
Scottish Journal of Arts, Social Sciences and Scientific Studies - ISSN 2047-1278
<http://scottishjournal.co.uk>

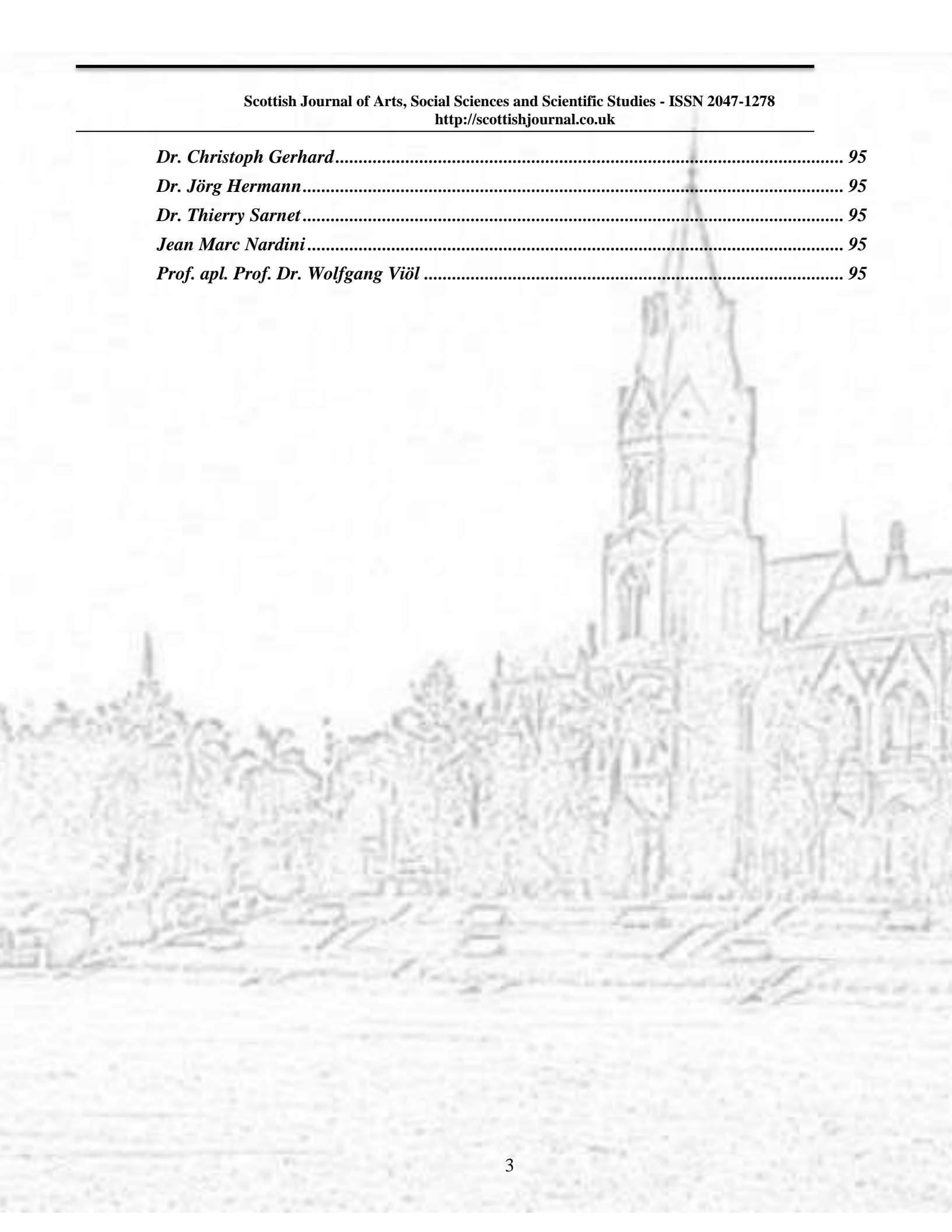
SCOTTISH JOURNAL OF ARTS, SOCIAL SCIENCES AND SCIENTIFIC STUDIES

VOLUME 26, ISSUE I
JUNE 2015

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Elements of the Algerian Experience in the Field of Renewable Energy Technology and Its Relationship to the Labor Market

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Abstract

This research aims to highlight the elements of the Algerian experience in the field of renewable energy technology and the extent of its contribution to the creation of new jobs in the labor market through the presentation of thinking backgrounds about renewable energies, their benefits, obstacles and the capacities of sustainable development in the creation of new jobs. The research will also present a set of international experiences in the field of renewable energies, including the Spanish experience and the extent of its contribution to reduce unemployment. As for Algeria, we will present the national policy for the development of renewable energies through the major features of the national program for developing them, in addition to the contribution of renewable energy projects as the project Dezertec to the creation of new jobs in Algeria through the projects realized by the Algerian competencies or in the framework of partnership projects.

Keywords: renewable energy, sustainable development, Algerian experience, labor market, Dezertec project.

Introduction:

Under climatic changes of the world, serious consideration should be given to reduce the greenhouse effect gases emissions resulting from the use of fossil energy resources, which have a close link to these climate changes. But all of this and because of the possibility of oil depletion after less than one century as it is confirmed by many researchers, it is imperative to go to clean alternative inexhaustible energy on its multiple forms.

Based on the experts warning about the depletion of oil reserves in Algeria within 50 years, the government has sought to find alternative ways to exploit the energy on post-oil era. It has revealed an ambitious plan to produce 10 per cent of electricity from renewable resources by 2020.

Sonelgaz Company prepared also in the year 2010 some projects launched in 2011, which would be a solid foundation for the deployment of this ambitious program. It concerns the project of a factory for the production of photovoltaics whose capacity is 100-120 MW, the production of gas turbines spare parts and the launch of a project to generate electricity by wind of a capacity of 10 MW, as well as the launch of two other model projects for two solar thermal stations at the provinces of El Oued and Bechar of a capacity of 100 MW for each one.

The significance of this program is reflected in its relationship with all other economic sectors as research, education, water resources and others that require more energy, plus it will positively affect social development as the factory of the production of silicon, a matter used in the production of solar panels, in 2013. This program would create 200000 jobs (100000 in the national production and 100000 in the exportation).

Based on the above, the problem of this research is centered on the following fundamental question:

How do renewable energy programs contribute to the creation of new jobs in Algeria?

To answer to this problem, the research will be divided into four sections: The first section is about thinking backgrounds about renewable energies, their advantages and obstacles. The second section is about the capacities of sustainable development in the creation of jobs and green jobs. While the third section deals with a set of international experiences in the field of renewable energies and the extent of their contribution to reducing unemployment. The last section presents the national policy for the development of renewable energies in Algeria, through the major features of the national program for developing them, in addition to the contribution of renewable energy projects in reducing the development of unemployment in Algeria, through the projects realized by national competencies or in the framework of partnership projects.

First, renewable energies

We believe it is useful before dealing with the advantages and the obstacles of renewable energies, to present some thinking backgrounds about them, by taking the subject of climate change as a direct cause for thinking about renewable energies as a sustainable alternative.

Climate change as a cause for thinking about renewable energies1

The agriculture in Africa, which represents 50% of total exports and 21% of gross domestic product, is exposed to the effects of climate change. According to expectations, it will be recorded a decline in agricultural yields of 50%, in addition to the low number of lands suitable for cultivation by 2080. In the absence of effective interventions, the number of people

suffering from malnutrition will increase by 50 million people. In addition to the above, 250 million people in Africa will suffer from water pressure in 2020. This number will rise to 350-600 million in 2050, especially in North Africa. This water pressure has disastrous effects on agriculture and industry.

The Climate change will also contribute to increase health burden on Africa, as a result of the movement of people, where 90 million additional people would be at risk of malaria by 2030.

We can present the annual costs total of adaptation for all sectors, according to the region as an absolute value or as a percentage from the gross domestic product during the period of 2010-2050 in the following table:

Table (01) annual costs total of adaptation for all sectors, according to the region as an absolute value or a percentage from the gross domestic product during the period of 2010-2050 in the following table:

	2010-2019	2020-2029	2030-2039	2040-2049
Annual costs total of adaptation (billions of dollars)				
East Asia and the Pacific	22.7	26.7	23.3	27.3
Europe and Central Asia	6.5	7.8	10.8	12.7
Latin America and Caribbean	18.9	22.7	20.7	23.7
Middle East and North Africa	1.9	2	3	5
South Asia	10.1	12.7	13.5	14.3
Sub-Saharan Africa	12.8	17.2	19.2	23.2
Total	72.9	89.1	90.1	106.2
Annual costs total as a part of the gross domestic product				
East Asia and the Pacific	0.19	0.15	0.09	0.08
Europe and Central Asia	0.11	0.11	0.12	0.11
Latin America and Caribbean	0.30	0.27	0.19	0.16
Middle East and North Africa	0.08	0.06	0.07	0.08
South Asia	0.20	0.16	0.12	0.09
Sub-Saharan Africa	0.70	0.68	0.55	0.49
Total	0.22	0.19	0.14	0.12

Source: World Bank, 2009b.

Observation: made according to the National Center for Atmospheric Research (NCAR, humid scenario).

The benefits of renewable energy

The benefits of renewable energy, energy efficiency and decentralized energy systems can be mentioned as below²:

- These systems rely on domestic energy resources available in the different countries, which ensure the energy security.
- Energy resources are sustainable, which means they will never deplete or damage the local, national or global environment.
- They are reliable resources. The system distributor for energy generation from a variety of renewable resources provides systems which are more durable and less prone to interruption of power supply compared to the central systems; if one of them is crashes, the whole city or the entire State sometimes will not live a case of emergency.

- These resources do not pollute the air, the land or the sea, while the air pollution by the transport and energy sectors has transformed many cities into a source of threat to our health.
- They also save the economies of crises caused by fluctuations in conventional fuel prices. Reliance on local renewable energy resources can protect local economies of the manifestations of economic chaos that arise from fluctuations in world commodities markets because of guesses.
- The distributor system is a renewable energy generation system and it remains safe from any attack, in the sense that it will not constitute a likely military targets. But even if that happens, the result will be a slight environmental damage. On the other hand, the great decentralized factories of nuclear power and fossil fuel pose a significant problem in terms of national security.
- These systems are characterized by their existence close to the communities they use, which provides a sense of the value and the common collective ownership and promotes sustainable development.
- Renewable energy systems provide new, clean and technologically developed jobs. The sector is a fast growing provider of high-quality jobs; it beats from afar in this context on the traditional energy sector, which requires the availability of a large capital.

Effectively, renewable energies have already started offering worthwhile arrangement possibilities; they allow currently the production of many kinds of products and energy vectors. This diversity of applications and the integration between their resources (sun, wind, biomass or biological materials) in addition to the good geographical distribution can allow the decentralized use of these energies, especially since this decentralized production can be achieved by adopting traditional networks actually exist: electricity grid, gas network, thermal network and fuels transport network, in a context of integration between them. All this without taking into account the potential of South-South cooperation in this domain. It is also possible to provide greater amounts of energy by applying the rational and efficient use of renewable energies which contribute to find solutions for the problems associated with the triple interface: Energy - Environment - Development. This last component (development) cannot be achieved without balanced exploitation of the geographical area. In this regard, the role of government is central because it is the only guarantor for the homogeneous and harmonious cover of the domain, and making the electricity available to all of the population of rural areas in developing countries has always been and is still an important social and economic challenge and carrier of hope for a better life for future generations and guarantor of the desired balance between the few number of population in the rural regions and the increasingly densely-populated cities.

That means that the empowerment of the rural population of the source or sources of energy enables it to stimulate economic activity which will improve the living conditions in parallel with respect to the environment and resettlement of these people to their lands, it is an important bet on the decision-makers in developing countries.

Among the solutions of the decentralized electricity production, solar option (which depends on the sun as an energy resource) has achieved a state of maturity that justifies its great adoption to meet the needs of the population of the distant dispersive loose rural regions to the energy within a utile technical and economic variety framework.

This option is actually adopted in many developing countries, and offers a sustainable alternative to traditional electrification allowing local communities (municipalities and other local structures) and decision-makers to meet the needs of rural regions to energy in an

equitable manner within a framework of integration between governmental intervention and local participation.

Most of the population of developing countries, especially Sub-Saharan Africa's population, depends on bio-energy (wood) for cooking and heating. This is due to the high cost of the electricity and gas services which are not accessible to the vast majority of impoverished inhabitants of this continent, and to the absence of an effective policy to encourage reliance on renewable energies in addition to the difficulty of access to many remote rugged nature areas which makes the provision of such services (especially electricity) for them very difficult.³

Obstacles

Future potentials and prospects of renewable energy technologies are available to contribute to meet the basic energy needs, and to support poverty alleviation and sustainable development. Different renewable energy technologies has been innovated and developed during the past two decades, and some of them has been tested in the field and has been developed on the application level, especially in the field of small and medium capacities in remote places where renewable energy has demonstrated economic effectiveness, while others are still in the step of research and development. However, it is worth saying that these technologies have not been yet used on a large scale to provide the energy services; there is still a number of constraints and obstacles facing the expansion of their use, including the high cost. Despite the technical maturity reached by electricity generation systems using wind power and solar thermal systems of a few hundred megawatts capacities, they are still unable to compete on a commercial scale, as their economies are heavily dependent on the nature of the site. It is necessary now to consider the programs of the development of these technologies and to evaluate them carefully in the sites that have great available resources.⁴

Second: Sustainable Development Potentials in Creating Jobs

Sustainable development plays a prominent role in creating jobs which can be presented as follows⁵:

Macroeconomic policies and sectoral development policies can promote the emergence of new economic initiatives in line with sustainable development through incentives that promote more sustainable patterns of consumption and production at the national level. The promotion of new non-polluting sectors, especially the services and the production of environment-friendly products can contribute to transform the direction of economic activities towards jobs creation in environmentally sustainable sectors.

Such initiatives are more promising in the domains where the social partners are effective and supportive for sustainable behavior, particularly where these partners will be willing to invest time and money in new technologies and environmentally sound skills.

For developing countries, new profitable projects in the environmentally sustainable economic sectors could be less common. However, the research and development in eco-technologies, eco-tourism, natural resources management and organic farming, In addition to finding and maintaining infrastructures provide all real opportunities for decent work.

The facilities managed by local communities and supporting sustainable tourism prosper in many countries. This means for fifty-five communities in the "Ecuador" which were object of surveys in 2003 a significant increase in the number of jobs and incomes over four years. Countries as "Costa Rica" have established a successful tourism industry enjoyed a good reputation in terms of sustainable development care. The labor-intensive infrastructure can provide – for countries of all developmental levels - an economically viable means to create

jobs that will protect and restore the environment. Brazil has succeeded in the early seventies in putting a great program to bring oil by "cane sugar ethanol". Recently, it launched a program of "bio-diesel" which heralds expansion on a large scale.

The ethanol, which is extracted from the cane sugar grown on 1.8 million hectares, represents currently more than 35 per cent of car fuel in the country. These possibilities of transition from non-renewable energy resources to renewable fuels based on labor-intensive agricultural production could have large positive impact on employment, particularly in rural regions, while ensuring a sustainable development path behavior.

Green Jobs

The twenty-first century faces two fundamental challenges: the first one is to ward off the dangers of climate change and natural resources degradation, which would threaten the quality of life for present and future generations. The second challenge is to provide social development and decent work for all.

The recognition that these two challenges could no longer be coped has led to increase the awareness of international agencies, governments, employers' organizations, workers' syndicates, environmental groups and civil society organizations, that work which is based on usual to the strategy "growth first and cleaning later" is not economically, socially and environmentally sustainable.⁶

Green jobs initiative launched by the International Labor Organization aims to the merger between the goals of reducing poverty and those of reducing the level of greenhouse gas emissions through the creation of decent work opportunities. This initiative is a responsive strategy to the negative effects of climate change and of the work, and it intends at the same time to reduce the environmental impact of structures and economic sectors to reach sustainable levels or to include functions preserve or re-qualify the environment including, but not limited to, jobs that protect ecosystems and biodiversity, and reduce the consumption of energy, materials and water through the use of highly effective strategies, in addition to the functions that achieve an economy free of carbon and reduce the generation of all types of wastes or pollution to a minimum level or by completely avoiding them.

The green jobs program is currently active in several countries and sectors in Latin America, Africa and Asia. The green jobs initiatives range between supporting these functions in the domains of biofuels and social housing in Brazil and in sustainable agriculture and ecotourism in Costa Rica; in addition to the creation of green jobs in the construction sector in South Africa and the promotion of green projects organization by young people in "Kenya", "Tanzania" and "Uganda"; supporting the creation of green jobs in the field of energy, heavy industry and recycling in China and the promotion of local development and renewable energy in India. The International Labor Organization conducts a worldwide study in which it uses cases studies of several countries to assess the required skills in the context of green jobs in different sectors, and to make recommendations about the policy of the development of skills and training strategies⁷.

Green Jobs are working to reduce the effects of the economic institutions and sectors on the environment and to make influence rates in acceptable levels. There are green jobs in many economic sectors from energy supply to recycling, agriculture, construction and transport. Green jobs help to reduce energy consumption, raw materials and water, from the highly-yield strategies; they also allow reducing the carbon and harmful gas emissions. In addition to minimizing or avoiding all forms of waste and pollution, and preserving the biodiversity. It is expected that green jobs will create 14.3 million new jobs in the world⁸.

Third: Presentation of International Experiences on Renewable Energies and their Role in Creating Job Opportunities

According to a report of Greenpeace Group interested in environment matters and the European Council of Energy, the strong shift towards renewable energies could create 7.2 million jobs in the power generation all over the world by 2030. The report invites governments to agree on a new UN treaty to combat climate change during the meeting which will be held in December in "Copenhagen" in part to protect employment.

Research proves that clean and renewable energy industries are essential to treat all of the climatic and economic crises. By pursuing strong policies to shift to renewable energy resources, the study predicts that the number of jobs increases in power generation to more than 2-3.11 additional million in 2030.

The report pointed out that the wind energy sector alone, for example, can employ 2.03 million people in power generation in 2030 compared to 0.5 million in 2010⁹.

A report revealed also that the strong shift towards renewable energies could create 2.7 million jobs in the power generation all over the world by 2030, more than if continuing to rely on fossil fuels. The study carried out by the group "Greenpeace" interested in the environment matters and the European Council for Renewable Energy called governments to agree on a strong new UN treaty to combat climate change in December in "Copenhagen" in part to protect the employment according to "Reuters".

The report pointed out that "the shift from coal to generate electricity from renewable energy would not only avoid ten billion tons of dioxide carbon emissions, but would also create jobs by 2030 more than if continuing to work as usual.

"Sven Teske" said in the "Greenpeace" that Governments have often been mistaken for fear that the shift to green power is a threat to jobs ... and windmills industry was actually the second largest consumer of steel in Germany after cars. He also said to "Reuters", about the prospects of solar, wind, tidal and biomass power (such as wood and crops wastes) and other renewable energies in power generation and renewable energy industries, that they can create a lot of jobs.

"Christine Lenz," the Secretary-General of the European Council for Renewable Energy, which represents clean energy industries, said: "this search proves that renewable energy is essential to treat all of the climate and economic crises."

By pursuing strong policies to shift to renewable energy resources, the study predicts that the number of jobs increases in power generation to more than 2-11.3 additional million in 2030 with the help of the increase in renewable energy jobs to 6.9 million from 1.9 million.

The report pointed out that the wind energy sector alone, for example, can employ a million people in power generation in 2030 compared to 0.5 million in 2010¹⁰.

At the European level, the following facts can be stated. They demonstrate the role of renewable energies in creating jobs¹¹:

Solar energy is one of the power resources providing more jobs and multiple advantages to the environment; it uses unimplemented energy(the sun) without making noise, and it has a lifespan of more than 25 years and produces weak costs to transform energy (maintenance and exploitation).

The rapid growth of the photovoltaic panels market in Europe will provide 3,000 to 4,000 new jobs per year, where a large number of which is linked to high technology.

Geothermics is an important resource of energy in the world; it constitutes its reserves through groundwater movement, and it is a supplier of direct production of heat and electricity.

The majority of jobs created by this type of energy are jobs at site. These jobs are directly produced, transformed and consumed at the local level.

Hydropower is a traditional resource of electricity which provides jobs linked to improving and maintaining existing equipments, as well as to creating new facilities.

Wind energy: The number of persons employed in the field of production, construction, maintenance is 72000 in 2002, and compared to 25000 in 1998 i.e. it is almost tripled.

In addition to the above, we believe it is useful to present Spanish experience which is considered a leading European experience, and the one of Morocco which is a Maghreb country that has made considerable strides in the field of renewable energies.

1. Spanish experience¹²

The worldwide economic crisis and the recession that has accompanied it caused the dismissal of millions of workers in various jobs and the increase of unemployment rates to a record in the world. Despite signs of economic recovery, this problem is still stuck and became a preoccupation for many of the rich, poor and developing countries alike. It needs to be resolved after the expiration of the darkest times of crisis and the insistence of the whole world represented in the Group of Twenty to reach safety.¹³

Green jobs have become an important principle for many governments, including the US government. Spain is not only qualified and enthusiastic but more qualified and more enthusiastic country and even more insistent on a combination of anti-recession and reducing greenhouse gas emissions.

Spain is already one of the leading countries in the domain of renewable energy by providing a government support of \$ 30 billion in clean energy. Obama's administration considered it as a typical example to create a green economy noting that Spain generates about 24.5 percent of its electricity through renewable resources compared to seven percent in the United States.

However, with the unemployment rate reaching 18.5 percent in Spain, the government has resolved to prepare for a very important step; through issuing many laws and promoting the public and private investment, officials believe that they could provide millions of green jobs over the next ten years. The plan would increase domestic demand for alternative energy through government support on the one hand, and obligating millions of Spaniards on the shift, whether voluntarily or involuntarily, to green energy, on the other hand.

The Spanish government is moving forward in the implementation of long-term plans to employ huge numbers of engineers and technicians in the wind mills stations and solar energy sheds amid the farms, gardens and fields of the regions "Andalusian" and "Galicia". Spanish officials say that renewable energy projects and the arrangements of constructions and homes to assimilate the green energy system could re-employ 80 percent of the millions of construction workers who lost their jobs in 2008.

Although the Spanish government estimates that the alternative energy sector provides about 200000 jobs in Spain, i.e. the double of the number in 2000, critics argue that it costs the taxpayers unbearable money, and, in some cases, it caused a confusion in the energy market although the goodwill of the government.

An example of this is what has recently resulted from the solar energy bubble in Spain; although the wind energy is still the alternative energy prevailing in Spain, the government has recently introduced attractive incentives to encourage the development of solar photovoltaic energy (a technology that uses sunshine-heated cells in generating electrical power). The Spanish companies of energy have run, thanks to the promise of getting new and great support allocations, towards the manufacture of huge quantities of silver silicon panels. As a result, the government support allocations for the sector jumped from \$ 321 million in 2007 to \$ 1.6 billion in 2008. But when the government headed towards reducing production and minimizing support allocations in the past year, the solar bubble burst resulting in silicon panels' prices falling and to lay off thousands of workers, even temporarily.

It is expected that the new law of economic sustainability in Spain would increase the demand for renewable fuels, but it is subject to some final adjustments before being put to parliament next month.

It will obligate all new homes and commercial buildings on higher levels of alternative energy standards, including solar energy resources, which will force owners to accept and acquire green habits.

Also, the subsidized loans provided by the government for companies will encourage everyone: the developer, the owner and the buyer on the installation and use of alternative energies.

An example of the new ambitions of Spain is a new factory for the kits of solar thermal power which costs \$ 300 million, about 100 miles South Madrid in a town called "Puertollano" in the territory of "Don Quixote", where we find that the partnership between the company "Iber Drola" for utilitarian services and one of the national energy agencies has employed 650 workers to build the factory during the previous two years. This giant factory was a savior for many workers laid off during the crisis.

2- Moroccan experience

Morocco enjoys an important solar heating (5 KW per square meter/day), a large exposure to the wind (6000 MW) and significant water energy (more than 200 sites). Energetic policy in Morocco is especially moving towards the development of isolated rural areas. It aims to achieve the following objectives:

- Universal access to energy.
- Strengthen the competitiveness of the productive sector.
- Preservation of the environment.

Fourth: the Algerian Experience in the Field of Renewable Energies and its Relationship to the Labor Market

This last part is about the national policies for the development of renewable energies and their reality, in addition to their contribution to reducing unemployment through the provision of new jobs which require, in turn, a new training and dependent functions.

1-National policies for the development of renewable energies in Algeria

The national policies for the development of renewable energies have been put within a regulatory framework and legal texts; the main texts are: Power Control Law, Renewable Energies Development Law in the framework of sustainable development as well as the Electricity and Public Distribution of Gas Law.

These policies are based on a set of economic bodies and institutions, so that all are interested, in the limits of their competences, in the development of renewable energies. There are three bodies, active since 1988, belonging to the sector of higher education and scientific research¹⁴:

- Renewable Energies Development Center;
- Solar Equipment Development Unit;
- Silicon Technology Development Unit.

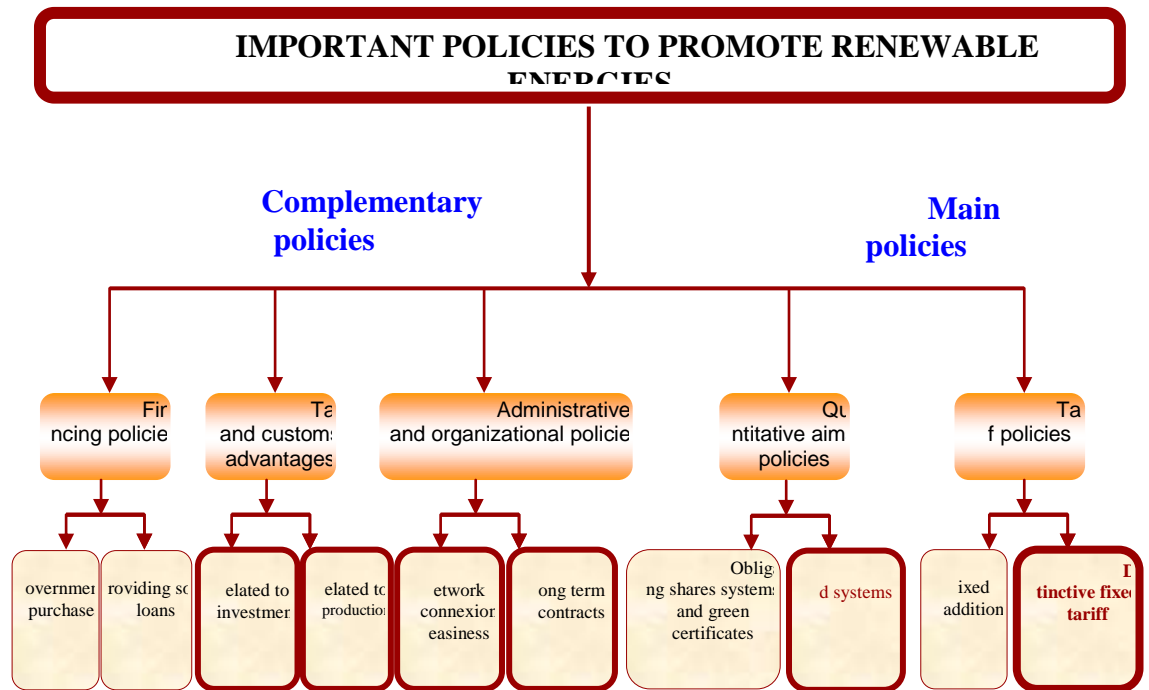
In the energy sector, the development of renewable energies activity is done by the Ministry of Energy and Mines, and the agency of the development and rationalization of the energy use; on the other hand the Center of Research and Development of the Electricity and Gas is in charge of the completion and maintenance of the solar equipment that has been accomplished in the framework of the national program for rural lighting. In the agriculture sector, it should be noted that there is the Higher Commissionership for the Development of Steppes which carries out important programs in water pumping and electricity supply through the solar energy for the benefit of steppe areas. At the level of economic operators, there are several active companies in the field of renewable energies.

In order to put a framework in which all research efforts are valorized and to prepare an effective tool that allows to put a national policy on renewable energies, the Ministry of Energy and Mines has established a joint company "New Energy Algeria" between Sonatrach, Sonelgaz and SIM Group in 2002, whose mission is to develop renewable energies in Algeria at the industrial level. The main tasks of NEAL are:

- ❖ The development of renewable resources of energy;
- ❖ Completion of projects related to renewable energies whose the most important are:
 - Project of 150 MW solar hybridization in Hassi R'mal;
 - Project of aerial hangar with a capacity of 10 MW in Tindouf;
 - The use of solar energy in rural lighting in Tamanrasset and the South-West (the project of electricity delivery to 1500 rural houses)

The aim of the renewable energies development strategy in Algeria is to reach, by 2015, a share of 6 per cent of these energies (including cogeneration) in the national outcome of the electricity. The results of the introduction of renewable energies are:

- More exploitation of the available capacities;
- The best contribution to the reduction of the dioxide carbon emissions;
- Reducing the share of fossil energies in the national energetic outcome;
- The development of the national industry;
- Providing jobs.



2- The Reality of Renewable Energies in Algeria: we present the reality of renewable energies in Algeria as follows:

2-1- The reality of solar energy in Algeria “Dezertec Project”

The extraordinary solar field that covers 2.381.745 square kilometers and more than 3000 hours of sun per year¹⁵. It is the most important in the whole Mediterranean Basin with an annual volume of 169 440 Terawatt / h. The annual rate of received solar energy is 1700 KW / h/m² per year in coastal and high plateaus areas, while it is 2650 in the desert¹⁶.

Table (02) shows the latent solar energy in Algeria

Areas	Coastal area	High plateaus	Desert
Surface %	4	10	86
Solar capacity average (hour/year)	2650	3000	3500
Available energy on average (KW/m ² /year)	1700	19	2650

Source: renewable energies guidebook, Minister of Engineering and Mines, Ed. 2007, Algiers, p.13.

Through this table, we can say that solar energy in Algeria represents a significant latent reservoir, which is an important opportunity to invest in the field of renewable energies.

The first efforts to exploit solar energy in Algeria has started with the creation of the first new energies commissionership in the eighties, the adoption of the South Plan in 1988, and the accommodation of major cities by equipments to develop solar energy. Though the approved legal arsenal between 1999 and 2001, the solar energy's share remains limited in Algeria and it is not used as required.

Algeria inaugurated in July 14th, 2011 the first station of hybrid energy (solar energy and gas). The production capacity of the electricity power station of Hassi R'mal in "Tighlmt" is 150 megawatts, of which 30 megawatts are of solar energy.

During the inauguration ceremony of the station supervised by the Minister of Energy and Mines Youcef Yousfi and his Spanish counterpart Miguel Sebastian, the Spanish official said that the completion of the project whose cost is 350 million euros is "a deep example of cooperation and leading experience for the Mediterranean region as a whole."

He added that the station which was built by the Algerian Company for New Energy (NEAL) and the Spanish Company "Obiener" is "a live model for power generation in rural and mountainous areas away from the traditional electric grids."

The Spanish minister stressed his country's desire to become a "strategic partner for Algeria" in the field of renewable energy.

The site of the station was chosen on 25 km North Hassi R'mal because it is near the gas facilities and thanks to the sunshine volume in the region, which is estimated at 3000 hours per year.

A group of Algerian state-owned banks contributed to 80 per cent of the project financing. The operation of the energy station will be supervised by a team of 70 people, including 65 Algerians and five Spaniards.

In addition to the energy production, the project will contribute to preserving environment because it will largely reduce dioxide carbon emissions and provide more than 7 million cubic meters of gas per year¹⁷.

In this context, it should be noted the greatest renewable solar energy project which is "Dezertec": a huge project that aims to connect several big solar thermal energy stations. It is also possible that it would include renewable energy fixing as wind farms, as the electricity distribution grid that supplies Africa, Eastern Europe and the Middle East.

Dezertec project is not limited to the production of energy, but it also contributes to the provision of jobs, in addition to its contribution to the training and collection of experiences and competencies and to the training of local labor that accepts to work in difficult desert conditions.

The major works have already begun despite the major challenges; more than 12 countries, especially Germany, are competing to put quickly their knowledge in the production of the first electrosolar current in North Africa including Algeria, in order to provide Europe with 15% of its energetic needs; during that, it is expected to establish more than 12 solar centers with a production volume of 5 MW each center in North Africa and the Middle East¹⁸.

It should be noted that Algeria is also interesting in solar photovoltaic energy; the project of "photovoltaic station connected to the network whose generating set has been set up on the roof of the administrative building of the Renewable Energy Development Center" is a pilot project for the technology demonstration and for the study of the applicability of equipment and testing them. It is the first of its kind at the national level, i.e., the first photovoltaic station which allows pumping a part of the produced energy in the low pressure electricity distribution grid.¹⁹

2-2- the reality of wind power in Algeria

Wind resource changes in Algeria from one place to another as a result of climate and topographic diversity. Algeria is divided into two geographical areas:

The North, which is bordered by the Mediterranean Sea and is characterized by a coast of 1200 kilometers and mountainous terrain represented by the chains of Tell and Saharan Atlas between which high plateaus and plains characterized by the continental climate of moderate speed and it is not very high;

In the South, winds are rapider than those in the North, especially in the South-West (4 m/s and exceed 6 m / s in "Adrar"). Thus, we can say the wind speed in Algeria is ranging between 2-6 m / s which is suitable energy to pump water especially in the high plains.²⁰

Mapping wind speed and capacity of the energy generated by the wind available in Algeria allows to identify eight areas of severe winds. They are able to embrace wind energy generation equipments, namely: Two areas on the coastal strip, three areas in the high plateaus and three other locations in the desert. Technical capacity of the energy generated from the winds has been estimated for these areas about 172 Terawatt / hour per year, 37 Terawatt/hour per year are exploitable from the economic angle; which is equivalent to 75% of the national needs for the year 2007²¹.

Through developments, it has been decided to construct the first winds farm in Algeria with a capacity of 10 MW in Adrar; the task has been temporarily entrusted to the joint complex between France and Algeria CEGELEC; as it suggested the best offer in the open tender regarding the project²².

2-3- The reality of the other renewable energies in Algeria

There are other renewable energies in the process of exploitation in Algeria, but they are not produced in the same effectiveness as the solar and wind energies; in this area we will talk about: hydropower, geothermal power and biomass power.

For hydropower, the share of hydraulic capacities in the electricity production burn is 5% or about 286 GW. This capacity is due to the insufficient number of hydraulic sites and to the non-exploitation of the existing hydraulic sites. In this context, the hydroelectric station in Ziama Mansouria (Province of Jijel) has been the rehabilitated with a capacity of 100 MW.

With respect to geothermal energy in Algeria, Jurassic Lime in the North represents an important reserve of the ground Geothermics which led to the existence of more than 200 sources of mineral water located mainly in the northeast and northwest regions of the country. These sources are often at temperatures exceeding 40 ° C; the hotter source is the source of Almaskhotine (96 ° C); these natural sources, which are generally leaks of reservoirs in the underground, flow alone more than 2 m³ of hot water, a small part of the reservoirs contents.

The great continental formation constitutes a huge reservoir of ground geothermics extending on thousands of square kilometers. This reservoir is called "alpine layer ", where the water temperature in this layer reaches 57°C. If the flow issued from the exploitation of this alpine layer is accumulated to the whole flow of hot mineral water sources, this will represent a capacity more than 700 MW.

Finally, Algeria is divided into two areas regarding biomass energy:

- Barren desert area which covers 90% of the surface of the country;

- Tropical forests area which covers a surface of 2.5 million hectares or about 10% of the country's surface; forests cover about 1.8 million hectares, while gradient forest formations in the mountains represent 1.9 million hectares.

The maritime pine and eucalyptus are two important plants in the energetic use, but they represent only 5% of the Algerian forests.

It should be noted that the exploitation of wastes and organic residues, especially animal wastes for the production of natural gas can be considered as an economic solution that would lead to sustainable development, particularly in rural areas. These residues are:

- Household wastes;
- Muds of dirty urban or industrial water purification stations;
- Industrial organic wastes;
- Agriculture and livestock wastes (leathers, animal wastes etc).

Conclusion

To make economic growth and development which are compatible to climate balance scales; and to ensure a sustainable environment, it should be done a radical change and chosen clean development and green economies that emit less carbon ratios. In this context, we can take advantage of the clean development mechanism adopted by the "Kyoto Protocol" in renewable energy applications to reduce greenhouse gases and to achieve qualitative development which makes compatibility between economic efficiency, social justice and rational management of natural resources, by re-consider not only the patterns of production, but the consumption as well as .

Despite criticisms which claim that supporting alternative energy projects constitutes a burden on the taxpayers on the one hand, and may even raise the price of electricity on the other hand, the advantages offered by providing new jobs opportunities, contribute to reduce unemployment which has been deepened by the worldwide financial and economic crisis. Regarding the Algerian case, the following suggestions can be presented:

- In front of the limited capacities of the Algerian petroleum, the reserves currently available and consumption required by the economic and social development, an important part of the traditional energies should be substituted by renewable and environment friendly energies by adopting a green strategy based on sustainable standards that must be respected by everyone: government, institutions, companies and individuals, which will bring long-term gains to the Algerian economy (reducing unemployment and increasing economic efficiency) and also to the environment.
- Strengthening the Algerian capacities regarding renewable energy resources and making them more profitable.
- The State must give some help for the development of renewable energies market, in view of the Algerian qualifications in this domain compared to the Maghreb countries, which have preceded us away.
- Giving the critical importance to human resources through their professional training.
- The importance of supporting technology and scientific research, especially in the search for energetic alternatives and the development of renewable energies.
- Activating laws and legislations to encourage the use of renewable and clean energy, and to rationalize the use of fossil energy.

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Density of the Refrigerant Fluids of R365mfc and R152a: Measurement and Prediction

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This work presents the density of new environmentally friendly refrigerants 1,1-difluoroethane (R152a) and 1,1,1,3,3-Pentafluorbutane (R365mfc) in their pure fluid and mixture. The density is covered in the temperature range of -10-45⁰C and the pressure range of p=0.65-10.47 bar. The density is measured by a vibrating-tube densitometer (DMA-HPM) manufactured by the Anton Paar. The apparatus supplies data in the temperature range of -10°C to 200 °C and a pressure range of 0 to 1400 bar, with an uncertainty of 0.1%. The experimental data is validated using the ‘Volume Translated Peng Robinson Equation of State’ and high precision fundamental equations of state by Outcalt and McLinden from the National Institute of Standard and Technology (NIST). Outcalt and McLinden model achieve deviations less than 0.56% for R365mfc and 0.51% for R152a. The deviations of VTPR are within 2.5% and 15% in the pure fluid and mixture respectively.

Key Words: density, VTPR, vibrating tube, Anton Paar, R152a, R365mfc.

1. Introduction

The last two decades have witnessed a significant increase in Chlorofluorocarbons (CFCs) and Hydro-chlorofluorocarbons (HCFCs) based refrigerants which are harmful to the atmosphere. These materials have been widely used as solvents, foam blowing agents, aerosols and especially as refrigerants due to their preeminent properties such as stability, non-toxicity, non-flammability and availability. However, these substances have a harmful effect on the earth's protective ozone layer. Since the declaration of the Montreal protocol in 1987 the use of these substances is consequently regulated [1]. Moreover the CFCs had been detected as substances contributing to global warming.

The Montreal protocol in its first stage recommended abolishing use of CFCs in the developed countries starting from January 1996 and in the year 2010 abolishing the production and usage of CFCs all over the world. Consequently, many research works have been conducted to investigate a suitable replacement for these harmful materials.

The first possible alternatives included some hydro chlorofluorocarbons (HCFCs), however they will also be phased out internationally between 2020-2030 because of their potential to deplete the ozone layer, and its global warming potential, [1] is almost as high as that of the CFCs [1].

This paper supports more accurate density data for these materials, including the pure fluids and mixtures of R152a and R365mfc. R152a is a HFC type refrigerant and has zero ODP and a GWP value of 120. The boiling point temperature at a pressure of $p=1.013$ bar is $\vartheta^s=-24.0^\circ\text{C}$ and the molecular weight is $M=66.1$ kg/kmol. R152a is a medium pressure refrigerant for the medium temperature refrigeration range [2]. The physical, thermodynamic and refrigeration characteristics are similar to those of the refrigerants R12 and R134a. Although R152a is a good refrigerant substitute for R12, it is not used in its pure form because of its flammability (flammability limits 3.7–21.8% by volume in air). For this reason, R152a is labeled as "highly flammable". R152a is preferably used in nonflammable refrigerant blends, particularly in the Drop-In method, e.g. as a R12 substitute in R401-blends (R22/R152a/R124 blends) and R405A (R22/R152a/R142b/RC318 blend) and also as an R502 substitute in R411 (R1270/R22/R152a blends). The refrigerants R401-blends, R405A and R411 include the chlorine-containing products R22, R124 and R142b and therefore have a contribution to ODP value. All the experiments in this work the same samples for R152a have been used in accordance to the specifications provided by the manufacturer GHC Gerling Holz & Co. Handels GmbH, the samples had a purity of $\geq 99.5\%$ and were used without further purification [2].

The R365mfc is a HFC type refrigerant. This fluid has zero ODP and a GWP value of 782. The boiling point temperature at a pressure $p=1.013$ bar is $\vartheta^s=+41.4^\circ\text{C}$, the molecular weight is $M=148.07$ kg/kmol. R365mfc is a new fluid which is mainly used for the production of rigid polyurethane foams used in insulation purposes, where a liquid foaming agent with a low thermal conductivity and a high vapor pressure at low temperatures are needed. Regarding thermodynamic properties and safety requirements, R365mfc is employed as a main component in binary blends with 7% or 13% by mass with 1,1,1,2,3,3,3-Heptafluoropropane (R227ea) in the production of liquid foaming agents [2].

Besides the fact that this fluid has no negative impact on the ozone layer, further environmental benefits can be achieved using R365mfc, like in the production of polyurethane foams. R365mfc has demonstrated that it acquires a high insulation capacity which, enables it to reduce energy consumption and therefore its contribution to global warming is reduced.

Beside its considered to be more eco-efficient than alternative solutions based, for example, on water as a blowing agent [3]. Eventually, another field of application is the use of R365mfc as a possible working fluid in high-temperature heat-pump systems at condensation temperatures of about $\vartheta=100^{\circ}\text{C}$.

For all the experiments in this work the same samples for R365mfc have been used in accordance to the specifications provided by the manufacturer Solvay Fluor & Derivate GmbH, Hannover, the samples had a purity of $\geq 99.7\%$ and were used without further purification [2].

In spite of these practical applications, only a very limited amount of data for the thermodynamics properties of R365mfc is available in the literature, more data were mentioned by Fröba et.al [23][25].

2. Experimental Methods

The first development of a vibrating tube densitometer apparatus was in 1965 by Hans Stabinger from the University of Graz, with the aid of Hans Leopold, in order to measure precisely the liquid densities. Some years later, their efforts witnessed more improvements and the first vibrating-tube densitometer was presented at the ACHEMA held in Frankfurt in 1967. It is reported in detail in literature by Kratky et al. [4] in 1968. The principle of the densitometer is very simple, so as to represent a unique relation between the natural frequency of the vibrating-tube and the density of fluid confined in this tube. The most recognized progress of the vibrating-tube densitometer is the high accuracy in relative density measurement with minimum amount of sample. Vibrating-tube densitometer technology has widely been extended in several industrial applications. Most of the commercial densitometers have been produced by an associated manufacturer, Anton Paar, K.G., Austria. There are many types of vibrating-tube densitometer for process engineering purposes. The principle of the vibrating-tube densitometer relies on a fixed relation between the natural frequency of the vibrating-tube and the density of fluid contained in the tube. Most of the theory behind vibrating densitometers can be derived from a simple mass spring model, detailed information is found in [5].

The vibrating-tube is usually bent in U-shape, sometimes in V-shape, and its two legs are firmly fixed to a rigid body; the body in the front side is omitted. The vibration of the tube is detected with a photo-detector, by counting the blinking of light from the light source blocked by the flag attached to the tip of the U-tube.

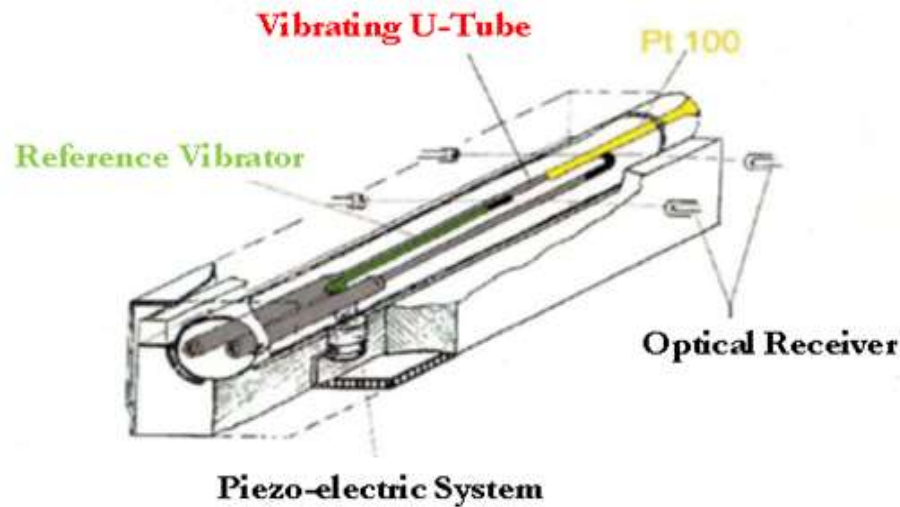


Fig.1. Vibrating tube densitometers with electro-optical system [7].

There is an electronic vibration circuit to activate and sustain a continuous vibration of the tube with its natural frequency, by means of the electromagnet fixed to the cell and the permanent magnet on the tube. This principle is an electro-optical system as shown in Fig.1. The direction of the vibration should be normal to the U-surface, and no twists are provided to occur [25].

The basic equation for the density using vibrating sensors is defined as:

$$\rho = A * \tau^2 - B \quad (1)$$

The experimental set up was carried out at the Institute for Thermodynamics, Hannover University, Germany. As shown in Fig.3 the density meter (DMA HPM, Anton Paar) was used to detect the liquid density in a temperature range of $\vartheta = -10$ – 45°C . Due to the high temperature dependency of density, the measuring cell is accurately thermostated. The temperature of the U-tube is controlled within $\pm 0.02^\circ\text{C}$ using an external thermostat (Lauda, ECORE 1050) to regulate the temperature inside the cell, whereas the whole apparatus was maintained in an isothermal isolation chamber ISOCHAM. Since the apparatus does not have any source for pressure generation, an auxiliary pressure generator was integrated into the apparatus. The pressure was measured by a high accurate pressure sensor (type: PAA35X-C-300, omega) with a precision of $0.1 \pm \text{kPa}$. The pressure measuring unit was successfully integrated into the density measuring cell via hand spindle pump SP (type Ruska, No 41619). To ensure fine adjustment and recharging of the pressure, an additional hand pump HP was integrated with the spindle pump. After evacuating the apparatus, all side products were accumulated in an external waste vessel WV by using a cold trap CT unit. The apparatus has two entrances for feeding IN1 and IN2, which were regulated manually by valves V4 and V5. The valves V1 and V2 are responsible of regulating the flow rate of the sample into the measuring cell. Evacuation of the apparatus was achieved by a water jet pump (type Brand, No 159665) with pressure up to 30 mbar. All valves used were needle valves (type: Autoclave 30VM4081-material of construction 316 stainless steel). Those valves have a small port and a threaded, needle-shaped plunger to allow precise regulation of flow, although they are generally only capable of relatively low flow and are approved for a total allowable pressure up to 2068bar. To avoid any dead volume problem all fittings were conducted directly to the target measuring unit particularly in the connection of the spindle pump and the pressure sensor. The samples were contained in sample glass cylinders which were suited in a high geostatic position to simplify

the flowing of the fluid into the cell. The layout of the measuring cell was suited to be in a low geostatic position to minimize flow of gas bubbles into the cell. During the charging process all fluids stacked between the cell and the sample cylinder in line V4 and V1 were considered in the pressure measurement. Since the density has a high dependency on the temperature, the measuring cell must be well thermostated. The temperature gradients will affect the quality of the measuring data. Therefore it is necessary to excite the cell well under isothermal condition. The measuring cell (type DMA HPM) was equipped with an internal heat exchanger which regulates the temperature of the surface of the vibrating U-tube. For this purpose an auxiliary thermostat (type Lauda ECORE 1050) [6] was integrated and the temperature was controlled up to $\vartheta = \pm 0.005^\circ\text{C}$. The temperature gradient between the measuring cell and the environment was also considered. Therefore, a house made isolation chamber was constructed to enhance the isothermal condition of the ambient air. During the operation the fluid to be measured must have the same temperature as in the vibrating U-tube. The electronic device (mPDS5, Anton Paar) presents the temperature at the surface of the vibrating tube and not the temperature of the fluid. Therefore after loading the temperature and pressure, a waiting time of about 10 minutes is required until the thermal equilibrium is reached.

Since all parts of the components were sealed, it had been very difficult for the operator to watch the fluid behavior in the vibrating U-tube. Thus, there is no grantee to remove all the bubbles from the samples. The formation of the bubbles will normally lead to poor density measurement results. To ensure minimum bubbles at the dead volume zones in the fitting tubes, a sample cylinder with upper and lower entrances regulated by two valves was used. The cylinder was put in a vertical position, where the upper side was exited to the vacuum pump and the lower connected with the entrance to the measuring cell. Waves of bubbles and soluble gases were removed and clearly seen at the surface of the fluid layers.

After possible disposal of the bubbles in the cylinder and the line IN1-V1 the upper valve of the cylinder was reopened to the ambient. To ensure a precise repeatability of the measuring data produced by the apparatus, the period of oscillation of different fluids were tested at least three times at the same conditions. The repeatability may be expressed with the repeatability standard deviation. This standard deviation was calculated from the measurements carried out under repeatability conditions. For a series of n -measurements of the period of oscillation data, the experimental standard deviation characterizes the dispersion of the results and is given by [7]:

$$S_{\tau} = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (\tau_i - \bar{\tau})^2} \quad (2)$$

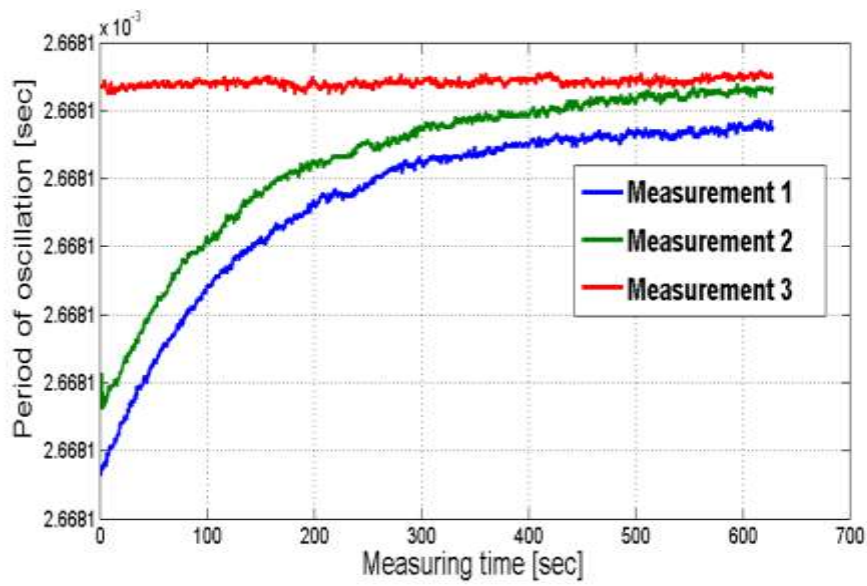


Fig.2. Oscillation profile during the measurement show the thermal equilibrium approach.

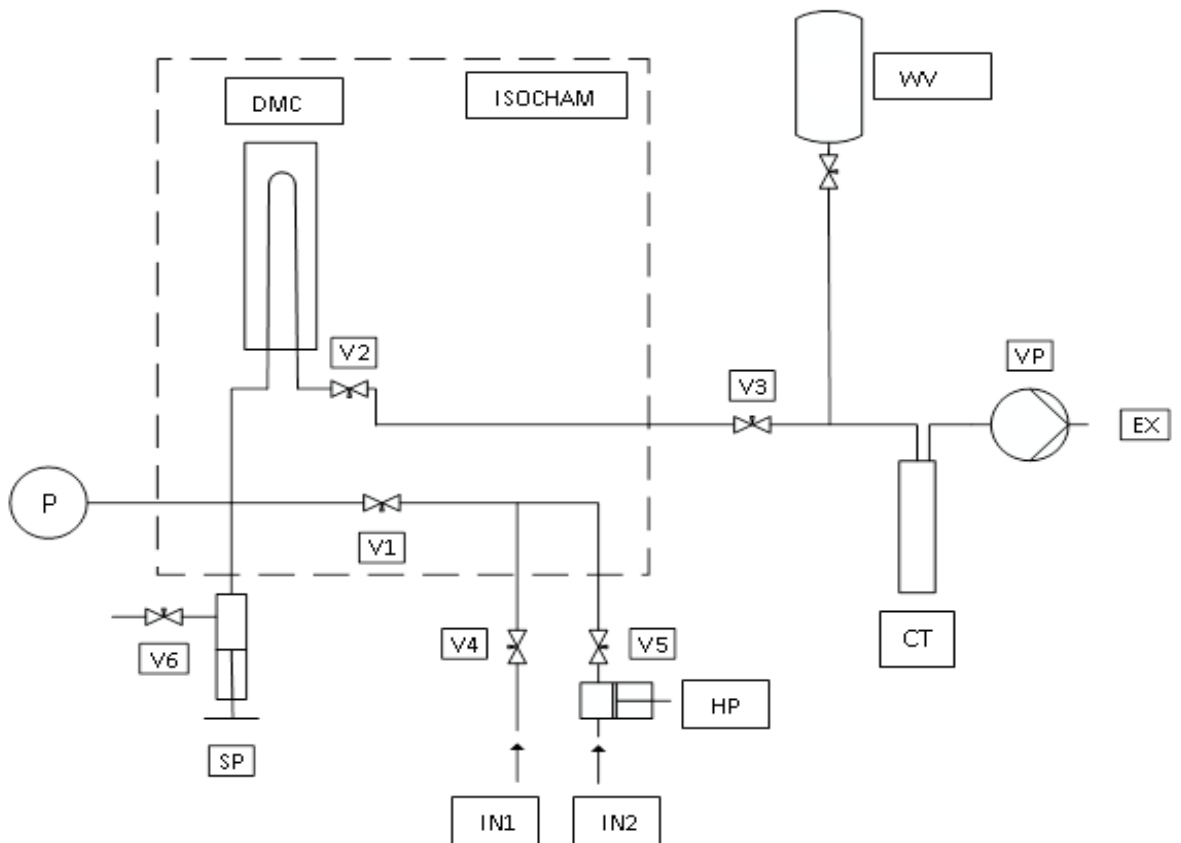


Fig.3. Density measurement apparatus flow diagram.

Table I. Equipment Abbreviation

P	Pressure Measurement
DMC	Density Measuring Cell
ISOCHAM	Isolation Chamber
VP	Vacuum Pump
CT	Cold Trap
WV	Waste Vessel
IN1,IN2	Inlet
EX	Exit
HP	Hand Pump
SP	Spindle Pump
V4,V5	Inlet Valve

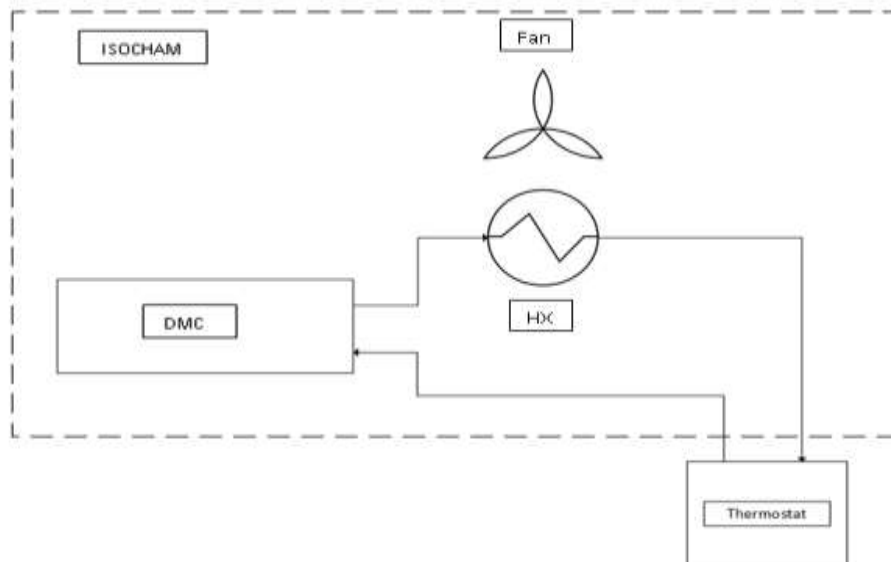


Fig.4. Isothermal cycle of the apparatus.

A calibration is the comparison of achieved measurement results with a standard reference value. This process was performed to validate the quality of measurements and adjustments [7]. The calibration was achieved with a precise measurement of the pressure, temperature and the density of two well-known fluids. To determine the density of the sample with a mathematical interpolation, the sample should have a density value between the higher and the lower densities of the two reference fluids. The constant parameters of equation (1) were calculated as a function of the period of oscillation and density which normally expressed as [5]:

$$A = \frac{\rho_1 - \rho_2}{\tau_1^2 - \tau_2^2} \quad (3)$$

$$B = \frac{\tau_2^2 \rho_1 - \tau_1^2 \rho_2}{\tau_1^2 - \tau_2^2} \quad (4)$$

Where ρ_1 and ρ_2 are the densities of the two standard fluids respectively ($\rho_1 > \rho_2$), τ_1 and τ_2 the period of oscillation of the two standard fluids respectively. The parameter constants A and B were supplied to the electronic device mPDS5 continuously after every calculation. An external Matlab program was used to analyze the measuring data. Furthermore, the density of the vibrating U-tube can be expressed in the following form [8] [9]:

$$\rho = (\rho_2 - \rho_1) * \left(\frac{\tau^2 - \tau_1^2}{\tau_2^2 - \tau_1^2} \right) + \rho_1 \quad (5)$$

Where ρ and τ are the density and the period of oscillation of the sample fluid respectively. For various applications the apparatus was calibrated using water and ethanol. The samples had a purity of $\geq 99.9\%$ and were used without further purification. The period of oscillation was measured under certain conditions ($p=1.01325\text{bar}$, $\theta=25^\circ\text{C}$) and the density of was successfully measured as well as the calibration parameters A and B. Fig.5 illustrated three dimension temperature dependency calibration of the period of oscillation measured for water and ethanol varying with density. Obviously the increase of temperature led to an increase of the period of oscillation.

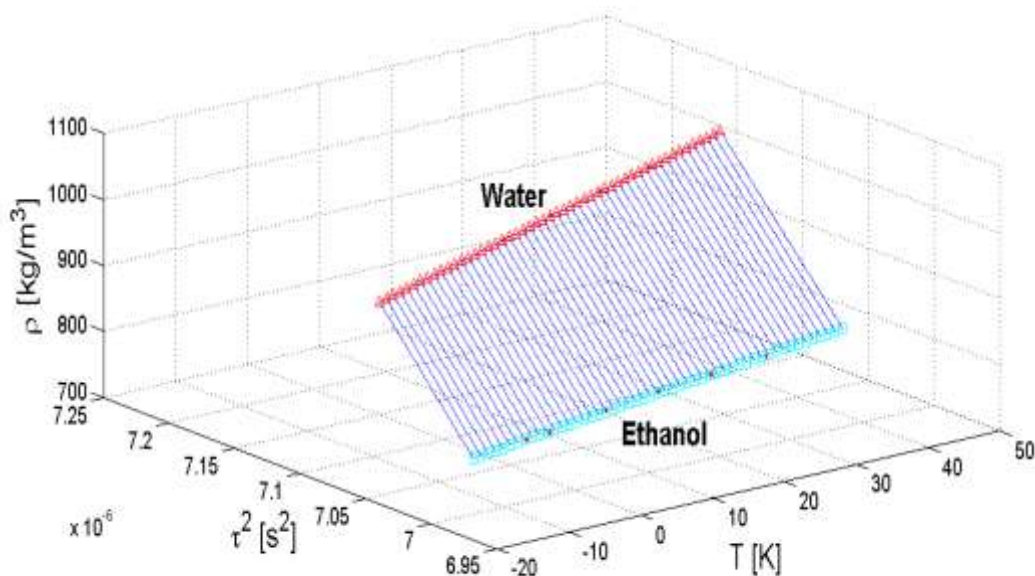


Fig.5. Variation of the density with period of oscillation and temperature.

3. Prediction Method

A new group contribution EOS has been developed by Gmehling and his coworker Ahlers [10]. The idea was to develop the model of PSRK and to assert more attention in prediction of saturated liquid densities. Ahlers and Gmehling [10], Wang et al.[11], Ahlers et

al. [12] have improved this model in a 5-part series which finally led to the successful Volume Translated Peng-Robinson group contribution EOS. The model consists of the following parts:

1. Volume-translated Peng-Robinson (PR) EOS, capable of delivering high accurate liquid volumes.
2. Two α function, to extend the temperature extrapolation.
3. Special mixing rules for the parameters a and b of the EOS, enhancing the prediction of asymmetric systems.
4. Temperature-dependent interaction parameters.

Especially for any g^E mixing rule the EOS used has great influence on accuracy of data [10]. The realization of applying a volume translation to the EOS was proposed by Peneloux and Freze [13] and directly applied to the Peng-Robinson EOS as follows [14]:

$$P = \frac{RT}{v+c-b} - \frac{a}{(v+c)(v+c+b)+b(v+c-b)} \quad (6)$$

The translation parameter (c) indicates the deviation between the experimental and the calculated liquid volume at a reduced temperature $T_r = 0.70$.

$$c = v_{\text{calc}} - v_{\text{exp}} \quad (7)$$

The subscripts 'exp' and 'calc' represent molar volumes v obtained from experiment and calculated from the EOS respectively. In the statement of Ahlers and Gmehling [10], if there is no experimental data for liquid densities, then the 'c' term could be estimated from critical data as follows:

$$c = -0.252 \frac{RT_c}{P_c} (1.5448Z_c - 0.4024) \quad (8)$$

For mixture the volume translation parameter c can be estimated by a linear mixing rule as follows [14]:

$$c = \sum_i x_i c_i \quad (9)$$

The parameter a and b are calculated as function of critical data as follows:

$$a_{ii}(T) = 0.45724 \frac{R^2 T_c^2}{P_c} \alpha(T) \quad (10)$$

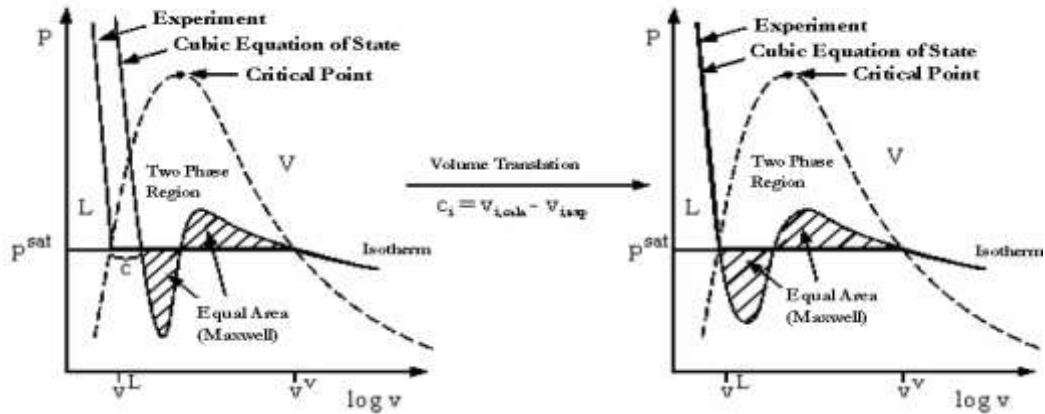


Fig.6. P-v diagram presenting the concept of volume translation [15].

$$b_i = 0.0778 \frac{RT_c}{P_c} \quad (11)$$

In this model the Mathias-Copeman α function was replaced with the Twu α function [16] [17] for the calculation of energy parameter a .

$$\alpha(T) = T_r^{N(M-1)} \exp[L(1 - T_r^{NM})] \quad (12)$$

The Twu α function improved the results of pure component vapor pressures and provided acceptable temperature extrapolations. The α function approaches zero at very high temperatures, meanwhile the Mathias-Copeman α function fails. The parameters N , M , and L have been predicted by fitting the vapor pressure experimental data of pure component, more data are well stored in DDB [18]. If the parameters are not available or if $T > T_c$, the generalized α function for the PR EOS, developed by Twu et al., can be used, as this work has followed the mentioned method. The α values for different compounds are presented as function of the acentric factor ω , for each temperature is given by:

$$\alpha(T) = \alpha^{(0)} + \omega(\alpha^{(1)} - \alpha^{(0)}) \quad (13)$$

To apply equation (13), Ahlers [10] has used special equation for subcritical conditions. This equation is generalized for aromatics, ketones, alcohols and the refrigerant fluids [15]:

$$\alpha^{(0)} = T_r^{-0.1883273} \exp[0.1048767(1 - T_r^{2.1329765})] \quad (14)$$

$$\alpha^{(1)} = T_r^{-0.6029386} \exp[0.5113343(1 - T_r^{2.2059312})] \quad (15)$$

In order to tackle problems associated with highly asymmetric systems, Ahlers et al [10] identified that the development of the VTPR model required the introduction of improved mixing rules for calculation of the a_m and b_m parameters. The G^E model calculated according to the UNIFAC model consists of two parts, the combinatorial and the residual part [14]:

$$g_\gamma^E = g_{\text{Comb}}^E + g_{\text{res}}^E \quad (16)$$

The combinatorial part which takes care of the entropic influence which is calculated using pure component relative van der Waals volumes r_i and surface areas q_i as shown below [14]:

$$g_{\text{Comb}}^E = RT \left(\sum_{i=1}^n x_i \ln V_i + 5 \sum_{i=1}^n x_i q_i \ln \left(\frac{F_i}{V_i} \right) \right) \quad (17)$$

Here V_i and F_i are the volume to mole fraction ratio and the surface area to mole fraction ratio respectively, calculated by [14]:

$$F_i = \frac{q_i}{\sum_{j=1}^n x_j q_j} \quad (18)$$

$$V_i = \frac{r_i}{\sum_{j=1}^n x_j r_j} \quad (19)$$

The mixing rule for this model is similar to the Huron-Vidal mixing rule; however the reference pressure is equal to 1 bar and not infinity. The residual part of the activity coefficient is used. The relative van der Waals volumes r_i was terminated in this mixing rule. The new g^E mixing rule in equation (20) has introduced the VTPR- g^E mixing rule [10].

$$a_m = b_m \left(\sum_{i=1}^n x_i \frac{a_i}{b_i} + \frac{g_{\text{res}}^E}{q_1} \right) \quad (20)$$

Where $q_1 = -0.53087$, $p^{\text{ref}} = 1$ bar and g_{res}^E is calculated according to the UNIFAC parameters [14]. In this work the g_{res}^E was obtained according to the UNIFAC method stated by Kleiber et al. [19] [20] as presented in Fig.7.

4. Results and Discussions

Fig.8 illustrates the attractive parameter for this equation of state as a function of temperature and composition relative to the more volatile component R152a under the use of VTPR mixing rule. The non-linearity is clearly observed in this model. Moreover the profile of the residual excess Gibbs energy for the system R152a and R365mfc in Fig.7 has shown similarity as of excess Gibbs energy. A maximum value of 138(J/mol) at temperature $T=335\text{K}$ is observed.

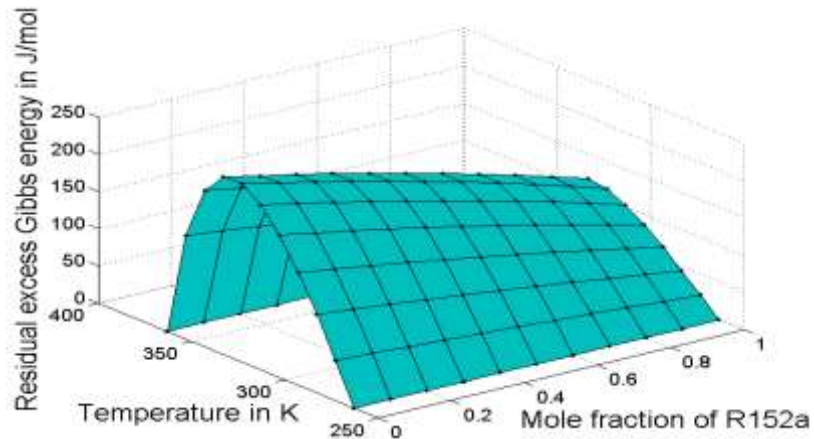


Fig.7.Variation of residual excess Gibbs energy with temperature and composition.

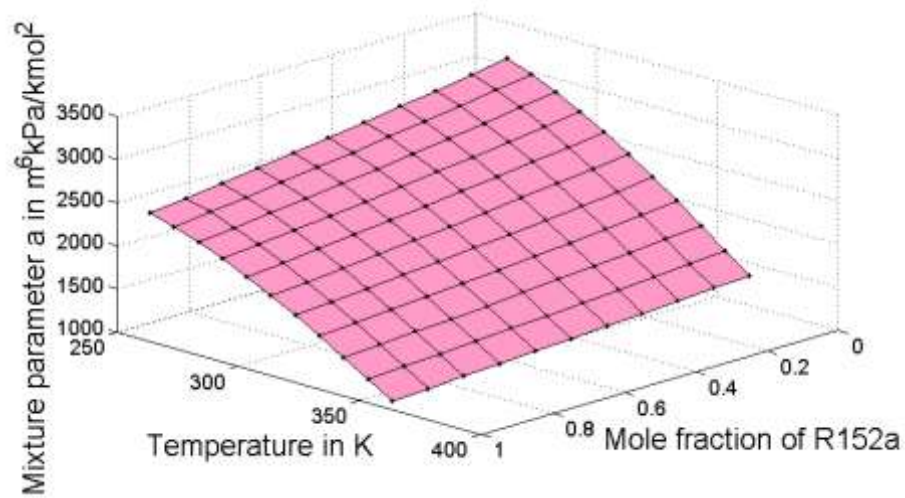


Fig.8.Mixture parameter a predicted for VTPR EOS.

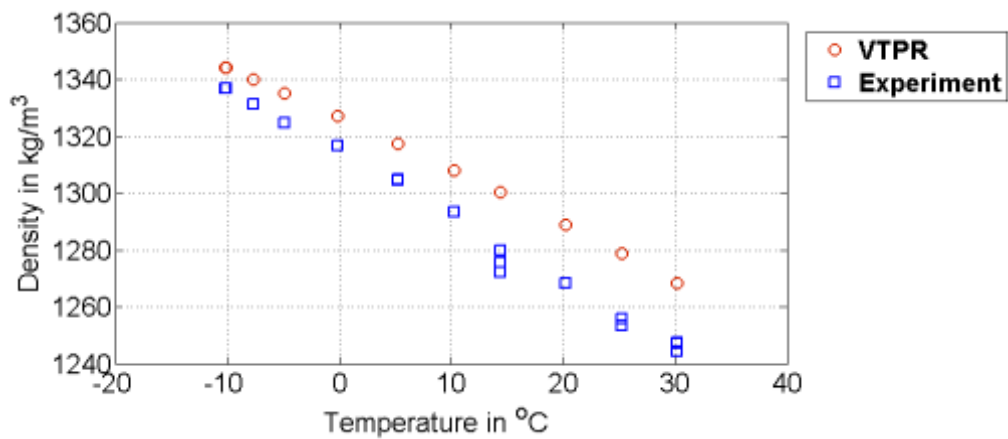


Fig.9.Liquid density measurement of R365mfc.

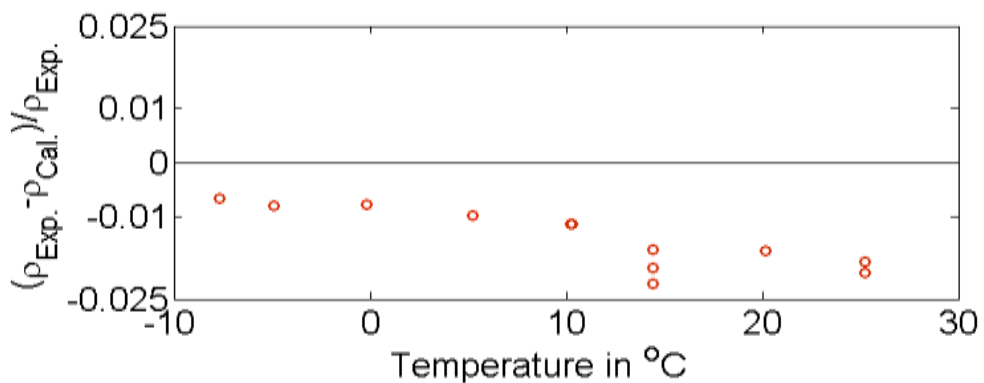


Fig.10. Relative deviation between liquid density measurement data and VTPR model for R365mfc.

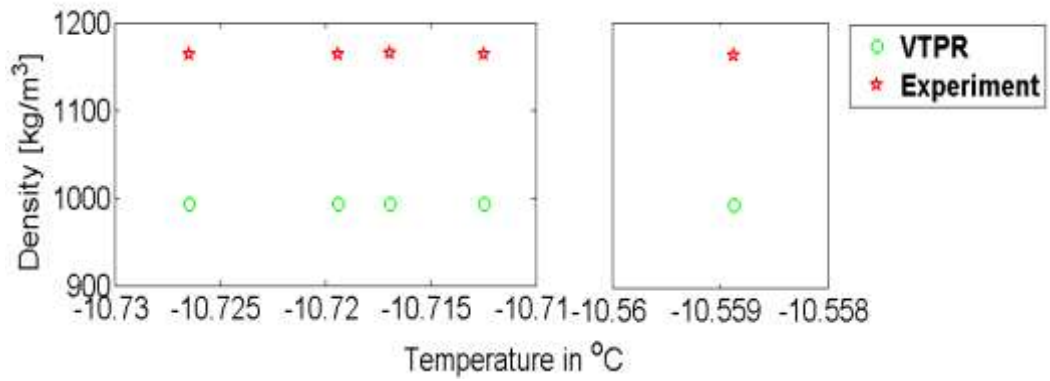


Fig.11. Liquid density measurement of R152a.

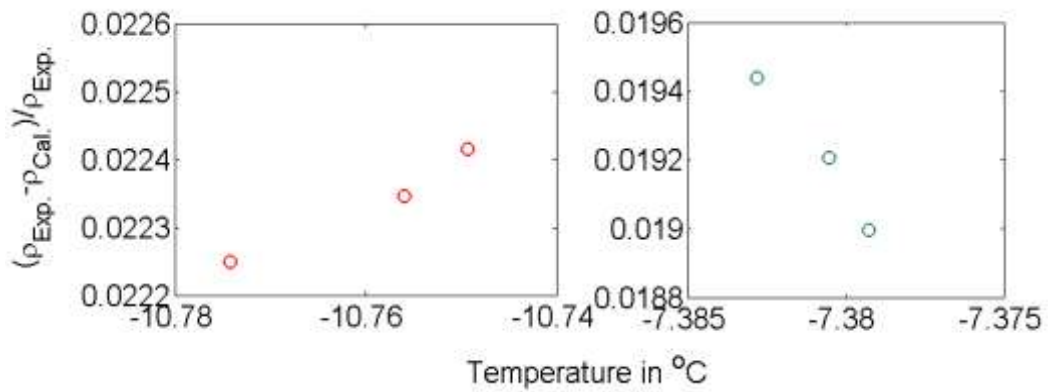


Fig.12. Relative deviation between liquid density measurement data and VTPR model for R152a.

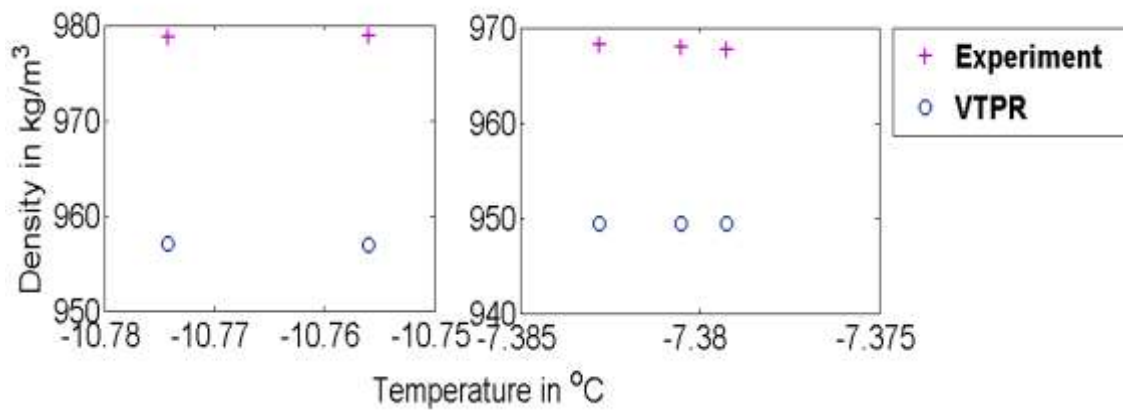


Fig.13. Liquid density measurement for 30%R365mfc.

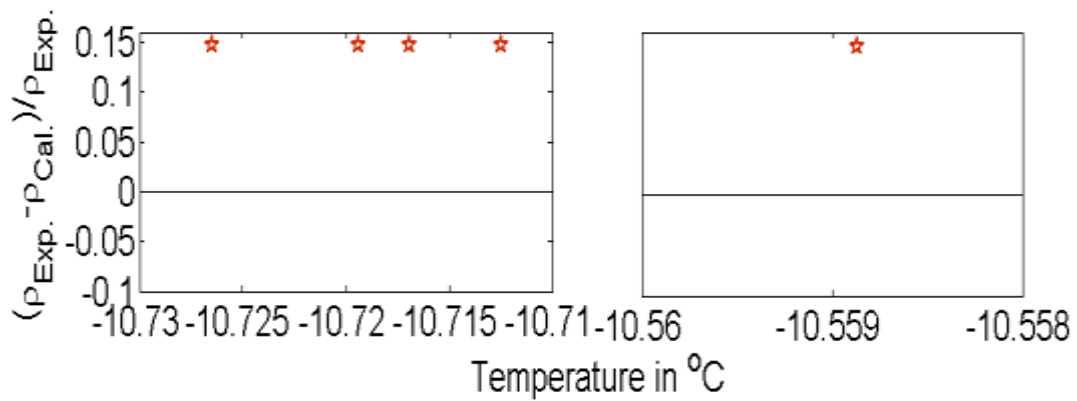


Fig.14.Relative deviation between liquid density measurement data and VTPR model for 30%R365mfc.

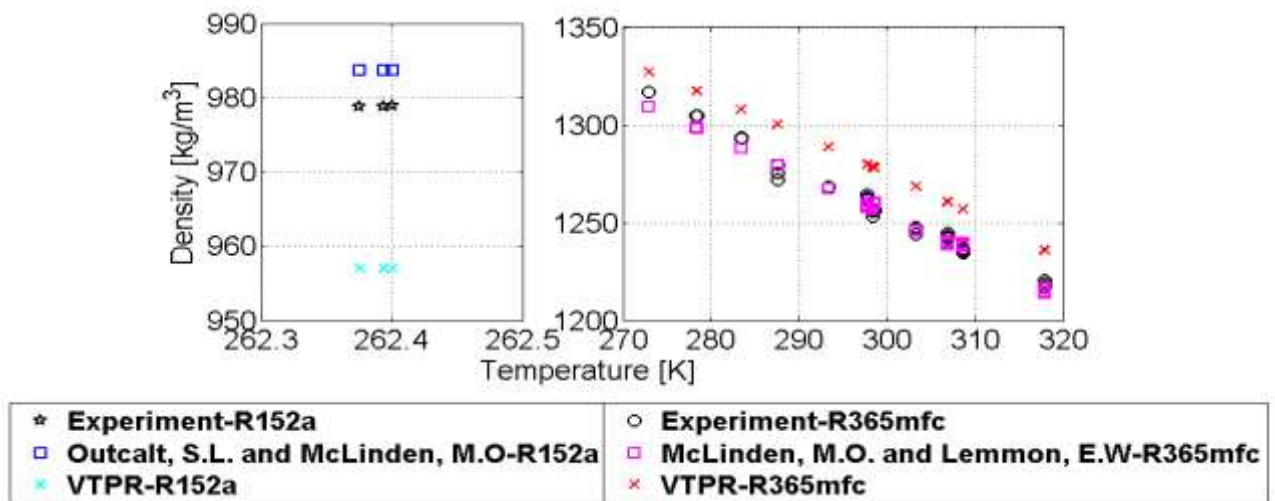


Fig.15. Liquid density measurement of R152a and R365mfc.

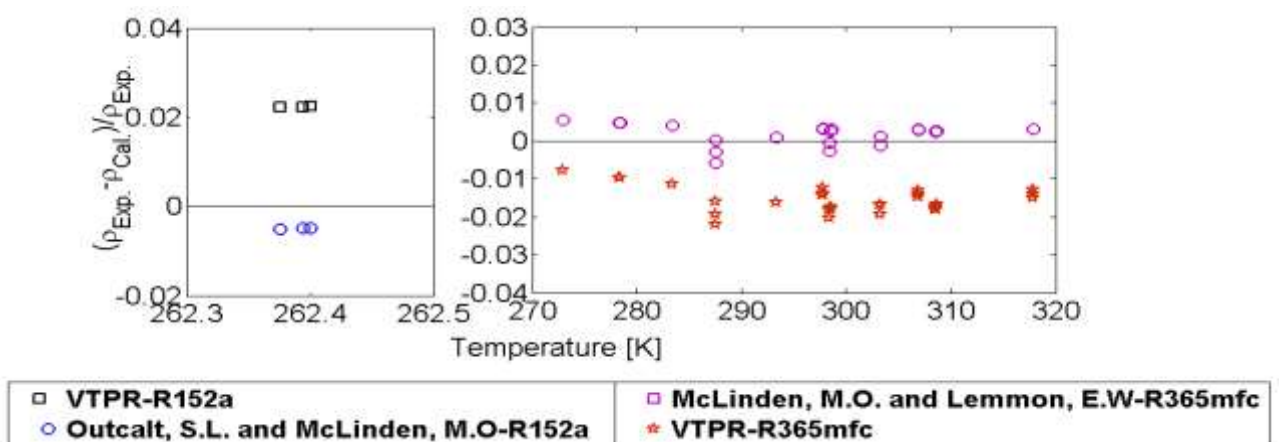


Fig.16.Relative deviation in liquid density measurement data of R152a and R365mfc.

Experimentally measuring the liquid density of R365mfc in a temperature range of $\vartheta = -10$ - 30°C , with the relative deviation as shown in Fig.10 has confirmed the model VTPR to be superior. Minimum positive deviation less than 1.95% was reached by this model. The density measurement of R152a in temperature range of $\vartheta = -11$ - -7°C has been presented in Fig.11. The mixture consisting of 30% R365mfc for a temperature range of $\vartheta = -10.74$ - -10.54°C , has been presented in Fig.14, illustrating that the model VTPR reached a relative deviation less than 15%. Additionally, the liquid densities of R152a and R365mfc were measured in a temperature range of $T = 262.35$ - 262.45K and $T = 270$ - 320K , respectively, and a pressure range of $p = 0.65$ - 10.47 bar as illustrated in Fig.15. The deviation diagram in Fig.16, has shown that the model belong to high precision equation of state by Outcalt and McLinden et al. [21] [22] confirming the superiority of VTPR model used in this work. The model of Outcalt and McLinden et al. (NIST) [21] [22] has showed a maximum deviation less than 0.56% for R365mfc and 0.51% for R152a. VTPR model delivered a maximum deviation less than 2.5% for both R365mfc and R152a.

5. Conclusion

The work has demonstrated the capability of the experimental setup which was used to detect the density of the environmentally friendly system of R152a and R365mfc using the vibrating sensor. Despite some challenges regarding the stability of the phases inside the vibrating U-tube particularly for the previously mentioned refrigerant fluids. The work provides necessary application of the new group contribution equation of state, as it executed the VTPR combined with modified UNIFAC method by Kleiber et.al which also improved the results considerably.

Acknowledgments

The author greatly acknowledge the financial support of German Academic Exchange Service (DAAD) and the Institute of Thermodynamics, Hannover University for technical execution. Special thanks for Dr.-Ing. Michael Kleiber for permitting to use his modified UNIFAC method.

Abbreviation

CFCs	chlorofluorocarbons
HCFCs	hydrochlorofluorocarbons
HFCs	hydrofluorocarbons
EOS	Equation of State
GWP	global warming potential
VTPR	volume translated Peng Robinson
HPM	high pressure measurement
DMA	density measurement apparatus
ODP	ozone depletion potential
DDB	dortmund data bank
ACHEMA	ausstellungstagung für chemisches apparatewesen
UNIFAC	universal quasi chemical functional group activity
NIST	national institute of standard and technology

Latin letters

A	first parameter of vibrating sensor
B	second parameter of vibrating sensor
T	temperature

p	pressure
v	molar volume
T_c, P_c	critical temperature and pressure
n	number of measuring data
T_r	reduced temperature
g^E	excess Gibbs energy
g_{res}^E	residual excess Gibbs energy
g_{comb}^E	combinatorial excess Gibbs energy
r_i	relative van der Waals volume of component i
x_i	mole fraction of component i in the liquid phase
q_i	relative van der Waals surface area of component i

Greek letters

τ	period of oscillation
ρ	density
ϑ	temperature
S_τ	standard deviation of period of oscillation
$\bar{\tau}$	arithmetic mean of period of oscillation
α	function in cubic equation of state
ω	acentric factor

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School Violence Factors as Predictors of Absenteeism and Truancy among In-School Adolescents in Akinyele Local Government Area of Oyo State

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Abstract

Regular school attendance is germane to academic excellence as school instructions are sequenced and cumulative. Various factors threaten students' student engagement and thereby make them stay away from school or a particular class. School violence has been found to be one of the most potent factors influencing school attendance. This study was designed to examine the unfriendly classroom climate and peer bullying as predictors of absenteeism and truancy among in-school adolescents in Akinyele Local Government Area of Oyo State. The descriptive survey research design was used in the study and data were generated using a self-developed and validate questionnaire with a reliability index of 0.75 on the Cronbach alpha scale. Inferential statistics of regression model was used to analyse data at 0.05 alpha level. Findings indicated that unfriendly classroom climate and peer bullying separately and jointly predicted absenteeism and truancy among the respondents. However, unfriendly classroom climate had the strongest effect compared to peer bullying. Evolving a pragmatic and responsive school health policy which has curbing violence at various ecological level of interaction in the school was recommended.

Keywords: School violence, in-school adolescents, absenteeism, truancy, school health policy

Introduction

Regular school attendance is germane to academic excellence as school instructions are sequenced and cumulative. A major problem facing schools is how to effectively deal with student absenteeism and truancy (DeSocio, Vancura, Nelson, Hewitt, Kitzman & Cole, 2007). When a student has not attended school for a long period of time or frequently misses school, they are classified as truants. When a student does not come to school for a lengthy period of time, one may assume these students are learning elsewhere, but unfortunately in most circumstances this might not be the case. Students start truanting in primary school, and often continue through secondary school and so on (Reid, 2005).

Classroom absence is a major factor responsible for falling standard in school education system today. Future of the nation always takes place in schools. School is such an organization which deals with the betterment of society (Khatri, 2013). School absenteeism has a far-reaching impact on a child's academic progress and future. Absenteeism creates a dead, tiresome and unpleasant classroom environment that makes students who come to class uncomfortable and the teacher irritable (Marburger, 2001). It disturbs the dynamic teaching learning environment and adversely affects the overall well being of classes (Segel, 2008). In quality terms, absenteeism is a waste of educational resources, time and human potential. Students who have absenteeism problem generally suffer academically and socially (William, 2000). Absenteeism in one angle view point is one of the most common causes of degrading performances of the students. Especially to those who are included in the advance intelligence curriculum, absenteeism causes a great lose and may result to giving up an aimed position. There are evidences that better attendance is related to higher academic achievement for students of all backgrounds, but particularly for children with lower socio-economic status (Epstein & Sheldon, 2002; Ready, 2010).

Absenteeism can be defined as persistent, habitual, and unexplained absence from school (Cook & Ezenne, 2010). According to Cunningham (2005) cited in Cook and Ezenne, (2010), truancy is the absence of a student from school without the knowledge or permission of parents. The truant leaves home under the pretense of going to school but turns away and become involved in out-of-school activities. Truancy is unauthorized non-attendance. Bond (2004) included fractional truancy, which occurs when students arrive late or leave early, or spend entire days away from school. Another dimension of absenteeism widely reported in literature is school refusal. School refusal however differs from truancy in that children refuse to attend school even in the face of persuasion and punitive measures from parents and school. These students stay at home with the knowledge of their parents and school administrators (McShane, Walter, & Rey, 2001).

This form of absenteeism is widely associated with social and medical disorder involving persistent non-attendance at school, excessive anxiety, and physical complaints (Australia, 2004; Bond, 2004). This type of absenteeism can be separated from the other types, given its psychological and/or medical composition. Several studies show that school refusal is an important dimension in understanding students' absenteeism (Dube & Orpinas, 2009; Kearney, 2007; McShane, *et al.*, 2001). For example, Dube and Orpinas (2009) noted three reasons for students' refusal to attend school: 17.2% of their participants refused to go to school to avoid fear- or anxiety-producing situations, to escape from adverse social or evaluative situations, or to gain positive tangible rewards; 60.6% missed school to gain parental attention or receive tangible rewards (positive reinforcement); and 22.2% had no specific reason for not attending school.

Student absenteeism and truancy have become a serious problem with students today and receives little attention due to the abundance of other issues and priorities that school health educators, social workers and counselors are faced with (Teasley, 2004). Truancy is like absenteeism, but truancy is an unexcused absence from school or classes about which parents typically do not know. Truancy in students has been found to stem from an influence of peers, relations with teachers, the way the curriculum is delivered to the student, family aspects, bullying and others (Reid, 2005). The main difference between truancy and absenteeism is that truancy is unexcused and unlawful absence from school without parental knowledge or consent (Teasley, 2004). A notable problem resulting from absenteeism is that students who stay away from school without permission will not only be left behind in the learning process, but worse still they will probably end up in drug abuse, gangsterism, alcohol consumption, casual sex, gambling and loitering. Certainly, playing truant is a discipline problem, and where do these truants go to and what they do during the time of their absence from school are also of grave concerns.

There are many factors why students stay away from school without permission. A violence prone school is more likely to result in a high rate of absenteeism and this violence could be physical or emotional or both. An unsafe school environment therefore a potent school related factor that can affect students' attendance (Heilbrunn, 2004). Schools with ineffective discipline policies that allow bullying to be tolerated create unsafe environments for students. Gastic (2008) identified bullying as a potential factor that increases students' nonattendance in school. Being bullied was found to be positively associated with increased risk of being frequently absent (Gastic, 2008). Victims often felt hopeless or defenseless and choose to miss school, rather than having to face their bullies and/or the social stigma that is associated with being a victim of bullying (Juvonen, Graham, & Schuster, 2003). Gastic (2008) also discovered that victims of bullying were more likely to engage in behaviors that result in disciplinary actions, such as in or out of school suspensions. Juvonen *et al.* (2003) explained that disciplinary behaviors occur when victims decide to stand up to the bully and fight back. Disciplinary actions in a school could also largely contribute to student absenteeism. When a school displays ineffective discipline policies, the message is conveyed that bullying is tolerated and that school is an unsafe and unwelcoming environment.

Moreover, the climate of the school, especially in regards to the classroom climate, is important for students' school attendance (Leyba & Massat, 2009). Teachers' characteristics and attitudes have been recognized as a factor that influences students' problematic absenteeism and/or truancy (Reid, 2005). Lindstadt (2005) found a correlation between teachers' attitudes and students' truancy. Students who thought their teachers displayed positive and supportive attitudes were less likely to be truant. Students who thought their teachers displayed a lack of support, respect, and attention towards diverse student needs were found to have more attendance difficulties. Teachers, with low expectations for student achievement, were also identified as a truancy factor. Hallinan (2008) studied the unique role that teachers play in shaping students' attachment and engagement to school. Attachment to school has been shown to impact student's attendance and academic performance. Hallinan (2008) examined the extent to which teachers support students socially and emotionally. Results revealed that teachers, who support their students by caring, showing respect, and praising them, are meeting their students' needs. When students' needs are being met, students are more engaged in school. Overall, students who have positive relationships with their teachers are more likely to have good attendance and academic success (Boesel, 2001; Hallinan, 2008, Leyba & Massat, 2009).

Summarily, notable factors that influence school attendance include influence of peers, fear of being bullied, fear of teachers, dislike of certain subjects, fear of academic failure (Suhid, Arof and Karmal, 2012), no encouragement from parents or family problems, and the school factor (Tan, 2006). All of these factors have resulted in students having no motivation to learn, therefore they turn their attention to hang around at other places or loitering. Research findings have also shown that students who do not support and participate in any school programs or activities are those who are not interested to be in school. Meanwhile, absenteeism and truancy have been significantly associated with poor academic performance and maladjusted behaviour, thus absenteeism and truancy constitute an important issue for research. This study was therefore designed to examine how school violence predict school attendance and truancy behaviour among in-school adolescents in Akinyele Local Government Area of Oyo State.

Objective of the Study

The main objective of this study is to examine the influence of school violence on absenteeism among in-school adolescents in Akinyele local government area of Oyo State.

Hypotheses

The following hypotheses were raised to guide the study:

1. Unfriendly classroom climate will not significantly predict absenteeism and truancy among in-school adolescents in Akinyele local government area of Oyo State
2. Peer bullying will not significantly predict absenteeism and truancy among in-school adolescents in Akinyele local government area of Oyo State
3. The joint effect of unfriendly classroom climate and peer bullying will not significantly predict absenteeism among in-school adolescents in Akinyele local government area of Oyo State

Methodology

The study adopted the descriptive survey research design. The population for the study were in-school adolescents in junior secondary schools in Akinyele Local Government Area of Oyo State. The sample size for the study was 500 respondents drawn using simple random sampling technique. 50 respondents were drawn across 10 schools in the local government area. Data were collected using a self-developed and validated instrument with a reliability coefficient of 0.74 on the Cronbach alpha scale. The instrument contained a total of twenty items with five items for each of the variable under study while five items were on demographic characteristics of respondents. The items were constructed on a modified Likert scale with four point rating. Generated data were analysed using regression models.

Results and Discussion

Hypothesis One: Unfriendly classroom climate will not significantly predict absenteeism and truancy among in-school adolescents in Akinyele local government area of Oyo State

Table 1: Influence of Unfriendly Classroom Climate on Absenteeism

R	0.632
R Square	0.400

Adjusted R Square	0.398				
Std. Error of the Estimate	1.35102				
	Sum of Squares	df	Mean Square	F	Sig.
Regression	604.773	1	604.773	331.336	.000
Residual	908.977	498	1.825		
Total	1513.750	499			

a Predictors: (Constant) (UNFRIENDLY CLASSROOM CLIMATE)

b Dependent Variable: ABSENTEEISM AND TRUANCY

The finding of the study as shown in the table revealed the predictive influence of unfriendly classroom climate on absenteeism and truancy among the respondents ($r = 0.632$ $p=0.000<0.05$). The findings of the study further revealed that 39.8% (Adj. $r^2 = 0.398$) of the variance in absenteeism and truancy among the respondents were accounted for by unfriendly classroom climate. The results from the regression analysis showed that there was significant predictive effect of unfriendly classroom climate on absenteeism and truancy; $F(1, 498) = 331.336$, $p=0.000<0.05$. Based on this, the hypothesis which states that the joint effect of unfriendly classroom climate and peer bullying will not significantly predict absenteeism and truancy among in-school adolescents in Akinyele local government area of Oyo State is therefore rejected.

Hypothesis Two: Peer bullying will not significantly predict absenteeism and truancy among in-school adolescents in Akinyele local government area of Oyo State

Table 2: Influence of Peer Bullying Classroom Climate on Absenteeism

R	0.343				
R Square	0.118				
Adjusted R Square	0.116				
Std. Error of the Estimate	1.63780				
	Sum of Squares	df	Mean Square	F	Sig.
Regression	177.920	1	177.920	66.329	.000
Residual	1335.830	498	2.682		
Total	1513.750	499			

a Predictors: (Constant) (PEER BULLYING)

b Dependent Variable: ABSENTEEISM AND TRUANCY

The finding of the study as shown in the table revealed the predictive influence of peer bullying on absenteeism and truancy among the respondents ($r = 0.343$ $p=0.000<0.05$). The findings of the study further revealed that 11.6% (Adj. $r^2 = 0.116$) of the variance in absenteeism and truancy among the respondents were accounted for by peer bullying. The results from the regression analysis showed that there was significant predictive effect of peer

bullying on absenteeism and truancy; $F(1, 498) = 66.329, p=0.000 < 0.05$. Consequently, the hypothesis which states that peer bullying will not significantly predict absenteeism and truancy among in-school adolescents in Akinyele local government area of Oyo State is rejected.

Hypothesis Three: The joint effect of unfriendly classroom climate and peer bullying will not significantly predict absenteeism and truancy among in-school adolescents in Akinyele local government area of Oyo State

Table 3: Influence of Peer Bullying Classroom Climate on Absenteeism

R	0.649				
R Square	0.421				
Adjusted R Square	0.419				
Std. Error of the Estimate	1.32804				
	Sum of Squares	df	Mean Square	F	Sig.
Regression	637.197	2	318.598	180.643	.000
Residual	876.553	497	1.764		
Total	1513.750	499			

a Predictors: (Constant) (UNFRIENDLY CLASSROOM CLIMATE, PEER BULLYING)

b Dependent Variable: ABSENTEEISM AND TRUANCY

The finding of the study as shown in the table revealed the predictive influence of school violence factors (unfriendly classroom climate and peer bullying) on absenteeism and truancy among the respondents ($r = 0.343, p=0.000 < 0.05$). The findings of the study further revealed that 11.6% (Adj. $r^2 = 0.116$) of the variance in absenteeism and truancy among the respondents were accounted for by school violence factors (unfriendly classroom climate and peer bullying). The results from the regression analysis showed that there was significant predictive effect of school violence factors (unfriendly classroom climate and peer bullying) on absenteeism and truancy; $F(1, 497) = 180.643, p=0.000 < 0.05$. Consequently, the hypothesis which states that school violence factors (unfriendly classroom climate and peer bullying) will not significantly predict absenteeism and truancy among in-school adolescents in Akinyele local government area of Oyo State is rejected.

Discussions

The findings of the study revealed that unfriendly classroom climate significantly predicted respondents' absenteeism and truancy. The classroom is expected to be friendly and supportive to enhance learning and school attendance. The adolescent child needs a supportive environment both at home and in the school to function properly and play out their school and domestic roles. Adolescents who are constantly jeered by their teachers or who feel that the teacher does not respect their personal dignity or perceive the teacher as being too brusque against academic failure. Teachers who scold students and fail to encourage them make the classroom socio-emotional climate tensed thereby stifling students' ability to enjoy classroom interactions. When this is the case, students either stay away from school with the slightest excuse or avoid classes thereby resulting in absenteeism and truancy. This finding of the study

confirmed the separate findings of Suhid *et al.*, (2012), Hallinan (2008) and Lindstat (2005) that also reported that classroom climate significantly affect school attendance.

The findings of the study also showed that peer bullying significantly predicted absenteeism and truancy among the respondents. Students in the respondents' developmental age still engage in undue wrangling and contentions that are better settled by their fists and/or verbal power. Students who perceive themselves as not being able to match the physical prowess of their opponents might stay away from school or class in order to avoid confrontation. It is therefore important to ensure that students are trained in alternative conflict resolution methods rather than resorting to physical fight and strife. Every human being have need for safety and in Maslow's theory, the need for safety is the most important need of man after physiological need for food, shelter and clothing. So when students perceive that their safety is not guaranteed, they might tend to avoid attendance either of school or class. This finding of the study that found peer bullying to be a significant predictor of absenteeism is in line with the findings of Juvonen *et al.*, (2003) and Gastic (2008) that separately reported school absenteeism and truancy are influenced by peer bullying.

Conclusion

Based on the findings of this study, it is concluded that school violence factors of unfriendly classroom climate and peer bullying are significant predictors of absenteeism and truancy among in-school adolescents in Akinyele Local Government Area of Oyo State.

Recommendations

Based on the findings and conclusion of the study, the following recommendations were made:

1. A pragmatic school health policy which has school and classroom safety as a significant constituent must be enacted and implemented with strong evaluation component.
2. Teachers must see their students as growing children and treat them as such but not as miniature adults. They must be encouraged to study and not compelled to such an extent that would result in violence
3. There must be educational interventions in form of creating awareness on the dangers of violence among students. Alternative methods of conflict resolution rather than resorting to violence must be taught in the schools in the form of blended instruction
4. Schools should identify training needs and organize symposium, workshops, conferences and staff development programs for teachers to enhance their skills and performance level.
5. Schools seeking to alleviate their attendance problems should study the particular
6. circumstances present in the school before adopting any plan. The successful programmes should be adopted which fit the needs of the schools
7. The school can enlists the help of parents and community agencies in the effort to reduce student absenteeism as schools cannot solve the problem alone.
8. Strong deterrent measures against student truants, their parents and school must be developed and implemented to reduce truancy among school students

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Development of Higher Order Thinking Skill in Mathematics Instructional on Senior High School

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Abstract

The purpose of this research was to develop an instrument that can be used to measure higher-order thinking skills (HOTS) in mathematics instructional of high school students. This research was conducted using a standard procedure of instrument development, from the development of conceptual definition, development of operational definitions, determination constructs, dimensions, and indicators, to the preparation of blue print, item preparation, expert validation, and testing. Data results from trials be analyzed using factor analysis and analysis of structural equation modeling (SEM). The data analysis shows that there are 9 factors HOTS that construct the instrument with good validity and reliability. This instrument classifies high school students in the five categories of HOTS ability. HOTS grouping results can be used by various interested institutions to evaluate the instructional of mathematics. These evaluations are used to determine the success of student learning and the success of teachers' teaching.

Keywords: instrument development, higher order thinking skill, mathematics.

1. Introduction

In Indonesian educational system, mathematics is one of the subjects getting high attention and considered very important. Recognizing the importance of the mathematics function, whether in structuring the thinking skill and formatting the students' attitude as well as in using the mathematics, the teachers' function in improving the mathematics achievement at every level of education should get high attention.

Complexity in studying mathematics increases in line with the increase in various fields today, including the increase in the field of mathematics itself. Therefore, the mathematics students need to learn today is not the same as that their parents and grandparents needed to learn. According to the National Research Council (NRC, 2001:1), *All young Americans must learn to think mathematically, and they must think mathematically to learn*. These learning activities should also be applied to students learning mathematics in Indonesia.

Lack of attention to thinking skills in Indonesian students who study mathematics can be predicted as the cause the low of students' thinking skills. This evident can be seen in the PISA report, regarding the mathematical literacy, which is the variable to measure the students' thinking skills in mathematics (Forster, 2004:14). The results of the PISA survey in 2012 showed that Indonesian students ranks 64th out of 65 countries. The scores achieved by the Indonesian students is 375, while 615, the highest score is obtained by the students in Shanghai, China (OECD:2012,19). The PISA report shows that Indonesian students' thinking skills in mathematics are currently very low. This fact also shows that the thinking skills Indonesian students, especially in mathematics, get less attention.

The human thinking skills can be classified into two categories; lower order thinking skill (LOTS) and higher order thinking skill (HOTS). According to King, *et al.*, the HOTS of a person will appear when encountered unfamiliar problems, uncertainties, questions, or dilemmas. Furthermore, according to Heong, *et al.* (2011:121), HOTS is an important aspect in teaching and learning. Thinking skills practices are part of the generic skills that should be infused in all technical subjects. Students with higher order thinking skills are able to learn, improve their performance, and reduce their weaknesses. Therefore, the HOTS of students studying mathematics need to know by the teachers, so they can perform the qualified mathematics instructional.

The importance of the role of HOTS for the students learning mathematics can be seen in the Murray study about the influence of the selection of materials on mathematics learning exercises conducted by the teacher to the students' HOTS (Murray, 2011: 34), as well as a research on the use of learning models Inquiry-based learning to improve the students' HOTS done by Rooney (2012: 99). In addition, the development of HOTS instrument is important in learning because the assessment of learning achievements is changing as worldwide reforms, particularly in science education, promote the shift from traditional teaching for algorithmic, lower-order thinking skills, to higher-order thinking skills (Barak and Dori, 2009:462).

Therefore, it is necessary to conduct a research to develop an instrument that can be used to measure the students' HOTS in mathematics instruction in senior high school. In order to develop an instrument that measures the students' HOTS, the first need to know what is HOTS? What indicators that construct the HOTS?

According to Wang and Wang (2011:209), there are three main components in HOTS, i.e. critical thinking skills, design thinking skill, and system thinking skill, while Miri *et al.* (2007:355), states that HOTS consists of three components, namely critical thinking skill, systematic thinking skill, and creative thinking skill. Furthermore, according to Rosnawati

(2009:3) and Yee Mey Hong *et al.* (2011: 121), critical thinking skill and creative thinking skill are two important indicators of HOTS. Thus, there are at least two indicators in HOTS, so that finding the students' HOTS can be conducted through observation concerning the critical and creative thinking skills.

HOTS is a latent variable that can not be measured directly as the physical variables. In order to measure the characteristics of latent variables, according to Naga (2012:13), the manifest variables can be used to be measured the latent variables. Measurement of the manifest variables requires a standardized instrument. The problem now is how the teacher can have a standardized instrument and be qualified to measure the students' HOTS.

On the other hand, the limited knowledge and time the senior high school math teachers have in developing a valid and reliable instrument to measure the students' HOTS becomes a constraint for the lack of attention in achieving the fundamental objectives in Mathematics instruction. Therefore, it is necessary to develop a HOTS instrument in mathematics instruction in senior high school.

Operationally, this study aimed to: (1) generate the indicators of HOTS in mathematics in senior high school, (2) determine the construct validity of the HOTS instrument in the mathematics instruction in senior high school, and (3) determine the reliability of the HOTS instrument in mathematics learning in senior high school.

2.Literature Review

Higher Order Thinking Skills (HOTS) is an ability to think that not only requires the ability to remember it, but others require a higher ability. HOTS according Yee Heong May, *etal.*, is an important aspect of the learning process. Students with a high level thinking skills capable of learning, improve their performance and reduce their weaknesses.

Tran Vuise as quoted Rosnawati states: Higher order thinking Occurs when a person takes new information and information stored in memory and interrelates and/or rearranges and extends this information to achieve a purpose or find possible answers in perplexing situations. Further more, King, Googson, and Rohani, stated that HOTS will appear when some one encountered an usual problems, unexpected, question or dilemma.

HOTS is thinking skills at a higher level than just memorizing. When a person memorize and give back the information with out having to think on call as rote. At that level, So us a categorized as the ability to remember that without thinking. Thus the ability to remember which is the first stage in a taxonomic Bloom is not a HOTS.

Further more, Wang and Wang stated that there are three main components in HOTS, i.e. critical thinking skills, design thinking skills, and systems thinking skills. Design thinking skills include creative ideas and planning process, while thinking system includes organizing factors and dynamic interaction. A similar opinion was expressed by Miri *etal.*, who says that even though there are many opinions about the components, HOTS is composed of three components, namely critical, systems, and creative thinking. Thus the design thinking skills to have the same meaning as creative thinking skills, so that according to a second opinion, there are three components of HOTS, i.e. critical, creative, and systems thinking.

Several other opinion states that HOTS is composed of two thinking skills. According to the Yee May Heong, *etal.* HOTS consists of two components, namely critical and creative thinking skills. When students apply these skills means that both students apply HOTS. The same thing was stated by Rosnawati which states that critical thinking skills and creative thinking are the two essential components HOTS. Further more, in the planning of the

University of North Carolina State in order to develop HOTS students, also uses only two variables, namely the critical thinking skills and creative thinking skills. Another opinion states that HOTS quite measured using critical thinking skills, aspect formed by Mirietal.

Based on some of these concepts, it can be concluded that at least HOTS consists of two main variables, namely: (1) critical thinking skills and (2) creative thinking skills.

3. Method and Sampling

This research was conducted in SMA 1 Manokwari, West Papua Province. Development procedure of HOTS instrument was done in eight primary steps, consisted of: theoretical review for building conceptual definition, building operational definition, defining construct, dimension, and indicators, constructing blueprint and items, analyzing readability and social desirability, field testing, and data analysis. Two field trials were conducted, the first was at 208 students, while the second trial followed by 203 students.

The data analysis was performed twice according to the number of trials, using factor analysis. The analysis of the first trial data aims to select the items that deserves to be continued in the second trial, while the results of the factor analysis of data followed by a second trial by using the analysis of Structural Equation Modeling (SEM).

There are several requirements in factor analysis, namely: (1) the correlation between the variables. The first stage in the analysis of factors according to Bryman and Cramer (2005:326), is to calculate the correlation between variables. If the observed variables are not significant, it is not possible formation of one or more factors, (2) the adequacy of the sample size by using Kaiser-Meyer-Olkin (KMO) formula, (3) test whether the observed data is a sample from a multivariate normal population distribution by using the Bartlett test of sphericity (χ^2). According Widarjono (2012: 242), factor analysis can not be used if the value of χ^2 has a probability (sig) is greater than 0.05, and (4) examine the Anti-image correlation (AIC) with the criterion measure of sampling adequacy (MSA) ≥ 0.50 . Santoso (2012: 66), states that the MSA item smaller than 0.50 released one by one from the models ranging from the smallest, to the next item remaining factors analyzed again until all remaining items meet the existing requirements.

The results of the factor analysis using IBM SPSS Statistics program package 20 was the establishment of several factors as a model which is a linear combination of the items. The model obtained is then analyzed by using the SEM analysis lisrel 8.8 program package. By using 8.80 lisrel program, the testing of Second Order Confirmatory Factor Analysis was conducted.

At this stage, three tests was performed, namely: (1) the suitability of the data with the model, (2) the validity and reliability of the model, and (3) the significance of the coefficients of the structural model. Hairetal (1998), as cited by Wijanto (2008:49), states that the evaluation of the degree of fit of the data to match the model through the entire model (overall model fit), the measurement model fit (measurement model fit), and the suitability of the structural model (structural model fit).

The suitability of the whole models was tested by using several measures, as proposed by Wijanto (2008:61-62), among others: *Normed Fit Index* (NFI), (2) *Non-Normed Fit Index* (NNFI), (3) *Parsimony Normed Fit Index* (PNFI), (4) *Comparative Fit Index* (CFI), (5) *Incremental Fit Index* (IFI), (6) *Relative Fit Index* (RFI), (7) *Goodness of Fit Index* (GFI), (8) *Adjusted Goodness of Fit Index* (AGFI), (9) *Parsimony Goodness of Fit Index* (PGFI),

(10) *Root Mean Square Residual (RMR)*, dan (11) *Root Mean Square Error of Approximation (RMSEA)*.

After the match the model and the data are met, then, according to Wijanto (2008:65-66), to test the measurement model fit, with an evaluation of each constructor separate measurement models through evaluation of the validity and reliability. Reliability measurements performed using CR and VE. A construct as a good reliability when every indicator has a value of $CR \geq 0.70$, and the value of $VE \geq 0.50$

4. Findings and Results

Based on the expert opinions, some improvements of the structure and content of the instruments that have been prepared were made, prior totrial several statistical value, which was generated in the first and second trials, are presented in Table 1.

Table 1. Some Statistics on Trial I and Trial II

No	Statistics	Trial I	Trial II
1	KMO	0,772	0,798
2	<i>Chi-Square of Bartlett Test</i>	4397,738	3283,242
3	MSA	0,542– 0,878	0,657 – 0,897
4	Number of factor	9	9
5	<i>Total Variance Explained</i>	84,230%	78,101%
6	NFI	0,91	0,86
7	NNFI	0,96	0,90
8	PNFI	0,82	0,77
9	CFI	0,96	0,91
10	IFI	0,96	0,91
11	RFI	0,90	0,84
12	GFI	0,85	0,77
13	AGFI	0,82	0,72
14	PGFI	0,71	0,64
15	RMR	1,12	0,54
16	RMSE	0,051	0,089
17	SLF	0,71 – 1,93	0,24 – 2,40
18	CR	0,80 - 0,97	0,79 - 0,95
19	VE	0,57 - 0,78	0,57 - 0,77
20	Nilai t	2,18 – 37,02	1,77 – 19,53

Table1 shows that all 20 values in the second test statistic are relatively the same. The conclusionis based on the values was also not statistically different. The statistical value of the first third, KMO, Chi-Square Test of Bartlett, and MSA in the second test gives the same result, so the factor or the formation off actor analysis can be performed.

The further results of the factor analysis in the second trial also not showed different ones. Number off actors formed in both analysis are the same, namely 9 factors, the total variance explained, is not too different, which is about 80%. The results of analysis by using SEM also shows that the results did not differ between the two experiments performed. Test of model fit the data used shows that structural equation models were generated in both trials give different results.

5. Discussion

The results of research showed that the instrument HOTS has good validity and reliability, so that it is qualified to measure the high school students' HOTS in learning mathematics. The diversity of the students' work results showed this evident. For example, consider one of the following questions:

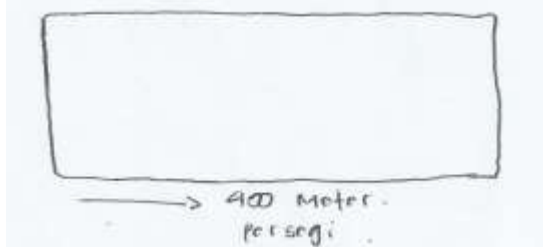
In accordance with Governor Jokowi program, an area in Rawamangun, Jakarta will be built as an open greenpark. If the planned park area of 400 square meters, then describe the area.

The answers given by the students involved in the research are very various. The diversity of this response indicates that the instrument can be used to measure the students' HOTS ability well. Some examples of the students' answers are presented below:

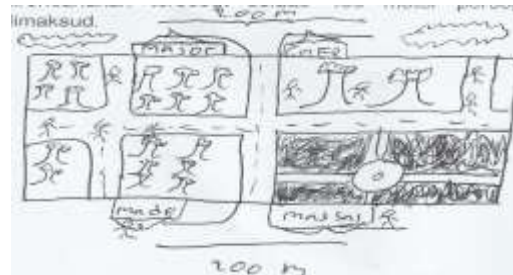


answer with score 1

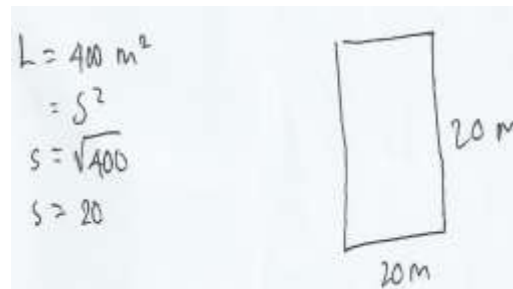
Area - Daerah Kawasannya Jakarta



answer with score 8



answer with score 6



answer with score 12

Figure1. Some Sample of Student's Answer

Answer in Figure1 section a, shows that students do not understand the purpose of the question either. Students have sketched garden square shaped, but the problem in question is not answered properly. Students have tried to give an answer, but the answer is wrong. There are two mistakes made that answer with out value and unit to indicate broad question.

Answer in Figure1 part b, indicates that the student has understood the question that is sketching a garden. Mistakes made in setting the numbers to determine the area of the park, as requested in the question.

In Figure1 section c, it appears that students have understood the intention of the question that is sketching garden. Students have established a unit to determine the number and size as required in the matter, but did not specify the length or width of each side.

The next student, as his work is presented in Figure1 part d, shows considerable work perfectly. The student's work shows that in addition to sketching a garden properly, students are also correct in setting the unit to determine the number and area of the park. The advantages of these students compared to students in advance, a number that represents the length and width of the side, is obtained by using a specific calculation.

The variety of the answers given students showed the variety of students' thinking skills, which also shows the variety of the sample used. The variety of characteristics of the sample because the data obtained in the trial also varied. The variety of the resulting data is suspected as the cause of the statistical analysis performed on both trials provide maximum results. This is in accordance with the opinion Tanujaya (2013:6), which suggests that the variety of data in statistics is an important factor in the analysis of research data, both the estimation and testing of the population parameter.

In addition to the variety of the sample, the following will be presented briefly how the preparation of instruments HOTS development so as to obtain maximum results.

First, this HOTS instrument is based on standard procedures that have been put forward by various experts of measurement. Determination of dimensions and indicators carried out by standard procedures to understand the concept of HOTS theory is good and true. According to Azwar (2012:11), less understood definition of an attribute being measured results in the desired measuring region in to a measuring region overlapping with other attributes. This causes the instrument obtained be comprehensive enough to reveal the desired attributes.

Second, after the draft was formed, the instrument was validated by expert. Validation of experts in addition to do in Jakarta and Bandung, also conducted in Manokwari, West Papua. In addition to technical improvements to the substance of mathematics, experts also give advice about the language and content of the material. Topics on derivative exponential removed from the instrument, because the subject has not studied by the high school students of class XI Science Department. Problem stories that are too long are also eliminated because the students will take a long time to do it. Some items that like the questions of mathematics Olympics also eliminated. All Criticisms and suggestions put forward by the experts are always considered. Expert opinion is an important component in the development of the instrument. This is in accordance with the opinion of various experts of measurement, which always include expert opinion as one of the things that must be one in the instrument development.

Based on the results of the factor analysis, as noted earlier. Then there are nine factors that are formed from the 27 indicators analyzed HOTS constituent instrument. The nine factors are cognitive activity over activity knowing (knowledge) and understanding (comprehension). HOTS is a cognitive activity that is more than just memorize and understand. This is in accordance with the opinions expressed Zohar (2004:1), which states that know and understand the cognitive activities are grouped into low-level thinking skills (lower order thinking), while HOTS is a high-level cognitive activity in the Bloom taxonomy analysis activity, synthesis, and create.

Some examples of cognitive activity HOTS classified according to the Zohar (2004:1-2), among others: preparing arguments, asking research questions, make comparisons, solve complex problems that non-algorithmic, dealing with controversy, and identify the hidden assumptions. Most scientific research skills, such as formulating hypotheses, planning experiments or draw conclusions, also classified as HOTS. Examples of the Zohar presented in conformity with the indicators HOTS constituent instrument in this study.

6. Conclusion

Based on the results of research and discussion that has been presented, it can be stated that HOTS instruments developed can be used to measure HOTS high school students in mathematics instructional. Thus the instrument used as a test to measure HOTS students, only consists of nine items. Every item that is used is representative of each factor, namely: (1) the

use of the concept, (2) the use of the principle, (3) impact predicting, (4) problem solving, (5) decision-making, (6) working in the limit of competence, (7) trying the newthings, (8) divergent thinking, and (9) imaginative thinking.

This instrument still needs to be improved by testing on students with different characteristics with SMA Negeri 1 Manokwari. Tests with broader samples intended that this instrument can be used in the wider population. In addition it is necessary to develop a matter for the whole class and other educational levels.

In this instrument there are groups of about equal previously developed for each indicator on each factor. However, in order to avoid leak age problems, it is necessary to develop similar matter even more in order to develop the bank of item.

HOTS instrument is intended for students of Class XI High School Science Department. The use of this instrument can be extended to all levels of education, after the development of items a teach level of education. Development of the items according to the factors obtained. The work of students was evaluated based on the rubric that has been developed. There are three important matters of assessment, namely: (1) understanding the problem, (2) troubleshooting procedures, and (3) the truth of the answer. Each subject has a rating score of 0 to 4, so that each item, scores obtained by students ranged from 0 to 12. Thus, for 9 instrument item is done, students obtain a scorering from 0-108.

The range of scores obtained by students can be grouped into several categories. The purpose of categorization according to Anwar (2012:147) is to put people in groups whose position according to a continue umbased on the attribute being measured, and the categorization is based on the assumption that individual score in a population of normal spreads.

Therefore to categorizing HOTS scores, first of all it is assumed that the students cores HOTS have normal distribution. Normally distribution population according to Subanar (2012:135) has two parameters, namely the average (μ) and standard deviation (σ). A normal distribution populations have measures of central tendency, which includes the average, median, and mode are the same. HOTS known minimum score is 0 and the maximum is 108, so that the average score of HOTS is 54, while the standard deviation is unknown, so need a simulation.

The simulation was performed using the Minitab to build a population of normal distribution of data, the data range 0-108, and a total population is 1,000,000. The simulation results show that the standard deviation of the population (σ) is 15. The value of standard deviation and average, according to Anwar (2012:148) is used as the basis for categorization, in order to obtain classification of HOTS, as presented in Table 2.

Table 2. HOTS Evaluations Criteria for High school students

No	HOTS Value	Categori
1	≥ 76	Very High
2	$61 \leq \text{HOTS} < 76$	High
3	$46 \leq \text{HOTS} < 61$	Moderate
4	$31 \leq \text{HOTS} < 46$	Low
5	< 31	Very Low

Based on Table 2, the HOTS of high school students who study mathematics grouped into 5 categories. Each category shows the level of HOTS students in understanding and

completing math problems. Categories achieved by students can be used as an evaluation study of mathematics. For example, if most of the students are grouped in categories that are very low, then the mathematics instructional in the class (school) needs to be thoroughly evaluated. On the other hand, if most of the students are categorized into high or very high level, it can be stated that mathematics instructional at the school has been going well, especially in the development of HOTS students.

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Analysis of Causes of Conflicts in Tenanted Properties in Nigeria

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Abstract

Conflicts in landlord-tenant relationship are inevitable. The need for effective conflict management has necessitated proper identification and classification of causes of disputes between landlords and tenants. This paper classified disputes relating to landlord-tenant relationship using descriptive statistics and factor analysis. The study elicited data from tenants in Lokoja residential property market in Kogi State, Nigeria on issues generating disputes between them and their landlords. Stratified random sampling was used in selecting respondent tenants from five neighbourhoods and a total of 300 questionnaires were administered on them out of which 235(78.3%) were retrieved and found good for analysis. Findings indicate that the desire to have value for rent paid on the part of tenants, and guide against possible misuse of demised premises from landlords' view are major dispute generators. It was recommended among others that there must of necessity be Tenancy Agreement guiding all leases.

Key words: Conflict, Factor Analysis, Landlord, Lokoja, Tenants

1. Introduction

The relationship of landlord and tenant is as old as the existence of the earth when man suddenly found himself in the world not made by him. It is a necessary alternative where individual cannot afford to own his own premises while seeking means of meeting one of the basic needs of man. Although most people would have avoided rental-housing and thereby avoid the landlord-tenant relationship; the yearning gap between housing need and supply particularly in the developing nations of the world makes the situation a must to live with. Not even in the developed nations can rental housing be avoided. The pessimistic mind-set with which some parties enter into landlord-tenant relationship accounts for many of their acclaimed negative experiences. Hundreds of millions of tenants live in cities in developing countries (United Nations Centre for Human Settlements, 1989). Although home-ownership has always been a priority in the government's housing policy, rental housing plays an important and indispensable role as well (De-Loor, 1992). Arku, Luginaah and Mkandawire (2012) observed that renting, which breeds landlord-tenant relationship is unavoidable, especially in urban areas.

According to Dabara, Olatoye and Okorie (2012), a landlord is a person or organization that owns a property (a building, house, apartment, or plot of land) that is rented to others (tenants). A tenant is similar to vassal because he does not own the property but is allowed to use it for a fee (Lehman and Pheps, 2005). The relationship between a landlord and tenant is guided by tenancy agreement. This instrument in property management purports to provide protection to all the parties involved in the rental housing sector (Dabara *et al*, 2012). Unfortunately, great deals of contracts in the cities of the developing world are informal and both landlords and tenants sometimes flout the law because of the inadequacies of the judicial system (UN-HABITAT, 2003). Tenancy Agreement are not enforceable because most of the contracts are "invisible" in the sense that most agreements are either done verbally or informally and being without a strong backing of the law, they are usually un-enforceable.

Like in most relationships, conflict in tenancy is inevitable. The need to let and rent an apartment opens landlord and tenants to conflict relating to tenancy. In order to avoid the kind of dispute associated with tenancy, some people will rather not invest in rental properties while some have found solution in engaging professional property manager whose training and skill can forestall some disputes. Lee (2010) warned that conflict can be a breeding ground for disruption and viciousness; it can cause stress, emotional pain and decrease job satisfaction.

Disputes relating to tenancy are diverse and enormous (Olukolajo 2012), they must be understood, classified correctly, and then can they be pragmatically tackled. It is against this background that this study was carried out. The remaining parts of the paper examine relevant literature, sets out methodology for empirical analysis, present findings and make recommendation.

2. Literature Review

2.1 Concept of Conflicts in Landlord Tenant Relationship

Generally, a landlord and tenant relationship exists if the property owner consents to let his premises; the tenant acknowledges that the owner has title and right to a future interest in the property; the owner actually has title to the property; the tenant receives a limited right to use the premises; the owner transfers possession and control of the premises to the tenant; and a contract to rent exists between the parties. Generally conflict is believed to be a disagreement between two or more people over a specific issue or action; however, conflict can also be a personal experience of one person over an issue or action. Oftentimes, people associate

conflict with chaos, arguments, fights, destruction, crisis etc. What all these concepts have in common is negativity. Conflicts usually reflect the diversity and complexity of human societies and should not be seen as a dysfunctional experience, as it can be an opportunity for change. If we look at it this way, conflict on its own is neither positive nor negative. It is worthy to note that conflict is a natural and necessary part of our lives. If conflict is managed in a constructive way, its resultant effect is development, change, interaction, progress, knowledge, peace etc.

Conflict is not always a bad occurrence. Conflicts can have both negative and positive sides. It is therefore important know how best to manage conflicts when they arise so that lessons arising from them can be used positively for promoting change and development.

2.2 Landlord-tenant conflict

One of the least loved economic classes in America was landlords in the 1930s and a similar sentiment is frequently expressed in many other countries today. Many tenants have a bad story to tell about their landlord and so also are many landlords. Failure to maintain the demised property, failure to return refundable deposits for one reason or the other, insensitivity to temporary economic setbacks, discrimination of all kinds, interference with tenants' privacy etc., are usual complaint from many tenants against their landlord (Olukolajo, 2012). According to Obasa (2011) out of a total of 1,395 new cases received by the Citizenship's Mediation Centre (CMC), Lagos (an alternative dispute resolution body) in August 2011; 1,382 (99,06%) were landlord/tenant cases. Also records obtained from the CMC showed that out of a total of 10,957 new cases received between January to August, 10,290 (93.91%) addressed issues involving landlords and tenants.

Oni (2011) observed that many prospective tenants of residential properties usually appear good at the recruitment stage but often become belligerent with grave challenge to the property managers with passage of time. In a study conducted by Gbadegesin and Ojo (2012) on recalcitrant tenants in metropolitan Ibadan property market; military personnel, police officers, lawyers, artisans and civil servants are the usual recalcitrant tenants; while few minorities of bankers and lecturers are not usually difficult to manage. The study concluded that commonest recalcitrant tenants are law enforcement agents who usually take laws into their hands; a confirmation of the current aberration against the rules of laws in Nigeria.

Gbadegesin and Ojo (2012) attributed disregard of some relevant factors such as police report, maintenance culture, rental arrears, family factor, personal/family crisis and mental illness/addiction, among others while selecting tenants to fill vacancies is responsible for recalcitrant tenants, and having problematic tenant can discourage investment in rental properties. Landlord-tenant relationship is a form of business relationship; the competitive environment is changing and the real estate owners are seeking new ways of differentiating themselves from competitors (Rasila, 2009). Almost all tenants assume tenancy on a good note; however, the relationship sometimes gets sour leading to many unpleasant experiences at both ends. Some of the consequences of conflict relating to tenancy include facing criminal charges, loss of income and time, damage to co-tenants' properties, damage to landlord's properties, bodily injuries to parties, distrust, noisy and rowdy environment, discomfort to neighbours, eviction, poisoning and death to mention but few (Gundersen, 2002, Warah, 2003, Durodola, 2010).

Many studies have been conducted on the causes of disputes between landlords and their tenants. Mwangi (1997) and Oruwari and Ogunene (2006) identified forceful ejection of tenant by their landlords. Conflict on issues of energy use in rented apartment was reported in

Dillahunt, Mankoff and Paulos (2010). They opined that a key source of conflict as seen from the landlord's perspective was tenant neglect or wastefulness; however, research suggests that residences deteriorate due to landlord negligence more often than they are destroyed by tenant harm, despite the fact that landlords are convinced that tenants do not take care of property. Yinger (1998) opined that discrimination against certain tribe, race, colour etc can lead to social conflict.

Crosby, Gibson and Murdoch (2003) conducted a study of the lease structure in United Kingdom and observed that inability to manage entry and exit, issues bothering on length of lease, the right to break, alienation clauses, type of review and repairing and insuring clauses, pose serious difficulties for occupiers of commercial properties. In Denmark the landlord-tenant dilemma occurs over issues bothering on energy-efficiency improvement of a property. According to Astmarsson, Jensen and Maslesa (2013), since tenants are responsible for energy consumption cost in rented apartments, many landlords do not invest enough in the energy efficiency thereby making tenants to expend more.

Arku, *et al* (2012) studies of low income housing market in Ghana revealed that abrupt rent increases and unjust eviction is rampant. Advance rent payments are demanded for period of two to five years despite Ghana's Rent Act stipulating maximum of six months advance rent. The practice of creating conflict with siting tenant in order to secure higher rent from potential tenants was noted with landlords. When landlord cannot have their way, they engage 'macho' men and hoodlums to forcefully evict tenants who cannot pay the demanded rent. All these contribute to unhealthy landlord-tenant relationship.

3. Materials and Methods

Survey research approach was adopted in this study. The approach was used, because it has the advantages of identifying attributes of a large population from a small group of individuals, rapid approach in data collection and the economy of the design (Kothari, 2004, Fowler, 1995). Tenants of residential property market at Lokoja were the targeted population for this study. The study area was stratified into five strata - Adankolo, Ganaja, Lokongoma, Sarkin-Numa, Kabawa - and 60 questionnaires were randomly distributed in each stratum. In all, 300 questionnaires were administered. Although, a total of 263 questionnaires were retrieved, only 235 (78.3%) constituted valid response on which the results of this study was based. The questionnaire was prepared on five likert scale on questions bothering on issues that generate conflict between tenants and their landlord based on tenants' point of view. Tenants are the consumers of rental properties and Rasila (2009) described Landlord-tenant relationship as a form of business relationship; the competitive environment is changing and the real estate owners are seeking new ways of differentiating themselves from competitors.

The study employed factor analysis and principal component analysis. Factor analysis identifies the structure underlying set of variables in form of latent factors and analyse only the shared variances. Factor analysis organizes, identify and minimize big items from the questionnaire to certain constructs under one dependent variable in a research (Chua, 2009). Principal component analysis provides an optimal ways to combine variables into small number of variables. KMO test was done to identify whether the data is suitable for factor analysis.

4. The Study Area

Lokoja was the first headquarter of Nigeria immediately after the amalgamation of North and South protectorates in 1914. The first Governor General of the Northern protectorate

– Sir Fredrick Lugard was sworn in on 1st January 1880 at Lokoja. It assumed the current status of state capital when Kogi State was created out of the old Kwara and Benue State on 27th August 1991. Since its creation, the state has been witnessing tremendous stride in housing and urban development. The teeming population experienced in the state capital has necessitated development of various types of properties ranging from commercial, residential, industrial etc. The participants in these developmental activities include individual investors, corporate and government. The population of Lokoja which was below 40,000 before it became state capital increased to 43,784 in 1991 and over 196,643 in 2006 census (National Bureau of Statistics, 2009).

5. Results and Discussion

The demographic characteristics of the respondents presented in table 1 shows that 166 (70.64%) are males and 69 (29.36%) females. Their age distributions indicates that majority (99.15%) of them falls within 20 and 60 years, and 80.85% of the respondents have lived in the study area for period not less than 5 years.

Table 1: Demographic Characteristics of Respondents

Classification/ Range	Frequency	%
Sex		
Male	166	70.64
Female	69	29.36
Age		
< 20yrs	2	0.85
21-40yrs	132	56.17
41-60yrs	101	42.98
> 60yrs	0	0.00
Duration in Property Occupied		
Below 5 years	45	19.15
5 – 10 years	154	65.53
11 – 20 years	36	15.32
Above 20 years	0	0.00

Source: Field Survey, 2011

The survey revealed that 70.64% of the tenancies in the study area do not have formal tenancy agreement drawn and all the respondents have had dispute with their landlord or his agent at one time or the other in the course of their tenancy. Only 38.30% of the respondents live in premises managed by an Estate Surveyor and Valuer (see table 2). By virtue of Decree 24 of 1975, Estate Surveyors and Valuers are authorized to manage land and landed properties in Nigeria.

Table 2: Tenancy Agreement and Experience of dispute with landlord/agent

Classification/ Range	Total	%
Existence of Tenancy/ Lease Agreement		
Yes	69	29.36
No	166	70.64

Record of Dispute		
Yes	235	100.00
No	0	0.00
Involvement of Estate		
Surveyor in Management of Property Occupied		
Yes	90	38.30
No	145	61.70

Source: Field Survey, 2011

The Bartlett's test of sphericity and sampling adequacy are presented in Table 3 and shows that the chi-square of 12077.901 is significant at 0.000 which is an indication that the sample used is adequate. The value of Bartlett's test of sphericity is significant ($p < 0.001$, $p = 0.000$). The Kaiser-Meyer-Olkin (KMO) is another measure of sample adequacy. It is an index for comparing magnitudes of the observed correlation coefficients between all pairs of Variables. KMO statistics varies between 0 and 1. A value of 0 indicates that the sum of partial correlations is large relative to the sum of correlations, indicating diffusion in the pattern of correlations (hence, factor analysis is unlikely to be appropriate). A value close to 1 indicates that pattern of correlations are relatively compact and so factor analysis should yield distinct and reliable factors. Values between 0.5 and 0.7 are mediocre, values between 0.7 and 0.8 are good, values between 0.8 and 0.9 are great and values above 0.9 are superb (Hutcheson and Sofroniou, 1999). For this study, the value is 0.935, which falls into the range of being superb; so there is confidence that factor analysis is appropriate for these data.

Table 3: KMO and Bartlett's test of Sphericity

Kaiser-Meyer-Olkin Measure of Sampling Adequacy. .935		
Bartlett's Test of Sphericity	Approx. Chi-Square	12077.901
	df	190
	Sig.	.000

Source: Field survey (2011)

Table 4 shows the table of communalities before and after extraction. Principal component analysis works on the initial assumption that all variance is common; therefore before extraction the communalities are all 1 (Field, 2005). The communalities under extraction column reflect the common variance in the data structure. For instance from the table 93.4% of the variance associated with High gap in Rent Revision is common or shared variance. The result of the communalities shows that all the variables are well and completely fitted with the factor solution and none could possibly be dropped from the analysis.

Twenty variables were used in this study. When subjected to factor extraction by principal component Table 5 shows that only two of the variables were found to be useful for this study due to low variance value of the common factors. The variables are highly correlated leading to multi-collinearity. The output of the analysis in the initial component matrix was subjected to rotation in order to fine tune the loadings on each factor. The initial Eigen values, the percentage variance explained, and the rotation sum of square loading are presented in Table 5. Before rotation, factor 1 accounted for 83.323% compared to 8.275% of factor 2. After extraction, it accounts for only 48.537% of variance. Factor 2 accounted for 43.060% of the variance. The clustering of factors constituting disputes within the two components generated normalized cumulative sums of squared loading of 91.598%.

Table 4: **Communalities**

	Initial	Extraction
High Gap in Rent Revision	1.000	.934
High Initial Rent	1.000	.918
Refundable Deposit	1.000	.887
Conversion/Deviation from Agreed Use	1.000	.938
Delay in payment of PHCN bill	1.000	.909
Delay in payment of water rate	1.000	.926
Delayed response to maintenance	1.000	.923
Delayed Response to Tenants Complain	1.000	.915
Interference with tenants Private life	1.000	.912
Interval of Rent Revision	1.000	.805
Keeping of Pets	1.000	.948
Unilateral Revision of Rent by landlord/Agent	1.000	.884
Non/Delayed -payment of Property Rate	1.000	.933
Number of User/Size of Family	1.000	.944
Payment for Community Security	1.000	.890
Poor quality of works	1.000	.933
Poor Routine Inspection of Property	1.000	.944
Sublet of Demised Property	1.000	.920
Unscheduled (impromptu) Property Inspection	1.000	.946
Use of Rent Revision as Treat of Eviction	1.000	.911

Source: Field survey, 2011

Component	Initial Eigen values			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	16.665	83.323	83.323	9.707	48.537	48.537
2	1.655	8.275	91.598	8.612	43.060	91.598
3	.492	2.461	94.058			
4	.284	1.422	95.481			
5	.238	1.189	96.669			
6	.161	.804	97.473			
7	.133	.665	98.138			
8	.075	.376	98.513			
9	.054	.268	98.781			

10	.045	.223	99.004	T able 5: Extracti on Method: Principa l Compon ent Analysis S ource:
11	.040	.202	99.206	
12	.035	.177	99.383	
13	.027	.136	99.519	
14	.023	.113	99.632	
15	.020	.100	99.733	
16	.015	.073	99.806	
17	.013	.065	99.871	
18	.011	.053	99.924	
19	.009	.046	99.970	
20	.006	.030	100.000	

Field survey 2011

Table 6: Rotated Component Matrix^a

	Component	
	1	2
High Gap in Rent Revision	0.913	
Delayed response to maintenance	0.893	
Delayed Response to Tenants Complain	0.862	
Poor quality of maintenance works	0.860	
Unilateral Revision of Rent by landlord/Agent	0.859	
Interval of Rent Revision	0.848	
Interference with tenants Private life	0.832	
Poor Routine Inspection of Property	0.808	0.540
Unscheduled (impromptu) Property Inspection	0.741	0.631
Payment for Community Security arrangement	0.734	0.592
Use of Rent Revision as Treat of Eviction	0.718	0.629
Delay in payment of water rate	0.716	0.643
Delay in payment of PHCN bill	0.694	0.654
Non/Delayed -payment of Property Rate		0.921
Conversion/Deviation from Agreed Use		0.897
Number of User/Size of Family		0.890
High Initial Rent		0.862
Keeping of Pets		0.857
Refundable Deposit		0.830
Sublet of Demised Property		0.826

Source: Field survey, 2011

In table 6, two components with eigenvalues greater than 1.0 were extracted using the factor loading of 0.50 as the cut-off point to ensure easy and quality of result interpretation. A total of two factors were extracted and the following two factor groupings were obtained.

Factor 1: **Value for Rent Paid**

- (a) High Gap in Rent Revision
- (b) Delayed response to maintenance
- (c) Delayed Response to Tenants Complain
- (d) Poor quality of works
- (e) Unilateral Revision of Rent by landlord/Agent
- (f) Interval of Rent Revision
- (g) Interference with tenants' Private life

Factor 2: **Misuse of Demised Property**

- (a) Non/Delayed -payment of Property Rate
- (b) Conversion/Deviation from Agreed Use
- (c) Number of User/Size of Family
- (d) High Initial Rent
- (e) Keeping of Pets
- (f) Refundable Deposit
- (g) Sublet of Demised Property

It is noteworthy that certain variables are common to the two identified factors. These are poor routine inspection of property, unscheduled (impromptu) property inspection, payment for community security, use of rent revision as treat of eviction, delay in payment of water rate and delay in payment of PHCN (electricity) bill.

6. Conclusion and Recommendation

This paper employed factor analysis in categorising various causes of dispute between tenants and landlords in Lokoja, Nigeria. The result of the factor analysis reduced the variables responsible for incessant clash between tenants and landlords into two factors, namely: the quest to have value for the rent paid and guide against misuse/un-authorized use of the demised property. These two factors with cumulative loading of 91.598% require a close attention if there would be healthy landlord-tenant relationship. Also, 70.64% of respondents do not have Tenancy Agreement executed between them and their landlords an indication that most of the existing lease are informal. The involvement of professional property manager (Estate Surveyors and Valuers) in Lokoja rental market is grossly low. Only 38.3% of respondents deal with their landlords through these professionals.

In light of the foregoing discussion, it is pertinent that tenants must insist on executing tenancy agreement with their landlords or their agents at the commencement of their tenancy. Although the existence of this all important document is not a guarantee against disputes, its existence makes parties involved to exhibit reasonable caution in the relationship. Informality and lack of official documentation of leases makes going to court an extremely impractical way of dealing with landlord-tenant conflicts.

There is need to intensify efforts towards creating more awareness about the services of Estate Surveyors and Valuers at Lokoja. This of course must be undertaken by the members of Nigerian Institution of Estate Surveyors and Valuers (NIESV) whose practice domicile in the study area through quality professional services. The public must be able to distinguish between the professionals and quacks who have dominated the property market and most time to the detriment of un-informed public.

Landlords and their agents must ensure their tenants have value for the rent paid. Maintenance works must be attended to promptly and good quality work must be ensured. Routine maintenance should not be compromised because *a stitch in time saves nine*.

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Development of Solar Powered Mobile Refrigerator for Transportation and Storage of Vaccines

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Abstract

The lack of adequate modern storage facilities in rural areas inspired the desire to embark on this project in order to save lives and contribute to the well being of the society. The lack of reliable power supply in most rural areas in Nigeria has posed death risk to the lives of mothers as well as infants who often need medical attention where electricity is erratic or absolutely not available; hence the design and construction of the solar powered mobile refrigerator for the transportation and storage of vaccines in local communities. The construction is model after the vapour compression system with power supply coming from a photovoltaic (PV) solar system (solar panel). The system has an average minimum temperature of 2°C and maximum temperature of 15°C with an efficiency of 74.18%. This project is tailored towards development and construction of a solar powered mobile refrigerator for transportation and storage of vaccines, to eliminate waste and spoilage of vaccines, to evaluate its performance with existing standards and to reduce the dependence on electricity for the storage of vaccines. The construction of the solar refrigerator to preserve vaccines is technologically feasible and will serve as an alternative source of refrigeration to rural communities which do not have electric power supply.

Key Words: Development, Modern Storage, vaccines, power supply, rural areas, refrigerator, solar powered, performance

Introduction

Refrigeration of vaccines and food is problematic in this part of the World where there is no electricity or where the electricity supply is unreliable. In these region vaccines are maintained by either kerosene powered refrigerator or battery-based solar refrigerator. There are significant concerns with both kerosene refrigeration and the existing generation of solar vaccine coolers.

The challenge of providing environmentally safe and affordable vaccine food preservation in the poorer regions of the world brought about health, developmental, and environmental issues. The need for environmentally friendly and affordable solar vaccine coolers and refrigerators was realized between 1998-2000 through separate discussions between United Nations Environment Programme (UNEP), World Health Organization (WHO) and Greenpeace International (GPI). Independently, around the same time; the Danish technological Institute (DTI), funded by the Danish Energy Agency, began the development of a new solar refrigerator that by-passed the use of batteries. The DTI working in conjunction with the Danish refrigerator manufacturer Vest frost collaborated with Danfoss Company of Denmark to develop a direct current hydrocarbon compressor. (Solar Chill, 2005.)

According to Laura, *et al* (2008), they concluded in their work on solar refrigeration that the overall coefficient of performance of a system can be defined as the ratio of the refrigeration capacity to the input of solar energy. However, this definition of the efficiency is not the most relevant measure for solar refrigeration system because the fuel that drives the system during the operation, the solar energy, is free. Other metrics that are much more important are specific size, weight and of course, the cost should play a pivot role in determining the system efficiency.

Methods of Achieving Solar Powered Refrigeration

The under listed methods are ways in which the Mobile Solar Powered Refrigeration can be achieved: Photovoltaic/Vapour Compression, Photovoltaic/Peltier Effect, Solid Absorption/Zeolite, Solid Absorption/Calcium Chloride and Liquid Absorption/Ammonia.

The Photovoltaic System

Solar cells represent the fundamental conversion unit of photovoltaic system. They are made from semiconductors, and have much in common with other solid-state electronic devices such as diodes, transistors and integrated circuits (Derrick *et al* 1991). The solar cell operation is based on the ability of semiconductors to convert sunlight directly into electricity by exploiting photovoltaic effect. In the conversion process, the incident energy of light creates mobile charged particles in the semiconductors which are then separated by the device structure and produce electric current. (Markvart, 1994).

To achieve the desired result, the solar circuit was interconnected with 75watts solar panel to power the 1/10hp compressor; 90Ah battery was also used for longer working time of the refrigerator with an inverter of 1KVA to aid the effectiveness of the refrigerator (Aero, 2010)

Refrigeration System

Stoecker and Jones, (1982) define refrigeration as the process of removing heat from enclosed space, or from substances and rejecting it elsewhere for the primary purpose of lowering the temperature of the enclosed space or substance and then maintaining that lower temperature. In order to reduce the temperature of a material you do not "add cold", instead you remove the heat; hence heat can be describe as the absence of heat. In order to satisfy the

Second Law of Thermodynamics, some work must be performed to this. The work is traditionally done by mechanical work but can also be done by magnetism, laser or by other means. However, all refrigeration uses the three basic method of heat transfer: Conduction, Convection, and Radiation (Frank, 2006).

There are four basic component parts of refrigeration system, these are: Evaporator, Compressor, Condenser, and Expansion valve. Mention also must be made of the medium which removes the heat from the product, that is, the Refrigerant. For the system to run efficiently the aforementioned materials must work together effectively.

In line with global call for the preservation of the environment and the need to make the mobile solar powered refrigerator environmentally friendly to its users, Tetrafluoroethane - R134_a (CF₂CH₂F) from the family of HFC was chosen; because it has very low level of Ozone depletion coupled with its other characteristics. Also consideration was given to the condenser and Evaporator temperatures, ranging from 40^oc and 2^oc respectively since the Vaccines are expected to be cooled rather than frozen.

The working system is based on the analysis of the vapour compression system. The temperature and pressure enthalpy of the system are as shown below:

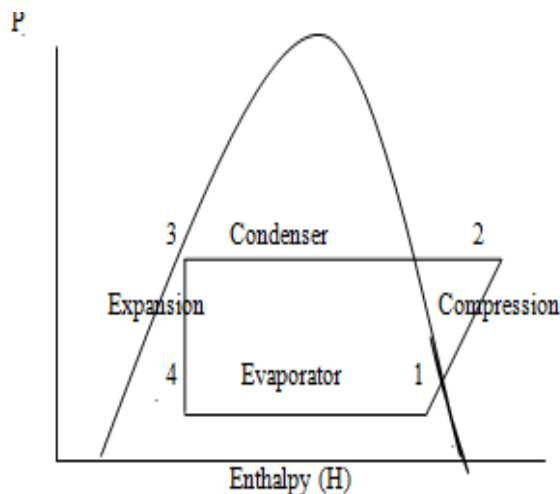


Figure 1: Determination of Enthalpy at Various Points

Obtaining the enthalpy of the refrigerator at all four stages in the vapour compression system was based on the thermodynamics table of R134a.

$$h_1 = (h_f \text{ at } 40^\circ\text{C})$$

By interpolation

$$h_f \text{ at } 39.39^\circ\text{C} = 105.29 \text{ KJ/Kg}$$

$$h_r \text{ at } 46.32^\circ\text{C} = 115.76 \text{ KJ/Kg}$$

$$h_f \text{ at } 40^\circ\text{C} \frac{40-39.39}{46.32-39.39} = \frac{h_1-105.29}{115.76-105.29}$$

$$0.61 \times 10.47 = 6.93(h_1 - 105.29)$$

$$6.3867 = 6.93h_1 - 729$$

$$6.93h_1 = 736.0464$$

$$h_1 = 106.211 \text{ KJ/Kg}$$

$$h_f \text{ at } 40^\circ\text{C} = 106.211 \text{ KJ/Kg}$$

$$h_1 (h_f \text{ at } 40^\circ\text{C}) = 106.211 \text{ KJ/Kg}$$

$$h_2 = (h_g \text{ at } 2^\circ\text{C})$$

By interpolation

$$h_g \text{ at } -1.23^\circ\text{C} = 246.52$$

$$h_g \text{ at } 2.48^\circ\text{C} = 248.66$$

$$h_g \text{ at } 2^\circ\text{C} = h_2$$

$$\frac{2 - (-1.23)}{2.48 - (-1.23)} = \frac{h_2 - 246.52}{248.66 - 246.52}$$

$$3.23 = \frac{h_2 - 246.52}{2.14}$$

$$3.23 \times 2.14 = 3.17(h_2 - 236.52)$$

$$= 6.9122 = 3.17h_2 - 914.5892$$

$$3.17h_2 = 914.5892 + 6.9122$$

$$= 921.5014$$

$$h_2 = \frac{921.5014}{3.17}$$

$$= 289.7481$$

$$h_g \text{ at } 2^\circ\text{C} = 248.38 \text{ KJ/Kg}$$

$$P_3 = (Pa)$$

$$P_3 \text{ at } 39.39 = 1 \text{ MPa} = 1 \times 10^6 \text{ Pa}$$

$$P_3 \text{ at } 46.32 = 1.2 \text{ MPa} = 1.2 \times 10^6 \text{ Pa}$$

$$P_3 \text{ at } 40^\circ\text{C} =$$

$$\frac{40 - 39.39}{46.32 - 39.39} = \frac{p_1 - (1 \times 10^6)}{(1.2 \times 10^6) - (1 \times 10^6)}$$

$$0.61 = \frac{P_3 - 1000000}{200000}$$

$$6.93 = P_3 - 1000000$$

$$122000 = 6.93 P_3 - 6930000$$

$$122000 = 6.93 P_3 - 6930000$$

$$P_3 = \frac{7052000}{6.93}$$

$$P_3 = 1,017,604.6 \text{ Pa}$$

$$P_3 = 1,017,604.6 \text{ Pa}$$

But recall

$$1 \text{ bar} = 1.013 \times 10^5 \text{ Pa}$$

$$P_3 = 1,017,604.6 \text{ Pa}$$

$$p_3 = \frac{1 \times 1,017,604.6}{1.013 \times 10^5}$$

$$p_3 = \frac{1,017,604.6}{1.013 \times 10^5}$$

$$P_3 = 10.045 \text{ bar}$$

$$P_3 = 10.045 \text{ bar}$$

$$P_3 (\text{bar}) = 10.045 \text{ bar}$$

Since process 4 – 1 is a constant enthalpy process

$$h_4 = h_1 = 106.211 \text{ KJ/Kg. (from R134a Table) (Ashrae, 94)}$$

$$h_3 = (h_g \text{ at } 40^\circ\text{C})$$

$$h_g \text{ at } 39.39^\circ\text{C} = 267.97 \text{ KJ/Kg}$$

$$h_g \text{ at } 46.32^\circ\text{C} = 270.99 \text{ KJ/Kg}$$

$$h_g \text{ at } 40^\circ\text{C} = h_3$$

$$\frac{40 - 39.39}{46.32 - 39.39} = \frac{h_3 - 267.97}{270.99 - 267.97}$$

$$0.61 = \frac{h_3 - 267.97}{3.02}$$

$$6.93 = h_3 - 267.97$$

$$h_3 = 274.90$$

$$0.61 \times 3.02 = 6.93 (h_3 - 267.97)$$

$$1.8422 = 6.93 h_3 - 1857.0321$$

$$6.93 h_3 = 1857.0321 + 1.8422$$

$$6.93 h_3 = 1858.8743$$

$$h_3 = \frac{1858.8743}{6.93}$$

$$h_3 = 268.2358 \text{ KJ/Kg}$$

$$h_3 = (h_g \text{ at } 400^\circ\text{C}) = 268.2358 \text{ KJ/Kg}$$

Isentropic efficiency of the compression is given as

$$\eta = \left(\frac{h_f - h_g}{h_f - h_g} \right) \quad (1)$$

$$\eta = \frac{h_3 - h_2}{h_3 - h_2} \quad (2)$$

$$h_3 = \left(\frac{h_3 - h_2}{\eta} \right) + h_2 \quad (3)$$

$$h_3 = \frac{h_3 - h_2}{0.75} + h_2 \quad (\text{Areo, 2010}) \quad (4)$$

$$h_3 = \left[\frac{268.2358 - 248.38}{\eta} \right] + h_2$$

$$= \frac{19.8558}{0.75} + 248.38$$

$$= 26.4744 + 248.38 \text{ KJ/Kg}$$

$$h_3 = 274.8544 \text{ KJ/Kg}$$

Design Calculation:

(a) Product Load: This is the heat which is removed from the product brought into the refrigerated space (Dossat, 1987). For this design, the product used is vaccine. Therefore, the product load involves the amount of energy that will be needed to cool the vaccine from 25°C room temperature to a range of +2°C to +8°C (Evaporator temperature).

Applying the equation,

$$\theta = mc\Delta t \quad (\text{Dossat, 1987; Eastop and Mconky 1993}) \quad (5)$$

Where:

θ = the quantity of heat (KJ)

m = mass produced (Kg)

c = specific heat capacity (KJ/Kg°C)

Δt = change in product temperature (°C)

The heat capacity of water is 4.2KJ/Kg°C

Density of water is 1000kg/m³ (Prasad, 1991)

The volume of the evaporated compartment is obtained thus:

$$\text{Volume} = V = L \times B \times D \quad (6)$$

Where $L = 0.445\text{m}$, $B = 0.413\text{m}$, and

$D = 0.455\text{m}$

$$V = 0.445 \times 0.413 \times 0.455 = 0.0836\text{m}^3$$

Therefore, volume of vaccine that would be cooled is 0.0836m³

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} \quad (7)$$

$$\text{i.e. Mass} = \text{Density} \times \text{Volume} \quad (8)$$

$$1000\text{kg/m}^3 \times 0.0836\text{m}^3 = 83.6\text{kg}$$

The amount of energy needed to cool the vaccine from 25°C to 2°C is obtained as follows

Where

θ = the quantity of heat (KJ)
 m = mass produced (Kg)
 c = specific heat capacity (KJ/Kg°C)
 Δt = change in product temperature (25°C – 2°C)
 $\theta = 83.6 \times 4.2 \times 23 = 8,077.9 \text{KJ}$

The product Load =

Energy required

Refrigeration running period/day (Dossat, 1987) (9)

Assuming a total running period of 10hours for the refrigeration per day

$$\text{The product load} = \frac{8.0779 \text{KJ}}{10 \times 3600 \text{ sec}}$$

$$= 0.2244 \text{KW}$$

This known as refrigeration load or refrigerating capacity

Determination of Mass flow rate (m)

$$\text{Mass flow rate (m)} = \frac{\text{Refrigeration Load}}{\text{Refrigeration Effect}} \quad (10)$$

$$\text{Refrigeration Effect (} q_c \text{)} = h_2 - h_1 \quad (11)$$

$$h_2 = 248.38 \text{KJ/Kg}$$

$$h_1 = 106.211 \text{KJ/Kg}$$

$$(q_e) = 248.38 - 106.211$$

$$= 142.169 \text{KJ/Kg (R134a table)}$$

$$\text{Refrigeration load} = \text{Product load} = 0.2244 \text{Kw.}$$

$$\text{Therefore, Mass flow rate (m)} = \frac{0.2244}{142.169}$$

$$= 0.001578 \text{kg/sec.}$$

The mass flow rate of the Refrigerant

$$= (0.001578 \text{kg/sec})$$

Compressor Design

(b) Compressor Power: = *Work of compressor x mass flow rate* (Marsh and Olivo, 1979) (12)

$$\text{Compressor Power} = [h_3 - h_2]m$$

$$[274.8544 - 248.38][0.001578]$$

$$= 0.04178 \text{KW}$$

Since 0.7463KW = 1horse power

$$\text{Hence the compressor power} = \frac{0.04178}{0.7463}$$

$$= 0.056 \text{hp} \approx 0.1 \text{hp}$$

Therefore, the compressor capacity required to produce the refrigeration load of 0.2244KW in 10 hours per day is $0.1 \text{hp} \left(\frac{1}{10}\right) \text{hp}$

Volume flow rate at compressor suction

$$\text{Volume flow rate (V)} = \text{specific volume (} V_s \text{)} \times \text{mass flow rate (m)} \quad (13)$$

$$= V_s \text{(at } 2^\circ\text{C)} \times m$$

From R134a Table

By interpolation

$$V_s \text{ at } (-1.23^\circ\text{C}) = 0.0718 \text{ m}^3/\text{kg}$$

$$V_s \text{ at } (2.48^\circ\text{C}) = 0.0632 \text{ m}^3/\text{kg}$$

$$V_s \text{ at } 2^\circ\text{C} = V_s$$

$$\frac{2 - (-1.23)}{2.48 - (-1.23)} = \frac{V_s - 0.0719}{0.0632 - 0.0719}$$

$$V_s = \frac{0.238648}{3.71}$$

$$V_s = 0.0643 \text{ m}^3/\text{kg}$$

$$V_s \text{ at } 20\text{C} = 0.0643 \text{ m}^3/\text{kg}$$

$$M = 0.001578 \text{ kg/s}$$

$$\text{Therefore } V = 0.0643 \times 0.001578$$

$$= 0.00010151 \text{ m}^3/\text{s}$$

(c) Compressor Power per KW of refrigeration

Power per (KW) of refrigeration

$$= \frac{\text{Compressor power}}{\text{Refrigerating rate}} \quad (14)$$

Refrigerating rate

Actual refrigeration rate = Theoretical refrigeration rate + factor of safety

Let the factor of safety = 10% refrigeration capacity

$$= \frac{10}{100} \times 0.2244$$

$$= 0.1 \times 0.2244$$

$$= 0.02244 \text{ KW}$$

Therefore actual refrigeration rate

$$= (0.2244 + 0.0244)$$

$$= 0.24684 \text{ KW}$$

Compressor power = 0.04178 KW

$$\text{Power per (KW) of Refrigeration} = \frac{0.04178}{0.24684}$$

$$= 0.169$$

(d) Coefficient of performance (COP)

The coefficient of performance (COP) for the actual system is given as

$$\text{COP} = \frac{\text{Refrigerating Effect}}{\text{Heat of Compression}} \quad (\text{Dossat, 1987}) \quad (15)$$

$$\text{COP}_{\text{actual}} = \frac{h_2 - h_1}{h_4 - h_2} \quad (16)$$

$$\frac{248.38 - 106.211}{274.8544 - 248.38}$$

$$\text{COP}_{\text{actual}} = 5.37$$

(e) Refrigeration Efficiency

This is the ratio of coefficient of performance of the cycle to that of the ideal of gas within the same temperature range (Stocker and Jones, 1982).

$$\text{COP}_{\text{actual}} = \frac{T_1}{T_2 - T_1} \quad (17)$$

$$T_1 = 2^\circ\text{C} = 275\text{K}$$

$$T_2 = 40^\circ\text{C} = 313\text{K}$$

$$\text{COP}_{\text{ideal}} = \frac{275}{313 - 275}$$

$$\text{COP}_{\text{ideal}} = 7.24$$

$$\text{Refrigerating Efficiency} = \frac{\text{COP}_{\text{actual}}}{\text{COP}_{\text{ideal}}} \times 100 \quad (18)$$

$$= 5.37/7.24 \times 100$$

$$= 0.7417 \times 100 = 74.17\%$$

Production cost

The cost of production of this machine covered bought out components, cost of machining and materials and non machining cost. This was estimated to two hundred and fifty six thousand naira (N256, 000:00) only. The initial cost is high but this will be complemented by its low maintenance cost and the long term usage will be of added advantage.

Performance Evaluation:

The solar powered refrigerator was tested using a thermocouple to determine the temperature at which the equipment will meet the set target of the research as well as to determine to know its efficiency. The data were collected at the Medical Centre of Federal University of Technology, Akure. The following temperature data's were collected at an interval of 5 minutes.

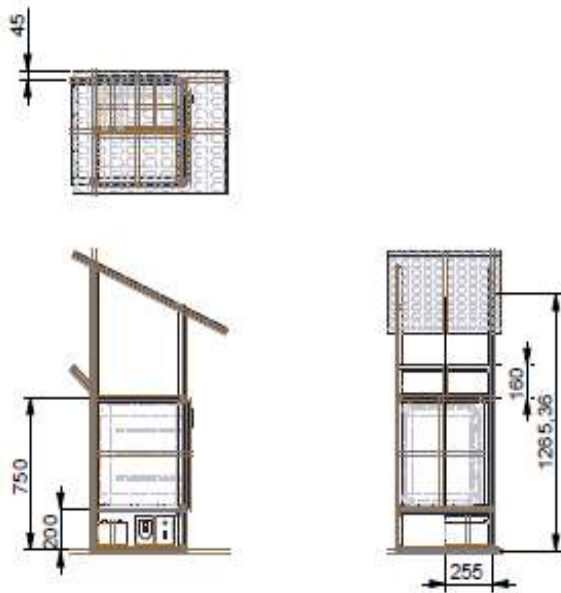


Figure 2: Orthographic view

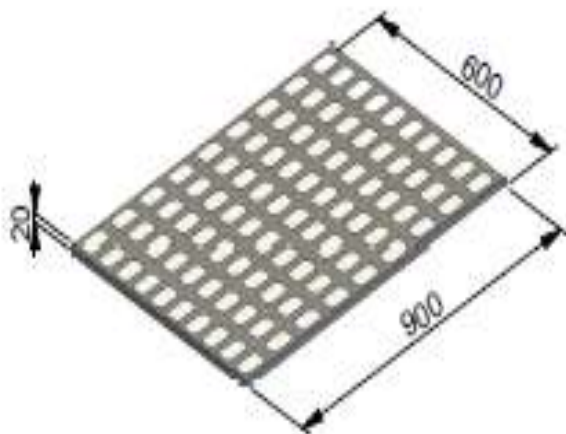
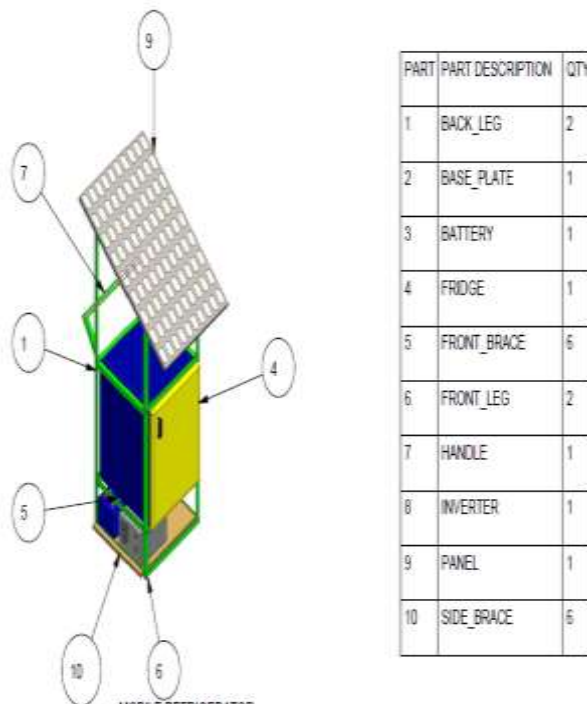


Figure 3: Solar Panel



powered vaccine Refrigerator

Figure 4: Assembly Drawing of Solar

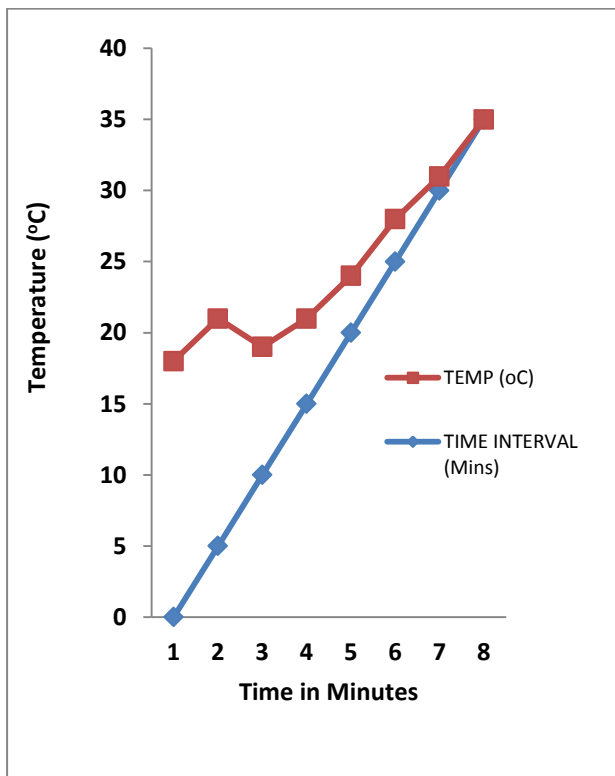


Figure 4: The graph above shows the relationship between time and temperature.

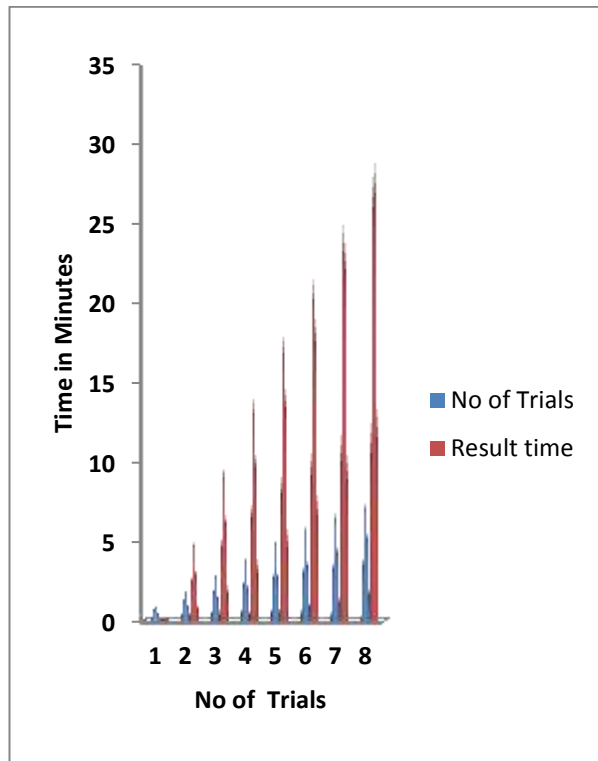


Figure 4: The graph above shows the number of trials and time taken

Conclusion:

The design and construction of the mobile solar refrigerator was done as a means of finding an alternative means of transporting and storage of vaccines in the rural areas where power supply is non-existent or epileptic. The efficiency of the constructed mobile solar powered vaccine storage refrigerator is 74.2%. The cost of production of the equipment is estimated at #256,000:00 which is about \$1,220 at #210:00 exchange rate, including materials, labour, and profit. The initial cost is high but this will be complemented by its low maintenance cost and the term usage will be of added advantage. This equipment could both be used in rural communities as well as other areas where power supply are in-adequate

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Mapping Dutch Higher Education Lecturers' Discourse on Research at Times of Academic Drift

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Abstract

With the introduction of research activities in higher professional education in the Dutch higher education system, the notions of 'research' that were previously silently agreed upon among academics in traditional universities also came under pressure. Additionally, both types of higher education actively claim to have educational programs of a different character. The ground underneath the difference is claimed to be the presence of distinct research activities. This study considers this difference through the discourse on 'research' of lecturers in both higher professional education and university education. In interviews, lecturers were asked to judge an argument on their own work-related activities to be 'research' or 'non-research'. Through a network-analysis approach, the data results in five discursive building blocks that all lecturers apply in their arguments, and three discursive themes on research. Furthermore, this research indicates that differences among lecturers on discursive themes are only partly based on institutional differences.

Keywords: higher education, research, discourse analysis, social network analysis, professional education.

Despite a long tradition in universities, there remain different notions of what research ought to be (Brew, 2001). In the second part of the twentieth century and as an effect of the massification of the higher education system, higher professional education (HPE) was seen as an important addition to the university system in several European countries. This resulted in the creation of, for example, the 'new' universities in the UK, and the uplift of HPE in the Netherlands (Huisman, 2008) and of the Liberal Arts Colleges in the US, although sometimes for different reasons (Jaquette, 2013). To fulfil their system change, the Dutch HPE, gained in 2001 the possibility of conducting publicly funded research (Dutch Ministry of Education Culture and Science & Netherlands Association of Universities of Applied Sciences, 2001). As often occurs with the introduction to newcomers in an existing field, notions that were previously silently agreed upon came under pressure. In this case, the notion of 'research' became part of a public debate on the function and position of both types of institutes in a single higher education system (Griffioen & De Jong, 2013). This added a new chapter to the international debate on what constitutes research. The current article adds to this debate by studying the discourse on research by lecturers in the Dutch higher education system.

Within the Dutch binary system of higher education, both the 14 publicly funded traditional and technical universities (here collectively called 'universities') and the over 40 institutes for higher professional education ('*hogescholen*'; here: HPE) each have their own position and history (De Boer, Enders, & Leisyte, 2007; Huisman, 2008). The Dutch institutes for HPE currently account for over 60% of all Dutch students in higher education (CBS, 2011), mostly provide undergraduate-level programmes in professional fields such as nursing, teaching and engineering, and do not have the right to award doctorate degrees. Some of the Dutch universities were among the first in Europe to be established. All universities provide bachelor, master, and doctorate programmes.

While the universities gained research responsibility in 1876, as an effect of the developments in German universities related to Von Humboldt, institutes for HPE have had the legal right to conduct research since 1986, but in practise, hardly any research activities were undertaken. Here, research activities usually only appeared in the final year of the curricula, and most institutions lacked any 'research culture' (Griffioen, De Jong, & Jak, 2013; Van der Linden, Bakx, Ros, Beijaard, & Vermeulen, 2012). In the context of the knowledge economy of the 21st century, public means for research have been provided to the HPE institutes since 2001, hence providing a stimulus to actually develop research activities. Thus, the current Dutch higher educational system consists of two types of higher educational institutes, each with their own teaching and research responsibilities.

All aforementioned developments were started by politicians and managers of the different higher educational institutes, while lecturers do not seem to have been present in the debates (Griffioen, 2013). At the same time, the educational programmes in which lecturers work seem to be even more important in the positioning of the institutes, since both mainly claim their differences due to their divergent research philosophies in their educational programmes. The universities aim to educate their students in the more fundamental types of research to become 'professional scholars'. The aim of institutes for HPE is to train their students in more practise-based or evidence-based types of research, resulting in the graduation of 'scholarly professionals' (Van der Rijst & Visser-Wijnveen, 2011).

Lecturers' perceptions can be expected to be of large importance in the actual orientation of both types of educational programmes. Previous research has shown that lecturers' research and teaching conceptions can be expected to form a foundation for the research-related education of students (Visser-Wijnveen, Van Driel, Van der Rijst, Verloop, &

Visser, 2009). Furthermore, research conceptions not only influence the shape of educational programmes or research directions. They also influence the balance lecturers apply between the different tasks of research, teaching, and working in professional fields (Boyd & Smith, 2011). At the same time, the connection between conceptions and behaviour is complex and remains inconclusive (Visser-Wijnveen, 2009). These notions result in the hypothesis that the differences between the both types of higher educational institutes in the Dutch system should be visible in the discourse on research that both types of lecturers wield. This should be the case at least if these differences are more than theoretical or political notions. Therefore the following questions are central in this study: 1) what are the structures—later called ‘building blocks—in lecturers’ discourse on ‘research’ and ‘non-research’?; 2) what are the discursive themes in lecturers’ discourse of ‘research’?; and, 3) are there any other differences between lecturers from higher professional education and lecturers from universities?

Discourse Analysis and Network Analysis in a Combined Methodology

The current study explores higher education lecturers’ discourse on research. The notion of discourse in this study is in its essence based on the work of Michel Foucault (2001), who defines discourse as ‘*a collective of concepts and practices (techniques, procedures) with a certain productive force*’. This means a discourse can be considered related statements and actions that collectively produce meanings and have effects. It also means that a discourse is considered to contain the human ability to create and label groups of people or objects by speaking or acting. By speaking and acting, people create and confirm the division between ‘healthy’ and ‘sick’ people, between ‘like’ and ‘dislike’ of food, or the demarcation between a ‘good’ and ‘bad’ score on a test (Carabine, 2001).

The work procedure in this study is rather different from the work of Michel Foucault and others on discourse analysis (Foucault, 2001). The current study applies a procedure by which a rich qualitative analysis is combined with a more quantified (social) network analysis of the lecturers and their statements on research. The procedure is similar to the procedure of social network analysis (Scott, 2013), but in a single map applied to both the statements and the people who uttered them. The result of this procedure is a visualization of the discourse of all respondents by a visualization of their similar and therefore interrelated statements. By this visualisation it is possible to see what statements are more central in the discourse, what statements are more on the edge, and how they are interrelated. Additionally, it is possible to find different discursive themes that are more or less central in the discourse. And finally, the position of the lecturers in the discourse is visualized.

Although applied in a different methodological approach, the principles of centre and edge, as well as of different discursive themes that co-exist, are in line with the notions of Michel Foucault. In his work, major ‘events’ can shift central notions of the discourse more to the edge, and therefore change the discourse over time. Hence, over time and space different rules limit the ‘truths’ of daily practise (in this study labelled as discursive themes), while on and off modifying the discourse by the same daily practise (Foucault, 2001). In the current study these notions are the starting point for the chosen approach. In this sense, the notion of ‘discourse’ is different from the notion of ‘concept’. Entwistle and Peterson (2004), where they refer to ‘concept’ as a shared understanding of something (here, ‘research’), while ‘conception’ is seen as the individual conditions that one applies to define an object. As opposed to ‘conception’, a ‘discourse’ is limited by how words and actions are handled in action to *produce* truth claims or what has been perceived as true (Bills, 2004).

In line with the productive force of actions (including stating something), in their daily practice, lecturers produce the demarcation of ‘research’ by dividing activities— their own as well as those of students, colleagues, and others—into ‘research’ and ‘non-research’. These divisions mostly happen intuitively. However, when encouraged to make the choice explicit— as this study has done in interview settings—lecturers find it suddenly rather hard to argue why they demark their ‘truths’ on research as they do (see also Neumann, 1993). At the same time, the demarcation of research by lecturers is relevant since it denotes the space of research-related activities in practise, e.g. for students when they choose topics and methods for their theses. Thus, the discursive structure of research enables and limits what activities are considered ‘normal’ for research (Carabine, 2001). And, whereas discursive systems are created and enacted by human action, the people involved are, at the same time, defined by them (Foucault, 2001). The central function of the lecturers makes it plausible that their ‘truth’ on research will influence the shape and execution of research in the educational programs and beyond.

Sample

HPE lecturers (N_h=16) who were previously part of a large survey study were found willing to participate in this study. Their selection was based on having teaching responsibilities, willingness to join in the somewhat time-consuming procedure, and the ability to participate in an interview on set days at their institution. In line with previous work of Eekelen (2005) and Kahneman, Krueger, Schkade, Schwarz, and Stone (Kahneman, Krueger, Schkade, Schwarz, & Stone, 2004), these respondents were first requested to keep a log of all their own work-related activities during ten subsequent workdays. The logs were the basis for structured interviews (45-60 minutes) in which the respondents were asked per activity to consider it ‘research’ or ‘non-research’ and to explain the answer. The interviews were transcribed and used as data. The logs themselves were not included in the analysis.

A second sample of university lecturers with teaching responsibility (N_u=19) was added to see whether there are differences in discursive themes between the lecturers of the two types of institutes. The second sample was matched to be comparable to the first sample and consisted of junior lecturers (in this sample, preferably without PhDs) and university lecturers (starting level based on having a PhD), half from the social sciences and half from the natural/technical science fields. The interviews with these respondents were based on a list of activities that was distilled from the activities present in the first group to make it less time-consuming for the participants, while keeping the list generic enough to fit all usual activities. Examples of activities were: to teach a class, or to create a research proposal. The further procedure was similar between the two groups (for respondents’ characteristics, see Table 1).

Table 1: Gender and educational level characteristics of participating lecturers. HPE=Higher Professional Education; TU=Traditional University.

N=35	Gender	Educational Level		
	% Women	% Bachelor	% Master	% PhD
HPE – Science & Technique (N=5)	-	20	60	20
HPE – Social Professions (N=11)	45	18	82	-
TU - Science & Technique (N=9)	66	-	33	67
TU – Social Professions (N=10)	30	-	90	10

Analysis

The first aim of the analysis was to find the basic coding structure for positive and negative judgements on research in the discourse, here called 'building blocks' (question 1). These building blocks are a prerogative to answer the research question on discursive themes, similar to a basic code structure in qualitative analysis (Charmaz, 2006). The audio of the interviews was transcribed *ad verbatim*. Eight of the transcripts were coded *in vivo* by deciding for each statement on research what the judgement was (research or not) along with the specific phrase used by the respondent. A statement was defined as an uninterrupted utterance. Statements where the judgement of the author was inconclusive or covered no content on research/non-research were excluded. This resulted in two lists of phrases: a) positive judgements ('in research...') and b) negative judgements ('in non-research...'). Then, the positive codes and the negative codes were ordered separately to find the building blocks among the statements. These building blocks were then applied on all transcripts, while paying attention to the possible need for new codes and building blocks, which were not found.

The second aim was to find the rules that demarcate 'research' from 'non-research' and hence indicating different discursive themes, by mapping the interrelatedness of all statements and the lecturers that uttered them (question 2). To create the discursive map, all transcripts were re-coded by creating one or more codes for each utterance by each time applying: a) one relevant building block along with b) one open code to provide for the content of the utterance. The direction ('research'/'non-research') of the codes applied was based on whether a part of the statement contributed to 'research' or 'non-research'.

The next step was to create a data file based on the different codes in two types of network connections: a) between the code and the person and b) between each combination of two codes that were applied within a single statement. Based on the frequency of the specific relations found, a relative weight was added to every relation. The data file thereby created was used for further analysis in the social network application NODEXL (Smith et al., 2010), resulting in a combined visual network of discursive codes and the lecturers who uttered them. The Fruchterman-Reingold algorithm (1991) was applied, indicating a graphical position for the vertices (here statement codes or persons), based on the principle of repulsive force among vertices. Hence, the visual position of a vertex in the graph indicates similarities and differences in application among vertices. Furthermore, the Clauset-Newman-Moore grouping tool was used to find groups of more homogeneous vertices based on the relations they have with other vertices. Since NODEXL is used here as a tool for discursive analysis, the content of the different groups found in the graphs were qualitatively interpreted as different themes within the discursive network on 'research' and 'non-research'. Hereby, the graphical display of vertices was qualitatively analysed and supported by the quantitative notions of 'degree' and 'betweenness centrality' of the vertices, as NODEXL provides.

Furthermore, the position of the respondents in the network is additionally qualitatively analysed to indicate similarities and differences between the lecturers' higher professional education and that of universities (question 3). For an overview of all analytic steps see Figure 1.

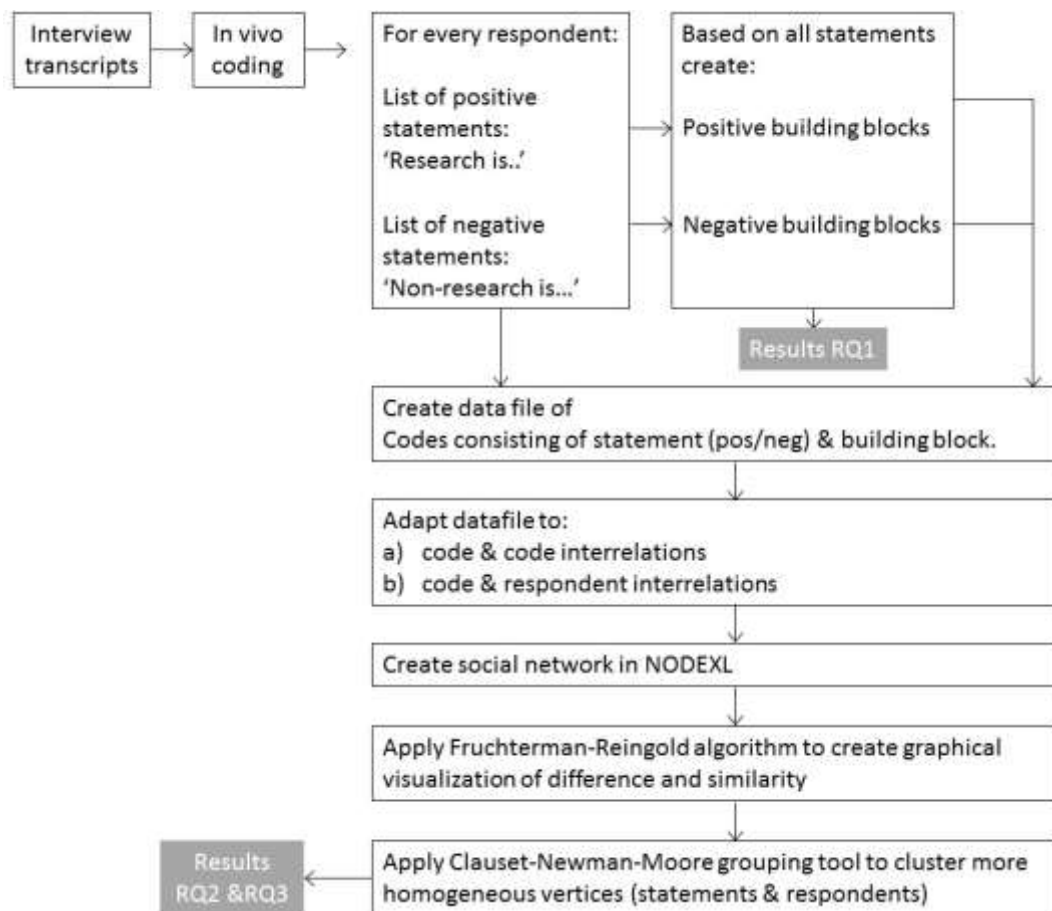


Figure 1: Overview of all analytic steps.

Findings

The findings are structured by the three analytic steps: 1) the building blocks of the discourse of research found, 2) the discursive themes, and 3) the characteristics of the respondents that are part of each discursive theme found.

Types of statements: building blocks of discourse

The ordering of the grounded codes of the first eight transcripts resulted in a coding structure for the positive statements and a coding structure for the negative statements. These were found to be similar where they could have been different. The structure consisted of five different 'research' and 'non-research' building blocks:

- a) *The quality or mode of research* in this building block indicates the difference between research and non-research. Something 'being new' could for instance be considered research, while 'existing', 'routine' or 'educational' are used as arguments for non-research.
- b) *The aims of the activity*. This building block is defined by the direction of the activity. Research and non-research are framed around a certain goal or aim that needs to be reached. Aims applied for research were for instance: 'to solve/improve', 'to find/discover' or 'to develop/create'. Aims for non-research were: 'to inform/exchange', 'to let perform' and 'to let learn'.

- c) *The actual activity*. The actual activity that is shown or done in a situation distinguishes for the respondents between research and non-research. Activities applied to distinguish research were: 'to collect/find', or 'to analyse/process, while 'to transfer/make available', 'to guide/support/council' and 'to use/compare' were applied for non-research.
- d) *The characteristics of the respondent him/herself* makes the difference between research and non-research in this building block. Most often this is by the respondent related to their roles in a situation, such as 'teacher' or 'researcher'.
- e) *The object part of the activity* is used as an argument to distinguish between research and non-research. When asked: is this activity research? The answer can be: yes, because there is 'data', but also 'no, because it is based on formats'.

Discursive Themes of Research

The application of the building blocks to all transcripts and the grouping analysis resulted in a map of the interrelation between statements and their lecturers on 'research' and 'non-research' divided into seven discursive themes: three large ones and four rather small ones. The three larger ones are further qualitatively described; the four smaller themes are considered outliers and not further investigated. The respondents who participated in this study are included in the different discursive themes and reported in the next section.

Theme 1: 'Research in phases versus transfer of existing knowledge'

The results show that the first theme is mostly built of subthemes in the building block Objects that demarcate 'research' for the lecturers, such as the presence of a question or problem, a theory, a method or instrument, a hypothesis, data, and conclusions or results. These subthemes seem to indicate a discourse of research in phases or cycles, also confirmed with the presence of the subtheme 'phases or steps'. Other subthemes that are part of the building block Activities are collecting, finding, and discovering; designing, planning, and choosing; analysing, writing, and reporting; and thinking and reflecting. The two subthemes of the building block Goals that are part of 'research' in this theme are solving, improving, or changing and encouraging reflection or thinking. The building block Modalities shows three subthemes that indicate 'research' in theme 1 is demarcated by a certain level, quality, depth, or complexity, but can also be considered 'research light'. Furthermore, it is mentioned that the activity needs modalities as (scientifically) relevant, valuable, and interesting to consider it research. Other modalities are as follows: of a critical nature, serious, or a quest. Furthermore, different types of research are named, such as qualitative, quantitative, clinical, or literature study, indicating that it is relevant to distinguish between *types* of research. The building block of Respondent Characteristics show by its subthemes that, to demarcate 'research', the role of the respondent him/herself as an active researcher has an influence on the judgement. This argument of researchers' role is combined with the aforementioned subthemes of the building blocks Objects and Activities that collectively can be labelled as research in phases with the modality of depth and complexity, which define an activity as 'research'.

The building block Activity implies that 'non-research' is defined by the transference of material, such as (the content of) curricula or books or knowledge and ideas. Furthermore, a prominent subtheme in the building block Modality indicates 'non-research' to be about something that already exists and is about a topic other than a research topic. Subthemes mentioned in the building block Aims are to find something out or to improve something. The building block Respondent Characteristics is framed as 'a guide or facilitator to others', and 'not as a researcher'.

Theme 2: 'New versus educational routine'

The results of theme 2 show for 'research' a higher portion of the Aims building block than theme 1, with subthemes adding or contributing knowledge or insight but also learning. Theme 2 also shows the building block Modality with subthemes 'directed towards a goal' and the building block Object with the subtheme 'intent' for an activity needed to be judged as research. The building block Activities show in this theme the subthemes: sharing or discussing, guiding or explaining, teaching, and checking. Furthermore, building block Objects show the subthemes: a gathering, thesis, or assignment; skills; and reflection. The Modality 'the respondent him/herself learns as well' is also part of this discursive theme. The Object building block 'subject' is one of the more prominent ones, and the respondents consider an activity research with Modality subthemes as 'the subject is the same as the respondents' research'. In contrast to theme 1 is the Modality subtheme 'new', positioned as the most prominent modality of 'research', along with: creative, explorative, without compromise, and state of the art. Furthermore, an activity can be considered 'research' when it can contribute to research or when it feels like research. An activity is considered 'research' when respondents themselves learn of it, while learning is also an argument part of 'non-research', such as by the goals of learning, guiding, developing, or gaining more insight.

Activity building blocks for 'non-research' in this theme are judging or checking, answering, testing, finding or collecting, and developing. The modalities to indicate that activities are non-research are educational, didactic, or informative and serve the function of graduation, with disciplining and preparatory as less prominent. Other modalities consider 'non-research' activities to be procedural, practical, fixed, and based on routine. The only subtheme of building block Respondent Characteristics in theme 2: 'passive'.

Theme 3: 'Tangible versus invisible'

The arguments that construct the judgement on 'research' in theme 3 are based mainly on the more tangible aspects of research. Relevant subthemes in the building block Aims to judge an activity as 'research' are: graduating (PhD), publishing, receiving funding, developing, creating, or generating. These mostly tangible, output-related goals are combined with some less tangible goals, such as: to keep up with the discipline, to substantiate or deepen, and to conduct research. Also, the formal status of the activity is important, indicated by Modalities' subthemes such as 'is formally research' as well as 'is formally non-research' as part of 'research' in this theme. The most prominent blocks of 'research' in this theme are creating, improving or solving (Activity), tangible output (Object), knowledge, ideas, facts (Object), and orienting or reading (Activity), and the modalities are scientific, structured, substantiated, coherent, and comparable, combined with exploratory and contradictory.

Judgements on 'non-research' are based on deliberation (Activity) and on the presence of a meeting or email (Objects), which indicate a more communicative perspective on activities. Furthermore, 'non-research' activities seem to be less about the respondent him/herself and more about someone or something else, indicated by Modalities such as facilitating and executing, and Respondents' Characterisations such as 'neutrality' or 'being an outsider'. Other (more active) respondent roles are lecturer or project leader, with the goals of checking, organising, or guiding.

Characteristics of respondents in each discursive theme

People create the discourse but are themselves also defined by it (Foucault, 2001). Hence, the respondents were placed inside the network analysis and were found to be clustered in one specific theme. See Figure 2 for an overview of respondents per theme. The results

show that, of the lecturers in theme 1, ‘research in phases versus transfer of existing knowledge’, four are employed in universities in natural/technical science disciplines and five are from behavioural sciences or social professions fields at both types of institutes. When this last group is considered in detail, three have a specific background in methodology and/or psychology, which in the Dutch educational system indicates that they have had extensive training in quantitative research principles and the empirical cycle.

Theme 2, ‘new versus educational routine’ is first applied by lecturers of the universities, both in the social science fields (4) and in the natural/technical science fields (4), along with a smaller group employed in higher professional institutes. When considered more closely, two of the lecturers from universities work in the economics sector and one in the professional education field of economics. Also, one of the lecturers from the natural science field in the university works in informatics, while another works in applied mathematics. Thus, at least five of the lecturers in theme 2 have a work environment that seems familiar with mathematical model-building activities.

Theme 3, ‘tangible versus invisible’, is dominated by lecturers from social science professions at the institutes for HPE, mostly from a ‘caring’ profession such as pedagogics, social work, or health care. Two lecturers from universities in this theme are from the social sciences, which in general has a positive feel toward care-related topics in society.

Based on the numbers of lecturers in this study, as well as the method chosen, this distinction of lecturers in groups can be considered of an explorative nature.

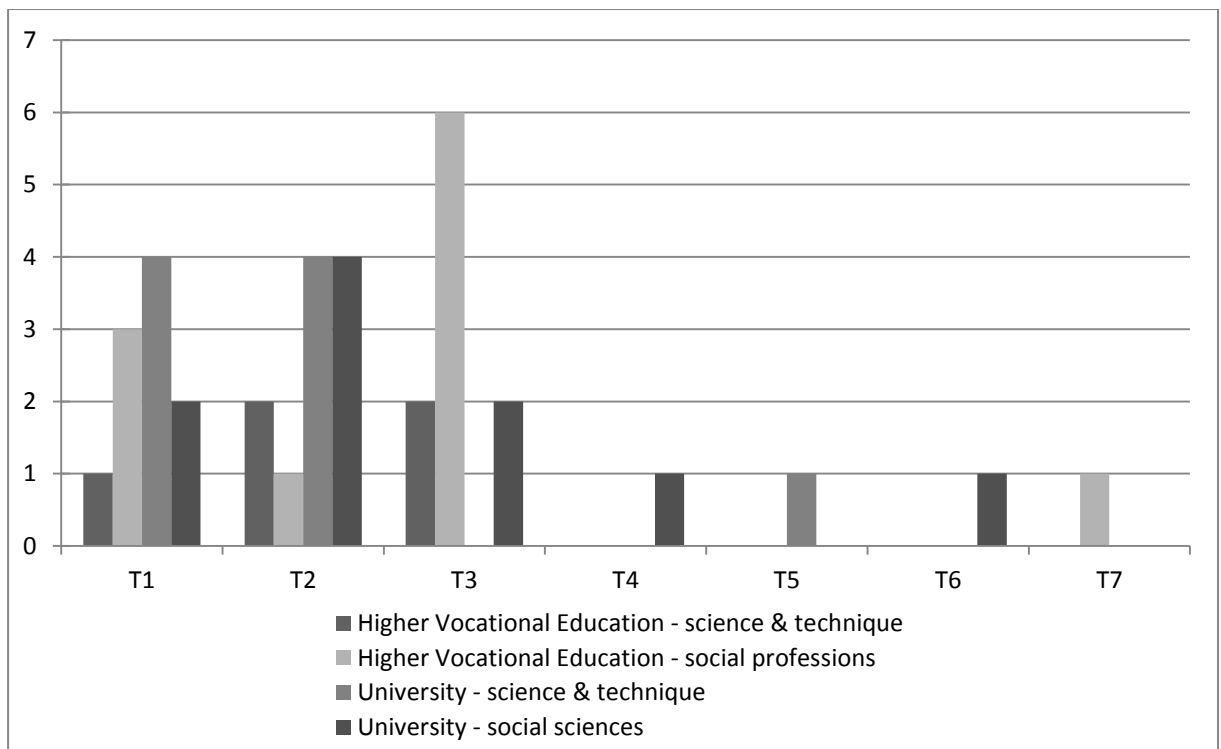


Figure 2: The number of different types of lecturers as part of the different discursive themes (T1-T7)

Discussion

This study has explored the discourse on research of lecturers in higher education with the aim of finding the characteristics of lecturers’ discourse on ‘research’ and ‘non-research’. To do so, lecturers were questioned on what activities they consider to be ‘research’ or ‘non-

research' and why. The activities that were discussed would generally be considered research activities or teaching activities. The grounded coding approach resulted in five different building blocks of lecturers' discourse on research (question 1). Based on the application of these building blocks to the interview transcripts, seven discursive themes on research have been found, of which three are prominent (question 2). Special attention was furthermore given to the differences and similarities between lecturers from higher professional education and lecturers who work for universities (question 3).

The five building blocks found were: a) the quality or mode of research, b) the aims of the activity, c) the actual activity, d) the characteristics of the respondent him/herself, e) the object part of the activity. Similar building blocks can also be seen when a number of previous studies on the nature of research are combined (e.g. Åkerlind, 2008; Brew, 2001; Meyer, Shanahan, & Laugksch, 2005), but before they have not been found as the results of a single analysis. Additionally, a sixth aspect, 'context', which was shown in the study of Bills (2004), was not found as a building block in the present study. Thus, based on the comparison of the results of the present study with previous results, six possible building blocks could be considered when the demarcation of research in higher education is discussed.

The content of each building block and a network analysis of the combination(s) in which they are applied resulted in seven different discursive themes (question 2)—of which three are prominent and four considered outliers—to be distinguished within the discourse on 'research' and 'non-research' among lecturers in higher education. The lecturers in the first theme—referred to as 'research in phases versus transfer of existing knowledge'—consider activities to be 'research' when the respondent functions as a researcher, when the activity is dividable into phases or steps, and when the activity needs to have a certain depth or complexity and (scientific) relevance or interest. Furthermore, the activity needs to be aimed to solve or improve something or to encourage thinking for respondents to consider it 'research'. An activity is considered 'non-research' when it is about transferring or finding out about existing knowledge (not new and mostly teaching-related objects such as books) of a different subject than the respondent's subject. The lecturers that employ this theme are mostly from the natural science field or from a closely related social science (behavioural) strand such as psychology. This theme is dominated by lecturers from the universities.

In the second theme, 'new versus educational routine', 'research' and 'non-research' are both often considered activities that can bring more insight. Research activities are new, creative, and feel like research, while 'non-research' activities can be considered more educational and more practical, fixed, and routine-based, with a more passive role for the respondents. Most respondents have a work context that is related to mathematical models, such as economics or applied math.

The third theme, 'tangible versus invisible', shows how arguments on 'research' are mainly based on tangible aspects such as publications or funding. The codes for 'non-research' are based on the invisibility of the respondents, who mainly have a facilitating character. Most lecturers that are part of this theme have social and care-related work contexts. This theme is dominated by lecturers from the HPE institutes. Furthermore, to provide an answer to question 3, the differences among lecturers in higher education can be somewhat based on institutional differences, but the differences between disciplinary fields seem much more prominent.

Based on the three discursive themes found, 'research' cannot be considered a single discursive entity. The rules underlying the demarcating of 'research' from 'non-research' by lecturers can be considered part of the same discourse in the sense that lecturers all apply

similar building blocks in their reasoning, although not always in the same amount or with the same content. One can say that lecturers of different discursive themes do understand the construct of the arguments (or rules) that lecturers in other themes apply, but they do not see eye-to-eye on what criteria actually delimits 'research'. Hence, they do not fully (re)produce the same construct of research in their actions with students and colleagues. The cyclical process and the active role of the lecturers in the first theme is a rather different perspective than the central role for learning and the modality of the activity in the second theme. There, cycles or phases are less relevant for it to be research as long as the activity has a certain depth, creativity, or newness. This is, again, a different perspective than the output orientation of the third theme.

Limitations

The discursive differences between lecturers found, can be considered both discipline based and institutional. One can wonder which boundary is more dominant when a larger and more diverse sample is investigated, or whether the boundaries will shift. More elaborate research (e.g. including humanities lecturers) can bring a firmer conclusion. Additionally, the matching of both groups of teaching academics meant that the highest levels of academics in universities – professors - were not included in this study. This was due to the fact that research professors in HPE often do not have teaching responsibilities. Future research should also consider these highest level academics to see how this alters the current results. Lastly, the difference in data-gathering between lecturers from both institutional types (using logs versus a prefixed list of activities) could have influenced the differences found. All and all, this study only set some first steps on the conclusions on institutional and disciplinary differences in perceptions of research by lecturers in HPE and universities. And on these, further research can be built.

An implication to consider is what effect each discursive theme has for choices in the balance between research and teaching (Boyd & Smith, 2011), as well as the choices of research methods, outputs, or partnerships with students and colleagues (Visser-Wijnveen et al., 2009). For the time being, the differences between the lecturers do not fully follow institute borders. Discipline—as always—plays an important role, while in day-to-day professional life many consider institutional differences the main differentiating aspect on research. Hence, lecturers (and researchers) from both types of institutes should consider lecturers from the other institutions more as colleagues than as strangers. They more fully share discursive themes on research among disciplinary colleagues than among colleagues of another field at a similar institute. Lecturers themselves, but also institutional policy officers should beware of that.

Acknowledgement: we would like to thank Bart Roosenboom and Katelijne Boerma for their operational assistance during this research project.

Word count 5246 (excl tables, references, etc.)

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Detection of Lead and Arsenic Soil Pollution in Abandoned Industrial Poles to the South of Marseille, France by Laser-Induced Breakdown Spectroscopy

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Abstract

We report on lead and arsenic soil pollution in abandoned industrial poles to the south of Marseille, France, where several lead production plants were active until the 1920's. Since this area is currently considered as building plot for residential districts, the detection of soil pollution is of great public interest. Here, a number of samples were collected and subsequently investigated by calibration-free laser-induced breakdown spectroscopy. It was shown that the concentration of both lead and arsenic within the collected samples is drastically elevated in comparison to the particular natural content as reported in literature. Since the applied method does not require any standards for calibration, it is easy to use in order to determine local soil pollution as a basis for soil clean up procedures.

Keywords: soil pollution, lead, arsenic, laser-induced breakdown spectroscopy

1 Introduction

Soil pollution in urban areas is a global anthropogenic issue (Alkorta *et al.*, 2004). For instance, it was shown that the concentration of heavy metals in conurbations such as Bangkok (Wilcke *et al.*, 1998), Palermo (Salvagio Manta *et al.*, 2002), and Sevilla (Madrid *et al.*, 2002) is significantly increased, even exceeding critical values in some cases. Razo and co-workers showed that soil pollution by arsenic and heavy metals, resulting from former mining and metallurgical activities, can contribute to a contamination of groundwater (Razo *et al.*, 2004). Further, Nahmani and Lavelle reported on the drastic damage of macrofauna growth due to heavy metal soil pollution (Nahmani and Lavelle, 2002). Regarding urban development, soil pollution in abandoned industrial poles represents a severe risk potential. Since such poles are typically located close to metropolitan and settlement areas, the detection and removal of hazardous substances is a challenging task in the course of the preparation of novel building sites. In the present work, the heavy metal pollution within the periphery of abandoned metallurgical plants to the south of Marseille, France was investigated at random samples. Since this area is currently considered as development area, such investigation is of great public interest.

For the detection of soil pollutants and for contamination surveying and mapping, laser-induced breakdown spectroscopy (LIBS) has turned out to be a powerful, reliable and easy-to-use method (Harmon *et al.*, 2009). Using this technique, even minor elements of lowest concentration can be recorded (Beldjilali *et al.*, 2010). The first portable LIBS system was developed for investigating the heavy metal contamination of military training grounds (Wainner *et al.*, 2001). Further, LIBS was already successfully applied for analysing the heavy metal contamination of road sediments (Cuñat *et al.*, 2009) and is even performed by NASA's "Curiosity" rover for soil analysis on Mars (Maurice *et al.*, 2012; Meslin *et al.*, 2013). Generally, materials testing methods require calibration standards for providing reliable information on the elemental composition of the investigated material. However, LIBS can also be performed without the use of such standards. Calibration-free LIBS (CF-LIBS) was first demonstrated by Ciucci and co-workers in 1999 (Ciucci *et al.*, 1999). Since that time, several approaches for improving CF-LIBS were suggested, based on the theoretical modelling of the laser-induced plasma. One basic approach, which was applied in the present work, is to consider the temperature and density gradients of the laser-induced plasma (Hermann, 2008). The suitability of this method was already demonstrated with alloy's analysis (Hermann *et al.*, 2010), groceries (Beldjilali *et al.*, 2010), construction materials for nuclear reactors (Mercadier *et al.*, 2013), and optical glasses (Gerhard *et al.*, 2014; Hermann *et al.*, 2014). Depending on the availability of theoretical data such as Stark parameters, a measurement accuracy of up to 5% can be obtained (Axente *et al.*, 2014). Such a calibration-free materials testing method with

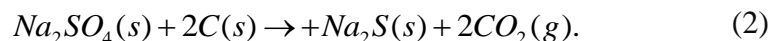
high accuracy is particularly appropriate for the analysis of polluted soils since the required calibration standards may not be generally obtainable.

2 The Industrial Poles South to Marseille - A Historical Overview

In the 18th century, the main industry in Marseille was soap industry with about 50 running production plants. At that time, the raw materials used for soap production were natural resources such as olive oil, sodium bicarbonate (which was mainly imported from Spain) and chalk. In the beginning of the 19th century, there were 62 manufacturers in the city and suburbs of Marseille. Due to the invasion of Spain by Napoléon Bonaparte in 1808 and the following naval blockade imposed by England, the required sodium bicarbonate could not be imported any longer. As a result, the price for this raw material increased by a factor of 7 per year. Thus, the production of synthetic sodium bicarbonate (Na_2CO_3) by applying the Leblanc process (Gillispie, 1957) was decided in 1809. In the course of this process, sodium sulphate (Na_2SO_4) is generated by the chemical reaction of sodium chloride (NaCl), obtained from sea salt, and sulphuric acid (H_2SO_4) according to:



where additionally, gaseous hydrochloric acid (HCl) arises as waste product. Subsequently, chalk [i.e. calcium carbonate (CaCO_3)] and carbon (C)-based substances such as coal are added to the sodium sulphate. Due to a subsequent firing of this mixture, carbon is oxidised to carbon dioxide (CO_2) whereas sodium sulphate is reduced to sodium sulphide (Na_2S):



Further, sodium sulphide and calcium carbonate react to the required sodium bicarbonate and another waste product, calcium sulphide (CaS) according to:



The needed sulphuric acid was produced by synthesis of sulphur and saltpetre and increasingly, the so-called lead chamber process (Jones, 1950) was applied for its condensation in a number of production plants, giving rise to considerable air pollution by the gases resulting from the production process. In order to overcome this pollution, appropriate regulations were decreed by the French government in 1810 and 1811. Consequently, the new installation of such production plants in or close to Marseille city centre was prohibited. Thus, existing production plants moved to deserted areas near to Marseille, namely, between La Madrague de Montredon and Callelongue as well as to other areas south to Mazargues such as Vaufrèges or Morgiou (see Figure 1), where new sites were constructed additionally.

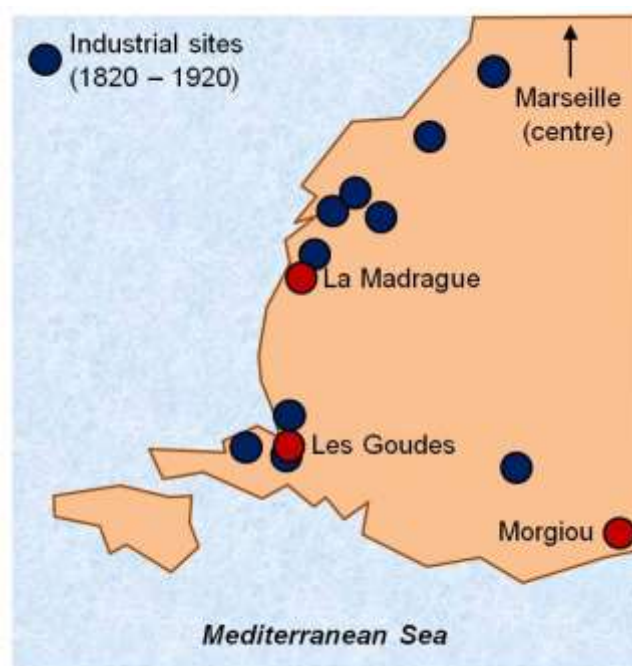


Figure 1. Position of abandoned industrial sites to the south of Marseille

These areas were chosen due to the fact that the dominating wind direction in Marseille is north/northeast, given by the famous Mistral, allowing an automatic evacuation of polluted air towards uninhabited regions or the Mediterranean Sea. Further, the access to the factories was simplified by the construction of new harbours and the location was also advantageous for business management reasons since it was situated outside of Marseille's customs area. Thus, a considerable pole of chemicals industry, providing sulphur, sulphuric acid, hydrochloric acid, vitriol, caustic potash and, of course, sodium bicarbonate, shaped up throughout the first half of the 19th century.

Starting in the 1850s another branch of industry established in this territory: the cupellation and roll thread of lead ore. This industry was rapidly growing and for about 30 years, Marseille has been the biggest centre for the production of lead in the world. However, the extraction of lead (and silver and copper, which was also extracted) from the ore was notably air-polluting. Furthermore, the ore which was mainly imported from the mines of Pennaroya in Spain contained a considerable amount of arsenic and antimony. These substances were vaporised and subsequently deposited in the surroundings of the furnaces. The smelting of lead and other heavy metals in this industrial pole was carried out until the 1920s whereas some of the plants were already closed during the First World War as a result of the mobilisation of the workers. Since that time, urban residential districts were constructed close to or even within the area of the abandoned factory premises.



Figure 2. Examples of vestiges of industry south to Marseille, top left: ruin of the lead production plant Escalette, top right: ruins of lead condensation chambers close to La Madrague de Montredon, bottom: waste dump of the lead production plant Escalette

As shown in Figure 2, there are still a number of industrial ruins and vestiges such as condensation chambers and chimneys as well as waste dumps left today. Even though the closure of these production plants took place about one century ago, there is still a significant soil pollution found in aforesaid area. According to a television broadcast by France3, the content of arsenic and lead amounts to 3% and 12%, respectively (i.e. approx. thousand fold more than the mean value in France) (Simonet, 2012). Against this background and given the fact that the abandoned production sites are partially located within the Calanques National Park which was established in April 2012, solutions and strategies for effective soil clean up become necessary. For such clean up, the identification of strongly polluted plots is of essential importance.

3 Materials and Methods

Investigated Samples

In this work, two different types of samples, limestone (with visible deposits) and scoria, were investigated. In total, 20 samples were collected at 8 different places in the area between Marseille-Montredon and Les Goudes (approx. 10 km to the south of Marseille's city centre). Here, several metallurgical plants, producing lead and other heavy metals, were located in former times as introduced above. After the closure of these plants in the beginning of the 20th century, the remaining waste and scoriae were stored on open-air waste dumps (e.g. in Escalette, see figure 2) and partially used as backfill and subsoil for roads and buildings as shown in figure 3.

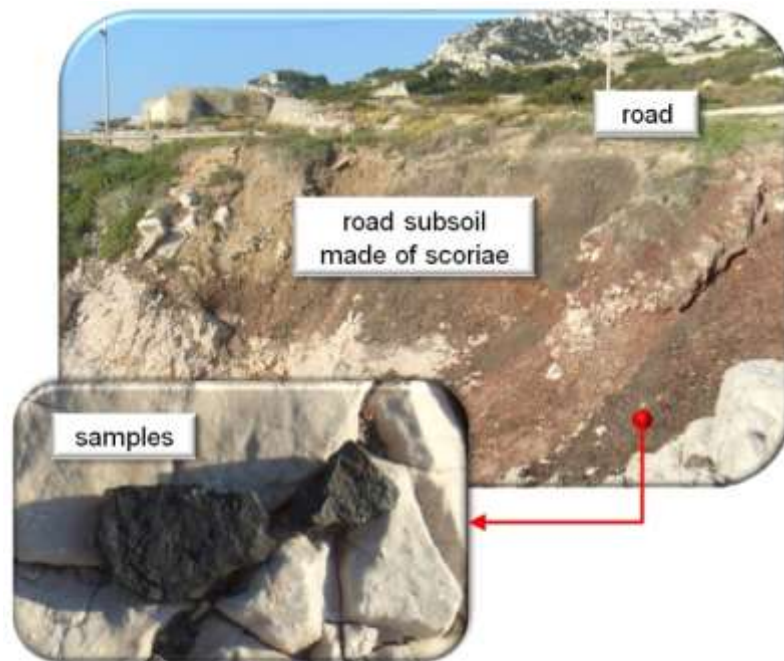


Figure 3. Example of a coastal highway's subsoil (close to Callelongue) made of scoriae from closed metallurgical plants

Experimental Setup

The used experimental setup is shown schematically in Figure 4. For igniting the laser-induced plasma, a Nd:YAG laser source (Brilliant from Quantel) with a pulse duration of 5 ns, an emission wavelength of 266 nm and a pulse repetition rate of 10 Hz was used. The laser beam was focused onto the sample by a convex lens with a focal length of 150 mm, resulting in a beam waist diameter of approx. 100 microns. Using UV-transparent optics (focusing lenses and a fibre), the plasma radiation was detected by an echelle spectrometer (Aryelle Butterfly from Laser Technik Berlin) with a spectral resolution of 9×10^3 . The spectrometer is coupled to an intensified charge-coupled device (ICCD) detector, allowing the time-resolved acquisition of spectra. The intensity calibration of the optical system was performed by a tungsten filament lamp (model 63358 from Oriel) and a deuterium discharge lamp (model DO544J from Heraeus) in the visible and ultraviolet spectral ranges, respectively. The samples were placed on a motorised xyz linear stage and laser-induced spectra were taken at several positions of the particular sample in order to obtain a high signal to noise ratio.

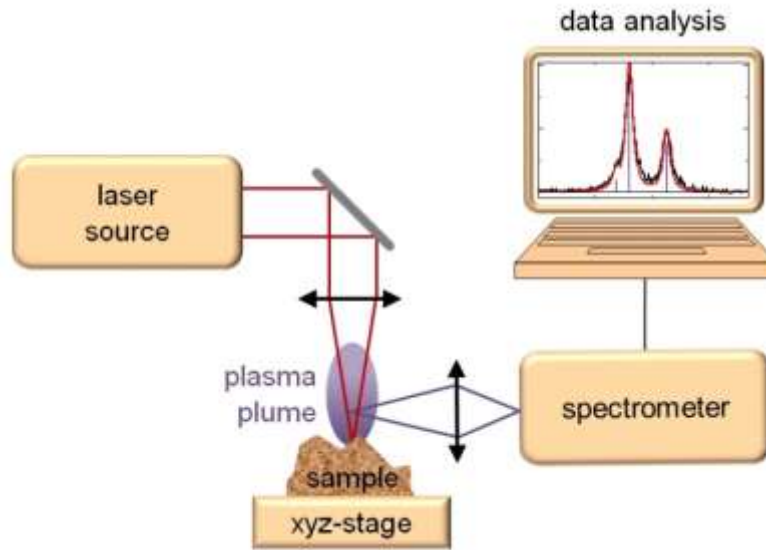


Figure 4. Experimental setup for calibration-free laser-induced breakdown spectroscopy

Data Evaluation Procedure

For the determination of the elemental composition of the evaporated material, the measured spectra were compared to the spectral radiance computed for a plasma in local thermodynamic equilibrium (LTE). A detailed description of the calculation procedure was given earlier (Axente *et al.*, 2014; Gerhard *et al.*, 2014). It was shown that LIBS plasmas produced in argon background gas are spatially uniform (Gerhard *et al.*, 2014) whereas plasmas produced by laser ablation in ambient air exhibit temperature and density gradients (Axente *et al.*, 2014). Thus, radiation generated by the hot plasma core may be absorbed by the colder peripheral zone, situated at the contact front between the ablated vapour and the ambient air. The absorption is particularly efficient for resonance lines and other transitions of large optical thickness (Axente *et al.*, 2014). Recently, we have shown that the nonuniform spatial distribution in air may be ignored if only spectra lines of small optical thickness were used for the LIBS analysis (Hermann *et al.*, 2014). In the present case, transitions of small or moderate thickness were available for all elements of interest, allowing us to use the simplified uniform plasma for spectra calculation. In that case, the spectra radiance of a plasma in local thermal equilibrium, obtained by integrating the radiation transfer equation, is given by:

$$B_{\lambda}(T) = U_{\lambda}(1 - e^{-\alpha(\lambda)L}) \quad (4)$$

Here, $B_{\lambda}(T)$ is the temperature-dependent spectral radiance, U_{λ} is the blackbody spectral radiance, L the plasma dimension along the observation direction. The wavelength-dependent absorption coefficient $\alpha(\lambda)$ is given by:

$$\alpha(\lambda) = \pi \cdot r_0 \cdot \lambda^2 \cdot f_{lu} \cdot n_l \cdot P(\lambda) \left(1 - e^{-\frac{h \cdot c}{\lambda \cdot k_B \cdot T}} \right), \quad (5)$$

where r_0 is the classical electron radius ($\approx 2.818 \cdot 10^{-15}$ m), f_{lu} is the absorption oscillator strength and n_l is the lower level population density of the transition. Further, h is the Planck constant ($\approx 6.626 \cdot 10^{-34}$ Js), c is the vacuum light velocity ($\approx 300,000,000$ m/s), k_B is the

Boltzmann constant ($\approx 1.381 \cdot 10^{-23}$ J/K) and T the temperature (Griem, 1964). The normalized line profile $P(\lambda)$ is calculated considering Doppler and Stark broadening since both effects are the dominant mechanisms of spectral line broadening in laser-produced plasmas which are typically strongly ionised (Zhao *et al.*, 1992). The convergence of both the measured signal and the theoretical spectrum is performed by an iterative algorithm as shown in figure 5.

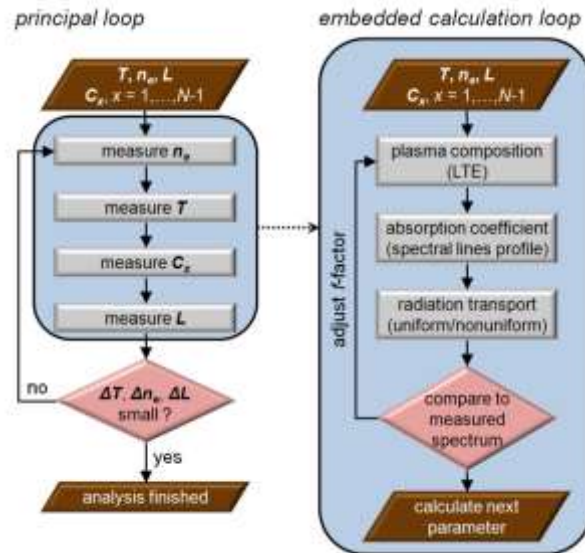


Figure 5. Data evaluation procedure for calibration-free laser-induced breakdown spectroscopy, consisting of a principal loop and calculation loops embedded in the principal loop

This algorithm consists of a principal loop and embedded calculation loops for each parameter of interest, i.e. the plasma temperature T , the electron density n_e , the plasma dimension L and the elemental concentration C_x of any element x . For instance, T was determined to amount to $16 \cdot 10^3$ K, n_e to $8 \cdot 10^{17}$ cm⁻³ and L to 0,52 mm when applying this measurement method to silicon dioxide (SiO₂) at a recording delay of 225 ns (Gerhard *et al.*, 2014). In the course of the evaluation procedure, these parameters are derived from the best fit of both the measured and calculated spectra. The good agreement between the measured and the calculated spectra is shown at the example of the spectral line of neutral lead (Pb I) in Figure 6, taken from previous work where the lead content within heavy flint glass was investigated as described hereafter.

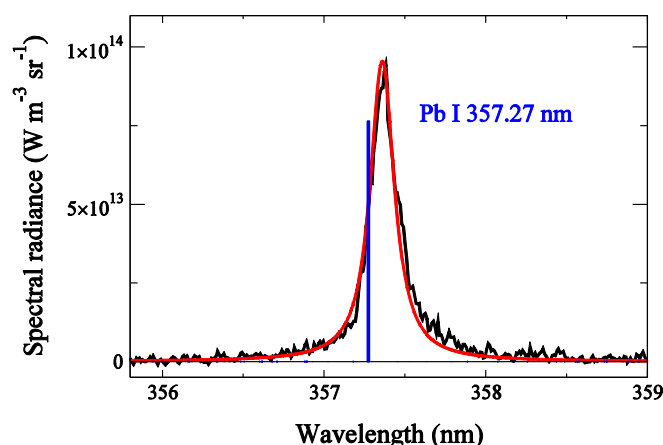


Figure 6. Measured (black line) and calculated spectral radiance (red line) of neutral lead (Gerhard *et al.*, 2014). The blue vertical line represents the nominal spectral line at a wavelength of 357.27 nm and was inserted in order to visualise the Stark shift and Stark broadening

Preliminary Considerations

The analysis of these samples was performed on the basis and the experiences of previous work where the elemental analysis of lead-containing heavy flint glass (SF5 from Schott) by CF-LIBS was studied (Gerhard *et al.*, 2014; Hermann *et al.*, 2014). Thanks to this study, the method described in section 2 could be validated with respect to two established reference methods, X-ray photoelectron spectroscopy (XPS) and energy-dispersive X-ray spectroscopy (EDS). Further, the spectroscopic data used for determining the lead concentration were carefully selected and verified in a separate experiment (Hermann *et al.*, 2010). As the accuracy of the transition probabilities of lead lines are not reported in the NIST (National Institute of Standard and Technology) database (Ralchenko *et al.*, 2011), the data were compared to those given by the Kurucz database (Smith *et al.*, 2011) and completed by supplementary values from literature (Alonso, 2001). The analysis of the limestone and scoria samples was performed using the suitable spectral lines which were chosen and identified in this previous work.

4 Results

Qualitative Analysis

A measured survey LIBS spectrum of limestone with deposit is shown in Figure 7. Here, the qualitative elemental composition of this sample can already be estimated at first view. Calcium (Ca), a main component of limestone, as well as further minor components of limestone such as magnesium (Mg) and silicon (Si) are clearly identified. Beyond that, characteristic spectral lines of some heavy metals are found.

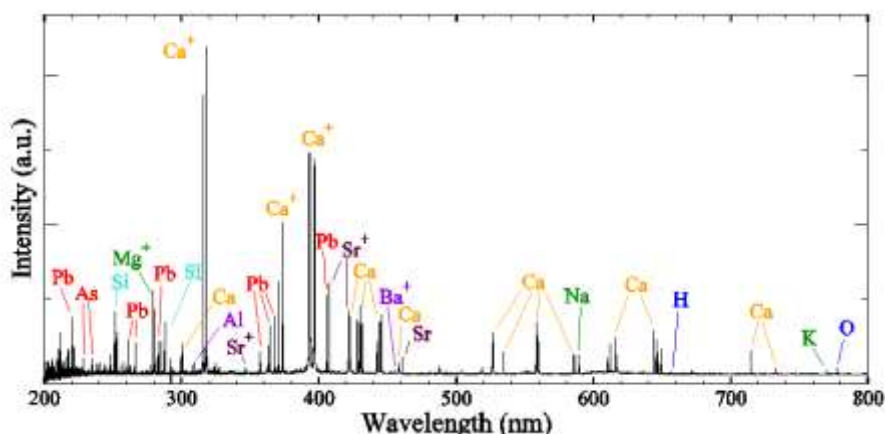


Figure 7. Survey LIBS spectrum of limestone with deposit

Figure 8 shows an example of a measured LIBS spectrum of limestone with deposit and, as a reference, limestone without any deposit. Additionally, the calculated spectrum for limestone with deposit is displayed. A distinct difference between the measured spectra of limestone with and without deposit can be stated: Characteristic spectral lines of lead (Pb) and arsenic (As) with relatively high spectral radiances were observed in the first case. In contrast, these lines were not detected for the reference sample without any deposit.

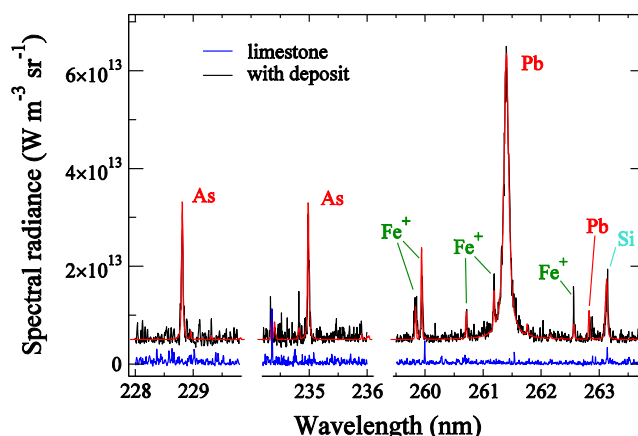


Figure 8. Measured LIBS spectrum of limestone with and without deposit including calculated spectrum for limestone with deposit

Quantitative Analysis

Generally, a certain content of lead was found for all investigated samples, limestone with deposit and scoriae. This observation is due to the fact that LIBS has a relatively low detection threshold for lead, which is in the range of some parts per million. Depending on the particular sample, different concentrations of lead (C_{Pb}) were determined. In addition, a notable concentration of arsenic (C_{As}) was detected for some samples as listed in Table 1.

Table 1. Concentrations C of lead C_{Pb} and arsenic C_{As} in limestone with deposit and scoriae measured by calibration-free laser-induced breakdown spectroscopy

sample type:	limestone with deposit			scoriae		
sample No.:	L1	L2	L3	S1	S2	S3

C_{Pb} in wt. %:	15	13	2.5	15	1.7	1.8
C_{As} in wt. %:	0.5	0.09	0.1	1.3	-	-

At an average, C_{Pb} is 8.2 wt.% and C_{As} amounts to 0.3 wt.%. Further, a marginal amount of strontium (Sr) and barium (Ba) in the range of some 100 ppm was detected.

5 Discussion

Based on the above-presented results it can be summarised that the area around the abandoned industrial poles to the south of Marseille's city centre exhibits mentionable heavy metal soil pollution. Such a high heavy metal content comes along with a number of potential risks.

Lead Pollution and Risks

The measured content of lead of 1.7 to 15 wt.% is drastically higher than the natural lead content of ground soil of $2 \cdot 10^{-6}$ to $6 \cdot 10^{-5}$ wt.% (Scheffer and Schachtschabel, 1992). Generally, lead in soils and stones can be evaporated or washed into the groundwater by erosion processes and thus be inhaled or ingested. Depending on the dose of intake, lead is a toxic substance (Srianujata, 1998), and can provoke several chronic diseases such as anemia, neuropathy or reproductive impairment. It is also known as a carcinogen (Landrigan, 1982) and can interact metabolically with other metals which are nutritionally essential (Goyer, 1997). As shown by Goldstein, lead inhibits the uptake of calcium in brain mitochondria (Goldstein, 1977). It is even able to attach within mitochondria, though displacing calcium (Kapoor and Van Rossum, 1984). As divalent cation, lead can bond chemically to sulfhydryl groups on proteins, induce a distortion of enzymes and affect the central nervous system (CNS) (Needleman, 2004). A blood lead level (BLL) of approximately 15 $\mu\text{g/dL}$ can already cause cognitive and behavioural deficits of newborns and infants (Goyer, 1993). For example, David and co-workers reported on hyperactivity of children due to an increased BLL of 26 $\mu\text{g/dL}$ (David *et al.*, 1972).

Arsenic Pollution and Risks

Similar to the measured lead content of the investigated samples, the measured content of arsenic of 0.1 to 1.3 wt.% is significantly higher than the natural percentage of the earth crust of $1.3 \cdot 10^{-4}$ to maximum $1 \cdot 10^{-3}$ wt.% (Wedepohl, 1995). Even though arsenic is also used in pharmaceuticals, it is of acute and sub-acute toxicity (Jain and Ali, 2000). Inorganic arsenic is one of the most potential human carcinogens (Roy and Saha, 2002; Hughes, 2002). and can provoke peripheral vascular and cardiovascular diseases (Wu *et al.*, 1989; Mandal and Suzuki, 2002) as well as dermatitis, sensory neuropathy and cirrhosis (Landrigan, 1982). The oxidation state arsenic trioxide (As_2O_3), arising from combustion of elemental arsenic in ambient atmosphere, even has a lethal effect at a relatively low median dose (LD_{50}) of 1.4 mg/kg body weight.

6 Conclusion

In this study, laser-induced breakdown spectroscopy (LIBS) was applied for the elemental analysis of limestones and scoriae which were collected in the immediate vicinity of abandoned metallurgical plants. Based on the above-presented results it can be stated that considerable soil pollution by lead and arsenic was detected, even though these plants were closed nearly one century ago. The used LIBS method allows soil analysis without the use of any standards. It is thus suitable for qualitative and quantitative analysis of soils of unknown and complex compositions since generally, calibration standards are not available in such

cases. Nowadays, several portable LIBS-systems are commercially provided by some suppliers. Using such systems in combination with the presented evaluation algorithm could thus allow easy-to-use and rapid soil pollution mapping and open a wide range of applications in environmental sciences, construction planning, urban development and renaturation/land restoration. Health hazardous “hotspots” could be identified, enabling an effective and selective soil clean up in order to decrease the public health risk of residents.

Acknowledgements

The research leading to these results was based on previous work on the detection of lead in optical glasses which was funded by LASERLAB-EUROPE (grant agreement no. 284464, EC's Seventh Framework Programme), project-ID CNRS-LP3001916. The authors acknowledge R. L. Kurucz and B. Bell as well as the Smithsonian Astrophysical Observatory in Cambridge, Massachusetts for the free access to the 1995 Atomic Line Data, Kurucz CD-ROM No. 23. Further, Y. Ralchenko, A. Kramida and J. Reader as well as the National Institute of Standards and Technology in Gaithersburg, Maryland are acknowledged for the free access to the NIST Atomic Spectra Database.

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