31% in agriculture teacher effectiveness in teaching with a beta of -0.56. This implied that head teachers’ leadership style contributed significantly to teachers’ effectiveness in teaching. The expected change (B) in coercive leadership style when other independent variables were held constant was found to be -0.96; democratic and coercive style -0.41; laissez-faire and coercive style -0.59; length of lesson periods 0.16; sex -0.17, and instructional leadership 0.58. The conclusions drawn from the findings of the study were that some variables like characteristics of an effective leader explained head teachers’ instructional leadership and teacher effectiveness while other variables did not provide adequate explanation.

Keywords: Instructional leadership, Head teachers, agriculture teachers, effectiveness, students’ academic performance
1. Introduction

Leadership is viewed as a pivotal force behind successful organizations and an active process (Bennis and Nanus, [1]; Kouzes and Posner, [2]). Kouzes and Posner [2] observed that leadership does not necessarily command commitment but inspires it. They further postulated that leadership is about challenging others, inspiring a shared vision, enabling others to act, modeling the way, and encouraging the heart. Such practices by people in leadership positions enable others especially followers or support staff to get extra ordinary things done in an organization. Leadership provides keenness to accomplish, thus, attaining the intended goal(s).

A study to investigate what values, that is, personal characteristics support staff look for and admire from their superiors or leaders was conducted in the United States of America by Kouzes and Posner [2] who revealed that (i) integrity; (ii) competence, and (iii) leadership qualities as key traits. According to Botha [3], these traits can be interpreted to mean a capable leader who is productive and efficient. Leadership commands inspiring, decisiveness and provides direction. Finally, the Kouzes and Posner [2] study revealed that a person in leadership role should be truthful and trustworthy, have conviction, and be of good character.

Goleman [4] conducted a study to determine the impact of leadership styles on drivers of climate at work place. He argued that the drivers of climate were fundamental traits in leadership. Also, that these traits control the environment under which organizational staff work. These traits were: flexibility, responsibility, standards, rewards, clarity, and commitment. These styles were derived from [2]. The traits were correlated with six leadership styles: coercive, authoritative, affiliative, democratic, pacesetting and coaching. From the correlation analysis in this study, authoritative ($r=0.54$); affiliative ($r=0.46$), commitment ($r=0.44$) and democratic ($r=0.43$) had very strong and positive correlation with the climate drivers. The remaining two, coercive ($r=-0.26$) and pacesetting($r=-0.25$) had negative impact on the climate drivers. The conclusion drawn from this study was that no one style should be relied on exclusively because all has short-term uses.

Leadership and performance are linked together [5]. The link was described earlier by Kouzes and Posner [2] who observed that a leader inspires support staff to discharge their assigned tasks. Once support staff is inspired, they are likely going to discharge their duties beyond expectations. Also, performance of duties assigned to each individual staff could be improved. According to Botha [6], in the context of a school environment, the headmaster is the one that plays the leadership function. Kruger [7] argued that a head teacher is to ensure that effective teaching and learning takes place. The head teacher hence can be described as effective. Magagula [8] and Botha [9] reported that, an effective head teacher is the one that inspires
and supports teachers to be more effective in teaching their classes. Ndza-bandzaba [10] found schools with good O’level results as one having the following characteristics: availability of quality and experienced teachers; availability of teaching facilities and resources, high dedicated teachers and headed by effective head teachers. Hence, Ndzabandzaba [10] deduced that the head teacher is the major core driver of support teachers’ effectiveness. Since the introduction of agriculture in high schools in Swaziland in the 1970’s, very little effort has been expended to investigate head teachers’ instructional leadership practices and their influence on agriculture teacher effectiveness. The purpose of the study was therefore to determine the factors perceived to influence head teachers instructional leadership style and teacher effectiveness in teaching Swaziland high schools. The specific objectives of the study were to describe the self-perceived: level of agreement with instructional leadership styles, management practices, and self-reported characteristics of effective leader by head teachers. The study also The effectiveness of agriculture teachers as reported by head teachers in teaching students agriculture, the relationship between agriculture teachers’ effectiveness in teaching and selected independent variables was also assessed; and the explanatory and predictor variables of agriculture teachers’ effectiveness by head teachers’ instructional leadership practices was identified.
The research was based on the hypothesis that head teachers’ instructional leadership practices explain variance on agriculture teacher’s effectiveness (Figure 1).

2. Methodology
The design of the study was an ex post facto using multiple regression procedures. Figure 1 shows the conceptual framework for the study. The target population of this study was all the head teachers in the schools offering the subject agriculture in Swaziland who had spent at least five years in the same school (N=86). The study was a census and sampling error was therefore not a threat to external validity of the study. Frame error was controlled by obtaining.

Rival independent variables (RIV): Sex, age, headship experience, highest qualifications, completed all management courses through in-service training, area of specialization, teaching experience, do you have classes to teach, how many periods do you teach, location of school, how far do you stay from school, marital status, number of years of teaching before promoted, number of staff members under your supervision, number of students enrolled in the school, does the school have electricity, does school have reliable source of water, number of heads of departments, school type, average class sizes, how long have you spent in the same school, do you delegate some duties, and leadership style practiced.

Figure 1. Conceptual framework of the study.
An up-to-date list of all head teachers was obtained from the Teaching Service Commission in the Ministry of Education. The list was purged through to avoid duplication of the names; thus, controlling selection error. As suggested by Dillman [11], a questionnaire was developed, validated, pilot tested before is was used to gather data. The questionnaire was divided into six parts. Part I assessed the extent to which head teachers practiced different instructional leadership styles. Respondents were asked to indicate the level of agreement with the extent to which head teachers espoused selected instructional leadership practices.
The Questionnaire

**Part I** consisted instructional leadership practices comprised of twenty-five practices using a six-point, summed rating scale to determine level of agreement with the extent to which head teachers practiced the selected instruction leadership. The rating scale ranged from 1 (*strongly disagree*) to 6 (*strongly agree*).

**Part II** contained items relating to perceived management practices by head teachers. The management practices consisted of twenty-two items which were summed to determine the level of importance of management practices. The respondents were asked to rate these items using a six-point likert scale that ranged from 1 (*very unimportant*) to 6 (*very important*).

**Part III** consisted of twenty-five items pertaining to perceived characteristics of an effective leader. The head teachers were asked to rate each item using a six point likert scale. The rating scale ranged from 1 (*strongly disagree*) to 6 (*strongly agree*).

**Part IV** had fifteen items regarding head teachers' level of agreement with perceived practices of an effective teacher. The head teachers were asked to indicate their level of agreement with each statement using a six-point rating scale. The rating scale ranged from 1 (*strongly*) to 6 (*strongly agree*).

**Part V** comprised leadership styles which were either a stand-alone or combined more than one style of leadership. In this section, head teachers were asked to indicate with a check mark the singular or combination of leadership style (s) they espoused in facilitating teaching and learning activities in their schools.

**Part VI** consisted of the remaining variables and the head teachers were asked to complete or tick (√) to provide background and demographic variables.

**Validity and Reliability Testing**
The researchers established the face validity of the instrument by using a panel of experts, consisting of three university lecturers, three head teachers, three deputy head teachers and the senior inspector for agriculture. These experts reviewed and attested to the content validity of the instrument. A pilot test was conducted with 30 agriculture teachers. Cronbach’s alpha reliability coefficients for the domains were computed from the pilot test data and the coefficients ranged from 0.69 to 0.97.
Prior to data collection, permission to conduct research was sought and obtained from the Ministry of Education and Training. Letters were then written to respondents to inform them about the study, its purpose and objectives of the study. The questionnaire used for data collection was self-administered, and were delivered the questionnaires to the head teachers. Each respondent was given two weeks to complete the questionnaire, after which, the researchers collected the completed questionnaire. University pens were used as incentives. A 100% response rate was achieved; hence, non-response was not a threat as noted by Miller and Smith [12].

The Statistical Package for Social Sciences (SPSS), Version 10.0 for windows, was used to analyze the data collected. Findings were summarised using descriptive statistics and correlations. Descriptive statistics were used to describe background and demographic variables of the respondent head teachers. Correlations were used to describe relationships between the dependent variable, agriculture teacher effectiveness, and the independent variables.

3. Results
About 88.4% of the head teachers were married males. Most of the head teachers held a Bachelor of Science degree and 69.8% had completed the INSERT modules offered to head teachers by the Ministry of Education and Training. Most of the head teachers (81.0%) were classroom teachers, from schools that were either urban (47.0%) or rural schools (59.3%) by location. There was an even split by types of schools, such that there Government (31.4%), Mission (37.2%), and Community schools (31.4%). Most of the schools (97.7% and 67.4%) of the schools had electricity and running water, respectively. A majority (61.6%) of the respondents specialized in arts. The mean of head teachers’ age was 48.8 ±6.75 years; 48.9% had had served for 1-9 years but 42.6% of them had 10-19 years of headship experience. Less than 50% of the head teachers were teaching from 2-8 periods per week. Nearly all the head teachers had taught between 7-29 years before being promoted to the headship position. The head teachers’ responses indicated delegation of duty (75.6%), to their deputies, heads of department, and assistant teachers.
Most of the head teachers had between 7-42 staff members in their schools; the lesson duration was between 30-40 minutes but very few had between 45 and 60 minutes. The average class sizes ranged between 37-43 and 44-50 students (Mean = 42.3 ±9.65). The length of stay in each school varied from 1 to 20 years, generally 9.76 ±6.45 years.
3.1 Frequency of Use of Instructional Leadership Styles by Head Teachers in Swaziland High Schools.

Findings contained in Table 1 show that most reported head teachers having used the democratic leadership (%) and to a lesser extent, the coercive leadership styles (20.9%) and democratic, laissez-faire and coercive styles (19.8%). The remaining leadership styles were seldom or very seldom practiced. The Laissez-faire in particular, was reported to be very rarely practiced.

Table 1: Self – reported instructional leadership styles practiced by the head teachers

<table>
<thead>
<tr>
<th>Leadership style(s)</th>
<th>1</th>
<th></th>
<th>2</th>
<th></th>
<th>3</th>
<th></th>
<th>4</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Democratic leadership style</td>
<td>1</td>
<td>1.2</td>
<td>8</td>
<td>9.3</td>
<td>42</td>
<td>48.8</td>
<td>35</td>
<td>40.7</td>
</tr>
<tr>
<td>Laissez- fare leadership style</td>
<td>62</td>
<td>72.1</td>
<td>19</td>
<td>22.1</td>
<td>4</td>
<td>4.7</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>Coercive leadership style</td>
<td>21</td>
<td>24.4</td>
<td>48</td>
<td>55.8</td>
<td>14</td>
<td>16.3</td>
<td>2</td>
<td>2.3</td>
</tr>
<tr>
<td>Democratic &amp; laissez – fare</td>
<td>34</td>
<td>39.5</td>
<td>29</td>
<td>33.7</td>
<td>17</td>
<td>19.8</td>
<td>3</td>
<td>3.5</td>
</tr>
<tr>
<td>Democratic &amp; Coercive</td>
<td>11</td>
<td>12.8</td>
<td>17</td>
<td>19.8</td>
<td>38</td>
<td>44.2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Laissez- fare &amp; coercive</td>
<td>53</td>
<td>61.1</td>
<td>27</td>
<td>31.4</td>
<td>3</td>
<td>3.5</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>Democratic, laissez- fare &amp; coercive</td>
<td>28</td>
<td>32.6</td>
<td>18</td>
<td>20.9</td>
<td>18</td>
<td>20.9</td>
<td>17</td>
<td>19.8</td>
</tr>
</tbody>
</table>

Rating scale was as follows: 1 = very seldom practiced, 2 = seldom, 3 = frequently practiced and 4 = very frequently practiced.
3.2 Head Teachers Self-perceived Management Practices

The respondent head teachers were asked to rate twenty-two items using a rating scale that ranged from 1=highly unpracticed to 6=highly practiced. Overall, the findings in Table 2 show that head teachers report frequent practice of the management functions. The highly rated management practices included treating staff with dignity (M=5.81); listening to the views of teachers and appreciating teachers’ ideas (M=5.74); informing staff of expectations of administration (M=5.66); and encouraging others to initiate ideas (M=5.60). Management practices that were rated low were abdicating leading role to individual teachers (M=3.33); allowing teachers to do as they wish (M=2.06); and ignoring teachers’ request (M=2.30).

Table 2: Means and standard deviations regarding Self – perceived level of agreement on the management practices by the head teachers

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listening to the views of teachers</td>
<td>86</td>
<td>5.74</td>
<td>0.75</td>
</tr>
<tr>
<td>Consulting with the staff in decision making</td>
<td>86</td>
<td>5.53</td>
<td>0.86</td>
</tr>
<tr>
<td>Treating staff with dignity</td>
<td>86</td>
<td>5.81</td>
<td>0.45</td>
</tr>
<tr>
<td>Respecting the people’s right</td>
<td>84</td>
<td>5.57</td>
<td>0.62</td>
</tr>
<tr>
<td>Encouraging others to initiate ideas</td>
<td>86</td>
<td>5.60</td>
<td>0.54</td>
</tr>
<tr>
<td>Allowing input of others</td>
<td>86</td>
<td>5.74</td>
<td>0.51</td>
</tr>
<tr>
<td>Empowering the staff to solve problems</td>
<td>86</td>
<td>5.55</td>
<td>0.69</td>
</tr>
<tr>
<td>Fostering collaboration among staff</td>
<td>85</td>
<td>5.53</td>
<td>0.70</td>
</tr>
<tr>
<td>Recognizing contributions of others</td>
<td>86</td>
<td>5.55</td>
<td>0.68</td>
</tr>
<tr>
<td>Informing staff expectations from administration</td>
<td>86</td>
<td>5.66</td>
<td>0.79</td>
</tr>
<tr>
<td>Delegating duties to teachers</td>
<td>86</td>
<td>5.73</td>
<td>0.47</td>
</tr>
<tr>
<td>Showing appreciation of teachers ideas</td>
<td>86</td>
<td>5.74</td>
<td>0.46</td>
</tr>
<tr>
<td>Seeking professional advice from teachers</td>
<td>86</td>
<td>5.57</td>
<td>0.60</td>
</tr>
<tr>
<td>Making individual decisions</td>
<td>86</td>
<td>4.46</td>
<td>1.13</td>
</tr>
<tr>
<td>Spelling out expectations to the staff</td>
<td>86</td>
<td>5.52</td>
<td>0.84</td>
</tr>
<tr>
<td>Communicating through in the school memoranda all changes</td>
<td>86</td>
<td>3.71</td>
<td>1.63</td>
</tr>
<tr>
<td>Informing staff about dead lines on which work must be completed</td>
<td>86</td>
<td>5.59</td>
<td>0.83</td>
</tr>
<tr>
<td>Allowing complete autonomy to the staff</td>
<td>86</td>
<td>3.98</td>
<td>1.47</td>
</tr>
<tr>
<td>Abdicating leading role to individual teacher</td>
<td>86</td>
<td>3.33</td>
<td>1.69</td>
</tr>
<tr>
<td>Allowing staff to make individual decisions</td>
<td>86</td>
<td>4.15</td>
<td>1.43</td>
</tr>
<tr>
<td>Ignoring teachers request</td>
<td>86</td>
<td>2.30</td>
<td>1.27</td>
</tr>
<tr>
<td>Allowing teachers to do as they wish</td>
<td>86</td>
<td>2.06</td>
<td>1.18</td>
</tr>
</tbody>
</table>

Total 86 4.94 0.89

Rating scale: 1 = Highly unpracticed, 2 = Slightly unpracticed, 3 = Unpracticed, 4 = Rarely practiced, 5 = Slightly practiced, 6 = Highly practiced.
3.3 Self-Reported Characteristics of Effective Leaders

The rating ranged from 1=strongly disagree to 6=strongly agree (Table 3). The findings were that head teachers reported themselves as effective leaders in schools with an overall mean score of 5.49 ±0.67. Highly rated characteristics of effective leaders were giving support to teachers (M=5.63); being honest (M= 5.66); delegating responsibility (M=5.69); being accessible to teachers (M=5.28); being competent (M=5.69); being supportive (M=5.69); supporting professional growth of staff (M=5.76), and hard working (M=5.69).

Table 3: Means and standard deviations regarding self-reported characteristics of an effective leader by the head teachers

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Give support to teachers</td>
<td>86</td>
<td>5.62</td>
<td>0.62</td>
</tr>
<tr>
<td>Able to motivate staff</td>
<td>86</td>
<td>5.38</td>
<td>0.65</td>
</tr>
<tr>
<td>Be honest</td>
<td>86</td>
<td>5.66</td>
<td>0.54</td>
</tr>
<tr>
<td>Have sense of vision</td>
<td>86</td>
<td>5.42</td>
<td>0.54</td>
</tr>
<tr>
<td>Have ability to read a situation</td>
<td>86</td>
<td>5.42</td>
<td>0.66</td>
</tr>
<tr>
<td>Being human</td>
<td>86</td>
<td>5.55</td>
<td>0.63</td>
</tr>
<tr>
<td>Believing in team work</td>
<td>86</td>
<td>5.74</td>
<td>0.64</td>
</tr>
<tr>
<td>Delegate other responsibility</td>
<td>86</td>
<td>5.69</td>
<td>0.67</td>
</tr>
<tr>
<td>Encouraging students’ participation</td>
<td>86</td>
<td>5.35</td>
<td>0.73</td>
</tr>
<tr>
<td>Being accessible to students</td>
<td>86</td>
<td>5.28</td>
<td>0.73</td>
</tr>
<tr>
<td>Being accessible to teachers</td>
<td>86</td>
<td>5.69</td>
<td>0.51</td>
</tr>
<tr>
<td>Being competent</td>
<td>86</td>
<td>5.69</td>
<td>0.51</td>
</tr>
<tr>
<td>Being supportive</td>
<td>86</td>
<td>5.69</td>
<td>0.55</td>
</tr>
<tr>
<td>Taking interest in students welfare</td>
<td>86</td>
<td>5.55</td>
<td>0.71</td>
</tr>
<tr>
<td>Being dependable</td>
<td>86</td>
<td>4.89</td>
<td>1.30</td>
</tr>
<tr>
<td>Being inspirational to students</td>
<td>86</td>
<td>5.50</td>
<td>0.76</td>
</tr>
<tr>
<td>Being sympathetic</td>
<td>86</td>
<td>5.33</td>
<td>0.76</td>
</tr>
<tr>
<td>Being influential</td>
<td>86</td>
<td>5.41</td>
<td>0.68</td>
</tr>
<tr>
<td>Being resourceful</td>
<td>86</td>
<td>5.51</td>
<td>0.68</td>
</tr>
<tr>
<td>Being achievement oriented</td>
<td>86</td>
<td>5.65</td>
<td>0.59</td>
</tr>
<tr>
<td>Being patient</td>
<td>86</td>
<td>5.29</td>
<td>0.7</td>
</tr>
<tr>
<td>Supporting professional growth of staff</td>
<td>86</td>
<td>5.76</td>
<td>0.46</td>
</tr>
<tr>
<td><strong>Domain</strong></td>
<td>86</td>
<td>5.49</td>
<td>0.67</td>
</tr>
</tbody>
</table>

**Rating scale:** 1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = slightly agree, 5 = agree, 6 = strongly agree
Head teachers were asked to rate the effectiveness of agriculture teachers in their execution of their duties (Table 4). The rating scale ranged from 0, which meant the head teacher had not had the opportunity to observe the teachers, to 6 which indicated that the head teacher strongly agree. Generally the head teachers The average mean score and standard deviation were (M=4.61) and (SD=1.37). The highly rated items were subject matter knowledge of agriculture teachers, (M = 5.25); their concern about student performance (M = 5.20); helpful to the learners M = 5.16; dedication to school work (M = 5.19); care for the learners (M = 5.12), and availability to assist students with academic work (M = 5.09).

Table 4: Means and standard deviation regarding the effectiveness of agriculture teacher as observed by the head teacher

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teach with clarity in class</td>
<td>86</td>
<td>4.55</td>
<td>1.94</td>
</tr>
<tr>
<td>Inspire the students towards learning</td>
<td>86</td>
<td>4.92</td>
<td>1.38</td>
</tr>
<tr>
<td>Make students enthusiastic</td>
<td>86</td>
<td>4.85</td>
<td>1.38</td>
</tr>
<tr>
<td>Being organized in teaching</td>
<td>86</td>
<td>5.00</td>
<td>1.43</td>
</tr>
<tr>
<td>Use good sense of humor</td>
<td>86</td>
<td>4.36</td>
<td>1.68</td>
</tr>
<tr>
<td>Being helpful to learners</td>
<td>86</td>
<td>5.16</td>
<td>1.32</td>
</tr>
<tr>
<td>Being dedicated to school work</td>
<td>86</td>
<td>5.19</td>
<td>1.41</td>
</tr>
<tr>
<td>Care for the learners</td>
<td>86</td>
<td>5.12</td>
<td>1.30</td>
</tr>
<tr>
<td>To develop interpersonal rapport with students</td>
<td>86</td>
<td>4.82</td>
<td>1.54</td>
</tr>
<tr>
<td>To be concerned about good performance of students</td>
<td>86</td>
<td>5.20</td>
<td>1.37</td>
</tr>
<tr>
<td>To be available to assist students with academic work</td>
<td>86</td>
<td>5.09</td>
<td>1.35</td>
</tr>
<tr>
<td>To encourage students to achieve more in life</td>
<td>86</td>
<td>4.95</td>
<td>1.53</td>
</tr>
<tr>
<td>Creating interest of learning among the learners</td>
<td>86</td>
<td>4.88</td>
<td>1.63</td>
</tr>
<tr>
<td>To prepare for lessons</td>
<td>86</td>
<td>5.05</td>
<td>1.43</td>
</tr>
<tr>
<td>Knowledgeable about the subject matter</td>
<td>86</td>
<td>5.25</td>
<td>1.41</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>86</td>
<td>4.61</td>
<td>1.37</td>
</tr>
</tbody>
</table>

Rating scale: 0 = Has not had an opportunity to observe, 1 = Strongly disagree, 2 = Disagree, 3 = Slightly disagree, 4 = Slightly agree, 5 = Agree, 6 = Strongly agree.
3.4 The Relationship between Agriculture Teachers’ Effectiveness in Teaching and Selected Independent Variables

Table 5 summarizes the relationship between agriculture teachers’ effectiveness and selected independent variables. The Pearson product moment was used to measure the degree of associations between variables. Descriptors by Davis [13] were used to describe the relationships between variables investigated, and the findings indicated that, a moderate association (r= .37) existed between the characteristics of effective leader and the agriculture teachers’ effectiveness in teaching students. A low association was found to exist between the variables, democratic leadership style (r= .20); distance from school (r= .22); age (r= .21); number of periods per day (r= .19); number of years in teaching (r= .17); instructional leadership practices (r= .16); number of periods per week (r= .15), and head teachers’ management practices (r= .14) and the agriculture teachers’ effectiveness in teaching students. Other variables had negligible association with the agriculture teachers’ effectiveness in teaching (-.22 ≤r ≤ .01). The findings therefore, ruled out confounding variables in the study.

Table 5: Davis’ scale of descriptors [13]

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Descriptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.70 and higher</td>
<td>Very strong association</td>
</tr>
<tr>
<td>0.50 – 0.69</td>
<td>Substantial association</td>
</tr>
<tr>
<td>0.30 – 0.49</td>
<td>Moderate association</td>
</tr>
<tr>
<td>0.10 – 0.29</td>
<td>Low association</td>
</tr>
<tr>
<td>0.01 – 0.09</td>
<td>Negligible association</td>
</tr>
</tbody>
</table>

3.5 Variables Perceived to Explain and Predict Agriculture Teachers’ Effective by Head Teachers’ Instructional Leadership Style

The sixth objective was to identify explanatory variables that predicted agriculture teachers’ effectiveness. Stepwise regression analysis was used to measure the relationship between the dependent variable, that is, agriculture teachers’ effectiveness in teaching agriculture to students and the independent variable-head teachers’ leadership styles (Table 6). Before the regression analysis, multi-colinearity was checked as advised by Dlamini [14] to exclude threat to the analysis.

Table 6 presents correlation coefficients of variables with agriculture teacher’s effectiveness in teaching (r). The descriptors in Table 5 were used to describe the relationship between perceived teacher effectiveness and the selected independent variables the information shows that teachers were rated to be highly effective (4.34≤M≤5.25, Table 4), and characteristics of
effective leadership had varying influence, described as negligible to moderate, Table 6, on agriculture teachers’ effectiveness in teaching \((0.01 \leq |r|, |rs|, |rpb| \leq 0.37)\).

**Table 6: Relationship between agriculture teachers’ effectiveness in teaching and selected independent variables**

<table>
<thead>
<tr>
<th>Variables</th>
<th>( r )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional leadership practices (int.)</td>
<td>0.16</td>
</tr>
<tr>
<td>Management practices (int.)</td>
<td>0.14</td>
</tr>
<tr>
<td>Characteristics of effective leader (int.)</td>
<td>0.37</td>
</tr>
<tr>
<td>Sex(nom., 0=female, 1=male)</td>
<td>-0.02 rpb</td>
</tr>
<tr>
<td>Age ---- (years) (int.)</td>
<td>0.21</td>
</tr>
<tr>
<td>Number of years in teaching (int.)</td>
<td>0.17</td>
</tr>
<tr>
<td>Number of years in headship (int.)</td>
<td>0.13</td>
</tr>
<tr>
<td>Highest qualifications (ord.)</td>
<td>-0.15 rs</td>
</tr>
<tr>
<td>Area of specialization (int.)</td>
<td>0.06</td>
</tr>
<tr>
<td>Do you teach any class (nom, 0=no, 1=yes)</td>
<td>-0.07 rpb</td>
</tr>
<tr>
<td>Number of periods per day (int.)</td>
<td>0.19</td>
</tr>
<tr>
<td>Number of periods per week (int.)</td>
<td>0.15</td>
</tr>
<tr>
<td>School location (nom, 0=rural, 1=urban)</td>
<td>0.18 rpb</td>
</tr>
<tr>
<td>Distance from school (int.)</td>
<td>0.22</td>
</tr>
<tr>
<td>Marital status(nom, 0=rural, 1=urban)</td>
<td>-0.01 rpb</td>
</tr>
<tr>
<td>Teaching experience before promotion (int.)</td>
<td>0.01</td>
</tr>
<tr>
<td>Staff members supervised (int.)</td>
<td>-0.07 r</td>
</tr>
<tr>
<td>Total enrolment of students (int.)</td>
<td>0.05</td>
</tr>
<tr>
<td>Availability of electricity (nom., no=0, 1=yes)</td>
<td>0.05 rpb</td>
</tr>
<tr>
<td>Availability of water (nom., no=0, 1=yes)</td>
<td>-0.07 r pb</td>
</tr>
<tr>
<td>Length of teaching period (int.)</td>
<td>-0.05</td>
</tr>
<tr>
<td>Number of heads of departments (int.)</td>
<td>-0.01 r</td>
</tr>
<tr>
<td>Average class sizes (int.)</td>
<td>0.04</td>
</tr>
<tr>
<td>Years spent in the school (Int.)</td>
<td>-0.22</td>
</tr>
<tr>
<td>Democratic leadership style (nom.)</td>
<td>0.20</td>
</tr>
<tr>
<td>Laissez-fare leadership style (nom.)</td>
<td>0.15</td>
</tr>
<tr>
<td>Coercive leadership style (nom.)</td>
<td>-0.01</td>
</tr>
<tr>
<td>Democratic and Laissez-fare leadership styles (nom.)</td>
<td>0.05r</td>
</tr>
<tr>
<td>Democratic and coercive leadership styles (nom.)</td>
<td>0.07r</td>
</tr>
<tr>
<td>Laissez-fare and Coercive leadership styles (nom.)</td>
<td>0.04r</td>
</tr>
<tr>
<td>Democratic, Laissez-fare and Coercive leadership styles (nom.)</td>
<td>-0.01</td>
</tr>
</tbody>
</table>

Note: \( r \) = pearson product-moment correlation co-efficient; \( rs \) = Spearman rank order coefficient; and \( rpb \) = Point biserial correlation.
Variable types included: int.=interval; Ord.=ordinal; and nom.=Nominal.

As can be observed from Table 7, six independent variables were found to explain and predict agriculture teachers’ effectiveness in teaching the subject. These variables included (i) coercive (R²=.31), (ii) democratic and coercive (R²=.42), (iii) laissez-faire and coercive leadership styles (R²=.51); (iv) duration of the lesson period in schools (R²=.59); (v) sex (R²=.67), and (vi) instructional leadership practices (R²=.75). From the Table 7, all the six variables were found to be statistically significant (P≤.05).

Table 7: Variables Perceived to Explain and Predict Agriculture Teachers’ Effective by Head Teachers’ Instructional Leadership Style

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>R</th>
<th>R²</th>
<th>R² change</th>
<th>B</th>
<th>B</th>
<th>t-value</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Coercive leadership style</td>
<td>.56</td>
<td>.31</td>
<td>.31</td>
<td>-.96</td>
<td>-.56</td>
<td>-3.78</td>
<td>.00</td>
</tr>
<tr>
<td>2. Democratic &amp; coercive leadership Style</td>
<td>.65</td>
<td>.42</td>
<td>.11</td>
<td>-.41</td>
<td>-.33</td>
<td>-2.42</td>
<td>.02</td>
</tr>
<tr>
<td>3. Laissez-faire &amp; coercive leadership style</td>
<td>.71</td>
<td>.51</td>
<td>.09</td>
<td>-.59</td>
<td>-.29</td>
<td>-2.26</td>
<td>.03</td>
</tr>
<tr>
<td>4. The length of lesson periods</td>
<td>.76</td>
<td>.59</td>
<td>.08</td>
<td>.16</td>
<td>.32</td>
<td>-2.37</td>
<td>.03</td>
</tr>
<tr>
<td>5. What is your sex</td>
<td>.82</td>
<td>.67</td>
<td>.08</td>
<td>-.17</td>
<td>-.35</td>
<td>-2.61</td>
<td>.02</td>
</tr>
<tr>
<td>6. Instructional leadership by head teachers</td>
<td>.86</td>
<td>.75</td>
<td>.08</td>
<td>.58</td>
<td>.38</td>
<td>2.88</td>
<td>.00</td>
</tr>
</tbody>
</table>

P<.05
Note: Adjusted R²= .68; SE = .66

4. Conclusion Remarks
Swaziland high school head teachers perceived themselves to be practicing appropriate leadership styles while executing their duties as heads of the schools. This is congruent with findings by Kruger [7] who reported that school principals in the South Africa are the significant drivers of efficiency and success of the school. Therefore, head teachers instructional leadership practices through providing direction, resources, and support to agriculture teachers become inevitable. Head teachers further claimed to be democratic and applied it along with coercive leadership style where necessary. It appears that head teachers devote their time to management practices and perceive themselves as effective, thus, transferring their effectiveness to agriculture teachers. Head teachers are cognizant of what constitutes an effective head teacher or agriculture teacher. The findings on the associations between the independent variables and teacher effectiveness suggest
that instructional leadership by head teachers is necessary for agriculture teacher effectiveness. The findings on the associations between the independent variable and the dependent variable suggest that instructional leadership by head teachers is critical to agriculture teacher effectiveness. These findings are also in agreement with Steyn [15]; Masitsa [16], Magagula [8] and Niemann and Kotze [5] who reported that head teachers are the core drivers of other teachers effectiveness in teaching. Head teachers have the potential to empower support teachers. In this regard, teachers are likely to see themselves as partners in managing an efficient instructional programme [17]. The conclusions from this study were based on perceptions of 86 head teachers. Thus, in-depth case studies based on practical observations need to be conducted to document head teachers instructional leadership practices and their influence on teacher effectiveness in Swaziland high schools. The value on such information would be useful in identifying strengths and weaknesses of head teachers' instructional leadership practices given their influence on teacher effectiveness, and hence on the outcomes of the teaching and learning process.
5. References


Metaphors of Migration and Survival: Negotiating Crisis Times Through Seeking Alternative Spaces

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*Polytechnic of Namibia*

**Abstract**

This paper is about the fictional representation of the tenacity, innovativeness and agency displayed by people who seek to better their living conditions and survive socio-economic and political cesspools. The aim is to demonstrate how political boundaries are surmounted and the various means used to migrate as a way to be in the diaspora and better one’s condition. A worst case scenario of Zimbabwe under a crisis is used to demonstrate the resilience and resourcefulness of ordinary people as they struggle to migrate and embrace global citizenry.

*Keywords:* Survive, agency, migrate, space, Zimbabwe, crisis, ubuntu, negotiate

**1. Introduction**

This paper explores the literary representation of migration, survival and how the ordinary people negotiate times of crisis through seeking alternative spaces, as represented in selected short stories set in crisis-hit Zimbabwe. The paper specifically centres on out-migration and does not intend to discuss other forms of in-migration. It is an axiom that the history of migration is essentially an account of the variegated struggles of people who seek to survive, to make ends meet and thereby escape the incessant crises occasioned by various factors which include natural disasters, drought, war, as well as economic and political turmoil. For Galbraith, “Migration is the oldest action against poverty. It selects those who most want help. It is good for the country to which they go; it helps break the equilibrium of poverty in the country from which they come. What is the perversity in the human soul that causes people to resist so obvious a good?” [1]

The action of migration abounds in canonical and literary texts, and goes as far back as biblical literature as it was taken by Jacob the founding father of the nation of Israel. Because of a famine in Canaan, Jacob and his extended family moved to Egypt. In periods of crisis, what is significant is the fact that spatial and physical dislocation in the form of internal and external migration is often pervasive, as people facing difficult situations move away from their places of residence to seek new livelihoods and other forms of survival [2]. Significant is the fact that when modern states go into terminal decline due
to a myriad of tempestuous causes or fail altogether as evidenced by the
Zimbabwean case study in question, the most predictable response of the
ordinary people is to get out - as soon as they can and to wherever they can.
The imagined existence of these tactics of survival, the fictionalisation of
how spaces are reconfigured and “owned” as people negotiate the national
borders to seek alternative livelihoods is a worthy cause in Afro-centred
literary circles which finds representation here. The short stories analysed are
purposively selected in as much as they hinge upon specifically outmigration,
which is the core of this paper. As a literary study, the theoretical framework
applied is resilience theory. Resilience is the capacity for strategically
absorbing disturbance and challenges, and for coping with the complex
uncertainties in life, so as to survive and move beyond survival. According
to Mlambo [3] analysing literary texts through the lens of resilience theory
means focussing on people’s survival techniques, their responsiveness in
exploiting opportunities, and their capacity to prop up agency even in the
worst of situations.

2. Escaping home by any means necessary in search of a
better life

This section looks at the making of global citizens as metaphors of survival,
and contributes to an understanding of the lived experiences of the ordinary
people as they “escape home” in search of better livelihoods. It demonstrates
the critical idea that, as shaped by the crisis, Zimbabwe’s social, economic
and political spaces are not confined to the territorial or geographic space
within the Zimbabwean borders, and that to survive a crisis, one of the tactics
is certainly to move.
It may be dangerous, uncertain and life-threatening, as well as life-taking,
but the journey out of the crisis-hit environment still remains one viable
option available to the ordinary people; however, this might have paradoxical
results. This paradox of migration as a curse and blessing is graphically
captured in Mlalazi’s story aptly titled “The border jumpers” [4]. Through the
use of simple, ordinary and unpretentiously descriptive diction, the reader
is carried into a vortex of the chilling, tranquil and eerie atmosphere of an
escape route used by illegal immigrants into South Africa. The story begins
in medias res and through this literary style Mlalazi manages to inject a
sense of urgency and life into the narrative; an urgency which by extension
also spells out how the ordinary man urgently needs to escape home and
seek alternative livelihoods. The panoramic view presented to the reader is
equally enchanting in Aristotelian terms of tragedy, where the reader both
fears and falls in love with the horrific incidents.
In this story, as a group of thirteen men are guided through the dangerous
and crocodile-infested Limpopo which is an escape route for those who
want to cross illegally into South Africa, a freak incident takes place. The only names which are mentioned in the story are those of Mbedzi, the paid-for guide, who is leading them and those of Zenzo and Vusa, whilst the other characters remain nameless. Some of them are just described as if the author Mlalazi wants these unnamed characters to be representative of the vast majority of people who have illegally crossed the Limpopo into South Africa. As they are crossing the river, the omniscient narrative voice only records how Zenzo panics whilst midway across the river and feels as if something has gripped him. The scream from Zenzo causes pandemonium as the group thinks of crocodiles which find easy prey in the border jumpers. After they have managed to cross, a head count is ordered by Mbedzi the guide and they discover that two men who were at the rear have gone missing and it is not clear whether they have been eaten by the crocodiles or returned to the Zimbabwean side of the river. But despite all the doubt and uncertainty, Mbedzi urges them on so that they can get at the rendezvous in time as he says, “Whatever happened back there, just forget about it”, he told them. “Your way lies only forward, and while we are standing here like the opposition discussing the Party, time is moving, and if we are late to the pickup point, the van won’t wait for anyone. I don’t have to mention to you the kind of shit you will be in should that happen [4].

One critical observation is that Mbedzi is one of the survivors of the crisis who accepts the reality of life and sees a niche that he exploits as a coping strategy. Mbedzi becomes a “professional” guide who gets paid to lead the migrants across the borders through secret routes. In this story, this is one of the groups he is ushering into South Africa with a success rate of 11 out of 13. From the quotation above, what is clear is that this is possibly a lucrative syndicate that works together as there is a designated pickup point and there is also a van so that they can beat the notorious “border patrol” which tries to stop illegal immigrants. The process of border jumping may sound haphazard and rudimentary, but there is a sense of organisation in the operation and with these basic structures, people manage to escape home. Therefore, Mbedzi represents one form of a set of survival tactics and the crafty coping mechanisms devised for survival. Despite its illegality and crudity, the trade he plies leaves the reader justifiably guessing that Mbedzi can manage to see another day due to the earnings he gets from this activity and this is despite its precariousness.

One more important observation is that despite the vulnerability of the border jumpers, Mbedzi does not prey on and dump them. There is a twinge of empathy that flavours the story, and Mbedzi’s concern is registered in the tone of the narrative voice in the story, which shows that despite the terrible and dehumanising dimension of the crisis, some people still remain humane. The African concept of *ubuntu*, African humanism and togetherness, still persists and this is the spirit that binds people together despite all the odds.
This Afro-centric lens of reading the story goes a long way to fight and dispel Afro-pessimisms, and shows that there is hope expressed through African literature. The artist, like Mlalazi, becomes a raconteur, whose duty is in true Achebean terms, a teacher to the community.

Furthermore, another seemingly mundane but necessary point to make in this story is on the spiritual dimension. Not only is the spiritual dimension symbolised by the snuff which Mbedzi the guide, pinches and sniffs, but also from the incantation he pronounces in case the missing two border jumpers are dead, “Wherever you are my two brave sons. Let it be known that it was not through your friends here that you got left behind. I plead with you to grant them a safe journey to Johannesburg, where you also headed. Also to grant them a safe haven from the poverty from which they are fleeing [4]. This prayer, uttered in a sombre, sincere and serene tone, closes the short story as Mbedzi leads the border jumpers onto South African soil and their intended destination is made clear – Johannesburg. Like the biblical Israelites led by a pillar of cloud and a star by night, this group also seemingly travels through the guidance of the supernatural; the spirits of their colleagues have been pleaded with to be guides and not to be haunting spirits in quest for vengeance. The group has crossed the river and jumped the border to the metaphorical Canaan which is Johannesburg. The critical argument to be made and emphasised from this story is that national borders become meaningless to the poor yet determined people in times of serious socio-economic crises. The border jumpers do not merely sit idly while hunger and extreme lack tear them to pieces. They are active participants in determining their destiny as they refuse to play the helpless victim – they devise ingenious ways of escaping and thereby seeking means of survival. The border patrol, national governments and immigration officials may criminalise such activities, yet such informal and “illegal” pursuits assist the poor where the state has failed. Denied the opportunity through bureaucratic processes to go to where they can sell their labour where it is needed, the ordinary people devise new ways and routes to escape home by any means necessary; this story highlights that such a survival strategy works for some of them.

This story brings to the fore the predicament of those ordinary people who could not raise enough money to acquire a national passport in Zimbabwe. During the crisis-hit and institutionally weak Zimbabwe, affording and obtaining a passport was a nightmare to many people. To make matters worse, even if one was fortunate enough to acquire a passport, another stumbling block was the South African government’s conditions to get a visa which were prohibitively stringent. Therefore, the surest escape route available was through the act of border jumping. Yet still, from Mlalazi’s characterisation, a quick reference to onomastics
indicates that Mbedzi, Vusa and Zenzo are Ndebele names, hence, historically pointing to a South African origin of the border jumpers in the story. Therefore, given the life threatening circumstances in their present country, the national boundaries set up by the colonial regimes can but only be ignored. The artificial, man-made border becomes a barrier to be circumvented. The need to survive dictates the *modus operandi* and border jumping is the surest way to escape home. Hopefully, the eleven who survive the Limpopo waters and crocodiles as well as the border patrol will manage to survive the poverty they are running from.

In the story “Crossroads” [5], the idea of escaping home and crossing the national border is furthered and the representation of survival tactics is extended. Whilst the previous story gives the reader a glimpse into the lived experiences of those who use illegal or informal entry points, in “Crossroads” the emphasis is on the legal or formal entry points. Narrated from a first person point of view, the reader is easily entrapped in the literary world of the plight and - most importantly - determination and ultimate success of the protagonist. The nameless narrator journeys to the South African embassy in Harare for a visa, and the story takes us through the road trip to South Africa and finally to Park Station in Johannesburg. The escape from home is complete, despite the challenges the narrator faces and the author’s economical use of characterisation makes the story more involving and easier to understand. Just like Mbedzi in “The border jumpers”, in the short story “Crossroads” there is another survivor of sorts who sees an opportunity that exists in those masses trying to escape home. First the narrator takes note of how, at the South African embassy in Harare, “Hawkers march up and down with their wares, pens and cigarettes, freezits and cool drinks, bananas and maphanzi [buns]. There is even a photographer, who points at a makeshift studio under a tree and yells, “Passport size photos, visa photos, any photo that they want I take, cheap-cheap photos ... [5].

The above scenario can be looked at with two lenses of interpretation. First is the tourist-like gaze which only sees the pitiful and desperate situation of the urbanites. Second, and the one propagated in this paper, is the gaze that sees and gives credit to the efforts of the urban poor to better their condition. The spatial location of these actors, the city of Harare, is a hunting ground of possibilities, and despite the meanness of the conditions, survival is possible through such entrepreneurial activities.

Given the gravity of the situation, those attempting to escape home, whilst waiting in snaking queues, are desperate for food and also for such utilities as a simple pen to use for filling in a form, hence the reason why some enterprising urbanites capitalise on such situations. This shows that agency is ubiquitous and the survivor personality of the people comes in a plethora of forms. This is further corroborated by the narrator’s observation of how, “The most amazing type of hawker approaches you the moment you join the
tail of the queue. “Sista, it is obvious from your place in the line, that you will not make it. They only take fifty people a day”. A dramatic pause. “But I can help you sista, my place is number twenty three. I will happily sell it to you.”

This is by no means an exaggeration nor hyperbolism as the reading can be verisimilitudinous to someone who has had firsthand experience of life during the Zimbabwean crisis. This “amazing type of hawker” has no intention of escaping home but certainly has found a rich ground for making it through those who are trying to escape home. This type of survivor personality, as soon as the sun sets, goes to the embassy to sleep at the gate, so that when other people come in early in the morning the hawker already occupies a couple of positions in the queue which he/she sells off to those whose position is after the fifty mark, the maximum number of those who are served by the visa authorities per day.

When approached by the hawker for the first time, the narrator is shocked that the amount the enterprising hawker charges is a hundred Rand, which is a very significant amount in crisis-hit Zimbabwe. However, after a couple of days of failure to make it in the top fifty, the narrator accepts the offer and one can imagine how much the hawker who sells her places in the queue makes per day, let alone per week and ultimately per year. Even professionals could probably not get that amount of money. This is also a further demonstration that whilst the crisis may have made making ends meet almost impossible, for the determined and inventive urban sleeker, possibility abounded. The lady hawker in the story ensures that she “owns” some of the fifty places every day which makes it a sellable commodity and becomes her own form of employment. Even the narrator, through a discernible authorial intrusion which permeates through the story, concedes that as much as the crisis in Zimbabwe has multiple dimensions, the people are also protean and crafty. To attest to this, there is a wry commentary made that, “Another ingenious method of making a living. Sleeping outside the embassy, queuing for those who do not have the means to be here early, charging a fee for ‘services rendered’. There is nothing that one cannot do here anymore. One’s ability to make money is limited only by the scope of one’s creativity [5]

The creative artist, the writer of this short story, is hereby expressing the value of creativity, innovativeness and resiliency, especially when applied to make ends meet. This apt quotation illustrates that survival is possible in spite of the impossible circumstances. Those escaping home, like the protagonist, also provide opportunities for others to survive. This is in the same manner as Mbedzi’s case in “The borderjumpers”. People make things happen for themselves and are active agents instead of the false perception of African apathy and docility.

Furthermore, the narrator’s travails did not start with the scenario at the South African embassy in Harare. In crisis-hit Zimbabwe getting hold of the
passport to get out of the mire was a difficult and almost an impossible task. However, the people devise ways of getting the document. The narrator recounts how she produced all the required documents for she was aware of the fact that at the embassy she had “... heard the most horrific stories about these people, how they will find practically any excuse to turn you away” [5]. Hurdles are lying everywhere for the ordinary citizen yet the human spirit to endure and surmount difficulties is inspirational.

Given such difficulties which have been explored above, therefore, it becomes interesting to note how the protagonist not only observes and comments on how others like the hawkers survive, but also how she herself manages to cope with the crisis. Determined to escape home and its attendant problems, the narrator approaches the visa counter with everything in order because she has managed to acquire all the documents, “Police clearance: seduced out of an officer old enough to be your father. A phone number had to be proffered, fake promises of a get-together made. You intend to be long gone by then. Two thousands Rands worth of traveller’s cheques. Money borrowed from Mi, your aunt who lives in South Africa, which you must give back upon arrival. A valid passport. Palms greased for this one. Corruption grins at every stage of the hierarchy [5].

Out-migration is, therefore, a survival mechanism for the urbanites that cannot stay in crisis-hit Zimbabwe. Whilst the South African government puts stringent visa mechanisms in place like that of requiring one to have two thousand Rands worth of traveller’s cheques, people devise ways to surmount this as we see happening between Mi and her niece, who is the protagonist in the story. These are the various coping strategies devised by the ordinary people who want to go beyond their borders in search of better livelihoods.

Moreover, the fictionalisation of coping strategies is further presented through the journey into the proverbial “promised land”. As a graduate of the “University of Life” called experience, the narrator, whilst in the bus prepares for the unexpected. As a novice and initiate into diaspora life, the narrator forms friendships and alliances with those who have been there before. That is why she talks of a new found friend for strategic reasons and she reminiscences, “Tari is a friend I picked up on the bus, a friend I will drop when we get to Park Station in Johannesburg. Somebody to show me the ropes at the border” [5]. The narrator’s survival instinct guides her to benefit from Tari, whilst not compromising herself, for instance like when she seduced the police clearance from a police officer with fake promises. This is the pragmatic morality that assures her a safe crossover; such situations call for wisdom, wit and a cunning mind, lest one gets run over by the forces at play in tempestuous and ever-changing Zimbabwe.

Tari is yet another metaphor of the diasporic survivor personality; a typical global citizen. He refuses to allow the fate of one country to be his as well.
Tari becomes a transnational personality who enjoys the global connectivity of countries, which is a reality of the 21st century. To understand Tari’s personality in terms of survival, Mbiba’s concept of global citizenry can be useful here. For Mbiba [6], “The term “global citizen” is used in an effort to imagine and bring into being a person whose social, economic and political life is not bound by the confines of a single country’s political boundaries. He or she can settle and contribute to the welfare of any place on the globe, and make home anywhere without restrictions. In reality, legal and social prejudices often constrain the development of this kind of citizen, but the term is used here as a way of stressing the dignity and positive contributions of displaced Zimbabweans.

Tari typifies this definition of a global citizen and also shows that for the sake of survival one does not have to forsake the home of origin. Survival as a coping strategy can be further understood to include straddling the national borders and malleably embracing the complexities of change. Tari brags about his coping tactics, as he flows with the current, and as the crisis trends shift, in a versatile and protean manner, he follows suit. Tari’s coping and survival strategy is through crossing the border. Under such circumstances the idea of home becomes blurred as one becomes a global citizen. He explains it thus, “My dear, I pass through here every two to three weeks. Two weeks in South Africa, two weeks in Zimbabwe... I am into buying and selling, I do everything and anything. It used to be petrol, even rands for forex. That is until those bastards top-up-there made forex legal tender [5]. As a typical survivor, Tari does not rely on only one form of survival strategy as if programmed, but has the plasticity to change and adapt. Given the phenotypical and linguistic semblance between some Zimbabweans and the majority of South Africans, this choice of destination is most ideal. Tari deciphers the laws of supply and demand so as to chip in where there is a niche and his survival is made certain through the cunning observations he makes, then taking the necessary steps.

Kadenge [7] discusses how talking about the crisis figuratively became an imperative survival strategy, mainly to “save face” or to protect oneself against victimisation and/or possible arrest. Such metaphorical and stylised communication that is distilled to make acceptable the otherwise unacceptable in strict social settings is also exemplified in this story. The narrator uses the phrase greasing palms or hands when referring to bribery or corruption as if this is literally making the hands more lubricated so as to release whatever the other party wants. When in the story there is a girl who attempts to get into South Africa with an almost expired visa, she is denied entry and pleads with the immigration officer loudly and those who are used to the system tell her, “You went about it the wrong way. How can you expect to change her mind when you are pleading so publicly? Are you trying to make a fool out of her? You need to talk to someone, one on one... Grease
a few palms [5].
The linguistic register of the day is a descriptor of the new code of conduct occasioned by the crisis. The constant use of the substitute and more acceptable metaphors is also indicative of an adopted pragmatic morality. The concept of *greasing the palm* being referred to ceases to be a Zimbabwean phenomenon only, but a trans-border phenomenon which has to be and is being practised by South African officers as well. When the narrator sees graffiti admonishing travellers to use pure toilet paper in the toilet and “NO ZIM DOLLARS”, she takes a photo of the inscription as, “A keepsake, to show my children one day, when my country is no longer lying on its back with its legs spread apart, in an act of incest with its fathers and their children [5]. This statement further reminds the reader that these are not normal circumstances; therefore, the moral logics of everyday life have to be adjusted accordingly. It is a crisis situation and for people escaping home, the line between what is legal and illegal is quite blurred. The determining factor in what one does is couched upon the desire to survive and make it. Leaving a country where food shortages are acute, with shops virtually empty and foodstuffs on the black market beyond reach and rarely available, incessant power cuts and erratic water supplies, the narrator sighs in great relief as she crosses into South Africa. Her perorations justify the reason for escape. Even though she has not acquired any money, the joy at being able to spend the little that she has is satisfactory. It has been worthwhile escaping home and in a state of euphoria she marvels thus, “Even the lights here seem brighter, more cheerful. It’s amazing the things that will make one leap with joy. No more power cuts. No more water shortages. No more queues. Joy is an emotion that never matures. I buy in a frenzy. A packet of Simba chips, Cadbury chocolate, a can of coke, bottled water, a chicken and mushroom pie. A packet of pinky sweets. Haven’t had those since I was a child. I feel like such a kid [5].
If in the short story “The border jumpers” the story teller left the story cliff hanging to allow the reader to imagine how the escapees feel; in “Crossroads” the reader is allowed a peep into the inner contentment and relief of the successful escapees. The long-buried emotions of joy and exhilaration are not pent up anymore but find full expression.
The uses of contrasts by the writer are quite illuminating as “The promise of auspicious beginnings” [5] take root and sprout in the narrator. A world of possibilities has been opened up for the narrator and she can dream big. Even the street posters urge her to think outside the box, whereas “Where I come from, we’ve learned to think without the box” [5]. Tari, the friend, also urges her to be on Facebook, which is yet another illustration of progress; potentialities abound and both can be seen at the practical and metaphorical level, as survival and hope are beginning to hatch. Despite the caution from
Mi, the narrator is adamant that “... after a year or so, I should have saved up enough money for university” [5]. Certainly Mi is right in saying that without papers it is difficult but at least one can afford to dream and with the strong will of the narrator, she refuses to bow down.

The mark of a survivor personality is discerned, when against all odds and where others falter, the person pulls through. Mi’s words are dampening the spirit of the faint-hearted as she says “School and all that crap, my dear, forget it. I came here, as naive as you are, with nothing but a pocketful of dreams. But look at me” [5]. Mi represents another breed of the diasporans who, though they have made it across the border, are content with only existence. However, according to the protagonist, in a world of possibilities, it is worthy moving beyond existence into flourishing mode. Ultimately the story ends with her vowing that she will be different and undeterred; “That’s you, I want to say. It’s not gonna be me” [5]. That is the audacity of hope in a narrator who escapes home in order to make it beyond borders. As the story comes to an end, she has set her goals and says “I keep smiling” [5].

The eleven men who cross over to South Africa in “The border jumpers” as well as Tari and the nameless narrator in “Crossroads” are, therefore, a representational fragment of the many people whose coping strategy is through escaping home. These fictionalised lives represent Zimbabwe’s exodus and their lived experiences bring another important dimension to survival through out-migration. Statistically, the number of people who left Zimbabwe is mainly based on estimates which range from the barely plausible to the totally outlandish. Whilst there is lack of clarity and some disagreements with regards to the statistics, the importance of fiction is illustrated. Fiction goes beyond mere numbers and represents the flesh and blood of the people, the pulse of their lived experiences and this is what the stories demonstrate. The reader metaphorically experiences the trials, tribulations and triumphs of a people who are trying to survive through escaping a nation under siege.

In addition, to show the multiplicity of these coping strategies in relation to escaping home, a look at the short story “My cousin-sister Rambanai” [8] is of critical importance. The story is about Rambanai who has been in America but who has returned for her father’s funeral. Her brother, who is in the United Kingdom, does not come back but instead sends the cherished pounds in crisis-hit Zimbabwe. Rambanai comes back a changed person and the envy to many, but after the funeral she does not go back to America. Later it dawns upon the narrator that Rambanai cannot go back to America because she no longer has a valid visa. Rambanai’s passport has been crossed out as an illegal immigrant possibly because of her overstay. But she does not give up
and sets on a shrewd mission to get herself out of the country so that she can escape the misery around her. She manages to surmount the challenges she faces and goes to an alternative destination, the United Kingdom, whilst the narrator (Rambanai’s cousin) and her husband also follow suit.

Rambanai is a typification of the “been-to” personality whom the prominent African writer Ayi Kwei Armah writes about in his novel *Fragments* [9]. She has been to the diaspora and for that she has a lot to show off with - two suitcases crammed with clothes and an accent being at the top of the list, let alone a venerable status in the society. This is evidenced when, “Having been in America for five years without coming home, she was the star at the funeral; everyone wanted to look at her” [8]. To survive, she chooses to join the diaspora community and instead of the traditional trend of going to South Africa, she goes to the United States of America. This illustrates the fact that the Zimbabwean exodus as a coping strategy is not limited to regional destinations but the people virtually make the whole globe their potential destination, more like a modern version of the conquistador of 15th century Spain.

Whilst the previous short story talks of South Africa as a metaphorical symbol of a perfect choice for outmigration of all regional destinations, in “My cousin-sister Rambanai” the destination is beyond the seas. For the sake of survival, one therefore does not need to be limited by regional or continental boundaries but needs to think beyond the immediate and intermediate environment like what Rambanai does. Instead of the typical Booker T. Washington adage in classical African-American literature, that to make it in life one has to “cast your bucket where you are”, in this instance, we see a different worldview altogether. At times there is a need to realise that people are not trees, they can move from one place to another in order to embrace a better livelihood.

To attest to the idea that where agency abounds, opportunity is equally plenteous this is what Rambanai says, “Our housemaid SisiDessy worshipped Rambanai and could not get enough of her stories. “America is the land of opportunity, SisiDessy,” Rambanai told her. There you can be anything you want, anything at all. Someone like you can be a housemaid today, and before you know it, you have your own TV show. [8].

For people who are in a crisis, opportunities are certainly limited and some have to cast their bucket where they are. Yet for the likes of Rambanai, opportunity lies in far off places and she goes for these greener pastures.

What needs to be underlined is the fact that this is a crisis situation, so
whatever the world has to offer one has to grab with both hands. The underlying fact is that survival is made possible and through the story writer the coping strategies are presented. The dream of escaping home is not limited to the Rambanais of the world but even the downtrodden masses from the “ghetto” like the Mbare hairdressers who are keenly aware of the value of being in the diaspora. That is why Rambanai’s hairdresser pleads with her, “I have a cousin-brother who is willing to do anything, please help him if you can”, and Rambanai gave Manyara her number in America and said she would definitely see what she could do” [8].

After being denied entry into America, surely there is “... the death of her American dream” [8], but survival in a cruel world with its multiple constraints like the one Rambanai lives in, means that she also has to devise multiple strategies. First, Rambanai has to accept the reality of her circumstances of the present so that she can map the way forward. Initially she has lived a delusional life, pretending that she is only taking long to go back to America because of problems with connecting flights and she even shops for her friends in America. However, to survive a crisis, it may be at personal, family or national level and to come up with practical solutions; one has to face the present reality. Finally Rambanai decides to face the truth, which also liberates her both metaphorically and practically, “America is a non-starter, she said cheerfully. They will never give me a visa now. I will go to London. At least we don’t need visas for England, being in the Commonwealth. In England, I can get an office job. I will continue my dancing. Or maybe acting, I have always wanted to be an actress. I will get a proper job, go to school at night. I will do something” [8].

Rambanai is a resolute and resilient individual who has a strong-willed determination and once she purposes in her heart, she does something. Resigning oneself to fate is not an option at times like this and Gappah created a resolute character like Rambanai to communicate the myriad of opportunities which await those determined to escape home and survive. Rambanai looks at life full circle and explores all the alternatives in search of the most viable niche. She confronts her problems head-on and claims her place in the world. Yet, it is still not enough to just discover a niche. There must be the means to get to that desired goal of being once again in the diaspora. With her passport endorsed she has to get a new one. This is yet another nightmare she has to contend with and her resourcefulness in this regard is worth celebrating by the author.

Significant to note in Rambanai’s tactics is the value of realising that despite stifling circumstances, the human spirit to resiliently pursue multiple options and possibilities is a survival and coping strategy of note. Unlike the 13 men
in “The border jumpers”, who swim their way across the river, she cannot swim across the Atlantic waters to the United Kingdom, nor can she smuggle herself into the country, given the sophisticated border controls of the first world, yet there has to be a way. Rambanai devises a way out of her problems and this is what she says, “Exactly. I can’t go as me; they have records, you know. I need another passport in another name. That’s what lots of people do when they have been deported; they just get new passports” [8].

This is yet another celebration of pragmatic morality by the author. She just has to choose another name she really likes and for Rambanai the opportunity of choosing her own name is a joy – it is a symbolical marker of self-determination. Her name means divorce each other, or disunion, or break up; yet now she can decide her own name. Whilst she is of the ruling Shona tribe (and possibly tired of being associated with the ruling tribe which is blamed for the crisis, after all), Rambanai, by changing her name, can afford to be “transported” to another tribe as she says, “I know, I will choose aNdex name. They have some really cool names. Nonhlanhla. Busisiwe. Sihle. Gugulethu. I know, Langelihle, that means a beautiful day. You can just call me Langa for short. I can be Ndebele. Oh, I could even be a Ndebele princess” [8].

Indeed she has the power to make her day beautiful and Rambanai goes on to do just that, remarking at the fact that even Oprah Winfrey is part Zulu. The Ndebeles are a splinter group of the Zulus and Rambanai is proud to choose her own name and change her identity as well as determine her future and destiny. She is equally unfazed by the fact that her Ordinary and Advanced level certificates are in her original name. She will simply explore other interests. This is an indication that to survive, one has to be protean enough to be able to adapt and explore virgin territories. Limitations are never absolutes and in the diaspora one can have a better chance to start afresh.

However, as has been indicated, one cannot escape home only through bright ideas, like the one Rambanai has of changing her name. A lot of money is needed to smooth the whole process and that is when the narrator and her husband Jimmy decide to assist. They sell some of the shares that Jimmy’s father had left for him and also postpone the buying of a new refrigerator so that they can help Rambanai. A significant amount of money is needed for “greasing” the many palms that are involved in acquiring a new birth certificate, identity card and finally, a new passport. This aspect of the narrator and her husband Jimmy helping out Rambanai further illustrates the concept of ubuntu and the role of the extended family in Africa as a support mechanism to help out those in need.
From another angle of analysis, instead of seeing it only as pure and unadulterated $\textit{ubuntu}$ and a benevolent gesture, this can also be read as a calculated move, meant to make Rambanai reciprocate and invite them to the United Kingdom as well. For later on the narrator searches all over for Rambanai, including searching on the internet sites like ZimUpdate as well as ZimUnite, which are used by the Zimbabweans outside the country who are homesick and want to reconnect. Finally, despite the fact that Rambanai does not at all communicate, they find their own way out of the country. “Two and a half years after, Jimmy and I decided to join the three million who had left the country. It was an economic decision, we explained to everyone who asked, it is an economic decision, we said to ourselves, but in our hearts, we knew that leaving our families was the only way to save our marriage. The time had come for our families to expect something, translucent ears, a bulging stomach, an aversion to strong scents, anything that could be evidence of a baby on the way [8].

The economic meltdown has bitten hard and surviving it requires ingenuity that culminates in leaving home thereby escaping the fangs of poverty. However, other than the national crisis, the clichéd scapegoat which is measured in economic terms, there is also often a private or personal one which faces the couple. Being married and taking long to have children, Jimmy and the narrator are pelted from all angles by relatives who see procreation as the ultimate goal in a marriage. Their marriage is heading for the rocks and the only way to save it is through escaping home and also the people at home and their mentality. The crises of life are therefore presented as multi-fold, and the means of surviving are equally multiple, with the idea of going into the diaspora being one of them as has been presented here.

Furthermore, it is necessary to emphasise that another look be cast on how Jimmy and the narrator buy their way out of their country which is facing pronounced economic and political difficulties. Like Rambanai they have some challenges. During the time when Rambanai was planning to emigrate, there was no need for a visa, but now the British have put in place some stringent measures for granting a visa. Zimbabwe is no longer in the commonwealth, and the easy route to the United Kingdom is now curtailed, but for one bent on surviving, there is always a way into the diaspora. This is how the narrator explains it, “In the end, we got our visa the same way Rambanai had got her passport, we used the Harare way – someone knew someone in the British embassy with whom we exchanged envelopes stuffed with cash. I gave up teaching and Jimmy engineering to be in England, where the curse of the green passport condemned us to work in the unlit corners of England’s health care system, in care homes where we took out
the frustrations of our existence by visiting little cruelties on geriatric patients [8].

Leaving for the diaspora has been made possible for both of them. The easiest way could have been through the links with Rambanai, but Rambanai having vanished into thin air in the United Kingdom, the narrator and her husband, Jimmy, have to find another alternative and it is “the Harare way”. This metaphorical statement, like “greasing” shows that the urbanites, the urban sleekers in crisis-hit Zimbabwe, do not wallow in apathy but learn to find means and ways of making it in life. By saying that they had to use “the Harare way”, what becomes clear is that the urban character is by all means a survivor. Even Rambanai, once in the United Kingdom, is not limited to a single place, but explores all the cities, hopping from Birmingham to Newcastle, to Leicester and London. If the international borders cannot limit her, then the town boundaries cannot at all curtail her adventurous spirit, all in the name of survival.

One of the diasporans is Rambanai’s older brother, Thomas. Through Thomas the value of the diaspora as a survival mechanism in crisis-hit Zimbabwe is made clearer. Thomas has been away for five years now and instead of coming for the funeral, “... Thomas wired seven hundred and fifty pounds through Western Union from Manchester, England where he lived” [8]. This is the tactful adjustment that is required in the diaspora, especially if one does not have the required papers to stay in the host country. Rambanai chooses to come, and it results in her passport being endorsed such that she cannot go back. But Thomas is wise enough to realise that he would rather send money than come in person for the funeral. As a result, through the effort of the diasporan, Thomas, the remittances he sends, “... enabled the family to bury my uncle in the splendour of the Paradise Peace Casket, a gleaming white coffin with golden handles and a gold frame on the surface into which my aunt put a photograph of my uncle in his University of Leeds graduation cap and gown [8].

The diasporan is making things happen, as testified in this short story. The situation in crisis-hit Zimbabwe and its attendant economic-meltdown are so dire and a funeral spells a mini-crisis for an ordinary family. Yet for those with a family member who is abroad, things are much better. They do not just use a coffin like everyone else but stand out even through death and mourning as the mourners observe, “It is a casket Vatete, not a coffin. A casket” [8]. Also noteworthy is that the late (who is Thomas and Rambanai’s father) was educated at the University of Leeds. Therefore, despite Jimmy being an engineer, leaving home for the diaspora is not always an indication of brain drain. It can as well be a form of brain gain. In colonial Zimbabwe and shortly
after independence, crossing the national borders in search of education was yet another form of seeking a livelihood through investing in education but now it is through going to sell one’s labour, whether skilled or unskilled.

3. Conclusions
What has been made clear in the foregoing analysis is that when times are hard, one way of surviving is through leaving the boundaries which define the crisis. This manner of leaving or escaping home is in the form of using the illegal means of border jumping, through manoeuvring past the hurdles of visa applications and also getting legal travel documents as well as buying one’s way out of one’s country. Without downplaying the drudgery of life in crisis hit Zimbabwe and also condoning the political malaise, the ultimate conclusion reached is that the characters in these stories provide an alternative understanding of ordinary people’s subjectivity and resourcefulness. Agency, resilience and innovativeness are all indicators militating against afro-pessimisms and these stories are inspirational and insightful.
4. References


A REVIEW OF CURRENT AND FUTURE CHALLENGES IN PAINTS AND COATINGS CHEMISTRY

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Abstract
Paints and coatings are very important to everyday life. However, their formulation is becoming more and more complex due to legislative demands, driven by environmental and health concerns, to reduce or eliminate completely volatile organic compounds (VOCs) and any solvents considered hazardous air pollutants (HAPs). Liquid coatings formulation must simultaneously meet VOC limitations and HAP restrictions by shifting to high solids, low-solvent coatings as well as water-borne coatings. Non-aqueous formulations that meet existing and pending VOC and HAP regulations and offer the performance customers expect/require are still being produced. Switching to environmentally-friendly coatings involves more than simply replacing organic solvents with VOC-free ingredients such as water. Efficient formulation demands that basic rules governing the rheological behaviour are well-defined. This paper highlights the formulation and some of the current and future challenges in the paints and coatings industry with emphasis on the chemical aspects.

Keywords: Coatings, Environmentally-friendly, Paints, Rheology, volatile organic compounds, water-borne coatings

1. Introduction
Paints and coatings are very complex and versatile materials, offering more challenges to the formulators than most other products. The paints and coatings industry has changed over the years and continues to change. The basic composition of the paints and coatings, their methods of composition as well as environmental factors are driving innovation in the industry [1]. The legislative demands, driven by environmental and health concerns, is to reduce or eliminate completely volatile organic compounds (VOCs) and any solvents considered hazardous air pollutants (HAPs)[2]. For instance, liquid coatings formulation must simultaneously meet VOC limitations and HAP restrictions by shifting to high solids, low-solvent coatings as well as water-borne coatings. Although a lot of research is now concentrating on water-borne systems, non-aqueous systems will still be with us for a while. So, non-aqueous formulations that meet existing and pending VOC and HAP regulations and offer the performance customers are willing to pay for are important to the industry. Switching to environmentally-friendly
coatings involves more than simply replacing organic solvents with VOC-free ingredients such as water. This paper highlights some of the current and future challenges in the paints and coatings industry with emphasis on the chemical aspects.

2. Definition and Composition of Paint/Coating

Paint, in its simplest form, is made up of the pigment and binder. Strictly speaking, a “coating” is a broader term, and includes formulations without pigment. However, good quality paints are made up of four components: pigment, film former, thinner (solvent) and additives [3]. Varnishes, which form transparent or semi-transparent films, are made up of the last three components, with coloured varnishes containing small amounts of pigment.

Pigment. This is possibly the most obvious part of paint. Pigments are fine powders that give the film its colour and help it to hide the surface underneath. They may provide other properties too such as altering the way paints flow or providing corrosion resistance. Not all coloured powders are suitable as pigments. They must be insoluble in water. It is helpful if the pigment is chemically inert and colourfast when exposed to light.

Similarly, not all white powders are useful as white pigments. Not only is insolubility and inertness being sort, but also they should be opaque in use. If they are not opaque, however, they may still be of value in paint for other reasons than opacity. We call these transparent white pigments “extenders”. They may help to prevent pigment settlement in the can, act as a matting aid, and provide a micro-toughness of the surface to assist adhesion of the next coat or act as reinforcement to strengthen the film.

Coloured pigments range from simply inorganic compounds such as red iron oxide (Fe₂O₃) to complex organic pigments, for example, dioxazine violet. By far the most commonly used white pigment is titanium dioxide (TiO₂) although zinc oxide (ZnO) and lithopone (ZnS + BaSO₄) find small use.

Many of the extenders used are naturally occurring minerals such as whitening marble (CaCO₃), barytes (BaSO₄), silica (SiO₂) and china clay (Al₂SiO₅·2H₂O).

Film former (binder, resin or polymer). As the name suggests, this component holds the pigment particles together and to the surface to be painted. It is invariably either a natural or synthetic polymer. These polymeric or polymerisable components provide the cohesion of a coating composition. The choice of binder is paramount and decides so many of the fundamental properties of the paint film such as hardness, toughness, flexibility, durability
and speed of drying. In other words, it is the material that forms the film, giving protection to the substrate and keeping the pigment in place and evenly dispersed. It may be made up of a single polymer, or a combination of polymers. These include polyesters (which include the alkyds), the acrylcs and the vinyls, epoxies and polyurethanes, phenolic and amino based resins, etc. (see Box 1) [4]. Paints are usually classified according to the binder present, for example, an alkyd gloss paint, a polyurethane car finish, a polyester wood finish, or a polyvinyl acetate latex paint. The binder may be dissolved in a solvent, or in the form of an emulsion or colloidal dispersion in water, which results in solvent-borne and water-based paints, respectively (see Box 2) [4]. A mixture of resin and solvent is called the “vehicle” for the pigment.

**Thinner (solvent).** These may be organic liquids or water, or a mixture of both. Thinners are chosen particularly for the solvency and evaporation rate. Commonly a blend of solvents is used. For instance, mild-odour aliphatic hydrocarbons might be used in a gloss paint for home whereas quick evaporating esters find use in car touch-up aerosols. Water would be used more widely except for its slow evaporation especially in humid atmospheres. They may be added to improve the spreading properties of the vehicle. The carrier thins the paint or varnish, allowing it to be brushed, sprayed, dipped or rolled. Once on the substrate, the solvent evaporates, leaving the dry film coating. The term ‘liquid carrier’ is preferable because the liquid may not be a true solvent for the binder. The function of paint solvents, therefore, are to keep the pigment and resin apart until the coating has been applied, to allow adhesion to the surface, and to lower the viscosity to allow spraying and levelling.

**Plethora of additives.** These are not strictly essential but can be used, in small amounts, to develop formulations with improved properties and assist the coating’s application. They are added to modify the film or paint. Examples are driers, which promote the drying time of some coatings; flow-control agents, which give a smooth surface; deformers, which prevent the formation of bubbles that could dry in the film; and anti-skinning agents to prevent the paint from a ‘skin’ in the can (see Box 3) [4]. Therefore, additives are often used as “improvers” to a basically satisfactory paint.

A coating material is a composition applied in a layer to all sorts of surfaces to decorate, protect, or in some way modify them. The term ‘paint’ can be taken to include all types of surface coatings that are used for decorating and protecting substrates as well as for various special applications such as fire protection. Even in general terms, most coatings cannot easily be defined and include not only several different and distinct classes of
conventional liquid paint formulations, but also stains and clear vanishes, as well as powder coatings and various other solid systems. It is clear that paints and coatings not only make our surroundings more attractive but they also protect and preserve them. Even the simplest form of coating is very complex in chemical terms and involves blending together of several different components in varying proportions.

3. Paint Formulation
As mentioned earlier, paint contains three classes of material namely a resin or mixture of resins, pigment and solvent (thinner). A mixture of resin and solvent is called the “vehicle” for the pigment. Most paints also contain small quantities of various additives e.g. driers to speed up the drying process, substances to adjust pH of the paint, etc. This section describes the way the paint chemist blends the “vehicle” and pigment together to make paint (see Figure 1 for the flowchart).

Pigments are supplied in the form of dry powders. These consist of “primary particles” which are sized to give the best results in paint films. For example, white pigments (titanium dioxide, TiO$_2$) scatters light most efficiently (whiteness and opacity) when the particle size is 0.22 microns [5]. Some pigments are much smaller, some larger. The small primary particles of pigment clump together when the powder is dried and stored to form relatively large clumps (A ‘clump’ of titanium oxide may contain 5,000,000 primary particles). These clumps are known as aggregates and it is in this aggregated form that the pigments are supplied. To produce good paints, it is necessary that the pigment be in its primary particle size when mixed with the vehicle. Otherwise most of the expensive coloured pigment will not be used efficiently and the dry film will not be smooth, glossy, opaque or have the correct colour.

It is therefore necessary to break down the aggregates of pigment particles in the presence of the vehicle and prevent them from re-aggregating. For this reason, it is not normally possible simply to stir the pigment into the vehicle, but rather work has to be done on the mixture in order to break down the aggregates and ensure that the resin coats the small particle surfaces. This process is known as “pigment dispersion”, in which the following must occur:

- “wetting” of the pigment surface by the vehicle;
- de-aggregation of the pigment aggregates to small primary particles; and
- “stabilisation” of these small particles by the resin to prevent re-aggregation.

A resin which is to perform well as a pigment dispersant must therefore be composed of molecules consisting of two parts [6]:

- an “anchor group”, which wets the pigment surface and becomes
associated with it; and

• a “stabilising chain” which is soluble in the solvent used and therefore stretches out into it.

Pigment particle surfaces contain areas of electrical charge. The “anchor group” in a dispersing resin is chosen for its ability to be attracted to some of these charged areas. In this way, during dispersion, the original surface of the aggregate, and the new surfaces exposed during grinding are covered by molecules of the dispersing resin. This process is known as “wetting”.

Many different types of dispersion machinery have been developed but they all use one or both of two mechanisms to break up aggregates. The machinery falls into two groups:

1) Those that use “dispersion media”, usually ceramic balls 9 to 12mm in diameter or glass beads 1 to 3mm (like marbles) in diameter. Dispersion occurs where the balls touch each other by a combination of impact and shear depending on the conditions.

2) Those that do not use media - these disperse entirely by shear.

Pigments are always dispersed at the highest concentration possible for technical and economic reasons. Finished paints contain only enough pigment to give the desired properties for the same reasons.

Millbases are, therefore, converted to paint by mixing with film forming resins, solvents and any necessary additives. This must be done carefully such that the mixing of the ingredients is in the right order to get the best results. Obviously the resins and solvents must be compatible but problems may arise if components with large differences in resin solids, viscosity or temperature are mixed - “pigment shock” – reaggregation of the pigment particles may occur. For these reasons pigment dispersions are usually “second staged” when dispersion is complete - they are diluted with resin and solvent to give a recipe which is still more concentrated than the final paint but much easier to use than the dispersion recipe. Waterborne millbases and paints must have the pH adjusted at this stage. The stages involved in paint making are summarised Figure 1.
Figure 1: Flowchart showing different stages in paint making

It may be a long time between the manufacture of a paint and the day that the tin is opened for use. The paint must therefore remain stable in the can and the ingredients must not react with another chemically under storage conditions. Some paints do not dry by chemical reaction, but solely by the evaporation of the liquid carrier. In such cases, the polymer is fully formed in the liquid state and does not change chemically on drying. Soon after application, it is expected to form a film. The way this happens differs with different paints but generally it might be as result of drying by either evaporation (lacquer drying) or chemical reaction.

The evaporation of thinner leads to a film deposition on a surface that is painted with a paint containing a binder dissolved in thinner. In this case the binders have high molecular weights in the order of 80,000 atomic mass units [4]. The high molecular weight is necessary in order for the binder to have good paint properties. Artists’ water colours are a simple example. Here a gum is dissolved in water and this solution is pigmented. When the water evaporates, pigment bound with gum is held to the paper. If you take some more of the original thinnings (in this case water) you can, of course, re-dissolve the paint and wash it away. Bitumen, chlorinated rubber and nitrocellulose are examples of binders that dry by evaporation of their thinnings [7].
Emulsion paints" exhibit a slight variation to drying of paints by evaporation described above. More accurately these are latex paints wherein the binder consisting of tiny rubbery spheres is suspended in water. As the water evaporates the particles pack closely and then fuse with each other to form a continuous film. The pigment becomes embedded as the particles pack close together. Since a latex is not a solution, the application of water to the dry film does not dissolve it or remove the pigment [3].

Modern latex particles are always man-made polymers. One of the original ones was built up from vinyl acetate monomer by opening the double bond to form polyvinyl acetate. More usually “copolymers” are used these days where two or more different vinyl or related acrylic monomers are reacted together to provide just the right balance of mobility, hardness and flexibility [8].

When films dry by evaporation alone, only a physical change that derived from the high molecular weight properties of the resin takes place. However, many films dry by a chemical reaction. It is true that even these must first evaporate their thinners, but in these cases they merely deposit a wet or sticky layer. They must undergo further chemical changes that result in increasing the molecular weight of the resin and thereby forming a hard film. Broadly these are the three alternatives:

- The sticky film may react with the oxygen of the air and the binder converts to a plastic solid. Decorative paints based on drying oils react by this so-called “autoxidative” process. It is rare to find a house paint based on, say Linseed oil alone. These days the oils are modified with synthetic resins such as polyesters to give alkyd resins, e.g. the Dulux Gloss Finish paint is based on an alkyd resin.
- Alternatively, two or more components within the binder can react together to change from liquids to a solid. Obviously this must not happen in the can. The film is in some way initiated into reacting. The simplest way to do this is by heating the painted object in an oven. Infrared lamps have also been used. Some speciality paints for the factory finishing of wood are hardened by ultra-violet light or by a beam of electrons.
- The third alternative is to have two reactive binder components which you keep separate, only mixing them immediately before application. Two pack epoxy paints use this principle, (a similar principle is found in two-pack epoxy adhesives, namely Araldite). Two-pack isocyanates are finding increasing use in the car finishing industry. They tend to be used wherever excellent resistance to chemicals and solvents is required.
The thin films of paint applied on various surfaces are called upon to work small miracles. A few µm thickness of paint must protect the steel of a drilling rig from a most aggressive atmosphere. Elsewhere, a manufacturer expects to be able to decorate a thin sheet of aluminium and then to stretch and shape it into cans and lids without the paint cracking or flaking off. For domestic use, house paints are made with such a complex pattern of flow that they are near solid in the container, fluid under the brush, remain fluid to allow brush marks to smooth away, but then set to prevent even over-heavy applications from sagging.

4. Rheology
The quality of paint to a very large extent is determined by its flow (rheological) properties. For instance, good quality paint will have the following properties [9]:

- easy of application (much of the paint is made for use by non-professionals);
- must remain stable in the can without settling too much;
- if it does settle, it must be easy to re-disperse by stirring;
- must stick to the brush without dripping off;
- but must flow freely from the brush onto the surface when it is sheared by the brush-stroking action and;
- must flow sufficiently to allow the brush marks to disappear, but not so much that it will sag under the influence of gravity.

Therefore, the important rheological characteristics are time dependence of the viscosity, shear rate dependence of the viscosity and the elasticity [10].

All the above characteristics reflect the type of interactions between the particles in paints and coatings dispersions. The main aim of colloidal dispersion rheology is to understand and quantify the effects of interparticle forces on the bulk properties of concentrated colloidal dispersions. In order to achieve such an aim one needs to obtain, among other studies, rheological (flow) data for model colloidal dispersions that are sufficiently well characterised for the particle interaction forces to be estimated. A lot of researcher shave used this approach to relate rheological properties to interparticle forces of model colloidal dispersions, i.e. from the knowledge of rheological properties the interaction forces have been estimated or vice versa [11]. They conclude that the complex rheology of colloidal dispersions indicates the interplay of the full range of forces at microstructural level. The shear viscosity, the shear modulus and the extent of shear thinning all increase as the interparticle potentials, either attractive or repulsive, become strong relative to Brownian motion. The low shear viscosity and modulus,
which derive from small perturbations of the structure at rest, provide the most sensitive probes of these particle potentials.

In many paint formulations, thickeners such as hydroxyethylcellulose are added to control the rheology of the dispersion. This is to reduce settling and ease of the application of the formulation. In certain formulations, the paint must be pseudoplastic or shear thinning and possibly thixotropic. It is now well established that addition on non-adsorbing (free) polymer to paint dispersion can cause several “things” to occur depending on the type, molecular weight and concentration of free polymer. Three types of flocculation have been documented and these are bridging flocculation, depletion flocculation and depletion restabilisation [6]. Experiments and theory have shown that concentrations of free polymer comparable to that at which overlap begins to occur (i.e. near the semi-dilute concentration, \(c^*\), of the polymer solution) can induce flocculation, while relatively higher concentrations can impart stability. The experimental and theoretical studies of the phase separation, viscosity and viscoelastic properties have been studied for non-aqueous polymer lattices especially sterically stabilised polystyrene (PS) and poly(methylmethacrylate) (PMMA). They have been used as “model” systems because they have a well-defined shape, and can easily be prepared with high degree of monodispersity over a wide particle size range. For instance, Goodwin et al. [12,13] and Kwaambwa et al. [14] studied PMMA model latex particles dispersed in poly(isoprene) (non-adsorbing) polymer solution. The solvent for the free polymer was dodecane. One of the solutions to the problem of VOCs is to use highly concentrated dispersions containing free polymer of low molecular weight (to minimise the viscosity) and low functionality (nearly non-interactive). The latter is to maximise the fluidity of the system and also insures that the build-up of structure by uncontrolled and irreversible bridging flocculation is minimised if not stopped completely. The shear-wave propagation measurements (or pulse shearometry) were used to determine the shear wave rigidity modulus or high frequency limit of the shear modulus and these measurements compared with those calculated using the depletion volume model. The model is based on simple considerations of the resulting depletion force (osmotic pressure) due to exclusion of the polymer from interparticle spaces (see Figure 3) [15]. The depletion interaction occurs in a colloidal dispersion when either (i) non-adsorbing polymer is added or (ii) adsorbing polymer is added to well above the adsorption saturation point or (iii) the added polymer is poorly (or weakly) adsorbed. The depletion force is taken as the work done in pulling flocculated particles apart to infinite separation (i.e. separation distance whereby added free polymer molecules can sit freely in the interparticle space) [15].
5. Coatings Prevent and Protect
Although the number of end-uses of paint is virtually unlimited, it is usual to divide them into three distinct groups namely architectural (also referred to as decorative or building), product line (also referred to as original equipment manufacture - OEM) and special-purpose coatings. We rarely see a ‘raw’ product. Our domestic and work spaces are certainly more pleasant and more conducive to good work when the interior decor is attractive. The millions of paint-protected cars on the roads, for example, benefit from years of coating research – giving products that reduce fading.
from sunshine, damage from rain, snow, road chippings, oil, petrol, ice and car-wash machines, not forgetting ever greater protection from rust. In the supermarket, meanwhile, we are confronted with shelves of coloured inks and coatings on all kinds of packaging. Food safety and labeling information depend on packaging and coatings. Packing must keep the right things in while keeping the wrong things out. Special internal coatings prevent interaction between the metal and the contents, ensuring the wholesomeness of the food.

It goes without saying that an object with protective coating will last longer than one that has none. It does not have to be replaced as often, reducing the demand for raw materials. Taking the car again as an example, uncoated cars would last only a year or two before rust rendered them unsightly and unsafe. The paint on a car, which costs less than half of one percent of its showroom price, adds many years to its life and saves steel and other materials as well as the energy that would be needed to produce and distribute its replacement.

Tree-lovers should also be grateful to paints and coatings. Coatings not only make wooden objects last longer, but also enable us to use less of the precious hardwoods by substituting coated renewable-forest softwoods that would otherwise be unsuitable for construction. Millions of tons of fuel are also saved by the world’s shipping companies through the clean ‘slippery bottoms’ of their vessels, made possible by modern anti-fouling paints [16].

Coatings also help to ensure that major structures like bridges, buildings and industrial plants are built to last. Without them, the maintenance of structures can be extremely costly. Even on a much smaller scale, however, coatings have an impact on our daily lives. Carrying home several bottles of wine, for example, is now easier with widespread use of lighter glass containers. By applying a thin coating to the bottles, the neck and walls are made thinner without losing strength. Such coatings are now saving the glass packaging industry thousands of tons of glass a year. Added together with savings in energy, transport and so forth, and the result is a substantial saving a year. Already established and growing fast is another glass market for coatings – fibres for telecommunications. Glass fibre cables can carry infinitely more information than copper wires and every glass strand needs a protective coating. The two layers of UV-cured coating not only identify, protect and waterproof the cables but they also help launch the laser light pulses on their path through the fibre core [17].
6. Driving Forces for Change to New and Improved Types of Coatings

After centuries of exploitation and degradation, we have finally learned that the destruction of our environment will lead to probable demise of our own species. In contrast to past environmental solutions, modern systems need to be effective, low cost, sustainable, and add value to the environment.

There is a continuing and insatiable demand for new and improved types of coatings, not only for competitive reasons but also to meet the increasingly stringent regulations designed to protect the environment. There are, therefore, three main driving forces that affect the development of new types of coatings:

i) **environmental** - the need to reduce the amounts of solvent emission to the atmosphere in the light of increasing concern over pollution;

ii) **economic** - reflecting the necessity for, say car, manufacturers to remain competitive in an industry suffering from world-wide over capacity; and

iii) **quality** - both of appearance and performance standards as major promotional and selling features.

New environmental regulations, particularly designed to minimize waste and encourage material recovery and recycling, will undoubtedly result in more widespread use of new coatings technologies over the coming years. Hence, although the markets for the coatings are likely to grow only moderately, the demand for new and improved systems will increase considerably.

While environmental pressure is the major driving force for the introduction of the new types of coatings, notice also has to be taken of their effect on the appearance and costs of application. Coatings producers are therefore now required to develop products that not only offer aesthetic appeal and a higher resistance to adverse atmospheric and service conditions, but that are also acceptable to the environment. The latter tends to restrict the choice of type of materials, as well as the nature of the process by which they are applied [18].

The paint and coatings industry is literally and figuratively ‘on the move’. Influenced by increasing environmental legislation, raw material price hikes, emerging new markets and consolidation in the industry, development of new products that are both more cost-effective and better for the environment has become more important than ever. On quality, it is clear that the paints and coatings that are now available on the market must achieve complex technical specifications in terms of rheology (flow properties), finish, material constituents and paint performance. In terms of the technology needed to make coatings, the basics of the wet paint production – requiring pigments,
resins/binders, a solvent/carrier and various additives – still apply. However, this description conceals a wealth of research by chemists, physicists and other specialists to match the changing needs of coating users in many fields discussed above.

There are three specific types of pollution arising within the coatings industry: air pollution, contamination by biologically active materials, and plant effluents [19]. Of these, air pollutants arising from the evaporation of organic solvents is the most important. Many of the paints and coatings formulations have traditionally contained aliphatic and aromatic organic solvents, among them xylene, toluene and mineral spirits, which dry quickly to leave a smooth paint finish. These solvents are the VOCs, which are damaging to both human health and the environment. Many governments are now pushing for restrictions in the use of VOCs and any solvents considered HAPs (see Box 3) [5,10]. Liquid coatings formulations must simultaneously meet current and pending VOC limitations and HAP restrictions by shifting to the new technologies. Newer technologies that are finding increasing use include water-borne systems, high-solid solvent-based systems, powder coatings and radiation-cured finishes.

Other factors contributing to the shifts in technology include the level of any involvement by the competition (companies often need to follow suit to maintain technical parity), the availability of the necessary raw materials, relative capital and operating costs of the different methods, the performance of the product and the timing of the investment cycle. Bearing these factors in mind, it is predicted that the growth of most types of high technology systems will be strong to the middle of this decade.

7. New Technologies
Several new types of coatings technologies have evolved over the past decade that offer the possibility of replacing traditional coatings with alternatives that can give improved performance at lower costs and without the danger of excessive and unacceptable environmental pollution. These technologies relate not only to new application and curing processes and equipment, but also to modifications and improvements in established practices. The technologies concerned can be most conveniently categorized into seven distinct groups:

- Improved low-solids (less than 70%) solvent-based systems (the compliance solvents)
- High-solids solvent-based systems (more than 70%)
- Powder coatings
- Radiation-cured (ultra-violet and electron beam)
- Reactive (plural-component catalysed) systems
• Water-borne electrodeposition coatings
• Other water-borne coatings including emulsions, latices and colloidal dispersions

The rate of acceptance of all these coatings methods will depend not only on the rate of successive development of acceptable and economically viable techniques, but also on the overall state of the economies. In addition to these generic high technology coatings systems, there are certain specialized types of coatings that are under continuing technical and commercial development. As an example, three technologies, namely water-borne, powder and radiation cured coatings, are discussed here in more details.

7.1 Water-borne coatings
Switching to environmentally friendly coatings involves more than simply replacing the organic solvents with a VOC-free ingredients, such as water. Water-borne formulations have proved to be acceptable for decorative usage and for this application water-based paints are now the norm. But for industrial application, the paint and coating industry has encountered problems [20]. Despite the fact that by the mid-1990s all of the major industrial paint manufacturers had produced solvent-free/low-solvent content alternatives, they found that these formulations were compromising quality and so did not gain acceptance among the customers, who were reluctant to switch to a more expensive, poorer quality product.

While VOC-free products might represent a valuable marketing tool and offer good financial returns, they have also come in for a considerable amount of criticism. Life-cycle analysis techniques are showing that some of the ‘environmentally friendly’ components that need to be added to the coatings to achieve the same technical sophistication are, in fact, more damaging to the environment than the solvent that they are replacing [21]. For instance, water-borne paints require a number of chemical additives (thickeners) to maintain a stable dispersion during storage. Some of these additives are toxic, and because they are water soluble, they are potential water pollutants.

Another problem of water-borne paint is drying which results in increase in viscosity [22]. At high volume fractions, the behaviour may change from shear thinning to shear thickening (or dilatant) behaviour common for very concentrated systems. This can result in ‘sticky’, partially dried paint which cannot be worked for long enough to produce smooth overlap into the next brush-load of paint.

Water-borne paints require more energy to remove the solvent. As compared to solvent-borne paints where the solvent flashes at ambient temperature, water-borne ones require a heated flash.
The swap from solvent-borne to water-borne is not simple for some bigger industries such as the coil and can coating industry. Here there is a big trade-off between potential water-borne advantages and the economics of the solvents used in the formulations that are then oven cured. These solvents are driven off in the ovens and are subsequently re-circulated into the ovens and burnt providing the energy to drive the ovens [23]. Just over a decade ago in Europe, there were conversions from water-borne to solvent-borne for this very reason.

7.2 Powder coatings
Almost an industry in itself, powder coating is growing fast despite its higher capital costs in manufacture and application. Powders are virtually VOC-free and manufacture is different from liquid paints. Resin, pigments and other additives are dry-blended to give a homogeneous mixture, which is then heated and extruded before being ground to a fine powder. Spray application uses electrostatics so that the powder adheres to the earthed workplace. After coating, the item is stoved at fairly high temperatures, generally 150–180°C, when the powder melts and flows out to a level, integral coating. The presence of any organic vapour in stoving would necessitate increased ventilation with consequent loss of energy efficiency [24].

Polymers for powder coatings are based on epoxies, polyesters, and occasionally, acrylics. Powder cross-linkers include dicyandamide and its derivatives (for epoxy resins), carboxylic anhydrides and acids. Acid tipped polyesters are cured with epoxies, most notably the weatherable triglycidylisocyannurate (TGIC), catalysts being selected from a wide range of amines, amidines, and phosphines.

The method has its own disadvantages such as [24]:

- TGIC is the stable curing agent for weatherable powder coatings but concerns about its toxicology are causing the industry to look for replacements.
- The need to stove at relatively high temperatures prevents their use in air-drying markets, and limits their use on temperature sensitive substrates such as wood and plastic films.
- The relatively high film builds that are necessary for good film coalescence has limited their use in can coatings and improvements in appearance, durability, and colour styling capabilities still need to be demonstrated before wide acceptance can be expected as car body coatings.
- As in water-borne coatings, it is very difficult in many applications to get customer acceptability because of inadequate post application and levelling.
So, a technology change allowing thin film powder coating application with excellent flow and levelling, gloss levels, and so forth would, for instance, be acceptable for automotive finishing.

7.3 Radiation cured coatings
As with powder coatings, radiation cured coatings do not require the use of solvents and produce virtually no VOCs. They can either be liquid or powder radiation cured coatings. Radiation cured powder coatings are less likely to irritate the skin of workers in factories, a possibility with radiation curable liquids.

Radiation cured coatings contain reactive diluents which reduce the application viscosity but which are reacted into the polymer structure during the curing process thus substantially reducing the emissions to atmosphere resulting from the use of conventional solvents in ‘conventional’ paint systems. However, radiation cured systems require fixed energy sources and cure rates vary according to the distance between the energy sources and the substrate. Thus, whilst these systems can result in reduced VOC emissions, their use is largely limited to the coating of sheet or flat web substrates in industrial processes, and is certainly not appropriate for coating car bodies nor for decorative air drying coatings [18]. In other words, they are only practical on specially adapted, original equipment manufacturers’ (OEM) product-coating lines.

Conversion from liquid coatings to alternative systems can be quite expensive, so paint users are generally eager to continue using newly developed low- or no-VOC liquid coatings on their existing paint production lines. However, paint additive manufacturers are working on new technology of radiation-curable powder coatings to extend the use of ordinary powder coatings [17]. Manufacturers of radiation curing additive initiators are working with resin producers and paint formulators to harness ultraviolet (UV) radiation to apply powder coatings to otherwise heat-sensitive substrates such as wood and plastics. Liquid UV-curable coatings generally are used over paper and paperboard.

8. New Challenges
Nowadays, there is the issue of ‘sustainable development’ that chemists and formulators should consider carefully. The original definition of sustainable development was that given by the World Commission on Environment and Development in 1987: ‘Development that meets the needs of the present without compromising the ability of future generations to meet their needs’ (quoted in Keatings [25]). Sustainable development usually refers to some
form of modern technological society, with business taking responsibility for its impact on society and the environment. Since chemistry is the hub of modern society, it is also essential part of sustainable development. But sustainable development is about more than the environment. It is based on four components: prudent use of resources, protecting the environment, economic growth and social progress. The target is better quality of life for everyone now and for generations to come.

In general, the following challenges for the paint and coating formulators are to find effective, non-VOC alternatives to solvents such as xylene, toluene and other aromatics and to develop technologies that exclude the use of solvents entirely, such as powder coatings, UV/radiation-cured coatings and high solid coatings. These challenges for the formulators may be summarised as finding new materials, developing modified chemical materials, finding alternative solvents, developing new formulations and new methods of application.

In short, product developers should formulate coatings that meet existing and pending VOC and HAP regulations and offer performance that customers are willing to pay for. The future may lie in the development of the green chemistry philosophy.

9. Green Chemistry

The term green chemistry was first defined by the US Environmental Protection Agency (EPA) as the ‘utilisation of a set of principles that reduces or eliminates the use of generation of hazardous substances in the design, manufacture and application of chemical products’ [26]. The EPA issued 12 principles of green chemistry (see Box 6), which go some way in explaining what the definition means in practice. The principles cover such concepts as:

- the design of processes to maximize the amount of raw material that ends up as product;
- the use of environmentally-benign solvents where possible;
- the best form of waste disposal – aiming not to create it in the first place.

Green chemistry is essentially chemistry for the environment; it is most definitely apolitical. In many ways green chemistry is a philosophy and a way of thinking. It is not a new branch of chemistry but is pulling together of tools, techniques and technologies that can help chemists in research and production to develop more eco-friendly and efficient products and processes.

The with regard to paints and coatings industry, only five areas are discussed here whereby the principles of green chemistry may be applied.
(a) **Resins are one key to lower VOC**

The development of new resin technology will make all the difference in the formation of low-VOC coatings. Winning resin technologies include acrylic, polyester, epoxy, and aliphatic urethane formulations - all of which can be formulated as high-solids, low-VOC coatings or water-borne coatings. Losing technologies will be those that require a large amount of solvents (up to 70% by volume) for application, including nitrile, chlorinated rubber, neoprene, polyvinyl chloride and alkyd formulations. Another possibility is put to considerable effort into the development of water-borne systems as well as of high-solids, low-solvent systems. For instance, developing water-borne polyurethane coating such that you get the isocyanate cross-linker in the coating to disperse in water yet not react too quickly in water. In solvent systems, urethane formulators are making an effort to stay away from HAPs. It has been found that when formulators move to low- or no-VOC systems, they also are able to remove HAP solvents from their systems. The efforts to reduce or eliminate HAPs and VOCs go hand-in-hand.

(b) **Substitutes**

Look for substitutes, for instance, tributyltin, used in marine anti-fouling and triglycidylisocyanurate, used as a cross-linker in powder coatings, are considered to be toxic. Partly in anticipation of concerns over health risks associated with certain paint ingredients such as certain surfactants. For example, manufacturers of nonyl phenol ethoxylate surfactants need to offer alternative surfactants. Nonyl phenol ethoxylates are believed to be estrogen mimics and pose some health concerns.

(c) **Additives**

We need highly efficient coatings additives that perform the functions required of them, namely to enhance performance, cut costs, and open up new applications.

(d) **Solvent suppliers**

Solvent suppliers face VOC and HAP rules. For instance, customers of solvent suppliers in North America are expected to choose solvents based on propylene glycol ether over ethylene glycol for both solvent-borne and water-borne formulations [27]. Ethylene glycol solvents appear on the list of HAPs. However, it should be pointed out that propylene glycols could seldom be one-for-one replacements for the ethylene glycol solvents. Notably on pound-for-pound basis, propylene glycols contribute the same VOCs to a coating formulation as do ethylene glycols. Regardless of this propylene glycols are “more efficient” because often a paint formulation requires less propylene glycol than ethylene glycol and thereby resulting in lower VOC formulation.
Switching to water- and powder-based systems is not always feasible. Yet another approach is to increase the concentration of solids in solvent-based coatings, which has an advantage that it leaves the basic composition unchanged. Crucial to the success of these high solids formulations are so-called reactive diluents, added to reduce product viscosity. Adding a reactive diluent does not alter the performance of the coating, but markedly reduces volatile emissions.

Polyurethane (PU) coatings are notable for their durability and resistance to chemical agents, abrasion and weathering. They are extensively used for car topcoats as well as in military and aerospace applications. Polyurethane paints are sold as both one pack and two pack systems as shown below [28].

\[
\begin{align*}
~~\text{R-NCO} + \text{H}_2\text{O} & \rightarrow [\sim \text{R} - \text{NH} - \text{CO} - \text{OH}] \rightarrow \sim \text{R} - \text{NH}_2 + \text{CO}_2 \\
\text{One component PU reaction} \\
\sim \text{R-(OH)}_n + \sim \text{R'-}(\text{NCO})_n & \rightarrow \sim \text{R} - \text{O} - \text{CO} - \text{NH} - \text{R-} \\
\text{Two component PU reaction}
\end{align*}
\]

Two pack systems require the user to mix a polyisocyanate with a polyol before applying the coating. In one pack systems the polyol and isocyanate come pre-reacted, in the form of a low molecular weight prepolymer. On applying this prepolymer to the object being painted, the coating hardens or cures by reaction with moisture in the atmosphere. One pack systems have a drawback that carbon dioxide is released as a by-product – often producing pinholes or bubbles in the coating. Two component systems are less prone to producing pinholes, but this can occur when reaction conditions, humidity and formulation parameters are not optimal. This can result in pin-holing defects in the coating and hazing problems with clear lacquer finishes.

For the past 20 years or so, industry formulators have known that a possible solution to this problem is to use polyols derived from bisoxazolidine structures. In the presence of moisture, bisoxazolidines hydrolyse by ring opening to reveal hydroxyl and amine groups that can react with diisocyanates to form the coating. By mopping up any water, bisoxazolidines therefore effectively prevent the reaction with diisocyanates that leads to the release of carbon dioxide.

Researchers found out that bisoxazolidines confer another advantage on some systems. Uptake of many polyurethane coatings – those based on aliphatic compounds – has traditionally been hampered by the slowness with
which the coating hardens or cures. In a bisoxazolidine in the formulation typically speeds up the curing process by three to four times. This is because the ring-opened bisoxazolidine reacts rapidly with diisocyanates [4]. On a car assembly line, for example, two pack polyurethane systems incorporating bisoxazolidines can reduce drying times to as little as two minutes.

Fuelled in part by growing pressures to reduce VOCs, companies such as ICL, began work to develop a reactive diluent for its range of polyurethane applications in the late 1980s. All of the company’s one and two pack systems relied on polyols dissolved in VOCs such as butyl acetate or toluene. Unlike other additives and diluents, bisoxazolidines effectively lock themselves into the polyurethane backbone during the reaction process and therefore do not contribute to VOC emissions as the paint dries. This lead to the first successful commercial oxazolidine diluent, Incozol. But still there was room for improvement. Although Incozol 4 helped to reduce VOC emissions, the compound is highly viscous. This meant including a large proportion of solvent in the formulations. The answer was to create a solvent-like version whose trade name is Incozol 4 – in other words a version with extremely low viscosity. Not only would such an additive be unable to evaporate to the atmosphere itself, but it could also reduce the amount of solvent required in the coating formulations. The original bisoxazolidine systems were so viscous because of the NH(CO)R group linking the bisoxazolidine together. This is able to form hydrogen bonds not only intramolecularly within itself, but also intermolecularly with other compounds in the mixture – increasing the viscosity of the system in either case. The answer was to form an alternative carbanato (-O(CO)O-) bridge. The resulting compound, now sold as Incozol LV, is incapable of hydrogen bonding and dramatically reduces the viscosity of the system. Commercialised in 1996, Incozol LV allows formulators to use a true reactive diluent that reduces solvent use and lowers emissions. Incozol LV possesses the key properties demanded of a good reactive diluents [29]:

- good polyol and solvent compatibility;
- low intrinsic viscosity (50 mPas at 20°C);
- reasonably high equivalent weight (90);
- virtually colourless (essential for clear lacquer finishing);
- workable pot life and good cure response; and
- no adverse effect on coating properties (including film hardness development and resistance, gloss and weathering properties).

10. The Future
And what does the future hold? On a global scale, it is difficult to predict the future but the paints/coatings industry certainly is on the move. There is no
doubt, however, that the industry will continue to thrive and evolve, even if the growth rate is unspectacular. New advances in paints and coatings are brightening up our lives and will continue to do so. The race to reformulate liquid coatings has opened up new opportunities for both coatings formulators and material suppliers. Formulators who can sell paints that meet regulatory limits and still provide performance comparable with or even better than older products will have a marketing edge. New coatings formulae and application methods have been developed to increase throughput, augment durability, reduce environmental impact, and buffer against rising oil prices.

Material suppliers have an opportunity to introduce new- and frequently higher priced components that allow the production of low- or no-VOC coatings. Material suppliers thus have an opportunity to gain entry or market share even as they are introducing value-added higher profit products into the market.

Paint is a very complex and versatile material, offering more challenges to the chemists, physicists, engineers and other specialists than most other products. New generic resin systems are certainly to be developed to suit the changing requirements of the users and to enable future coatings systems to conform to increasingly stringent environmental regulations. There are ample opportunities for the chemical innovations making the coatings industry an exciting place for future generations of scientists. The challenge set for the future is for all paints to be waterborne which requires dedicated scientists to understand paint chemistry and create innovative new products. The chemists should consider the issue of ‘sustainable development’ carefully. As for the companies, the way forward is the so-called ‘triple bottom line’ approach which focuses on understanding and measuring a company’s value according to its environmental and social performances as well as its economic performance.
11. References


12. Appendices

Box 1: Types of binders (Marrion, 2004)

Alkyd: Produced by condensation reactions between polycarboxylic acids and polyhydric alcohols - often phthalic acid or anhydride and glycerol. Further reaction with an oil (e.g. soya bean oil) or fatty acid gives a resin suitable for use in decorative gloss paint.

Vinyl: These are usually based on copolymers of vinyl acetate with vinyl chloride, acryl or methacrylic esters or styrene, produced by addition polymerisation. Decorative vinyls are generally based on emulsions in water, whereas heavy duty and industrial finishes may use solution vinyls (in organic solvents) or as dispersions in plasticiser (organosol/plastisol).

Acrylic: Many monomers are used in the preparation of thermosetting, thermoplastic and dispersion acrylic polymers for coatings. Examples are ethylmethacrylate, styrene, acrylonitrile, ethyl acrylate. These are often reacted by addition polymerisation, and by ionic group transfer and coordination catalyst polymerisations. Different functionality may be introduced by using comonomers such as methacrylic acid (carboxylic acid groups) or hydroxy ethyl acrylate (hydroxyl groups). These can later be reacted with other polymers during curing.

Epoxy: Epoxy resins are actually oligomers, which must be reacted with other polymers such as polyamines, polyamides and polyesters. The most important epoxy resin series is formed by the condensation polymerisation of Bisphenol A with epichlorohydrin.

Polyurethane: Polyhydroxy materials can be reacted in a rearrangement polymerisation with diisocyanates to form polyurethanes.

Box 2: Water-based coatings vs solvent-based coatings (Marrion, 2004)

<table>
<thead>
<tr>
<th></th>
<th>Water-borne</th>
<th>Solvent-borne</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-flammable</td>
<td>Better drying in cold, damp conditions</td>
<td></td>
</tr>
<tr>
<td>Clean up with water</td>
<td>Better low-temperature storage</td>
<td></td>
</tr>
<tr>
<td>Quick drying in good conditions</td>
<td>No can corrosion problems</td>
<td></td>
</tr>
<tr>
<td>Low VOC content</td>
<td>Less wood-grain raising</td>
<td></td>
</tr>
<tr>
<td>Low odour</td>
<td>Higher gloss</td>
<td></td>
</tr>
<tr>
<td>Non-yellowing</td>
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</tbody>
</table>

*The terms solvent-based and water-based are not strictly accurate. The coating is not ‘based’ on water or solvent, but is either dissolved or suspended in it. “Water-borne’ and ‘solvent-borne’ would be more accurate descriptions.*
Box 3: Examples of functions of additives
(Tadros, 2010; Tablert, 2007)

Biocides – in-can preservatives as a result of a shift to water-borne organic resins which can support bacterial growth whereas dry-film biocides help preserve paint that has dried on a substrate i.e. discourages growth of algae or fungi.

Thickeners – aid brush and roller paint pickup and application.

Plasticisers – give paints better chip resistance.

Defoamers/Antifoamers – aid in mixing paint and reducing film imperfections.

Surfactants – pigment dispersants in water (anionic surfactants) and pigment stabilisers (nonionic surfactants). Some have thixotropic properties that help to thicken paint while allowing the user to spread the paint easily on a substrate, whereas some provide hydrophobic properties to dry-paint films, giving the paint water resistance under long-term exposure.

Corrosion inhibitors – forms a monomolecular barrier to protect the metal surface from water and improve coating adhesion.

Ultrasound light absorbers – stabilise the paint film and preserves it against breakdown under exposure to sun e.g. benzotriazole-based film additive.

Miscellaneous - anti-skinning agents, deglossing agents, stabilisers, surface modifiers, adhesion promoters, rheology control agents.

Box 4: Three main paint categories

<table>
<thead>
<tr>
<th>Product coatings</th>
<th>Architectural</th>
<th>Special-purpose coatings</th>
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<td>Appliances</td>
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<td>Arts &amp; crafts</td>
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<td>Electrical insulation</td>
<td>Undercoaters, primers &amp; sealers</td>
<td>Automotive &amp; machinery refinishing</td>
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<td>Factory-finished wood</td>
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<td>Bridge maintenance</td>
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<tr>
<td>Film, paper &amp; foil</td>
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<td>High-performance maintenance</td>
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<tr>
<td>Machinery &amp; equipment</td>
<td></td>
<td>Metallics</td>
</tr>
<tr>
<td>Marine</td>
<td></td>
<td>Multicoloured roof</td>
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<tr>
<td>Metal containers</td>
<td></td>
<td>Swimming pool</td>
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<tr>
<td>Metal furniture &amp; fixtures</td>
<td></td>
<td>Traffic marking</td>
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<tr>
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<td></td>
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<tr>
<td>Pipe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheet, strip &amp; coil</td>
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<td></td>
</tr>
<tr>
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Box 5: Some of HAPs used in paints (USA Clean Air Act of 1990)

| Acetamide                                      | 1,2-Dichloroethane                        |
|                                              | Hexachlorobenzene                         |
| Pentachlorophenol                            | Acrylamide                                 |
| 1,3-Hexane                                   | Dichloroethyl ether                       |
| Diethanolamine                               | Phenol                                    |
| Acrylonitrile                                | Acrylic acid                              |
| Styrene                                       | Hydroquinone                              |
| Maleic anhydride                              | Propylene oxide                           |
| Toluene                                       | Dimethylaminoazobenzenelisorphonine       |
| Benzene                                       |                                            |
| 2,4-Toluene diisocyanate                     | Allyl chloride                            |
| 1,3-Butadiene                                | Dimethylformamide                         |
| Methyl isobutyl ketone                       | 1,1,2,2-Tetrachloroethane                 |
| Ethylbenzene                                 | Aniline                                   |
| Catechol                                      | Dimethyl phthalate                        |
| dibromideNaphthalene                         | Methanol                                  |
| 2,4,6-Trichlorophenol Cumene                 | Epichlorohydrin                           |
| Nitrobenzene                                 | Methyl ethyl ketone                       |
| 2-Nitropropane                               | Ethyl acrylate                            |
|                                              | 1,1,1-Tetrachloroethane                  |
|                                              | Caprolactam                               |
|                                              | Methylene chloride                        |
|                                              | Trichloroethylene                         |
|                                              | Ethylene                                  |
|                                              | Ethylenimine                              |
|                                              | Vinyl acetate                             |
|                                              | Formaldehyde                              |
|                                              | Vinyl chloride                            |
|                                              | Xylenes (m-, o-, p-)                      |
Box 6: The 12 EPA principles of green chemistry (quoted in Lancaster, 2000)

1. Prevention – it is better to prevent waste than to treat or clean up waste after it has been created.

2. Atom economy – synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.

3. Less hazardous chemical synthesis – wherever practicable, synthetic methods should be designed to use and generate substances that possess little or no toxicity to people or the environment.

4. Designing safer chemicals – chemical products should be designed to effect their desired function while minimizing their toxicity.

5. Safer solvents and auxiliaries – the use of auxiliary substances (e.g. solvents or separation agents) should be made unnecessary whenever possible and innocuous when used.

6. Design for energy efficiency – energy requirements of chemical processes should be recognized for their environmental and economic impacts and should be minimised. If possible, synthetic methods should be conducted at ambient temperature and pressure.