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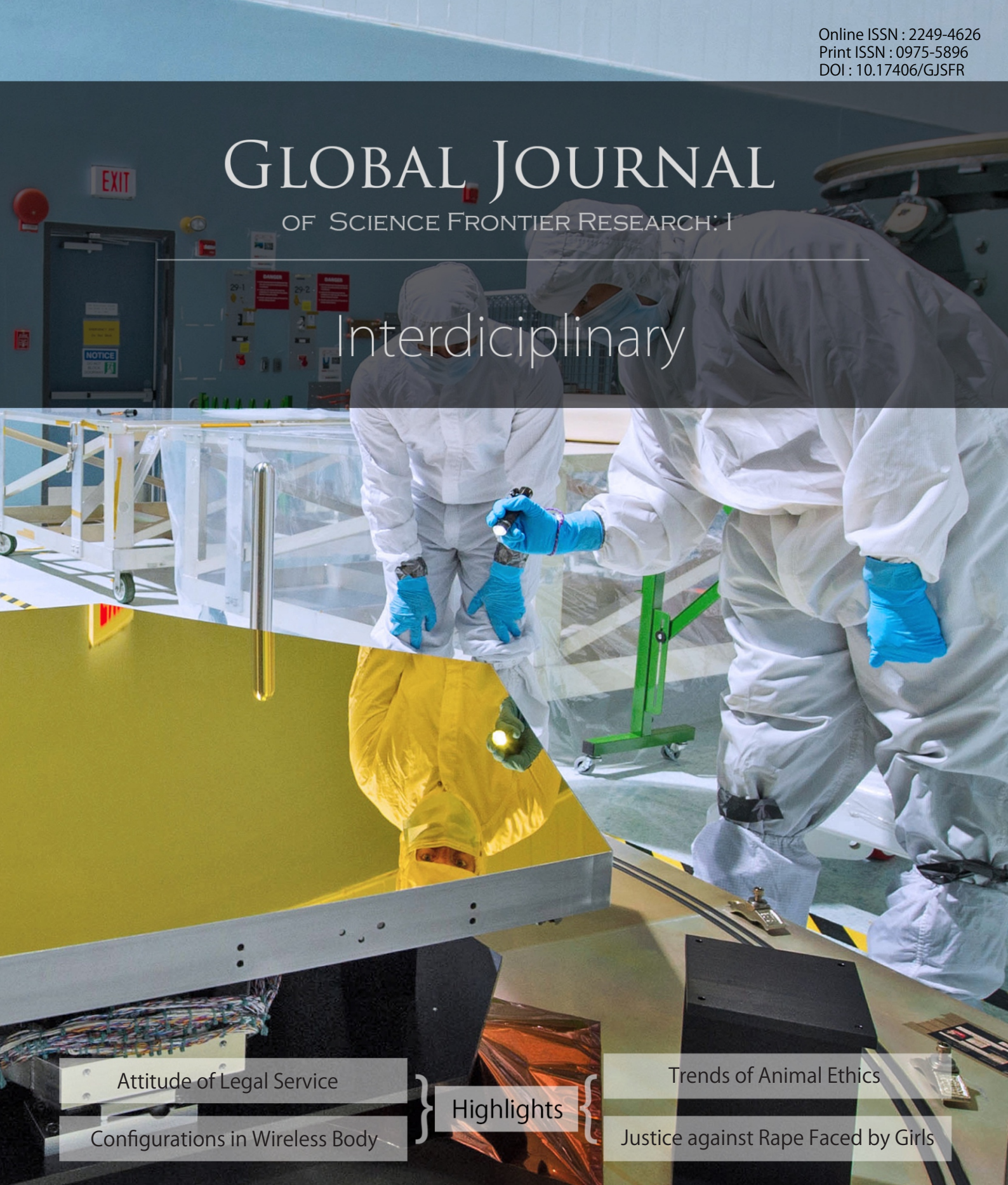

Highlights

- Attitude of Legal Service
- Configurations in Wireless Body
- Trends of Animal Ethics
- Justice against Rape Faced by Girls

Discovering Thoughts, Inventing Future

VOLUME 17 ISSUE 1 VERSION 1.0

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Knowledge and Attitude of Legal Service Providers towards Rape Victim of Girls and Women: The Case of Wolaita Zone, SNNPR, Ethiopia

By Bereket Tessema Zewude, Kidus Meskele Ashine & Abebayehu Tora Kacho
Wolaita Sodo University

Abstract- An attempt has been made to observe knowledge and attitude towards legal service providers of the victim of rape. The objective of the study was to assess knowledge and attitude towards legal service providers of rape victims in study area. Regarding the knowledge and attitude of the legal service providers, 89.5% defined rape as a forced penetration of vagina with penis while less than half considered forced anal and mouth penetration with penis as rape. Majority legal service providers have bad attitude towards rape victims. On the other hand, the majority of respondents literally indicated that they would reject the case of the compliant, if the victim willingly went to the suspect's house (48.4%), if the victim couldn't provide enough eye witness (56.4%), if there is no medical proof and other exhibit available (89.8%), and if the suspect is husband to the victim (42.5%).

Keywords: *attitude, ethiopia, legal service providers, knowledge, rape, wolaita zone.*

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Knowledge and Attitude of Legal Service Providers towards Rape Victim of Girls and Women: The Case of Wolaita Zone, SNNPR, Ethiopia

Bereket Tessema Zewude [α], Kidus Meskele Ashine [σ] & Abebayehu Tora Kacho [ρ]

Abstract- An attempt has been made to observe knowledge and attitude towards legal service providers of the victim of rape. The objective of the study was to assess knowledge and attitude towards legal service providers of rape victims in study area. Regarding the knowledge and attitude of the legal service providers, 89.5% defined rape as a forced penetration of vagina with penis while less than half considered forced anal and mouth penetration with penis as rape. Majority legal service providers have bad attitude towards rape victims. On the other hand, the majority of respondents literally indicated that they would reject the case of the compliant, if the victim willingly went to the suspect's house (48.4%), if the victim couldn't provide enough eye witness (56.4%), if there is no medical proof and other exhibit available (89.8%), and if the suspect is husband to the victim (42.5%). The findings in this study indicate that rape victims in Wolaita Zone have higher chance of being rejected after involvement in the legal process not merely due the less admissibility of the cases before the court, but the influence of legal and extralegal factors that come into play through shrinking the chance of believability among prosecutors and judges which could indicate their knowledge and attitude towards rape victim. Also, there is no statistical association between knowledge and attitude of legal service providers with sex, age, education level, professional background and job profile. Hence, introducing standardized, internationally acknowledged, and locally adoptable rape case management procedures, providing up-to-date and sustainable trainings to the judges and public prosecutors are highly recommended to realize justice to the rape victims.

Keywords: attitude, ethiopia, legal service providers, knowledge, rape, wolaita zone.

I. Introduction

a) The situation of rape in Ethiopia

In Ethiopia, various studies indicated the prevalence of gender based violence in general and sexual violence in particular. A study among high school students revealed that girls are even denied their freedom of movement and are afraid of moving or walking alone in broad day light even in the streets of big cities like Addis Ababa and of the 6.2% of the students who have started sexual intercourse, 26.1% were raped cases and 75.9% of the students reported being sexually harassed (Lelisa & Yusuf, 2008). School based cross sectional survey conducted in Debark, north western Ethiopia also indicated the prevalence of completed and attempted rape to be 8.8% and 11.5% respectively (Worku et al., 2002). In a cross sectional survey conducted in Addis Ababa University among 612 female students, the prevalence of lifetime completed and attempted rape was 12.7 % and 27.5% respectively while sexual harassment in lifetime and 12 month period accounted 58% and 41.8% respectively (Tadesse, 2004). A study conducted in Hawassa University recorded the overall prevalence of gender based violence among 1330 female students and found 59.9% lifetime, 46.1% since enrolling college and 40.3% current academic year (Dodie et al., 2008).

Though there is paucity information in Ethiopia, a number of cross sectional studies recorded sexual violence particularly rape as the most common problem for women and girls. However, large number of rape and sexual assault cases remains under reported to authorities because of complex socio cultural and institutional reasons. Even when reported, the rate of charges and conviction are less likely. Among the major reasons identified in other settings, institutional constraints related to laws and procedures of rape, and knowledge, attitude and beliefs of legal service providers about sexual violence play an important role in determining the reporting and prosecution process of rape. This study therefore intended to identify constraints faced by girls and women after their involvement in the legal process. In our case we tried to explore the knowledge and attitude of legal service providers of rape victim in wolaita zone, Ethiopia.

II. Methodology

a) Description of study area

The study was carried out in Wolaita Zone, Ethiopia year of 2013. Wolaita Zone consists of 13

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woredas found in temperate region of South Nationalities and Peoples (SNNP) regional state with capital town of Sodo. Sodo town is located (54^0N latitude and 380^0 S longitude) and 396km south of Addis Ababa and 130km from regional town Hawassa.

b) Study Design

The research design was qualitative as well as quantitative research design can be employed.

c) Source of Population

The source of population consists of 12 woredas and 3 admistrative towns legal service providers found in wolaita zone for study purpose.

d) Sampling Technique

Among 12 Woredas and 3 administrative towns we take a sample of 6 woredas and 1 administrative towns using purposive sampling technique.

e) Variables Identification

For study purpose our dependent variables includes: knowledge and attitude towards legal service providers.

f) Independent Variables

Socio-demographic variables.

g) Data Collection

Both primary and secondary data collection method were applied to get the desired information. Primary data were collected through a questionnaire. The questionnaire was prepared, pre tested and administered for the selected woredas and administrative towns.

h) Data Entry and Analysis

Data entry and cleaning were carried out using statistical soft ware package SPSS version 22.0 for the analysis. The analysis employed here is that descriptive statistics analysis was used to show the frequency distribution and its results were presented by tables. Also chi-square result was used.

III. Results and Discussion

Table 1: Respondents' knowledge and Attitude of rape

Variables	Category	Yes		No	
		Frequency	Percent	Frequency	Percent
Conditions of rape	When forced penetration of vagina with penis is made	246	89.5	19	6.90
	When forced penetration of anus with penis is made	97	35.5	168	61.1
	When forced penetration of mouth with penis is made	132	48.0	133	48.4
	I don't know	262	3.5	305	96.5
	Not willing to answer	2	0.7	263	95.6
Categorization of rape victims	When wife or husband complains that she or he has been forced to make sex without consent	147	42.5	155	56.4
	When a girl has been forced to make sex without consent	253	92.0	19	6.90
	When a boy has been forced to make sex without consent	158	57.5	113	41.1
	When adult women have been forced to make sex without consent	202	73.5	70	25.5
	When adult men have been forced to make sex without consent	121	44.0	151	54.9
Type of rape legal service providers must take it seriously	Rape committed by marriage partner	46	16.7	228	82.9
	Rape committed against child girls and young women	268	97.5	6	2.2
	Rape committed against child boys and young men	106	38.5	168	61.1
	Rape committed against adult women	160	58.2	114	41.5
	Rape committed against adult men	60	17.1	205	82.5

Based on table 1, the result indicates that most of the participants i.e. 89.5% defined rape as a forced penetration of vagina with penis. Below half of the participants considered forced anal and mouth penetration with penis as rape. When asked to categorize the rape victims, the large majority considered rape victimization of girls and adult women constituting 92 % and 73% respectively. Nearly 40% of

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the respondents considered marital rape and rape against adult men. 97.5% and 58.2% of the respondents indicated that rape against child girls and adult women respectively must be taken seriously among the legal service providers (we can't conclude based on descriptive statistics). Only 38.5% of the respondents considered rape against child boys.

Table 2: Chi square result

Variables		Knowledge and Attitude towards rape victims(Bad and Good)	
Variables	Total	χ^2	p-value
Sex: Male Female	154(40.84%) 221(58.6%)	42.44	0.36
Age: 18-21 years Greater than 21 years	196(51.98%) 168(48.02%)	1343.3	0.363
Level of education: Diploma Degree Masters Others	77(20.42%) 150(39.78%) 115(30.5%) 35(9.28%)	152.2	0.601
Professional background	154.1		0.993
Job profile	4154.0		0.693

The average score of respondents on the Attitude towards Rape Victim's Scale is 39.97 while the minimum and maximum scores are 0 and 78 respectively. Majority of the respondents have rated their attitude on the 25 items scale above the average i.e. 54.2%. This implies that most of the legal service providers tend to accept the rape might and have relatively bad attitude towards rape victims. Interestingly, there is no statistically significant association in knowledge and attitude of legal service providers across sex ($\chi^2 = 42.44, p = 0.36$), age ($\chi^2 = 1343.3, p = 0.363$), level of education ($\chi^2 = 152.2, p = 0.60$), professional background ($\chi^2 = 154.1, p = 0.993$) and job profile ($\chi^2 = 4154.0, p = 0.691$).

IV. Conclusions

- Based on chi-square result there is no statistically significant difference in knowledge and attitude of legal service providers across sex, age, educational level, professional background and job profile.
- Based on descriptive result most of the respondents' defined rape as a forced penetration of vagina with penis. Below half of the participants considered forced anal and mouth penetration with penis as rape in line with their knowledge and attitude towards rape victims.

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Global Trends of Animal Ethics and Scientific Research

By Manshu Jain, Ritu Gilotra & Jitendra Mital
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Abstract- This article deals with global trends and guidelines followed by different countries in scientific research. The various objectives of animal research, pros and con and alternative method for animal research by the use of 3Rs are disused here it is felt that however animal research is indispensible in several research but in certain alternative are alternately effective means of animal rights. This article reviews various aspects which are related to this issue.

Keywords: *animal models, ethics, guideline, cons.*

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Global Trends of Animal Ethics and Scientific Research

Manshu Jain [α], Ritu Gilotra [σ] & Jitendra Mital [ρ]

Abstact- This article deals with global trends and guidelines followed by different countries in scientific research. The various objectives of animal research, pros and con and alternative method for animal research by the use of 3Rs are disused here it is felt that however animal research is indispensible in several research but in certain alternative are alternately effective means of animal rights. This article reviews various aspects which are related to this issue.

Keywords: *animal models, ethics, guideline, cons.*

I. Introduction

Humans have benefited from research involving animals, in every medical achievement in the past century. Developments in the many treatments such as diabetes, leukaemia and heart surgery transplantshave been possible through the use of animals in research. The majority of the scientific community consider that the use of animals in research justified.The public also now accepts the use of animals in research due to the following reasons:

- They believe now there is no unnecessary suffering to the animals;
- The research is for serious medical or life-saving purposes;

There is no reliable and informative alternative to their use. It is important to recognise that work on animals in research, whose benefits to health and in treatment ofdisease are not evidenced firstly.This is highly useful as it provides or gives the groundwork or basic structure for medical advances. The moral for animal's research should be tominimise animal suffering and maximise the benefits to medicine, health, agriculture and fundamental understanding of body.

Animal research only takes place within a framework of robust controls. UK legislation requires refining the procedure to keep the minimum suffering of animals, and the use of animals should be that much only which gives meaningful results and the use of animals with non-animal alternatives methods is also appropriate. However, sometimes the use of non-animal methods may not be useful for some types of research. The majority of research using animals is about 84% in which the rodents are important subject for the experiment. Basic research and drug development for 82% of all procedure is safely performed comparing to the remaining 18% research. [13, 14, 15].

The use of animals in research can be alternative research method evidence that research by using animal is unnecessary. Non-animal methods, such as tissue culture, computer modelling, research using human test subjects and population studies, are used and have utility for scientific and medical research. All the research guidelines which are for animal welfarehad very high value for scientific and medical understanding. This is because a research study sometime needs more than knowing how individual molecules, cells or tissues behave, but then too it is unethical and illegal to expose human or animal new medicines knowing that it is benefited or not, so the only alternative method is useful for study of the new entity for health improvement and for treatment of diseased condition. The guidelines which work for animal welfare or for ethical research on animal give the many guidelines on the different level such as Royal Society for animals welfare they give numerous bodies, including government departments, funding agencies, charities and discussion meetings [16, 17].

II. Pros and Cons for Animals

Animals are essential for research which is use in cures and treatments of diseases that affect human. A better life and health is found by the experiment on the animals, but with this good thing comes a bad one too that is experiment on animals some time which lead to chronic toxicity or death of the animal. There are many people and community who opposing the use of animals in experiments by claiming it as non-ethical way to have anexperiment on animals.

This section helps us to know the pros and cons of animal in research:

Pros [1]:

- Animal testing is useful as it contribute in life-saving by cures and treatments in human.

  CASE STUDY: The California Biomedical Research Association states that nearly every medical breakthrough in the last 100 years has resulted directly from research using animals. Experiments in which dogs had their pancreases removed led directly to the discovery of insulin, critical to saving the lives of diabetics.

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- Animal research has also contributed to major advances in understanding and treating conditions such as breast cancer, brain injury, childhood leukaemia, cystic fibrosis, malaria, tuberculosis, leprosy, blood cancer, insulin and many others, and in the instrumental development of pacemakers, cardiac valve substitutes, and anaesthetics.
- Much research cannot be possible without animal studies.

  FOR EXAAMPLE: "we wouldn't have a vaccine for hepatitis B without chimpanzees",a disease that kills more than 14,000 people every year in the United States.
- Animals are always used when ethical considerations prevent the use of human subjects, the lives of human volunteers and patient cannot be put in danger unnecessarily. The World Medical Association Declaration of Helsinki states that human trials should be preceded by tests on animals.
- It will be very unethical to perform experimental procedures on human beings before tested on animals, such as in the genetic manipulation experiment to directly impose on human subjects before animal testing.
- Animals themselves get benefit from the results of animal testing, such as if vaccines were not tested on animals, millions of animals would have died from rabies, distemper, feline leukaemia, infectious hepatitis virus, tetanus, anthrax, and parvo virus.
- Animal research is highly regulated, with laws and guidelines to protect the animals in laboratory and research by mistreatment. Such as Animal Welfare Act (AWA) since 1966, these give minimum housing standards for research animals and also work for regular inspections by veterinarians.
- Animal researchers treat animals humanely, both for the animals sake and to ensure reliable test results which will be helpful for human too, as all experiment perform under approval of by an Institutional Animal Care and Use Committee (IACUC)
- Commercially VS Research use of animal.

  Example: 1. People in the US eat more than 9 billion chickens and 150 million cattle, pigs and sheep annually, as compare to them only 26 million animals are used for research, in which 95% of which are rodents, birds and fish. As compare to them we eat more than 1,800 times the number of pigs than the number used in research.

Similarly, the use of animal in leather preparation is more than the animal use in research it is approximately more than 15% as compare to research.

Cons [1]

- Animal testing is cruelty of the human for the animals. As the animal is forced for feeding, forced inhalation, food and water deprivation, prolonged periods of physical restraint, fasting for long period of time, and give them the infliction of burns and other wounds to study the healing process, the infliction of pain to study its effects and remedies, and "killing by carbon dioxide asphyxiation, neck-breaking, decapitation, or other means."
- Is really an inhuman behaviour by human towards the animal?

  FOR EXAMPLE: The Draize eye test, is another method used by cosmetics companies to evaluate irritation caused by shampoos and other products, in this the rabbits being incapacitated in stocks with their eyelids held open by clips, sometimes this test take the long-time not only hours but days too, so they cannot blink the eyes during products testing.
- During LD50 the animal was killed to test the toxicity they were sacrificed after the experiment due to severe condition happened during experiment.

  CASE STUDY: The US Department of Agriculture (USDA) reported in 2010 that 97,123 animals suffered pain during experiments while being given no anaesthesia for relief, including 1,395 primates, 5,996 rabbits, 33,652 guinea pigs, and 48,015 hamsters, is this correct with animal?
- Alternative testing methods can be used to replace the need for animals. Drugs that pass animal tests are not necessarily safe.

  CASE STUDY 1: The 1950s sleeping pill thalidomide, which caused 10,000 babies to be born with severe deformities, was tested on animals prior to its commercial release. Later tests on pregnant mice, rats, guinea pigs, cats, and hamsters did not result in birth defects unless the extremely high dose of drug was administered.

  CASE STUDY 2: Animal tests on the arthritis drug Vioxx showed that it had a protective effect on the hearts of mice, yet the drug went on to cause more than 27,000 heart attacks and sudden cardiac deaths before being pulled from the market.
- 95% of animals used in experiments are not protected by the Animal Welfare Act.

  SUCH AS, Animal Welfare Act does not cover rats, mice, fish and birds, which comprise around 95% of the animals, used in research they, are small or not necessary as animal what the reason?
- The Animal Welfare Act has not succeeded in preventing horrific cases of animal abuse in research laboratories.

  CASE STUDY: In Mar. 2009, the Humane Society of the United States (HSUS) found 338 possible violations of the Animal Welfare Act at the federally

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funded New Iberia Research Centre (NIRC) in Louisiana.

- Medical animal research may still have been made without the use of animals but, there is no enough money and resources to use the alternative method, for this the community working for animal welfare and common people should take the action by participating in the animal welfare issue.
- *Statements from Animal Rights Extremist Groups are as follow:*

  "I don't think you'd have to kill too many [researchers]. I think for five lives, 10 lives, 15 human lives, we could save a million, 2 million, 10 million non-human lives."

  –Jerry Vlasak, spokesperson for SHAC and ALF

  "In a war you have to take up arms and people will get killed, and I can support that kind of action by petrol bombing and bombs under cars, and probably at a later stage, the shooting of vivisectors on their doorsteps. It's a war and there's no other way you can stop vivisectors."

  –Tim Daley, ALF

III. Why use Animals in Research?

The experiment on animal is due to several reasons:

- First, in some research by studying animal behaviour, we can gain an understanding of human behaviour.
- In a similar manner by understanding the impact of different or many environmental factors such as crowding, cognitive stimulation, enrichment, or deprivation on animal behaviour, by this we understand how these environmental factors affect human behaviour.

  FOR EXAMPLE: The work of Harlow and Zimmerman (1959), In their experiment, infant monkeys was separated from their mothers and kept under two different surrogate conditions; in one condition thesurrogate "mother" was constructed of wire with a wooden head, while in the other condition the wire was covered with terry cloth to provide softness and warmth. The experimenters were interested in seeing whether the primary function of attachment to the mother was simply for survival as she provides food. What the studies found was that, regardless of which "mother" provided the food, the baby monkeys spent more time clinging to the terry cloth "mother." By this experiment they concluded that attachment is not merely for survival (food) but for contact comfort: something warm and soft to cling. However, the studies also found that, regardless of which type of surrogate the monkeys had, all developed problems later on. They were either inappropriately aggressive or timid, and the females tended to neglect or abuse their own young. Can we conclude from this study that attachment between human infants and their mothers also goes beyond the simple need for food and survival? In other words, we can say the findings of the Harlow et al. studies to human children and hypothesize that a lack of opportunity for contact comfort, or attachment, will also have an adverse effect on human development? The studies conducted by Harlow et al., for example, could not have used human participants for obvious ethical reasons.
- Many of the drug and treatment was developed through the use of animal research are used and it also help in the treatment of animals themselves.

  EXAMPLE: Diseases such as tuberculosis, scarlet fever, and polio, not to mention high blood pressure, would continue to claim millions of lives. In addition, According to Perkins, 90% of the animals used in research are rats, mice, and fish, and are bred solely for research purposes.
- Misguided attempts on animals can also have tragic consequences for the animals themselves.

  FOR EXAMPLE: In a recent attack on the animal research laboratory at the University of Minnesota, the animals were "liberated" and set free on a field near the school. Many of the animals were found wandering by the road, hardly a safe environment for animals, and several of the stolen rats were found dead.
- On the basis of this type of issue, animal research does continue, and it is governed by ethical guidelines for research involving human participants is regulated.

a) Alterative Method to Avoid use of Animal

"ALTERNATIVES" as encompassing any subjects, protocols, or technologies that '(replace the use of laboratory animals altogether, reduce the number of animals required, or refine existing procedures or techniques so as to minimize the level of stress endured by the animal"[4,5].

Example:

- Vitro (in glass) testing, such as studying cell cultures in a petri dish, can produce more relevant results than animal testing on different rodent and non-rodent species because human cells can be used. Micro dosing can be administered to the human who gives the appropriate result on human volunteers, whose blood is then analysed.
- Artificial human skin, such as the commercially available products EpiDerm and ThinCert, can be used as it is made from sheets of human skin cells grown in test tubes or plastic wells which can produce more useful results than testing chemicals on animal skin as some times result varies animal and between human.

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The animals use in scientific research is act as tool in improving the understanding of how biological systems work both in health and disease condition. The developments of new medicines are for both humans and animals, and for the protection of our environment. Hence, it was properly regulated by use of animals in improving the health and lives of humans and animals and to the safety and sustainability of our environment.

This research supports the UK's world-class research base on the environmental, agricultural, medical and other life sciences. The alternative method improves health and diseased condition of patients and animals in the UK by the outcomes of research.

National Health Service is the primary source of research and testing on animals – such as by the licensing of new medicines, and the development of new and safe vaccines and for the detection and control of infectious diseases.

For Example:

- The development of monoclonal antibody had completely transformed our ability to treat diseases including breast and other cancers.
- Rheumatoid arthritis and multiple sclerosis treatment was also developed by the use of this technology.

It also supports a number of highly skilled jobs in research on the base of an attractive regulatory environment. Economically the life sciences sector contributes over £50bn a year to the UK economy with agriculture contributing £9bn and it underpins the UK's £26bn sector providing us with healthy and wholesome food.

In 2010, the Government made a commitment to reduce the work on use on animals in scientific research. It encompasses REPLACEMENT, REDUCTION AND REFINEMENT (the 3Rs) more broadly, putting them at the science-led approach.

Implementing of the 3Rs requires in every research proposal, which include:

- Animals are replaced with non-animal alternatives wherever possible,
- The number of animals used is reduced to the minimum needed to achieve the results sought, and
- For those animals which must be used, the procedure should be refined as much as possible to minimise the suffering of animal.

The scientific imperative for developing new approaches to research and development is very strong. Similarly, there are concerns about the utility of animal studies for testing environmental chemicals.

- FOR EXAMPLE, Animals are exposed to too much higher doses than typical human exposures making interpretation difficult.

An international science organisation called for the development of assays that are more predictive to human biology. Attention has focused on non-animal technologies; it include tissue engineering, stem cells, and mathematical modelling [5].

On 18 July 2012, Written Ministerial Statement set our ambition to deliver the commitment such a science-led programme, spearheaded by relevant government departments and agencies, working together where appropriate, and by the National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs), an organisation with record in promoting the 3Rs in animal research.

Plan demonstrates how taking advantage of technological developments, including increased computer power and wider scientific innovation, to provide the perfect environment and catalyst for scientific change and progress which will help to reduce the use of animals in research. The Delivery Plan set out the Government three strategic by putting the 3Rs at the science-led programme:

- Advancing the use of the 3Rs within the UK;
- Using international leadership to uptake and adoption of 3Rs approaches globally;
- Understanding and awareness about the use of animals where no alternatives exist.

Strategic priorities are considered in detail in Section 2 of this Delivery Plan.

In this Strategy UK Life Sciences was published in 2013 whose aim is to make the UK the location for research and development together for manufacturing. This Delivery Plan shows how 3Rs makes a real contribution to realising benefits for humans, animals, environment and sustained economic growth.

HENCE, for all these above points we use the alternative methods which help to sustain growth of economic, animals and humans and environment too. [6]

3Rs

3Rs is proposed by Charles Hume, founder of the Universities Federation for Animal Welfare (UFAW) in 1954, consideration alternatives was made for animal testing on laboratory animal experiments. R.L. Burch and the zoologist W.M.S. Russell is the microbiologist who publishes the work, "The Principles of Humane Experimental Technique" in London in 1959, and the book also defined the animal testing alternatives as "The Three R's: Refinement, Reduction, and Replacement [7,8]

Laboratory animals are manly used in following areas:

- BIOMEDICAL RESEARCHERS use animals to understand the body metabolism and catabolism, disease and health condition of the body, and to develop new vaccines for treatments of various diseases.
- INDUSTRY uses animals to test the effectiveness and safety of consumer products.

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SUCH AS: for drugs, cosmetics, household cleaning products, pesticides, industrial chemicals, and for many more test.

- EDUCATIONAL uses include dissecting earthworms or frogs in biology class which are now rarely used, as well as in advanced training of surgical techniques for veterinary and medical students.
- PSYCHOLOGICAL OR SOCIAL BEHAVIOURS RESEARCH is used for study of animals to learn more about a given species, its biology and behaviour. They may learn from the special skills or abilities of an animal as well such as animal models were used.

  FOR EXAMPLE, Navy researchers have studied dolphin echolocation--their built-in biological sonar system to improve the human-made sonar systems used on board ships. [9]

In the research laboratory an animal may be poisoned; deprived of food, water or sleep; skin and eye irritants were applied; subjected to psychological stress; deliberately infected with disease; brain damaged; paralysed; surgically mutilated; irradiated; burned; gassed; force fed and electrocuted. [10, 11]

Replacement of Animals in Medical Experiments (FRAME) considered that the animal experimentation is unacceptable, but the abolition of all animal in experiment is not possible. New consumer products, medicines, and industrial and agricultural chemicals can be tested in order to identify potential of human and animal health, and to the environment. [10]

Alternative methods fall into three broad categories. These are called the 3 Rs

- Replacement,
- Reduction, and
- Refinement.

Replacement is what most people think of when you say "alternatives to animal testing"

- The animals are replaced, either by methods that don't involve animals at all that are called as absolute replacement.
- By those that use only the cells or tissues of animals that is called as relative replacement.

  SUCH AS: Many replacement alternatives involve in vitro or in glass techniques, where the studies are perform with cells or tissues in culture. If the cells come from human beings, it's absolute replacement, and if from animal it is called as relative replacement. [10]
- Replacement also means replacing 'higher' animals with 'lower' animals.

  SUCH AS: Microorganisms, plants, eggs, reptiles, amphibians, and invertebrates may be replaced by the warm-blooded animals in many experiments.

Live animals may be replaced with non-animal models, i.e. dummies for dissection in teaching the animal or the human body structure, mechanical or computer models, audio-visual aids, or in vitro modelling. [12]

- Replacement utilizes the pre-existing knowledge for new system to look similarities and for using less expensive animals or models to have research on agents for toxicity or mutagenicity. [10]
- Disadvantages for replacement is that if any model are dependent on pre-existing information, the complex physiology and pathology of organism was not known. Hence, research on new biological processes must utilize a living organism; unfortunately, replacement isn't always an option. [12,10]
- EXAMPLE OF REPLACEMENT: of a replacement alternative is no longer considered an alternative it has become the norm. Not too many years ago, if a woman wanted to find out if she was pregnant, she'd have to get a laboratory test that involved killing a rabbit. Now, she can buy a small kit over-the-counter that tests her urine for certain chemicals the rabbits have been replaced. [10,11]

Reductions mean minimizing or reduce the number of animals needed to perform an experiment or teach a concept.

- In research testing some test cannot perform without animals, at least at this research time. Researchers can also work by reduce the number of animals used in a given study.
- Sometime the uses of far fewer animals are given valid results. These methods include performing pilot studies to determine the potential problems in an experiment before numerous animals are used.
- Designing a study is done by utilizing number of animals by our own control, it include to have a maximum amount of information from each animal, or gathering many or much data from more than one experiment concurrently.
- Statistician consult should be taken for numbers of animals required to achieve significance result during result, or by Minimizing variable condition of animal which affect the result such as, disease, stress, diet, genetics, etc.
- The appropriate species of animal also useful for the data collection, and Replacement should be done whenever it is required or possible. [9, 8, 10]

Refinement means refining experimental protocols to minimize pain or distress to the animal whenever it is possible for the experiment.

- For those animals that do undergo testing, scientists may refine their methods to lessen or eliminate pain, distress, or suffering and to make the animals more comfortable. [10]
- Examples of refinement which include it for the identification pain and distress and making plans and executedfor preventing or relieving it.

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- During measuring the toxicity of a compound or survival can be determined not by death just by chronic toxicity.
  SUCH AS: Atumour achieves a certain size; at the time of coursedeath is predictable. Subsequent experiments may beutilized the earlier endpoint of tumour size or clinical signs of toxicity, rather than death as the endpoint.

Refinment Can Be Done By: [8, 10]

- Receiving adequate or proper training for performing a procedure
- By using proper handling technique for animals.
- By ensuring that drug doses are correct and drugs should not expired,
- The performed experiment on the animal is reasonable for that species.
- Usinganalgesicsand anaesthetics for potentially painful procedures.
- Performing surgeries procedures aseptically to prevent infection.
- Performing only a single major survival surgery on any one animal, whenever possible.

IV. Different Alterative Methods

Alternatives to animal use in biomedical and behavioural research fall into four broad categories:

- Continued, but modified, animal use, including a reduction in the number of animals used, improved experimental design and statistical analyses of results, substitution of cold-blooded for warm-blooded vertebrates, substitution of laboratory mammals for domestic or companion mammals, and reduction of pain or experimental insult;
- Use of living systems, including in vitro cultures (of cells, tissues, and organs) embryos, invertebrates, micro-organisms, and plants;
- Use of non-living systems by using chemical or physical systems; and
- Computer simulation.

Biomedical and behaviouralhad focus attention on drug development by using alternatives rather than animal methods. Alternative methods in research show advantages that can be based on the prospect as follow i.e. on scientific, economic, and humane which include including:

- The number of animals used can be reduced;
- Animal pain, suffering, and experimental insult can be minimized;
- Reduction in investigator-induced and art factual physiological phenomena;
- Using the process which provide more quickly result;
- To perform ability for replicative protocols on a routine basis;
- Cost of research reduction;
- Alter conditions for flexibility with experimental protocol;

At the same time, these methods are fraught with inherent disadvantages, including:

- Ability of organismal growth process reduces;
- Ability to study cells, tissues, and organ systems reduces by acting in concert;
- Biochemical and metabolic pathways cannot studies;
- Behaviour study on cell tissue or organ cannot possible;
- Study of recovery of damaged tissue cannot possible;
- Interaction between the organism and its environment ability reduces;
- Decrease ability to study of idiosyncratic or species specific responses;
- Drug effect on male and female-specific phenomena cannot be possible; and Different alternative methods are as follow:

a) Organ Culture

In history of research, investigators have attempted success in every major and minororgan of mammalian body in variety of research purposes. In last few years, techniques were improved, such as artificial blood media system which helps in, successful organ culture. The applications of organ culture include the study of protein synthesis in lactating mammary tissue [21] and by using human placentas in toxicology studies[18].Whole organs are not use in long-term in vitro culture. The complexity of whole organs makes it impossible for nourishment and for normal function of growth without any external support. Cryostat sections of organ are studies into organ-specific test for metastatic tumour cells. These in vivo events reflect the use of whole animals in a very active research area.[20] Whole mammalian embryos are used basic development in biological research and other experiment, which have been cultured in vitro for other purposes. Protocols included the effects of hormones and teratogens [22].

b) Tissue Culture

Tissues from humans and animal species can be studied in tissue culture. The progress have been achieved in 1907, by R.G. Harrison who studied first frog tissue outside the body for weeks, which had changed the tissue culture from an art of science. Bacteria or virus are alive for more than few hours to gain a better result in the antibiotic study. The tissue culture was extended by controlling bacterial contamination. In tissue culture, isolated tissue of a living organism is maintained by various cells which are arranged as they were in the original organism. Tissue cultures are both “better” and “worse” than a single cell type. They act as better in the manipulation in different natural

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environment and different cell typeswhich show interaction similar to in vivo, as they are worse in more difficult condition to maintain. Tissue-culture experiment requires animal sacrifice, as they are alternative to numerous sections of animal adjoining tissue to use. By this way, two or more research can be performed in the single animal tissue, rather than a number of individual animals. Tissue culture is successfully used in biomedical research. In neurology, embryonic rat tissues are used to examine the destruction of dopamine neurons [25], which is prior to development, as monkey act as best model for the study of degenerative and the other study to degenerative effect observed in humans.

c) *Cell Culture*

It is not a new technique; development and application of cell culture are seen in many past year in different fields. Cell culture every ethic of biomedical research, as well as in clinical practice.

The approaches of biomedical research by cell culture method are as seen:

- Eggs and sperm of many species are used in the study of fertilization and early development. [28, 19]
- Mutants are used to understand membrane associated proteins which are essential for knowing animal cell function [29].
- In oncology, bacterial recombinant DNA induces in the transformation of white blood cells which is used toobserved infection, cancer, and rheumatoid arthritis [30].
- Steroid metabolism is studied by using rat epididymis cells [31].
- A kidney cell of monkey was use to demonstrate the metabolic effects of many drug [26].
- Surgical research is use to cultured human epitheliums for permanent coverage oflarge burn wounds has moved from the lab- oratory into clinical trials [32].
- In immunology, studies on antibody synthesis and response have been bolstered by the Nobel-prize-winning elucidation of monoclonal antibodies.

Biologists have developed techniques for the controlled disruption of cells that can leave many organelles intact or allow the harvesting of selected intracellular membranes. These fractions have proved to be invaluable in the search for information at the molecular level.

FOR EXAMPLE,

- Microsomal membrane fractions from rat and human liver have been used in comparative anaesthesia research [27].
- The most unique uses of subcellular fractions involves the bringing together of mixed species systems in biochemical studies of protein transport across intercellular membranes.
- Researchers studying intracellular protein translocation used dog pancreatic microsomes, bovine pituitary and rabbit reticulocyte messenger RNA, bacterial nuclease, and a wheat germ cell free system to elucidate the structure of the signal recognition particle [33].

V. Ethical Issue [12, 34, 35]

Many ethical issue works in animal research which are explained in the different issue as quarry with solution:

'Are humans or animal status are different?'

People in large number believe that humans have the high moral status, then animal they believe animals are inferior then humans. However, others disagree and say that this discrimination is having no justification in it. Status of humans and animals can be discussed in following ways:

- One characteristic i.e. self-awareness or rationality.
- Capacity of suffering by animal, which characterised as is an animal's sentience, or to understand its pain, suffering and pleasure.
- Social relationships of animal should also considered, while many animals differ in these characteristics from humans, and also different between animal to animal.

'How can we know how much animals suffer?'

A recent data show that the amount of pain suffered by animals is more as people think; it is very difficult to understand human concepts and emotions about pain, distress, fear, happiness or affection to animal. Even if we can say that animals have similar brain activity as humans, which means pain suffering in the animal is in the same way.

'Can we justify making animals suffer?'

Many people believes that it is wrong to make animal suffer without reason; but some people think that there is some condition more than the interests of people outweigh the interests of an animal, this justify animal suffers more than enough.

In research using animals, the costs, in the form of suffering, are largely experienced by the animals while any benefits arising from the research are largely directed to human patients.

VI. Guidelines for Ethical Research [36, 37, 38, 39]

The UK has regulation on research involving animals worldwide. Law of the Animals are (Scientific Procedures) Act 1986. This law was act to protect animal by cause "pain, suffering, distress or lasting harm" must be licensed. 'Protected' animals include all vertebrates (mammals, birds, reptiles, amphibians and fish, and octopus). All procedures must carry three separate licenses for the premise; the researcher and the project.

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a) Licences for Research Involving Animals

i. *Premise Licence*

The place where research is conducted must meet standards of animal housing and care and is regularly subject to inspection by the Animals (Scientific Procedures) Inspectorate. In 1999, there were 296 designated premises in the UK.

ii. *Personal Licence*

Any person conducting animal procedures must be competent to do so and must have completed an accredited training course in order to be awarded a licence. This licence specifies which procedures can be conducted and on which species. In 1999, there were around 13,700 active personal licences in the UK.

iii. *Project Licence*

This defines the types of animals which may be used, the estimated number to be used, and the procedures that may be carried out. The licence application includes details of the purpose of the project, an initial welfare assessment and a limit of severity for each procedure.

In general, project licences should only be granted if:

- The research cannot be done without animals;
- The likely costs of the research are weighted against the potential benefits in a cost benefit assessment, and the benefits are deemed to be greater;
- The minimum number of animals will be used;
- Researchers and technicians are trained and experienced in animal testing;
- Research premises have facilities for animal care.

Inspectors visit laboratories to assess licenceregulations. There are currently 25 inspectors in the UK, who make more than 2,100 in every year. The independent Animal Procedures Committee (APC) was established to advise the Secretary of State on the operation of the 1986 Act.

b) Testing Guidelines

Testing guidelines are developed for a variety of reasons:

- To allow results of various test substances or species to be easily compared,
- To encourage the use of certain protocols so that testing need not be repeated, and
- To facilitate the work of those who design and carry out tests.

Many organizations differently developed their own testing guidelines.

- FDA Guidelines Involving Whole Animal Testing
- OECD Guidelines Involving Whole Animal Testing
- Pesticide Assessment Guidelines Involving Whole-Animal Testing

Ethical guidelines of animal testing are:

- CPCSEA Committee for the Purpose of Control and Supervision on Experiments on Animals
- CARE Community on Animal Research and Ethics
- GCUASR Guidelines For Care And Use Of Animals In Scientific Research
- NACLAR National Advisory Community for Laboratory Animal Research
- APA American Psychological-al Association

Table 1: Different Community Work for the Ethical Guidelines for Animal

	CPCSEA	CARE	GCUASR	NACLAR	APA
Full Form	Committee for the Purpose of Control and Supervision on Experiments on Animals	Community on Animal Research and Ethics	Guidelines For Care And Use Of Animals In Scientific Research	National Advisory Community for Laboratory Animal Research	American Psychological-al Association
Guidelines Followed In Country/ Countries	India	Washington, DC	Indian National Science Academy (India)	Australia, Canada, New Zealand, US	US
GOAL	Guidelines is to promote the humane care of animals used in biomedical and behavioural research and testing with the basic objective of providing specifications that will enhance animal well-being, quality in the pursuit of advancement of biological knowledge tl1at is relevant to humans and animals.	Important parts of these endeavours are teaching and research on the behaviour of nonhuman animals, which contribute to the understanding of basic principles underlying behaviour and to advancing the welfare of both human and nonhuman animals.	The interest of society and the welfare of animals.	Guidelines set out the responsibilities of all the parties involved in the care and use of animals for scientific purposes, in accordance with widely accepted scientific, ethical and legal principles.	The acquisition, care, housing, use, and disposition of nonhuman animals in research must be in compliance with applicable federal, state, and local, laws and regulations, institutional policies, and with international conventions to which the United States is a party.

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Table 2: Points Covered in Different Guidelines

CPCSEA	CARE	GCUASR	NACLAR	APA
Veterinary care	Justification of the research	Sources of experimental animals	General principles for the care and use of animals for scientific purposes	Justification of the Research
Animal procurement	Personnel	Laboratory animal husbandry and management	Animal housing and management	Personnel
Quarantine, stabilization and separation	Care and housing of animals	Transport of laboratory animals	Procurement and transport of animals	Care and Housing of Laboratory Animals
Animal care and technical personnel	Acquisition of animals	Anaesthesia and euthanasia	Staff at housing and research facilities	Acquisition of Laboratory Animals
Functional areas	Experimental procedures	Disposal of animal carcasses	Veterinary care	Experimental Procedures
Animal husbandry	Field research	Laboratory animal ethics	Responsibilities of institutions and the institutional animal care and use committees (IACUC)	Field Research
Record keeping	Educational use of animals	Legal provision	Responsibilities of investigators	Educational use of nonhuman animals
Laboratory animal ethics	-	-	Responsibilities of teachers	-

Table 3: Brief Explanation of all the Guidelines

POINTS	CPCSEA	CARE	GCUASR	NACLAR	APA
Veterinary care	Daily observation of animals,	Care should be done according to "American Veterinary Medical Association (AVMA) Panel on Euthanasia."	The post-operative holding rooms, cages and the care should be under the supervision of a qualified veterinarian.	Investigators must have ready access to veterinary care for the animals at all times.	Care should be done according to "American Veterinary Medical Association (AVMA) Panel on Euthanasia."
Justification of the research	No animal should be used for experimentation for more than 3 years unless adequate justification is provided.	Research should be undertaken with a clear scientific purpose. There should be a reasonable expectation for research.	Research should be undertaken with a clear scientific purpose.	All animals found in a moribund state must be euthanized unless there is specific justification to do otherwise.	Research should be undertaken with a clear scientific purpose. There should be a reasonable expectation for research.
Sources of experimntal animals	Institution Biosafety committee and Institutional Animal Ethics Committee.	The USDA and local ordinances should be consulted for source of animal.	The only authentic source of getting right type of animals for research should be from recognized scientific animal facilities	A licensed or otherwise legally permitted source.	The USDA and local ordinances should be consulted for source of animal.
Care and housing of animals	Housing different species in separate rooms; however, cubicles, laminar-flow units, cages that have filtered air or separate ventilation, and isolators shall be suitable alternatives.	The facilities housing animals should meet or exceed current regulations and guidelines (USDA, 1990, 1991), and are required to be inspected twice a year (USDA, 1989).	It is important that they are housed in an isolated building located as far away from human habitations as possible and not exposed to dust, smoke, noise, wild rodents, insects and birds.	Animals should be housed in a manner that facilitates the expression of species-typical behaviour and minimises stress–induced behaviours.	The facilities housing animals should meet or exceed current regulations and guidelines (USDA, 1990, 1991), and are required to be inspected twice a year (USDA, 1989).
Legal provision	The Animal House should maintain records of chemicals, Breeding, stock, purchase, staff, sales records	-	Record should be kept for the breeding,stock, purchase, staff, sales records, death and animal use in experiment.	Record should be available to the personnel providing post-operative care.	-
Functionl areas	The size and nature of a facility will determine whether areas for separate service functions are possible or necessary.	Research conducted in populated areas should be done with respect for the property and privacy Of the inhabitants of the area.	-	The area should be according to the experimental protocol.	Research conducted in populated areas should be done with respect for the property and privacy Of the inhabitants of the area.

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VII. Conclusion

The global trend for the use of animals in research is indispensible in several field hence the use of animal in research should be justify as the animal use in research maybe ethical in some way where alternative methods are not known or very expensive. The different methods which are alternatively used are sometimes beneficial sometimes not as seen in animal use too. Hence if experiment were performing on animal should be ethical as given in the guidelines for animal.

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Constraints to Justice Against Rape Faced by Girls and Women: The Case of Wolaita Zone, SNNPR, Ethiopia

By Bereket Tessema Zewude, Kidus Meskele Ashine & Abebayehu Tora Kacho

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Abstract- An attempt has been made to see the victim of rape which indicates that one in every five women is victim of rape in her lifetime. The fear, psychological distress, and physical injury not only have a debilitating consequence on the victims of rape. But, the families and associates around them are exposed to various forms of social problems. However, rape and sexual assault against women remains a hidden crime for many of its victims. Even when reported to authorities, rape victims are still exposed to secondary victimization that results from the bureaucratic and institutional procedures. In addition, common myths and shared cultural definitions of 'real victims' and 'real rapes' have significant influences on public prosecutors and judges in the determination of real victims of rape.

Keywords: *attempted rape, completed rape, decision making, prosecution process, rape, wolaita zone, ethiopia.*

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Constraints to Justice Against Rape Faced by Girls and Women: The Case of Wolaita Zone, SNNPR, Ethiopia

Bereket Tessema Zewude [α], Kidus Meskele Ashine [σ] & Abebayehu Tora Kacho [ρ]

Abstract- An attempt has been made to see the victim of rape which indicates that one in every five women is victim of rape in her lifetime. The fear, psychological distress, and physical injury not only have a debilitating consequence on the victims of rape. But, the families and associates around them are exposed to various forms of social problems. However, rape and sexual assault against women remains a hidden crime for many of its victims. Even when reported to authorities, rape victims are still exposed to secondary victimization that results from the bureaucratic and institutional procedures. In addition, common myths and shared cultural definitions of 'real victims' and 'real rapes' have significant influences on public prosecutors and judges in the determination of real victims of rape. The objective of the study was to assess the prosecution process and rape case management and identify factors that influence the prosecution process in general and the decision making in particular in line with assessing the level of reported rape cases and identify factors that influence prosecution process by analyzing the filed documents in court for the last three years in study area. The result revealed that there is significant variation in the level of reported rape cases among the selected woredas. The age of the victims and suspects ranges from 2.5 to 50 years and 7 to 60 years, respectively while the mean age is 16.9 years for the victims and 23.5 years for the suspects. Over 50% of the rape victims were within 9-17 years of age while 69% of the suspects were within 18-35 years. Interestingly, married couples constitute the significant number in terms of both reporting and victimization that is 18.4% for the victims and 29.7% for the suspects. Compared to attempted rape, completed rape is the dominantly reported type of rape. For only 5.1% of the victims, police and public prosecutors could collect exhibits of which 2.2% were knives. Majority of reported rape cases have been rejected either before or after the public prosecutor instituted the case considering that the evidences were insufficient to be admissible which accounted 32.9%. Only on 19.3% of the reported rape cases the judges reached to the decision that the suspect is guilty and must be sentenced. On the other hand, over 45% of the cases have been interrupted either before or after the public prosecutor instituted the case. Those victims who report attempted rape have also higher chance of being rejected compared to those who report completed rape ($\boldsymbol{OR = 3.168, 95\%\, CI = 1.45, 6.92}$). The average years of imprisonment for the suspects proved guilty is 8.7 while the minimum and maximum are 3 months and 20 years, respectively. There is also a moderate inverse correlation between victim's age and penalty determination among judges observing correlation coefficient $\boldsymbol{r = -0.423, p = 0.001}$.

Keywords: attempted rape, completed rape, decision making, prosecution process, rape, wolaita zone, ethiopia.

I. Introduction

Crime statistics available from many countries would indicate that most victims of rape or sexual violence make the choice not to report the crime to the authorities and as a consequence '. . . rape remains a hidden crime for many of its victims' (Edwards, 1996, 332). Estrich further states that rape is distinguished from other crimes not so much because of the 'disproportionate numbers of actual complaints but because of the disproportionate numbers of cases that are never reported' (Estrich, 1987: 54). Studies have shown that victims may be reluctant to report sexual violence for a variety of reasons (Temkin, 1987)11; Adler, 1987:4; Katz and Mazur, 1979:186). Interviews with victims have consistently revealed that the reasons for not reporting include: (i) fear of how they will be treated by people within the criminal justice system, (ii) not wanting what happened to them to become public, (iii) fear of lack of evidence (U.S. Dept. of Justice, 1994). Moreover, societal presumptions and myths about rape may foster feelings of guilt and self-blame which inhibit victims from reporting. McColgan (1996) concludes that many women do not define their experience as rape, particularly if they know their attacker.

Involvement in the legal process usually results in secondary distress to the victims too often endure insensitive treatment at the hands of the criminal justice system, or what has come to be referred to as 'secondary victimization'. Holmstrom and Burgess (1978), in their now classic study of how legal and medical institutions react to the victims of rape, emphasize that the very institutions which exist in part to aid and protect in reality often further victimize victims. These authors point out that ' . . . Rape does not end with the departure of the assailant. Instead, the institutional processing that occurs can be equally

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devastating for the victim' (Holmstrom and Burgess, 1978, p.vii).

Regarding the extralegal factors influence the prosecution process of rape common myths and shared cultural definitions of 'real' rapes and 'real' victims also combine to enhance victims' fear of being disbelieved (Stewart et al, 1996). The extra-legal factors are also taken into account both by the police and by prosecutors in deciding whether to pursue a case or not. Prior consent to sexual intercourse with the accused; 'risky behavior' such as getting into a car with a man met at a bar, kissing at a bar, having too much to drink, or inviting a man into the house to have a drink; all are signs of 'misconduct' which implicated the woman (Stewart et al., 1996).

When we come to situation of rape and sexual assault in Ethiopia showed that 6.2% of the students who have started sexual intercourse, 26.1% were raped cases and 75.9% of the students reported being sexually harassed in study area, Addis Ababa (Lelisa& Yusuf, 2008). Also, the prevalence of gender based violence in general and sexual violence in particular. A study among high school students revealed that girls are even denied their freedom of movement and are afraid of moving or walking alone in broad day light even in the streets of big cities like Addis Ababa and school based cross sectional survey conducted in Debark, north western Ethiopia indicated the prevalence of completed and attempted rape to be 8.8% and 11.5% respectively (Worku et al., 2002). Also the study conducted in Addis Ababa University among 612 female students, the prevalence of lifetime completed and attempted rape was 12.7 % and 27.5% respectively while sexual harassment in lifetime and 12 month period accounted 58% and 41.8% respectively (Tadesse, 2004). A study conducted in Hawassa University recorded the overall prevalence of gender based violence among 1330 female students and found 59.9% lifetime, 46.1% since enrolling college and 40.3% current academic year (Dodie et al., 2008).

II. Methodology

a) Description of study area

The study was carried out in Wolaita Zone, Ethiopia year of 2013. Wolaita Zone consists of 13 woredas found in temperate region of South Nationalities and Peoples (SNNP) regional state with capital town of Sodo. Sodo town is located (54^0N latitude and 380^0 S longitude) and 396km south of Addis Ababa and 130km from regional town Hawassa.

b) Study Design

The research design was qualitative as well as quantitative research design can be employed.

c) Source of Population

The source of population consists of 12 woredas and 3 admistrative towns in wolaita zone for study purpose.

d) Sampling Technique

Among 12 Woredas and 3 administrative towns we take a sample of 6 woredas and 1 administrative towns using purposive sampling technique.

e) Variables Identification

For study purpose our dependent variables includes: Rape victims and suspects, condition of reported rape cases and decision making process.

f) Independent Variables

Socio-demographic variables

g) Data Collection

Both primary and secondary data collection method were applied to get the desired information. Primary data were collected through a questionnaire. The questionnaire was prepared, pre tested and administered for the selected woredas and administrative towns. Secondary data collected by using document analysis in selected woredas and administrative towns. Two separate cross sectional studies have been conducted through document analysis on prosecution process.

h) Data Entry and Analysis

Data entry and cleaning were carried out using statistical soft ware package SPSS version 22.0 for the analysis. The analysis employed here is that descriptive statistics analysis was used to show the frequency distribution and its results were presented by tables. Also binary logistic regression model (odd ratio) was used.

III. Results and Discussion

Table 1: Condition of reported rape cases

Variables	Category	Frequency	Percent
Type of Rape	Attempted	131	41.5
	Completed	185	58.5
	Total	316	100
Time of report	Reported more than 24 hours later	188	59.5
	Reported within 24 hours	88	27.8
	Total	276	87.3

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Place where rape committed	Suspect house	34	10.8
	Victim house	44	13.9
	Jungle	35	11.1
	Hotel room	9	2.8
	On the way to or from home	13	4.1
	Around the river	10	3.2
	At school	4	1.3
	Farm place	3	.9
	Work place	1	.3
	Church compound	1	.3
	Not stated in the document	162	51.3
	Total	316	100.0
Reported means used to attempt or commit rape	Through oral intimidation	32	10.1
	Through intimidation using weapon	70	22.2
	Through using Physical force	191	60.4
	Through fraud or cheating	18	5.7
	Total	311	98.4

Based on table 1, compared to attempted rape, completed rape is the dominantly reported type of rape. However, about 60% of reported rape cases were reported more than 24 hours after the incident. Interestingly, for 51.3% of the reported rape cases, the police or the public prosecutors did not trace where exactly the suspects attempted or committed rape. For those cases scene of rape indicated, majority of rape have been attempted or committed at victims' and suspects' house respectively. Victims also indicated those means used by the suspects during the incident. The use of physical force and intimidation using weapon accounted 60.4% and 22.2% respectively.

Table 2: Decision making and prosecution process

Variables	Category	Frequency	Percent
Decision	Case rejected	107	33.9
	Suspect proved guilty and sentenced	61	19.3
	Total	168	532
Stage at which case has been rejected	Case rejected by public prosecutor	65	20.6
	Case rejected by judges in the court	42	13.3
	Total	107	339
Reason for decision	Due to lack of sufficient evidence	104	32.9
	Evidence persuaded beyond reasonable doubt	61	19.3
	The suspect was too young to qualify for prosecution	1	.3
	For unknown reason	2	.6
	Total	168	532
Interruption	Interrupted before the public prosecutor institutionalized prosecution	109	34.5
	Interrupted while the case was being taken care of in the court	34	10.8
	Total	143	45.3
Reason of interruption	Disappearance of suspect	59	18.7
	Lack of follow up by the victim	22	7
	The suspect was too young to qualify for prosecution	3	0.9
	Due to arbitration by two families	29	9.2
	Witnesses were blocked or disappeared	23	7.2
	Total	136	43.
Number of days elapsed after involvement in the prosecution process	30 and below	95	30.1
	31-90	92	29.1
	91-180	48	15.2
	181 and above	22	7.0
	Total	257	81.3

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From table 2 the result shows that among 316 reported rape cases, 168 (53.2%) were identified in the documents with decision passed either by public prosecutor or judges in the court as rejected or proved guilty. Majority of reported rape cases have been rejected either before or after the public prosecutor instituted the case considering that the evidences were insufficient to be admissible which accounted 32.9%. Most of the rejections were made by public prosecutors before prosecution was instituted. Only on 19.3% of the reported rape cases the judges reached to the decision that the suspect is guilty and must be sentenced. On the other hand, over 45% of the cases have been interrupted either before or after the public prosecutor instituted the case. Interestingly, most interruptions of the prosecution process were attributed to disappearance of the suspect after the incident or in the trial process. Other cases were interrupted due to reasons related to arbitration, disappearance of witnesses and luck of follow up by the victims constituting 9.2%, 7.2% and 7% respectively. After involvement in the prosecution process, the average amount of time the complaints must wait is 83.3 days. But, the number of days elapsed after involvement in the prosecution process ranges from 1 to 1820. The interesting side of timing is that majority, i.e. 30.1% of the reported rape cases remain active in the prosecution process for less than 30 days. Over 29% of the cases lasted about 31-90 days (that is 1-3 months) while 15.2% of them stayed in the prosecution process for about 91-180 days. Only 7% of the reported rape cases lasted for more than 6 months.

IV. Binary Logistic Regression Analysis

Table 3: Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	494.061[a]	.29	.36

From the above table Nagelkerke R^2 in model summary table above is 0.36, which indicates that 36.0% of the variability in rape was explained the explanatory variables.

Table 4: Goodness of fit (Model Diagnostic)

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	13.732	7	.075

As it is observed from the table above since P-value is 0.075 is greater than the level of significance at 5%. We can conclude that the data fits the model well. Since the p-value is 0.075 which is insignificant therefore our fitted logistic regression model is good fit (Table 4).

Table 5: Binary Logistic Result

		B	S.E.	Wald	df	Sig.	Exp(B)=0dds ratio	95% CI
Step 1[a]	Attempted rape Completed rape (ref.)	1.153	.218	5.289	1	*.042*	3.168	(1.45, 6.92)

From table 5 those victims who report attempted rape have also higher chance of being rejected compared to those who report completed rape ($OR = 3.168, 95\%\ CI = 1.45, 6.92$).

Also there result of correlation coefficient indicate that there is also a moderate inverse correlation between victim's age and penalty determination among judges observing correlation coefficient $r = -0.423, p = 0.001$.

V. Conclusions

- From binary logistic regression analysis the result of the study concluded that attempted rape has also higher chance of being rejected compared to those who report completed rape.
- From correlation analysis there is moderate inverse correlation between victim's age and penalty determination among judges.
- Based on descriptive statistics analysis compared to attempted rape, completed rape is the dominantly reported type of rape.
- Majority of reported rape cases have been rejected either before or after the public prosecutor instituted the case considering that the evidences were insufficient to be admissible.
- More cases have been interrupted either before or after the public prosecutor instituted the case.

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Parabolic Dish Concentrating Collector for Indirect Solar Cooking

By Amós Veremachi, Azher Zia, Boaventura C. Cuamba, Jorgen Lovseth & Ole Jorgen Nydal

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Abstract- Thermal performance of a point focus solar concentrating collector comprising a 2000 mm diameter, and a 665 mm focal length symmetric parabolic dish concentrator covered with reflective aluminum tiles of 0.9 reflectivity and SiC honeycomb volumetric absorber, which use atmospheric air as heat transfer fluid is experimentally investigated. The absorber was tested for two different mass flow rates. The test was intended to assess the potential of this collector as a component of solar cooker with heat storage, a prototype that has a potential to enable indirect and off-sun cooking. The prototype of a solar cooker under investigation is intended to be used in rural areas (in Mozambique) to meet multiple domestic needs in thermal energy as part of a global effort to mitigate the consequences of one of the severe problems the world faces today (desertification and deforestation), some of which are attributed to climate change.

Keywords: *energy; parabolic dish; renewable sources; thermal performance; solar cooker.*

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Parabolic Dish Concentrating Collector for Indirect Solar Cooking

Amós Veremachi [α], Azher Zia [σ], Boaventura C. Cuamba [ρ], Jorgen Lovseth [ω] & Ole Jorgen Nydal [¥]

Abstract- Thermal performance of a point focus solar concentrating collector comprising a 2000 mm diameter, and a 665 mm focal length symmetric parabolic dish concentrator covered with reflective aluminum tiles of 0.9 reflectivity and SiC honeycomb volumetric absorber, which use atmospheric air as heat transfer fluid is experimentally investigated. The absorber was tested for two different mass flow rates. The test was intended to assess the potential of this collector as a component of solar cooker with heat storage, a prototype that has a potential to enable indirect and off-sun cooking. The prototype of a solar cooker under investigation is intended to be used in rural areas (in Mozambique) to meet multiple domestic needs in thermal energy as part of a global effort to mitigate the consequences of one of the severe problems the world faces today (desertification and deforestation), some of which are attributed to climate change. Thermal efficiency of the collector was estimated for the two mass flow rates. Preliminary results have shown that at the target temperature range the collector efficiency remained above 70 % and that the higher the mass flow rate, the lower the temperature of the air coming out of the collector.

Keywords: energy; parabolic dish; renewable sources; thermal performance; solar cooker.

I. Introduction

External energy sources are an important factor for human life and development. Sufficient access to quality energy is one of the indicators of human development.

Mozambique is ranked among the countries with lowest access to electricity per capita, with only 25 % of its population connected to national electricity grid [1]. Like many other African countries, it has the majority of its population living dispersed in rural areas and depending mainly on biomass as a source of thermal energy for their multiple domestic needs. The biomass share on the country's primary energy is more than 78% [2].

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Currently, however, the sources of biomass are becoming scarcer due to deforestation, changes in land use, desertification [3]-[4]. The deforestation rate in Mozambique is more than 5.6 % [5]. This reality put at risk the future of many women and children whose burden is increased due to the fact that at the present more time is required on fetching firewood to meet the families daily energy needs for cooking.

Luckily, Mozambique is among the countries with a considerable potential of renewable sources of energy. In particular, owing to the country's geographical location, the solar radiation intensity is good; with a daily annual average of $5.2\ kWh/m^2$ [2]-[3]-[6]. Therefore, direct collection of solar thermal energy can be an energy source for multiple domestic needs (cooking, frying, hot water, pasteurization, etc) in rural areas of Mozambique. Adoption of solar energy as a source of thermal energy also holds other indirect benefits such as an increased time availability for women and children to dedicate to their educational activities; improved in-door environment and natural environment, and less risk of burning accidents [29].

Cooking is energy intensive activity requiring medium-to-high temperatures, and thus demanding appropriate technology for harnessing and using it in an efficient way. This requirement and the low density of solar radiation at the Earth's surface turn the harvesting of this resource for cooking applications a difficult task. In direct sun, however this is possible using solar concentrators.

Over a global growing concern, on the future of conventional energy resources, solar concentrating collectors became one of the major focuses of research endeavors mainly for large scale Concentrating Solar Power applications, for more details see [7]-[8].

Currently, however there is also a growing concern over energy scarcity in small scale applications as the world witnesses the depletion of the major energy sources for people living in rural areas in developing countries. Thus, in some groups of interest small scale prototypes became a major focus of research aiming to assess their potential to benefit people in rural areas of developing countries, as a source of thermal energy for multiple domestic purposes.

Solar cooking has witnessed improvements in both research and design and deployment. In fact, solar cookers of different configurations have been suggested and some have been applied. However, the more

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widespread solar cooker types allow for direct cooking; in which case collection and cooking are performed simultaneously, for more details see [9]. Normally the cooking pot is placed onto focal point of the concentrator and the person performing cooking is subject to perform it under sun; facing all the potential consequences arising from excessive exposition to solar radiation.

Direct solar cookers can, however, only be used during periods of direct sun shine. Therefore, they have limited usefulness when the sun shine is intermittent due to weather conditions and cannot be used in off-sun conditions.

The intermittency of the sun shine, the risks associated with the reflected radiation and the lack of cultural acceptance, are some of the factors that have limited the use of solar cookers in Mozambique, as discussed by Otte [10].

To overcome some of the limitations of direct solar cookers, a thermal storage is essential in the solar system. Solar heat can then be collected while the sun is available and stored for later use. So, a solar stove with heat storage, which has a potential to enable indirect and off-sun cooking has be proposed.

The proposed system comprises a collector subsystem (parabolic dish solar concentrator-PDSC and absorber), heat storage (HS) and the tracking mechanism.

The collection of solar thermal energy can be done through different configurations. In one of them, the absorber can be a component part of the HS, as it was done by [11]-[12]; in which case the charging is done by direct illumination of the storage [29]. Thus the heat is absorbed at the top part of the HS and conducted through the storage medium; in the other configuration, the absorber and HS are different entities, for details see [13]-[14]-[15]. In the latter case, a heat carrier medium is required to transport the generated heat in both charging and discharging mode.

In many applications, PDSC appears coupled with Stirling engine for electricity production purposes [16]-[17], and some studies on application of PDSC that have thermal energy as an end product for cooking purposes used oil as heat transfer fluid [18]-[19]. Meanwhile common applications of solar collectors using air as HTF are intended for space heating and crop drying [20]. Scarcely are found examples of successful applications of PDSC that use air as heat transfer fluid that are intended for collection of solar thermal energy for cooking purposes.

The performances of the components are interdependent in some way and together they determine the performance of the prototype. However, the performance of the collector subsystem is crucial and can affect the performance of the enter system. If the collector has poor performance, then the storage component becomes meaningless.

To assess the potential of PDSC collector to be used as a component of a solar cooker intended to enable indirect cooking; in this paper its thermal performance is experimentally investigated. The PDSC is coupled with Siliconized Carbide (SiC) honeycomb as absorbing material and air as heat transfer fluid (HTF). The collected heat is stored as sensible heat in a rock-bed HS. The rock-bed is a two phase system comprising a solid material and HTF. During charging mode the HTF enters the storage at high temperature and as it goes through the voids gives up heat to the rocks and emerges at the exit at low temperature. As a consequence the bed temperature rises. To enable the purpose of this paper, outdoor tests were performed at Norwegian University of Science and Technology-Department of Energy and Process Engineering (NTNU-DEPE). The present paper will not include thermal analysis on the storage.

Nomenclature:

A_{ap}	[m^2]	Concentrator aperture area
A_{abs}	[m^2]	Absorber area
C	[..]	Geometric Concentration ratio
I_b	[W/m^2] [..]	Beam radiation Intensity
η_o	[..]	Optical Efficiency
η_{th}		Thermal Efficiency
$\dot{Q}_u$	[W]	Usel heat rate
$\dot{Q}_l$	[W]	Heat loss rate
$\dot{Q}_{abs}$	[W]	Heat rate generated at the absorber surface
$\dot{m}$	[kg/s]	Mass flow rate
U_l	[W/m^2K]	Overall loss coefficient
C_P	[J/kgK]	Specific heat at constant Pressure
F	Indice	Refers to fluid
T_{out}	[K]	Temperature of the air leaving the collector
	[K]	Average temperature at absorber surface

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T_{av}	[K]	Ambient temperature
T_a	[m^2]	Cross-sectional area of the pipe
A	[m/s]	Average air velocity
v_{av}	[kg/m^3]	Density as a function of Temperature
$\rho(T)$	[kg/m.s]	Dynamic viscosity of air
μ		
D	[m]	Hydraulic diameter
v	[m/s]	Air speed through channels

Subscripts

f	Fluid
th	Thermal
out	Leaving the system
av	Average
abs	Relative to absorber
a	Ambient
o	Optical

II. Background Information and Governing Equations

Concentrating solar collectors are optical devices that concentrate low density solar radiation falling on their reflective surface onto a small area (absorber), thus turning the low energy density into high energy density. At the absorber surface, solar radiation is converted into thermal power and, due to high flux of solar radiation falling on it, high temperatures are produced and this effect can be used for different purposes including cooking.

Receivers are an integral part of any solar collector. In the context of PDSC applications, cavity receivers and volumetric receivers are the two types of receivers commonly used [21].

Witness of the relative importance of solar receivers, is the endeavor among researchers that have been focused on receiver modeling, not to name all, see for example [4]- [22] or through experiment [13]- [23]- [24].

Receivers for concentrating collectors should be designed in such a way to intercept as much reflected radiation from the concentrator as possible while at the same time ensuring that radiative heat losses from the receiver are minimized. Therefore, their size is determined by the compromise between intercepted radiation maximization, and heat loss from the receiver minimization to enable maximum power at sufficient temperatures for the intended application [22]. For high temperature applications, solar absorbers should have high temperature stability [16].

Consonant to these requirements, [23] performed experimental investigation of heat losses from a small cavity receiver, using simulated solar heat source and a Synthetic Schlieren technique for flow pattern visualization out of the cavity. In addition to this, numerical modeling of convective heat losses from the receiver through CFD analysis was carried out for positive angles.

In their turn [18] designed, fabricated, studied and compared the performance of three different receivers (Volumetric Flash-VF, Volumetric Box-VB and conical tube-CT) using a PDSC designed to charge the HS. The receivers were designed to use oil as HTF. One of their findings suggested that the CT was appropriate for the concentrator due to its high thermal efficiency compared to the others, for a given flow rate.

Using air as HTF, [13] investigated the thermal performance of two similar flat solar absorbers made of different materials (stainless steel fiber wire mesh and SiC honeycomb) in a small scale PDSC. Their findings point out that HTF temperature and flow rates correlate negatively, while efficiency and flow rates correlate positively. In either case, the stainless steel absorber had a good performance as compared to honeycomb absorber.

Another study on the thermal performance of a point-focus PDSC was done by [25]. A cylindrical receiver intended for hot water or steam generation applications was used. The purpose was to find the optimal operating temperature and the impact of environmental conditions on heat loss mechanisms of the external receiver under windy conditions and in different facing directions of the blackened absorber. Their findings confirmed the well-known strong effects of absorber wall temperature, wind velocity and direction and ambient air temperature on total heat loss from the absorber.

The attainment of high temperatures in solar concentrating collectors is directly connected to the concentration ration of the collector. This notion relates the aperture area of a solar collector with the area of its absorber. Concentrator aperture area A_{ap} is the area of the collector that intercepts solar radiation. The

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concentration ratio C is the ratio between aperture area of the concentrator and the absorber area, A_{abs} :

$$C = \frac{A_{ap}}{A_{abs}} \quad (1)$$

Not all the solar radiation incident onto the concentrator surface is intercepted and captured by the absorber. The optical efficiency η_o is the ratio of the energy absorbed by the absorber to the energy incident on the concentrator surface.

$$\eta_o = \frac{\dot{Q}_{abs}}{A_{ap}.I_b} \quad (2)$$

The ratio between the power incident at the absorber surface and the power received by the concentrator is a function of many factors (e.g. the ability of the tracking mechanism to keep the optical device accurately aligned with the sun, optical properties of the reflective surface and the nature (perfect or imperfect) of the concentrator geometry.

Again, not all the energy absorbed at the absorber surface is converted into useful energy. The high energy density at the absorber surface gives a high temperature. Therefore, temperature gradients between absorber and ambient arise and become a driving force for heat losses; the absorber becomes hotter than the surrounding components and ambient. As such, heat losses may occur in different modes (conductive, convective and radiative). The ability of the absorber to minimize heat losses is connected to thermal efficiency of the absorber. Thermal efficiency of the absorber is given by the following expression:

$$n_{abs} = \frac{\dot{Q}_u}{\dot{Q}_{abs}} \quad (3)$$

This parameter accounts for all types of thermal losses from the surface where heat is generated.

From formula (3), an alternative expression for useful heat can be obtained as follow:

$$\dot{Q}_u = \eta_{abs}\dot{Q}_{abs} = \eta_o\eta_{abs}A_{ap}I_b = \eta_{th}A_{ap}I_b \quad (4)$$

In the expression above $\eta_{th} = \eta_o\eta_{abs}$ is the overall efficiency of the collector for the optical to thermal conversion.

Energy balance equation formulated at the absorber can be written as:

$$\dot{Q}_{abs} = \dot{Q}_u + \dot{Q}_l \quad (5)$$

Where

$$\dot{Q}_u = (\dot{m}.c_P)_f.(T_{out} - T_{in}) \quad (6)$$

$$\dot{Q}_l = A_{abs}.U_l.(T_{av} - T_a) \quad (7)$$

In the above equation U_l is the overall heat loss coefficient. Solving for $\dot{Q}_u$, the following expression is strait forward:

$$\dot{Q}_u = \dot{Q}_{abs} - \dot{Q}_l = \eta_o A_{ap} I_b - A_{abs}U_l(T_{av} - T_a) \quad (8)$$

To characterize the thermal performance of a solar concentrating collector, the concept of thermal efficiency is used. This concept refers to the ratio between useful energy carried by the HTF and the energy falling onto concentrator aperture:

$$\eta_{th} = \frac{\dot{Q}_u}{A_{ap}I_{ap}} = \frac{(\dot{m}c_P)_f(T_{out} - T_{in})}{A_{ap}I_{ap}} = \eta_o - \frac{A_{abs}U_l}{A_{ap}I_{ap}}(T_{av} - T_a)$$

$$\eta_{th} = \eta_o - \frac{U_l}{\frac{A_{ap}}{A_{abs}}I_b}(T_{av} - T_a) = \eta_o - \frac{U_l}{CI_b}(T_{av} - T_a) \quad (9)$$

Assuming all radiation reflected from the concentrator surface reach the absorber surface:

$$\dot{Q}_l = \eta_o A_{ap} I_b - \dot{Q}_u \Leftrightarrow A_{abs}U_l(T_{av} - T_a) = \eta_o A_{ap} I_b - \dot{Q}_u$$

The energy balance enables the computation of U_l as a function of the absorber temperature:

$$U_l = \frac{\eta_o A_{ap} I_b - \dot{Q}_u}{A_{abs}(T_{av} - T_a)} = \frac{\dot{Q}_l}{A_{abs}(T_{av} - T_a)} \quad (10)$$

III. Research Methodology

For the test to take place, a SiC honeycomb absorber 105 x105x105 mm^3 from the Chinese Company Pingxiang Zhongying Packing Co. LTD was delivered at DEPE-NTNU.

A cubic receiver housing with truncated cone terminal was prepared in Department's Lab and the Sic was inserted within the housing, see Fig.1 .In [8], advantages of SiC honeycomb absorber that favor its application in solar industry are outlined; not to name all, high temperature tolerance, thermal shock resistant and also mechanical strength are some of them.

The receiver was then mounted onto parabolic dish concentrator through a support structure that enabled it to have the lower surface to be located at the focal region of the concentrator, see Fig.2.

Then the receiver was connected to an air carrying pipe comprising stiff pipe which in turn was connected to the flexible pipe (made of 3 pieces of corrugated steel flexible pipe connected one after the other). The pipe was intended to carry the heated air from the receiver to the storage.

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To monitor temperatures at the irradiated surface of the absorber and also temperature of the air leaving the absorber, 3 to 4 thermocouples were used. One at the absorber surface, 3 at different positions along the air carrying pipe of which the first was positioned 5 cm above the upper surface of the absorber.

a b c

Figure 1: Showing a) SiC honeycomb absorber, b) Absorber housing and c) The receiver

Then, the absorber housing was covered with one layer of 5 mm Aerogel insulation, followed by a cover of two layers of reflective aluminum film on top. The geometric concentration ratio of the collector is 272.

Table 1: Sic honeycomb properties

Property	Values	Property	Values
Nr channels	17x14	Side wall thickness	1.3 mm
Channel dimension	7.5 mm	Specific surface area	366 m^2/m^3
Wall thickness	1.2 mm	Void (%)	57 %
Specific heat	750 J/kg.k	Thermal Conductivity	50-250 W/m.k

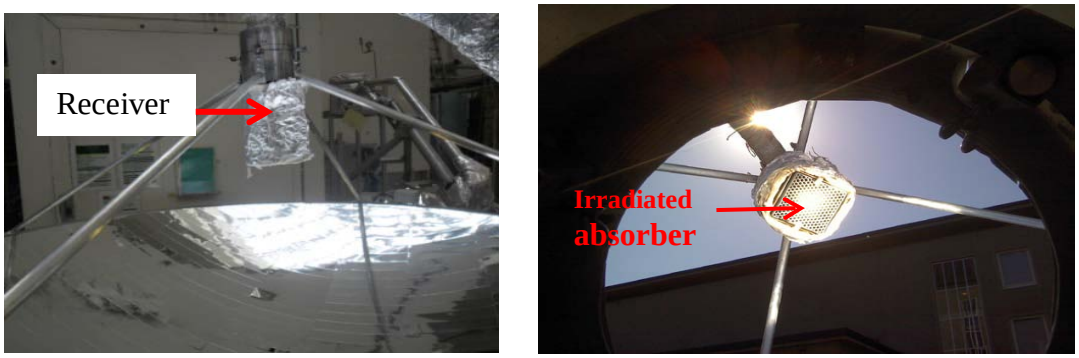

Figure 2: Shows receiver mounted on the setup (left) and irradiated receiver during tests (right)

The forced convection is generated by a fan with speed controller-P.Lemmens from air movement Company Type ESB3 Rev04-010009 connected to the HS outlet. The air speed is measured at fan outlet which has the same diameter as the air carrying pipe. Assuming no air leakage along the pipe and in steady state the air speed at the fan outlet can be used to calculate the air speed along the carrying pipe.

The average air mass flow rate is estimated through the expression (11):

$$\dot{m} = Av_{av}\rho_{av}(T) \qquad (11)$$

In this expression A is the cross sectional area of the pipe, v_{av}, the average air speed (air speeds were measured each 30 min, using a handheld W_M Digital Anemometer DA 4000 and from the data the average was calculated); $\rho_{av}(T)$ the average air density as a function of temperature (taken from tables of thermophysical properties of air).

The mentioned set of thermocouples was then connected to a data logger which in turn is interfaced to a PC through a labview program to log temperatures each second.

The incident beam flux was measured using a pyrheliometer at meteorological station located at the roof of Physics Department building located at the same Campus as the test location.

The following figure shows the setup used during the experiment.

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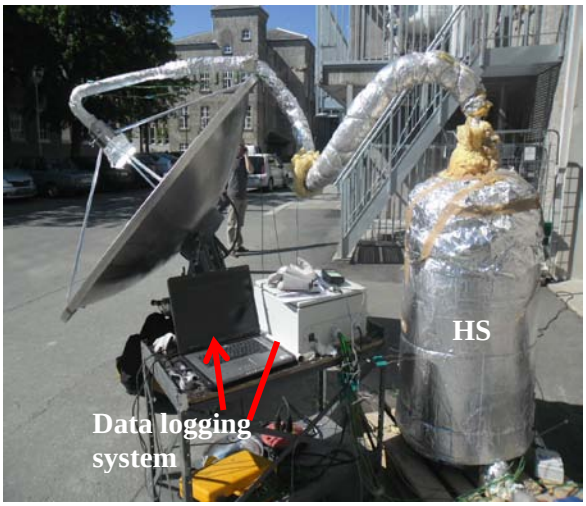

Figure 3 a: Showing the heat storage and data logging system

Figure 3 b: Showing the collector sustem during the test

In the first experiment, run under an average air mass flow rate of 4.4 g/s, only 3 thermocouples were used to monitor temperature of air along the pipe. The thermocouple located at the surface of the absorber had a cupper support to help fix it at the central honeycomb absorber channel. However, due to high flux density the metal was melt and the sensor did not give the readings. So, T_1 is the first thermocouple measuring the temperature of air leaving the collector.

In the second test however, run under an average air mass flow rate of 5.52 g/s, another thermocouple was positioned at the absorber surface. Therefore, T_1 represents reading from that thermocouple, while T_2 is the temperature of air leaving the collector given by the first of 3 thermocouples along the air carrying pipe.

The pressure drop is an important parameter for the collector performance as it is a source for an informed choice of pumping power. With Reynolds number estimated at 725.5, through the small channels of the absorber the flow regime is laminar and the pressure drop can be calculated as in [26] by :

$$\Delta p = \frac{32\mu v \Delta x}{D^2} \tag{12}$$

The power required can be calculated as follow:

$$P = \frac{\dot{m}\Delta p}{\rho(T)} \tag{13}$$

IV. Results and Discussion

Figure 4 shows temperature of air leaving the collector at different points along the pipe and beam intensity at the first test.

As can be seen from fig.4, the air leaves the collector at temperatures above 350°C during the experiment; with even high temperature between 10:19 and 11:34 probably due to high beam radiation intensity registered during this period. The sharp drops in air temperature encounter justification on weather conditions, shading of sun by clouds. This factor can be witnessed by the curve of beam radiation. Other factors are radiation loss due to imperfect focusing and increased convective heat losses.

In most of the cases, the drop in air temperature is not simultaneous with drop in beam radiation intensity. Due to thermal inertia, when beam radiation drops due to passing clouds, the absorber is still hot and hot air is pumped in; only after some time it also drops.

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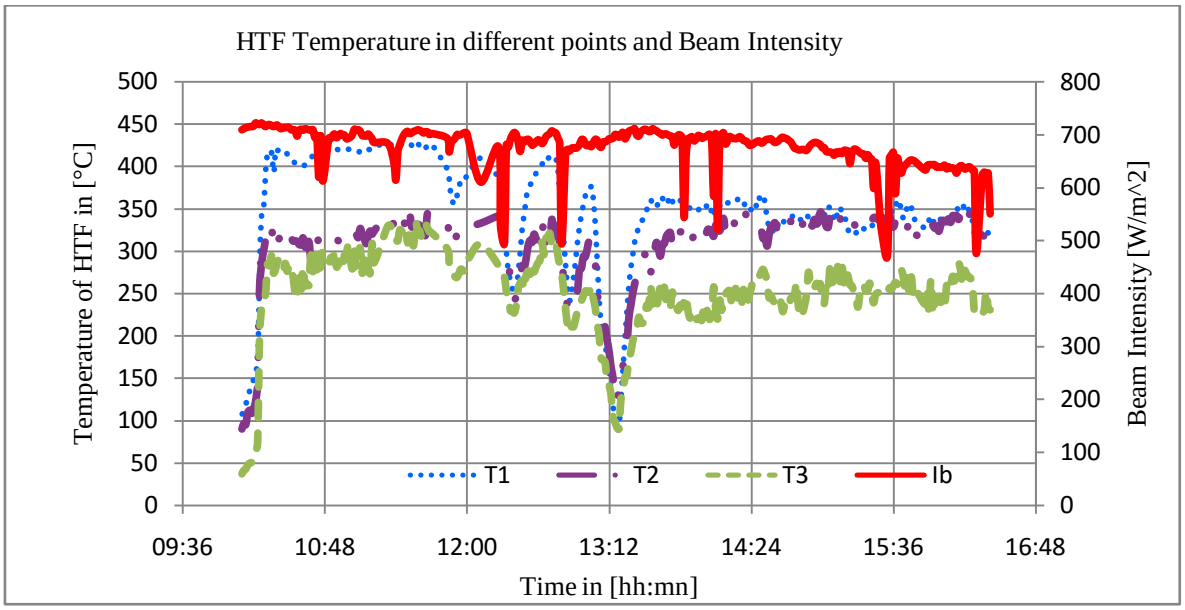

Figure 4: Showing Beam Intensity and temperature profiles of the air leaving the colector in 3 different points along the pipe during 1st experiment (9/7/2014)

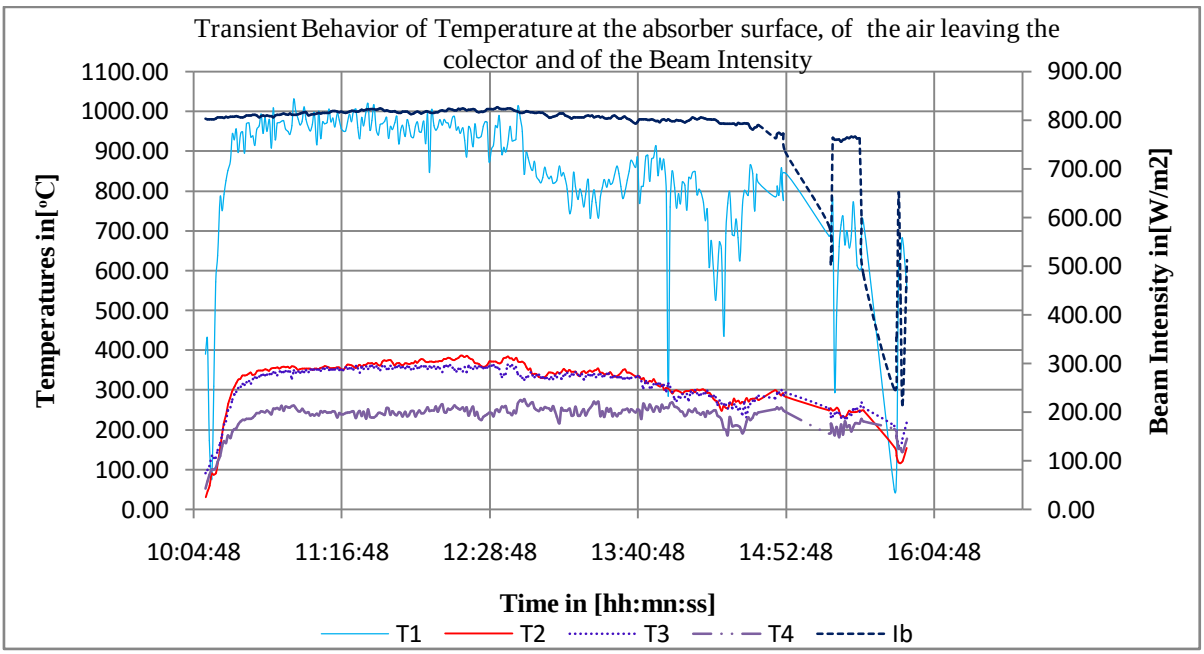

Figure 5: Showing beam radiation intensity, temperature profile at the absorber surface and of the air leaving the collector at 3 different points along the pipe during 11.07.2014 test

In figure.5, the behavior of beam radiation intensity I_b, the temperature at the absorber surface T_1 and the temperature of the air along the air carrying pipe (T_2 to T_4) during second test are compared. The experiment was run under an average air mass flow rate of 5.52 g/s. This mass flow rate is almost 25% higher than the mass flow rate in the first experiment. This increase is mainly due to an increased sucking speed. The immediate consequence of an increased fan speed is less time interaction between the HTF and the absorbing material.

As can be seen from the I_b curve, during the second test, beam intensity remained almost steadily during the major part of the test (from 10:11 hrs to 14:40 hrs), but the temperature at the surface of the absorber surface varied appreciably. These variations can be attributed to radiation loss due to imperfect focusing and convective heat losses. Despite these factors, it can be noted from the readings of the first sensor for air temperature, T_2 that during this period the HTF left the collector at the temperatures above 350°C most of the time.

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Figure 6 shows the behaviors of the beam radiations during the first and second tests. From this chart it can clearly be seen that the weather during the 2nd experiment was good during most of the time as compared to the 1st test. Hence, the beam radiation for the 2nd test remained stable and slightly higher than during the 1st test. However, a comparison between Fig.4 and Fig.5, reveal the effect of an increased air mass flow rate on the temperature of the air leaving the collector. This can be easily seen by the fact that although beam radiation intensity was slightly lower in the first experiment as compared to the same quantity in the second experiment, the temperature of the air leaving the collector is lower in the second experiment.

Although there was a drop on the air temperature leaving the collector during the 2nd test, caused by an increased mass flow rate, in both cases the HTF leaves the collector subsystem at temperatures above 350°C, suitable for cooking and frying purposes.

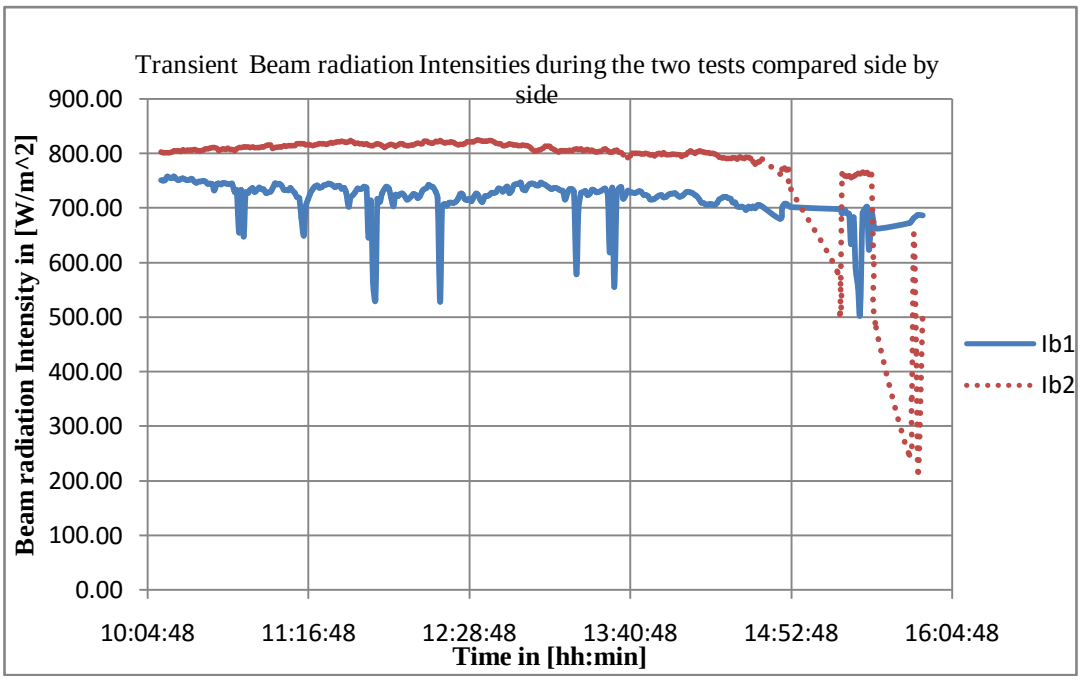

Figure 6: Charts showing the behavior of beam radiation during the 1st (09/07/2014) and 2nd (11/07/2014) tests

In figure 7, the behaviors of solar power input, the useful heat, radiative heat losses and the absorber temperature during the 2nd test are compared.

As can be seen from fig.7 the curve showing the behavior of radiative heat losses throughout the test is similar to the curve of the absorber temperature during the same period, as expected. The higher the absorber surface temperature, the higher the radiative heat losses become.

High temperatures were observed at the absorber surface during the test. From Stephan-Boltzmann law, radiative heat losses become pronounced at temperatures of order of 10^2 degrees. In our case, despite the small absorber area, radiative heat losses are expected to be dominant over other forms of heat losses owing to high temperatures at its surface, as indicated by the curve given by T_1 in figure 5.

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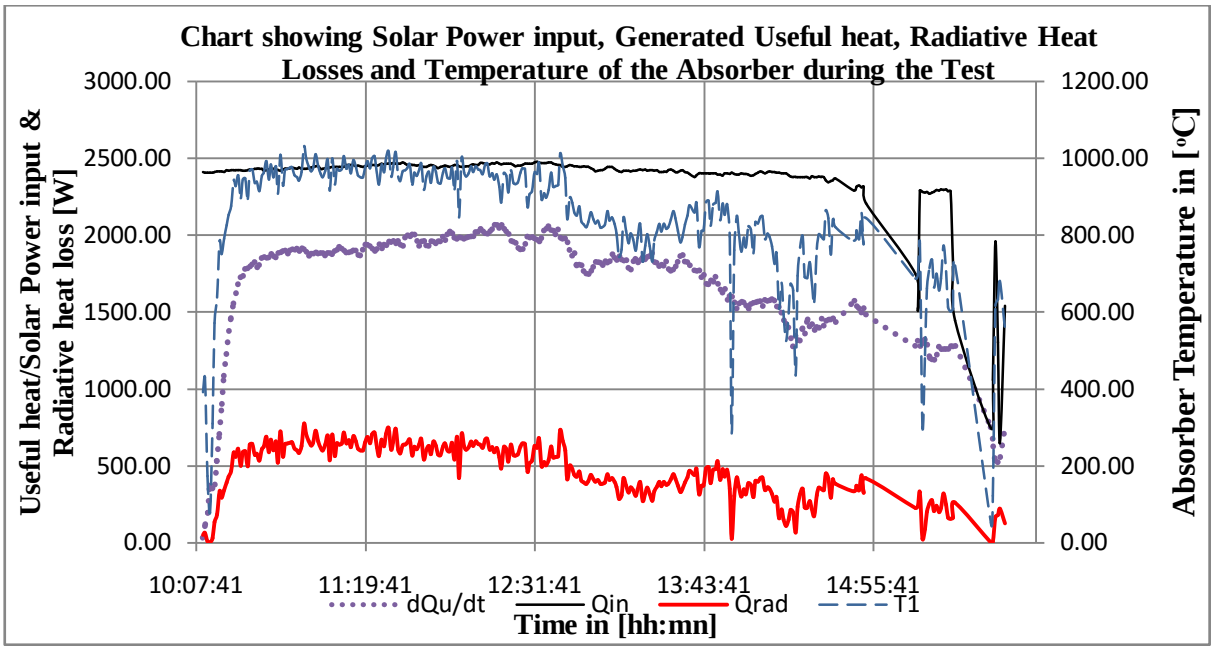

Figure 7: Showing Solar Power input, Useful heat, radiative heat losses and Absorber temperature during the test

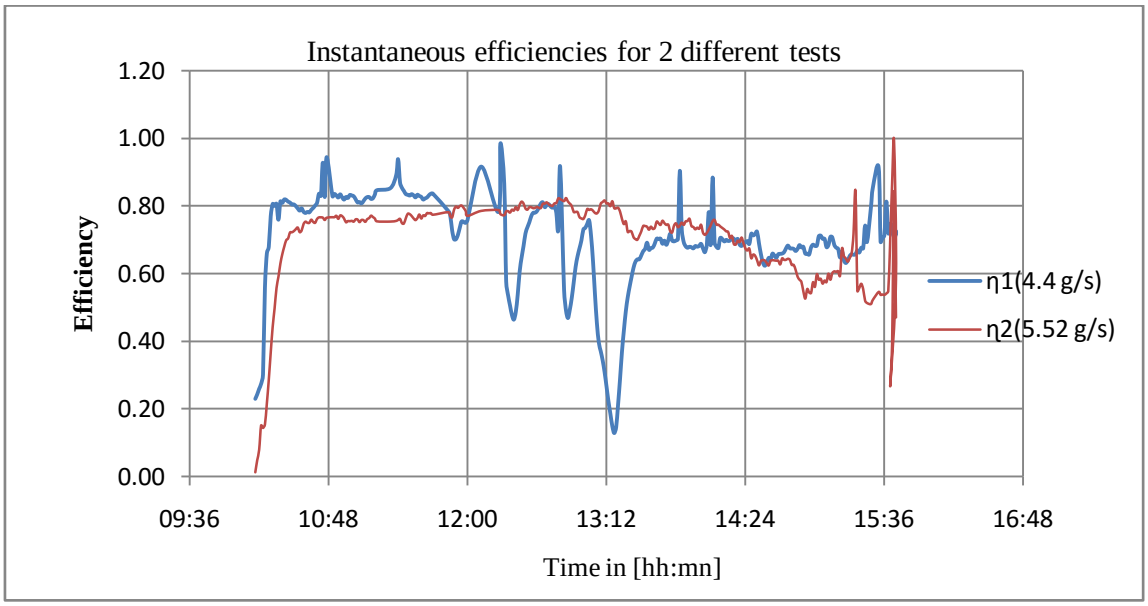

Figure 8: Showing transient instantaneous efficiencies for both tests

In figure 8 the transient behavior of instantaneous efficiencies for two experiments, performed under different mass flow rates, are presented. As can be seen from the chart, the instantaneous curve for the first experiment exhibit sharp increases and sharp drops on the efficiency, while for the second test is stable between 10:15 hrs until 13:00 hrs. The behavior of the instantaneous efficiency reflects the behavior of beam intensity during the experiments, respectively. Sharp increases reflect the consequence of source obstruction by clouds and the phenomenon of thermal inertia of the absorber, as explained before. But sharp drops may reflect loss of radiation due to imperfect focusing as well as an increased wind speed. Both factors lead to a decrease on useful heat carried by the HTF.

The solar heat is absorbed on the receiver surface, pass into the material by conduction and is then transferred to the air flow. Thus, the temperature of the surface is considerably higher than the air exit temperature, dependent on the conductivity of the absorber material and the heat transfer process. A simplified model for heat transfer will be discussed. As the radiation distribution on the receiver was not monitored, constant radiation intensity on the top was assumed. The flow through the receiver is laminar by a clear margin. This means that the heat transfer coefficient h is independent of channel air speed and

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that the pressure drop is given by equation 10. The width between parallel hexagonal channel sides is 5.5 mm and Δx is length. Since μ varies approximately as $T^{2/3}$ in the actual region, v will be depressed in the hot, central region, and mass flow is reduced because of the $\frac{1}{T}$ temperature dependence. Temperature differences may thus be increased during the air heating process. The temperature differences will to a certain degree be reduced by sideways heat conduction in the material, but due to the hexagonal structure, sideways conductivity is about half of the longitudinal one.

Heat transfer SiC – air is calculated assuming the same flow and temperature in all channels. With T_s & T_a representing absolute temperatures in SiC & air; Q_s heat current in SiC, Q_{s0} front surface value, the equations governing the heat transfer with the assumptions mentioned above are given in [27]:

$$Q_s = \Lambda . \frac{dT_s}{dx}, \tag{14}$$

Λ is longitudinal heat conductivity of absorber material times its total cross section. The derivation is relative to distance x from receiver surface.

$$\frac{dQ_s}{dx} = H.(T_s - T_a) \tag{15}$$

Where $H = h.L$, h is heat transfer coefficient and L total inside wall length of channels.

$$Q_{s0} - Q_s = J.(T_a - T_{amb}) \tag{16}$$

Where T_{amb} is ambient temperature, $J = \dot{m}.c_P$ (air mass flow rate times its heat capacity).

By derivations and substitutions these equations can be converted to an equation in the variable part of T_s:

$$\frac{d^2Y}{dx^2} + a.\frac{dY}{dx} - b.Y = 0 \tag{17}$$

Where $Y = T_s - T_{amb} - \frac{Q_{s0}}{J}$, $a = \frac{H}{J}$ and $b = \frac{H}{\Lambda}$

Assuming constant coefficients, the acceptable solution of this equation is

$$Y = Y_o.\exp(-\alpha.x) \tag{18}$$

Where $$\alpha = \frac{\sqrt{a^2 + 4b} + a}{2}$$

A solution to the model in [27] indicated in eqs. (14 to17) is shown in the chart presented in Figure 9. From this chart, the air cooling effect on the receiver with an increased mass flow rate can be noted, with the receiver presenting lower temperatures for the case of higher mass flow rate.

As discussed above, the model is based on a homogeneous heating on the top and the same air flow through all channels. The first condition is not satisfied giving also unequal flow, amplified by the fact that the viscosity of air increases with temperature, giving higher flow through the cooler parts. SiC thermal resistance is temperature dependent, and the curves in Fig. 9 are calculated using data for siliconized SiC given in [28]; 40 W/ (m.K) at 25 °C, 15 W/(m.K) at 630°C.

By using standard models as discussed e.g. in [26], we find α = 46 and 57 m^{-1} at absolute temperature 600 and 1000 K, respectively. This means that the 1/e-length is of the order of 2 cm for the variable Y. A value of 50 W/(m.K) was assumed for the material heat conductivity, probably a too high value. In reality, the coefficients are functions of x through T_a and T_s; thus, we have a nonlinear equation that must be solved numerically. The model should ideally also be extended to include a realistic distribution of the focused solar radiation on the absorber surface.

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The numerical solution to the equation is shown below:

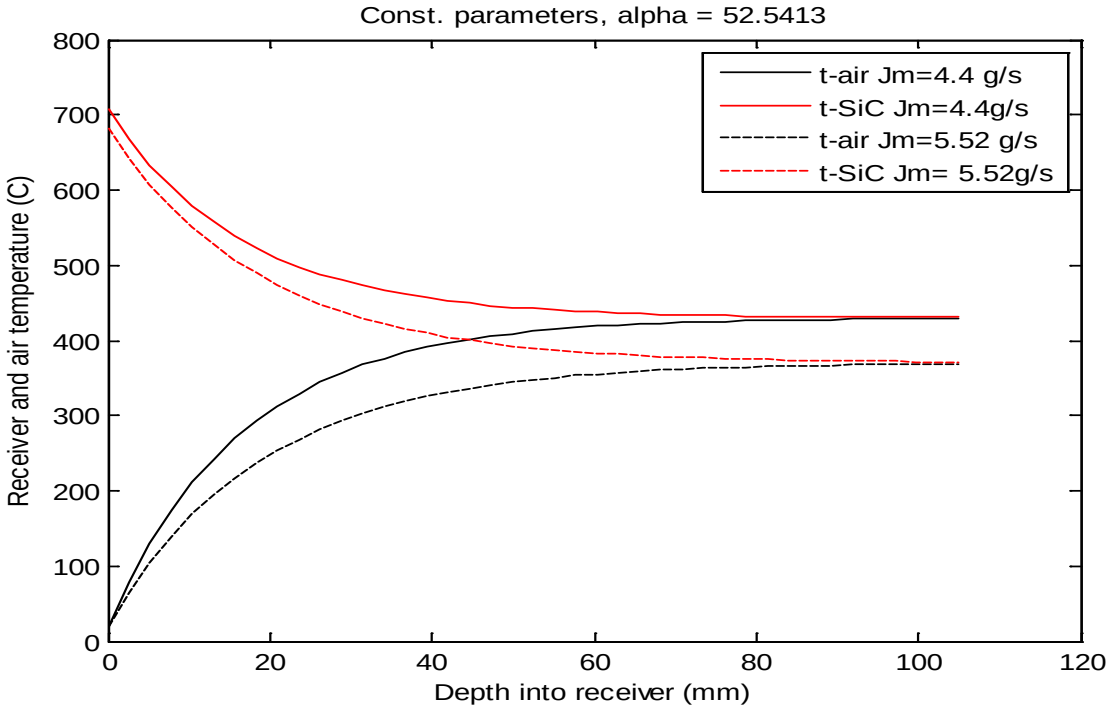

Figure 9: Modeled temperature dependence in air and receiver material to depth of the absorber for the two rates mass flow

The above discussion shows that the absorber should be as narrow as possible, still catching most of the incoming radiation. It should be made of a material with very high heat conductivity to allow transversal temperature equalization and avoid cool air an easy flow in the peripheral channels to mix with the hotter air from the inner ones. Good heat conductivity will also reduce the front temperature. A model should be made to optimize the receiver, both with respect to pumping power and heat loss.

The shape of the present receiver allows easy flow of cool air in the outer parts, and reduces mass flow of hot air in the central part, mixing at the output. This gives higher heat loss and increased pumping power for a given flow and temperature of air output.

It should be noted that for the experiments performed under the two different air mass flow rates, the transient behavior of thermal efficiency indicate a fairly good performance in both cases with the average thermal efficiency around 70 %.

Thus, the efficiencies are about the same which enables the user to choose the relevant temperature optimal for the application by selecting the air flow from the heat conservation. This evidence suggests that, Honeycomb SiC absorber, despite the economic concerns around it as compared to some of its competitor materials, holds a potential to be used as an absorber for PDSC in small scale applications like solar cooker with HS.

In the present study the overall heat loss coefficient was found to be absorber temperature dependent as discussed in [30]. However its average value was found to be around $51.22\ W/m^2K$. The average pressure drop through the receiver was found to be around 330.2 Pa for the first test, which implies a fan power of 4.416 W.

V. Conclusion

Thermal performance of a point focus concentrating solar collector comprising a 2000 mm diameter parabolic dish concentrator covered with reflective aluminum tiles of 0.9 reflectivity and a focal length of 665 mm and SIC honeycomb volumetric absorber, which use atmospheric air as HTF is experimentally investigated. The absorber was tested for two different mass flow rates in order to evaluate its potential as absorber material for solar cooker prototype with HS. The results indicate that the increase in flow rate leads to decrease in the temperature of HTF. Besides, the two flow rates gave a considerable good collector thermal efficiency of around 70%. The results of this study, concerning both high temperatures and efficiency show that an air based solar cooker is possible. However, further tests are required to assure this possibility.

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References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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